The Economic Geography of Global Warming - Readme

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Contents

1 Preliminaries

The code in this replication package constructs the main analysis files for Cruz and Rossi-Hansberg (2023). Analyses are conducted in Stata and MatLab. To generate the results of this paper, run the code as follows:

1. Run temp_downscaling.do.
2. Run fundamentals.m.
3. Run damage_function.do.
4. Run main.m.

The replicator should expect to run the code for about 5 days. It will produce all the figures and tables of the paper, the online appendix and the supplementary materials section. A thorough description of each program and database, and how to run the code is displayed below.

2 Data

2.1 Description of files

A description of the datasets provided in the replication package is presented below. These databases are already stored in the predefined folder *Data*.

- `H0_areal.mat`

  Matrix of 180×360 yielding the density of land per cell (Hastings et al., 1999), where each cell is $1° \times 1°$ and the cell with the largest amount of land has a land density of one.

- `trmult_reduced.mat`

  Matrix of 17048×17048 containing the bilateral trade costs for each cell with positive land. The derivation of this matrix is described in Desmet et al. (2018).

- `geo_data.csv`

  Table containing cell-level data on elevation, roughness, standard deviation of elevation, distance to the coast, distance to the ocean, distance to the water, vegetation density, albedo, share of land covered by ice and type of land (NASA, 2023, 2009; Nordhaus and Chen, 2016; SIO, 1977).

- `global_temp.csv`

  Table containing global-level data on temperature from 1950 to 2019 for every month from the Berkeley Earth Surface Temperature Database (BEST, Rohde and Hausfather, 2020).

- `climatology.csv`

  Table containing cell-level data on monthly climatology from BEST (Rohde and Hausfather, 2020).

- `temp_data.csv`

  Table containing cell-level data on temperature from 1970 to 2017 for every month from BEST (Rohde and Hausfather, 2020).

- `temp_mom_time.csv`

  Table containing cell-level data on the share of agriculture in value from Conte et al. (2021) for the year 2000, and extreme temperature indices from BEST (Rohde and Hausfather, 2020) for the years 1990, 1995, 2000, and 2005.

- `pop_Gecon.mat`

  Matrix of $180 \times 360 \times 4$ containing the cell-level population for the years 1990, 1995, 2000, and 2005 from the G-Econ database (Nordhaus, 2006; Nordhaus and Chen, 2016).

- `wage_Gecon.mat`

  Matrix of $180 \times 360 \times 4$ containing the cell-level production per capita for the years 1990, 1995, 2000, and 2005 from the G-Econ database (Nordhaus, 2006; Nordhaus and Chen, 2016).

- `C.csv`, `D.csv`, and `Africa_map.csv`

  Matrix of 180×360 containing the cell-level indices for countries, the developing and developed world, and Africa and the rest of the world, respectively.

- `CO2_EDGAR.mat`

  Matrix of $180 \times 360 \times 4$ containing the cell-level residential CO_2 emissions for the years 1990, 1995, 2000, and 2005 from Crippa et al. (2019b).

- `CO2_country.csv`

  Matrix of 168×4 containing the country-level CO_2 emissions from fossil fuels for the years 1990, 1995, 2000, and 2005 from Crippa et al. (2019a) and IEA (2019).

- `clean_country.csv`

  Matrix of 168×4 containing the country-level clean energy use for the years 1990, 1995, 2000, and 2005 from BP (2019).

- `HDI_GDPpc.csv`

  Table containing the yearly cell-level Human Development Index from 1990 to 2015 from Kummu et al. (2018).

- `areal.csv`

  Matrix of 180×360 containing the size of each cell (Hastings et al., 1999).

- `subcountry_EU.csv`

  Table containing the cell-level indices of sub-national units when Europe is aggregated at the country-level and into four regions (Eastern, Northern, Western and Southern Europe).

- `CO2_ff.csv`, `CO2_noff_smooth.csv`, and `Forcing_noCO2_smooth.csv`

  Tables of 601×4 containing the global-level CO_2 emissions from fossil fuels, the global-level CO_2 emissions from non fossil fuels and the global-level forcing from non-CO_2 emissions from 2000 to 2600 according to the RCP scenarios 8.5, 6.0, 4.5 and 2.6 (Riahi et al., 2007; Fujino et al., 2006; Yasuaki et al., 2008). The latter two files are smoothed versions of the raw projections.

- `CO2_cost.csv`

  Table containing the global-level relation between the extraction cost and the cumulative CO_2 extraction from Bauer et al. (2017).

- `CO2_hist.csv` and `CO2_hist_ff.csv`

  Tables containing the global-level of CO_2 emissions from 1950 to 1999, as well as their trends, for total emissions and for fossil fuel combustion, respectively (Riahi et al., 2007; Fujino et al., 2006; Yasuaki et al., 2008).

- `clean_energy_hist.csv`

  Table containing the global-level clean energy use from 1965 to 2000 from BP (2019).

- `Forcing_hist.csv`

  Table containing the total forcing from 1825 to 2000 (Riahi et al., 2007; Fujino et al., 2006; Yasuaki et al., 2008).

- `birth_death_pop.csv`

  Table containing yearly country-level data on net natality rates from 1950 to 2020 from UN (2019).

- `pop_uncert.csv`

  Table containing observed data and projections of global-level population from 1950 to 2100, according to the 90% and 80% confidence intervals as well as the median estimates from UN (2019).

- `temp.mat`

  Matrix of size $180 \times 360 \times 51$ containing the cell-level January temperature for the Northern hemisphere and the July temperature for the Southern hemisphere from 1950 to 2000 from BEST (Rohde and Hausfather, 2020).

- `map_grid.mat`

  Matrix of size 2700×5400 denoting the cells with positive land, where the cell size is $0.067° \times 0.067°$ (Hastings et al., 1999).

- `share_agri_grid.csv`

  Matrix of size 180×360 containing the cell-level share of agriculture in value added Conte et al. (2021).

2.2 Data Availability and Provenance Statements

Below we describe the origin, location and accessibility of the primary sources from which the data is obtained.

- Population and GDP: Population and GDP (in Power Purchasing Parities) at $1° \times 1°$ is obtained from the G-Econ 4.0 research project (Nordhaus, 2006; Nordhaus and Chen, 2016). Data can be downloaded from `http://gecon.yale.edu/sites/default/files/files/Gecon40_post_final.xls`. We consider the same 17,048 cells that in 2000 have positive population, GDP and land. If some of these cells display missing values for 1990, 1995 or 2005, we linearly extrapolate the missing data, and, in each period, we cap GDP per capita at the percentile 97.13. A copy of the data is provided as `pop_Gecon.mat` and `wage_Gecon.mat`.

- Human Development Index (HDI): The HDI is obtained from Kummu et al. (2018). Data can be downloaded from `https://datadryad.org/stash/dataset/doi:10.5061/dryad.dk1j0`. This data is presented at a resolution of 5 arc-min, so we aggregate it at a resolution of 60 minutes by considering the mode across cells. A copy of the data is provided as `HDI_GDPpc.csv`.

- Trade costs: The paper uses publicly available replication files from Desmet et al. (2018) to construct the iceberg trade costs. Replication files can be downloaded from `https://doi.org/10.1086/697084`. A copy of the data is provided as `trmult_reduced.mat`.

- Geographical attributes: Elevation data is obtained from SIO (1977). Data can be downloaded from `http://research.jisao.washington.edu/data_sets/elevation/`. To construct the standard deviation and the mean absolute error, also known as *roughness*, within each $1° \times 1°$ cell, we use the aforementioned dataset at a resolution of $0.25° \times 0.25°$ and compute these statistics over the cells with positive land. Distance to the coast is obtained from NASA (2009). Data can be downloaded from `https://oceancolor.gsfc.nasa.gov/docs/distfromcoast/`. We compute the distance in each $1° \times 1°$ cell as the average across the cells of size $0.1° \times 0.1°$. Distance to non-frozen oceans is obtained from the G-Econ 4.0 research project (Nordhaus, 2006; Nordhaus and Chen, 2016). Data can be downloaded from `http://gecon.yale.edu/sites/default/files/files/Gecon40_post_final.xls`. Distance to nearest water body either inland or sealand is obtained from Carrea et al. (2015). Data can be downloaded from `https://catalogue.ceda.ac.uk/uuid/84d4f66b668241328df0c43f8f3b3e16`.

The following data are obtained from the NASA Earth Observations (NASA, 2023) and can be downloaded from https://neo.sci.gsfc.nasa.gov: vegetation density (average over the period 1951-1980), share of ice-covered land (April of 2010); albedo (April of 2010) and land cover (classification considers the year 2010). A copy of the data is provided as geo_data.csv.

- Land density: Land density is obtained from the Global Land One-km Base Elevation (Hastings et al., 1999) Digital Elevation Model. Data can be downloaded from https://www.ngdc.noaa.gov/mgg/topo/globe.html. For each $1° \times 1°$ cell, we compute the share of the $30'' \times 30''$ cells that are on land. Then, since the size of a $1° \times 1°$ cell is larger in the Equator than in the poles, we adjust the land density by the size of each cell, where the size of a cell is calculated with the MatLab function areaquad.m of the Mapping Toolbox, setting the reference sphere to the Earth. Finally, we normalize this measure, so that the cell with the largest amount of land has a land density of one. A copy of the data is provided as H0_areal.mat (land density) and areal.csv (cell size).

- Temperature: Gridded monthly temperature data at a resolution of $1° \times 1°$ are obtained from the Berkeley Earth Surface Temperature (BEST, Rohde and Hausfather, 2020). Data can be downloaded from http://berkeleyearth.org/data-new/. For the cells with missing temperature, we take the simple average temperature across the surrounding cells, that is, we create a block of cells of size 3×3 centered at the cell with missing data. If there are still cells with missing temperature (occurring for small islands), we create a block of cells of size 5×5 centered at the cell with missing data and take the simple average temperature. We continue with this procedure until the cell is filled with temperature data. A copy of the data is provided as global_temp.csv (global-level temperature), climatology.csv (cell-level monthly climatology), temp_data.csv (cell-level monthly temperature), temp.mat (cell-level January-July temperature) and temp_mom_time.csv (extreme temperature indices).

- CO_2 emissions and clean energy at country-level: CO_2 emissions for each country are taken from Crippa et al. (2019a). Data can be downloaded from https://edgar.jrc.ec.europa.eu/overview.php?v=booklet2020. Since Crippa et al. (2019a) considers international marine and international aviation, we split those emissions across countries according to the distribution provided in IEA (2020). As for the use of clean energy, we use information from BP (2019) and define it as the sum of nuclear, hydroelectricity and renewables (wind, solar, among others). Data can be downloaded from https://www.bp.com/en/global/corporate/energy-economics/statistical-review-of-world-energy/downloads.html. Since this database provides information for some aggregate regions, like Other South America and Other Middle East, we partition the energy use of those aggregate regions across countries according to the pattern for CO_2 emissions presented in Crippa et al. (2019a). A copy of the data is provided as CO2_country.csv and clean_country.csv.

- CO_2 emissions and clean energy at $1° \times 1°$: Gridded CO_2 emissions are taken from the Emission Database for Global Atmospheric Research (EDGAR, Crippa et al., 2019b) version 4.0. Data can be downloaded

from https://data.jrc.ec.europa.eu/collection/edgar. We employ the CO_2 distribution from residential emissions and aggregate the resolution from $0.1° \times 0.1°$ to $1° \times 1°$ by summing across cells. Finally, we adjust the country-level value of CO_2 emissions to exactly Crippa et al. (2019a), keeping the same distribution within countries. A copy of the data is provided as `CO2_EDGAR.csv`. As for clean energy, we split the country-level clean energy use using the spatial pattern of Crippa et al. (2019b).

- Projections of non-fuel combustion CO_2 emissions and non-CO_2 forcing: Forecasts of CO_2 flow and forcing for RCP 8.5 and 6.0 are taken from the RCP Database version 2.0 (Riahi et al., 2007; Fujino et al., 2006; Yasuaki et al., 2008). Data can be downloaded from https://tntcat.iiasa.ac.at/RcpDb/dsd?Action=htmlpage&page=welcome. Carbon dioxide from deforestation is considered as *OtherCO2* and non-CO_2 forcing is considered as *Total anthropogenic and natural radiative forcing* minus *CO2 forcing*. We smooth projections of CO_2 from land use and forcing from greenhouses gases different than CO_2 using the `smoothdata.m` function of MatLab considering the moving average and a window of 13. A copy of the data is provided as `CO2_hist.csv` (historical global-level total CO_2 emissions), `CO2_hist_ff.csv` (historical global-level CO_2 emissions from fuel combustion), `CO2_ff.csv` (projected global-level CO_2 emissions from fuel combustion), `CO2_noff_smooth.csv` (projected smoothed global-level CO_2 emissions from land use) and `Forcing_noCO2_smooth.csv` (projected smoothed forcing from greenhouses gases different than CO_2).

- Natality rates: Crude birth rates and crude death rates are taken from UN (2019). Data can be downloaded from https://population.un.org/wpp/Download/Standard/Population/. A copy of the data is provided as `birth_death_pop.csv`.

- Projections of global population: Global population projections are obtained from UN (2019). We consider the medium scenario, as well as 80% and 95% confidence interval-scenarios, which can be downloaded from https://population.un.org/wpp/Download/Standard/Population/. In order to make consistent total population from United Nations and G-Econ in the year 2000, from the former dataset we subtract the total population of the initial period and add the total population of the year 2000 displayed in the G-Econ database. A copy of the data is provided as `pop_uncert.csv`.

- Cost of extracting fossil fuels: The relation between cumulative extraction and cost of extraction is obtained from Bauer et al. (2017). Data can be downloaded from https://www.sciencedirect.com/science/article/pii/S235234091630703X. We choose the scenario SSP5 (development based on fossil fuels), which is the one that closest resembles the RCP 8.5. Then, we aggregate the costs of hard coal and lignite into a single fossil fuel in terms of tCO_2 per usd, considering the conversion factors of 0.0946 and 0.1012 $GtCO_2$ per EJ, respectively. Finally, we rank costs from the least to the most expensive. A copy of the data is provided as `CO2_cost.csv`.

- Share of agriculture in value added: The paper uses publicly available replication files from

Conte et al. (2021) to construct the share of agriculture in value added. Replication files can be downloaded from https://doi.org/10.1093/jeg/lbab008 or https://rossihansberg.economics.uchicago.edu/replication_files/Replication_LSSWW.zip. A copy of the data is provided as share_agri_grid.csv and temp_mom_time.csv .

2.3 Statement about Rights and Summary of Availability

We certify that we, the authors of the manuscript, have legitimate access and permission to use the data used in this manuscript. All data in this replication archive are publicly available.

3 Computational Requirements

3.1 Software Requirements

- Stata (code was last run with version 16.0 on January 23, 2023), with packages:
  - tsegen
  - gtools
  - reghdfe
  - acreg
- MatLab (code was last run with MatLab Release 2021a on January 23, 2023)

3.2 Memory and Runtime Requirements

The code was last run on a 10-core M-1 based Macbook with Mac OS Monterey Version 12.0.1. The full execution of the code takes approximately 5 days.

4 Programs

4.1 List of MatLab running codes

- fundamentals.m
- main.m

4.2 List of MatLab functions called

- initialize.m

- estim_model.m
- migration_costs.m
- model_initial_period.m
- natal_fct.m
- backward_climate.m
- forward_climate.m
- histwc.m
- plots_backward.m
- plots_central.m
- plots_RCP_agg.m
- plots_unc_agg.m
- plots_source_agg.m
- plots_adap_agg.m
- plots_migr_agg.m
- plots_taxsub_agg.m
- plots_temp_var_agg.m
- plots_agri_agg.m
- plots_append_agg.m
- plots_sigma_agg.m
- plots_lbar0_agg.m
- plots_naive.m

4.3 List of Stata do files

- temp_downscaling.do
- damage_function.do

4.4 Instructions to replicators

In order for the code to save the results properly, the replicator must have three folders labelled *Data/derived*, *Maps and Figures* and *Output* in the same folder as `readme_EGGW.pdf`. Note that these folders are already included in the replication package, where they are empty.

4.5 Description of programs

A description of the programs provided in the replication package is presented below. These programs are stored in the predefined folder *Code*.

- temp_downscaling.do

  Estimates the linear down-scaling from global to local temperature, given by the function $g(\cdot)$, as described in Section 3.4 and Online Appendix D.

  - Loads `geo_data.csv`, `global_temp.csv`, `climatology.csv` and `temp_data.csv`.
  - Constructs cell- and global-level temperature anomalies as temperature level minus climatology.
  - Transforms the natural and geographic variables into Chebyshev polynomials.
  - Runs the regression of local temperature anomalies on the Chebyshev polynomial of order 10 of natural features of each cell interacted with the global temperature anomaly.
  - Produces the down-scaling function: `scaler_temp.csv`.

- fundamentals.m

  Computes the cell-level distribution of amenities and productivities, $\bar{b}_t(\cdot), \bar{a}_t(\cdot)$, for the years 1990, 1995, 2000, and 2005 based on population, wages and energy data, following the procedure of Supplementary Materials Section I.2.

  - Loads `trmult_reduced.mat, H0_areal.mat, pop_Gecon.mat, wage_Gecon.mat, C.csv, CO2_EDGAR.mat`, `CO2_country.csv`, `clean_country.csv`, `HDI_GDPpc.csv`.
  - Uses data on population, wages, fossil fuels, and clean energy to compute the amenities-to-utilities and productivity that rationalize the observed data in the years 1990, 1995, 2000, and 2005. And stores them in `amen_util.mat`, `prod.mat` and `realgdp.mat`.
  - Calculates the migration costs that rationalize observed population in the year 2001, and stores them in `m2.mat`.
  - Runs the model forward starting in 1990 up to 2005, retrieves the levels of innovation, and stores them in `prod_model_1990.mat`.
  - Arranges the previously computed data and stores them in `amen_prod.csv`.

- damage_function.do

  Estimates the effect of changes in temperature in fundamental amenities and productivities, given by the functions $\Lambda^b(\cdot), \Lambda^a(\cdot)$, as described in Section 3.2, Online Appendix B and Supplementary Materials Section M.

  - Loads `amen_prod.csv`, `HDI_GDPpc.csv`, `geo_data.csv`, `temp_data.csv`, `temp_mom_time.csv`, and `subcountry_EU.csv`.
  - Runs a regression of cubic HDI on log real income and estimates the wellbeing parameter of the utility function, ψ.
  - Runs a non-parametric regression of amenities and productivities-to-innovation on local temperature, controlling for natural features and sub-national trends.
    * Uncomment line 271 to run non-parametric regressions of population density, wage, and real GDP per capita on local temperature.
    * Uncomment line 273 and 861-959 to run non-parametric regressions of amenities and productivity-to-innovation on different measures of local temperature (e.g., January temperature, temperature for one year, 50 temperature bins, average temperature, extreme temperature index, and share of agriculture in value added) and generate additional tables for temperature variability.
    * Uncomment lines 963-1092 to run regressions with different structure of errors (e.g., spatially correlated errors at 1100km, homoskedastic errors, heteroskedastic errors, and errors clustered at sub-national level) and compare results.
  - Estimates the logistic smoothing of the damage functions and stores them in: `amen_coeff_10y_1h_20b_550d.csv` and `prod_coeff_10y_1h_20b_550d.csv`.

- main.m

  Main script of the model: Loads the required data, estimates the remaining parameters, simulates the model forward in the baseline scenario and each scenario displayed in the paper, creates the figures and tables, and stores the output.

  - Section 0: Employs initialize.m to load the data and generate the global variables of the model.
  - Section 1: Employs estim_model.m to estimate the parameters of the natality rate function, the migration cost function, and the elasticities of energy productivity growth to global real income growth.
  - Section 2: Employs backward_climate.m to simulate the world economy backward in time.
  - Sections 3-12: Employs forward_climate.m to simulate the world economy forward in time in the baseline scenario across different levels and sources of the damage function; degrees of adaptation

in trade, migration, and innovation; border frictions; values of carbon taxes, clean energy subsidies and abatement technologies; sectoral composition of damages; naive estimates of damages; no endogenous population growth; sizes of fuel deposits and elasticities of substitution between energy types; RCP scenarios; and elasticities of utility to real income.

  - Sections 13-27: Employs plots_backward.m, plots_central.m, plots_RCP_agg.m, plots_unc_agg.m, plots_source_agg.m, plots_adap _agg.m, plots_migr_agg.m, plots_taxsub_agg.m, plots_temp_var_agg.m, plots_agri_agg.m, plots_naive.m, plots_lbar0_agg.m, plots_append_agg.m, plots_sigma_agg.m, and plots_lbar0_agg.m to generate the figures and tables of the paper.

- initialize.m

  Function that loads the data and generates the global variables of the model.

  - Inputs:
    - ind_RCP: RCP scenario for CO_2 emissions from non-fossil fuel combustion and forcing from non-CO_2 sources; can take the value of 8.5, 6.0, 4.5 or 2.6; RCP 8.5 is the baseline.
    - maxCO2: total stock of CO_2 available in the ground; 19,500 is the baseline.
    - eps: elasticity of substitution between fossil fuels and clean energy; 1.6 is the baseline.
  - Loads `H0_areal.mat`, `amen_util.mat`, `prod.mat`, `pop_Gecon.mat`, `wage_Gecon.mat`, `share_agri_grid.csv`, `HDI_GDPpc.csv`, `trmult_reduced.mat`, `C.csv`, `D.csv`, `Africa_map.csv`, `CO2_ff.csv`, `CO2_noff_smooth.csv`, `CO2_EDGAR.mat`, `CO2_country.mat`, `clean_country.mat`, `CO2_cost.csv`, `CO2_hist.csv`, `Forcing_noCO2_smooth.csv`, `Forcing_hist.csv`, `temp.mat`, `scaler_temp.csv`, `amen_coeff_10y_1h_20b_550d.csv`, `prod_coeff_10y_1h_20b_550d.csv`, `birth_death_pop.csv`, `pop_uncert.csv`, `clean_energy_hist.csv`, `CO2_hist_ff.csv`, and `map_grid.mat`.
  - Creates all the global variables of the code.

- estim_model.m

  Function that estimates the parameters of the natality rate function, the migration cost function, and the elasticities of energy productivity growth to global real income growth.

  - Inputs:
    - coeff_pop_i: guess for coefficients of the natality rate function.
    - upsilon_fossil_i: guess for the elasticity of fossil fuel productivity growth to global real GDP growth.
    - upsilon_clean_i: guess for the elasticity of clean energy productivity growth to global real GDP growth.

    - ind_dam: level of the damage function, with values from 1 to 9, 9 is the baseline.
    - update_vect: speed of parameters' update.
    - tol_vect: tolerance of errors in the iteration.
  - Calls model_initial_period.m, natal_fct.m, backward_climate.m, forward_climate.m, and migration_costs.m.
  - Uses backward_climate.m to simulate the model backward for 50 periods, given the guesses for the migration cost function and the natality rate function.
  - Updates the parameters of the natality rate function through the Non Linear Least Square procedure described in Supplementary Materials Section K.
  - Uses forward_climate.m to simulate the model forward for 20 periods to update population levels, given the parameters of the natality rate function.
  - Updates the migration cost function using migration_costs.m.
  - Updates the elasticities of fossil fuels and clean energy productivity growth to global real income growth.

- model_initial_period.m

  Function that estimates population, real GDP, and utility of the initial period, consistent with the initial distribution of amenities, productivity and migration cost.

  - Input:
    - m2: migration cost function.
  - Uses equation (69) to solve for $\hat{u}_0(\cdot)$ and retrieves $L_0(\cdot), y_0(\cdot)$ and $u_0(\cdot)$.
  - Outputs:
    - l0, u0, uhat0, realgdp0: solution for population, utility, transformed utility, and real GDP.

- backward_climate.m

  Function that simulates the world economy backward in time, as described in Supplementary Materials Section I.4.

  - Inputs:
    - T: number of periods for which the economy will be simulated.
    - ind_clim: source of damages, a value of 0 indicates no damages, 1 damages on both amenities and productivities, 2 damages only on amenities, and 3 damages only on productivity.

    - ind_dam: level of the damage function, so that a value of 1 (2) indicates the lower (upper) curve of the 95% confidence interval, 3 (4) the lower (upper) curve of the 90% confidence interval, 5 (6) the lower (upper) curve of the 80% confidence interval, 7 (8) the lower (upper) curve of the 60% confidence interval, and 9 the baseline estimate.
  - Constructs $\Lambda^a(\cdot)$ and $\Lambda^b(\cdot)$.
  - Computes $\bar{a}_t(\cdot)$ and $\bar{b}_t(\cdot)$ from equations (2) and (6).
  - Uses equation (85) to solve for $\hat{u}_t(\cdot)$ and retrieves $u_t(\cdot)$ from equation (87).
  - Derives $L_t(\cdot)$ and $y_t(\cdot)$ from equations (3) and (4).
  - Derives $e_t^f(\cdot)$ and $e_t^c(\cdot)$ from equations (47) and (48).
  - Computes L_t, y_t^w and E_t^f and iterates over these variables.
  - Outputs:
    - l, u, prod, realgdp, amen, emiCO2_ff, temp_past_out, price_fossil, clean, price_clean, net_births: cell-level population, utility, productivity, real GDP, amenities, CO_2 emissions from fossil fuel combustion, temperature, fossil fuel price, clean energy use, clean energy price, and net births for T periods.

- forward_climate.m

  Function that simulates the world economy forward in time, as described in Supplementary Materials Section I.1.

  - Inputs:
    - T: number of periods for which the economy will be simulated.
    - ind_clim: source of damages, a value of 0 indicates no damages, 1 damages on both amenities and productivities, 2 damages only on amenities, and 3 damages only on productivity.
    - ind_dam: level of the damage function, so that a value of 1 (2) indicates the lower (upper) curve of the 95% confidence interval, 3 (4) the lower (upper) curve of the 90% confidence interval, 5 (6) the lower (upper) curve of the 80% confidence interval, 7 (8) the lower (upper) curve of the 60% confidence interval, and 9 the baseline estimate.
    - ind_exo: indicator variable so that a value of 0 denotes that CO_2 emissions, temperature and population are endogenously computed and a value of 1 denotes these variables are exogenously taken from the baseline scenario.
    - taxCO2: path of carbon taxes for every cell and period.
    - subclean: path of clean energy subsidies for every cell and period.
    - abat: share of CO_2 emissions abated in every cell and period.

    - val_adap: vector of size 4×1 controlling the cost of trade, migration, innovation, and inverse of migration elasticity.
    - migr_exp: vector of size 2x1 controlling the border costs.
    - ind_agri: indicator variable so that a value of 1 denotes that the damage function takes into account of agriculture share of value added and a value of 0 denotes that the damage function does not.
  - Employs equation (69) to solve for $\hat{u}_t(\cdot)$ and retrieves $u_t(\cdot)$ with equation (70).
  - Derives $L_t(\cdot)$ and $y_t(\cdot)$ from equations (3) and (4).
  - Derives $\phi_t(\cdot)$ from equation (44).
  - Derives $e_t^f(\cdot)$ and $e_t^c(\cdot)$ from equations (47) and (48).
  - Computes y_t^w and E_t^f, and iterates over these variables.
  - Computes $CumCO2_{t+1}, S_{t+1}, F_{t+1}, T_{t+1}$ and $T_{t+1}(\cdot)$ from equations (9), (17) and (34)-(36).
  - Computes $\Lambda^a(\cdot)$ and $\Lambda^b(\cdot)$.
  - Computes $\bar{a}_{t+1}(\cdot)$ and $\bar{b}_{t+1}(\cdot)$ from equations (2) and (6).
  - Computes L_{t+1}.
  - Outputs:
    - l, u, prod, realgdp, amen, emiCO2_ff, emiCO2_total, stockCO2, temp_global, temp_local, price_fossil, clean, price_clean, net_births: cell-level population, utility, productivity, real GDP, amenities, CO_2 emissions from fossil fuel combustion, global CO_2 emissions, global CO_2 stock, global temperature, cell-level temperature, fossil fuel price, clean energy use, clean energy price, and net births for T periods.

- migration_costs.m

  Function that computes the migration cost function matching the population levels, as described in Supplementary Materials Section I.5.

  - Inputs:
    - m2_i: guess for the migration cost function.
    - amen, prod, pop, price_energy: cell-level amenities, productivity, population to be matched, and energy price.
    - tol_m2: tolerance for the error.
  - Uses equation (88) to solve for the migration cost function.
  - Output:

    - m2_f: solution for the migration cost function.

- natal_fct.m

  Function that computes the natality rates, as described in Section 3.3 and Online Appendix C.

  - Inputs:
    - logrealgdp: cell-level logarithm of real GDP.
    - temp: cell-level temperature.
    - logrealgdp_w: logarithm of global-level real GDP.
    - coeff_pop_d: coefficients of the natality rate function.
  - Computes cell-level natality rates according to equations (23), (24), (29) and (31).
  - Output:
    - natal_fct_val: cell-level natality rates.

- plots_backward.m

  Function that generates the maps and figures of the natality function, historical population, and energy use of Section 3 and Supplementary Material Sections I.2 and K.

  - Input:
    - ind_dam: level of the damage function, with values from 1 to 9, 9 is the baseline.
  - Transforms data from vectors to map grids.

- plots_central.m

  Function that generates the maps and figures of Sections 4 and 6, Online Appendix E, and Supplementary Materials Sections J.1, J.2, L.1, N.1, and O.1.

  - Inputs:
    - nbins: number of bins of the histograms.
    - ind_dam: level of the damage function, with values from 1 to 9, 9 is the baseline.
    - ind_type: source of damages, 0 indicates no damages, 1 RCP 8.5 damages on both amenities and productivities, 2 RCP 8.5 damages only on amenities, 3 RCP 8.5 damages only on productivity, 4 RCP 6.0 damages on both amenities and productivities, 5 RCP 8.5 damages by sectoral composition.
    - name_adap_vect: degree of adaptation.
    - taxCO2_val: value of carbon taxes.
    - name_tax_growth: label for the growing rate of the carbon tax.

    - ind_tax_pct: indicator for *ad-valorem* carbon taxes.
    - subclean_val: value of clean energy subsidies.
    - name_abat: level of abatement.
    - eps: elasticity of substitution between fossil fuels and clean energy.
    - maxCO2: total stock of CO_2 available in the ground.
    - beta: discount factor.
    - sigma: elasticity of utility to real income.
    - ind_plot: indicator variable so that when 1 plots all the maps and figures.
  - Transforms data from vectors to map grids.
  - Computes the Present Discounted Value (PDV) of real GDP and welfare.
  - Compares variables relative to the counterfactual scenario.
  - Calls the function histwc.m to create weighted histograms.
  - Outputs:
    - amen_w_ratio, prod_w_ratio, realgdp_w_ratio, util_w_ratio: global amenities, productivity, real GDP and utility relative to the counterfactual scenario, for every period of the simulation.
    - PDV_realgdp_ratio, PDV_util_ratio: cell-level PDV of real GDP and welfare relative to the counterfactual scenario.
    - emiCO2_total_factual, emiCO2_total_counterfact, clean_total_factual, clean_total_counterfact, temp_global_factual, temp_global_counterfact: global CO_2 emissions, temperature and clean energy use in the factual and counterfactual scenarios.
    - BGP_realgdp_w_factual, BGP_realgdp_w_counterfact, BGP_util_w_factual, BGP_util_w_coun terfact: Balanced Growth Path (BGP) growth rate of real GDP and utility in the factual and counterfactual scenarios.
    - lbar_total_factual: global population in the factual scenario.
    - realgdp_w_counterfact: global real GDP in the counterfactual scenario.

- histwc.m

  Function that generates a vector of cumulative weights for data histogram.

  - Inputs:
    - vv, ww: vector of values and weights.
    - nbins: number of bins.
  - Outputs:
    - histw: weighted histogram.

    - vinterval: intervals used.

- plots_RCP_agg.m

  Function that generates the maps and figures of different RCP scenarios of Section 4.

  - Inputs:
    - PDV_realgdp_RCP, PDV_util_RCP: cell-level PDV of real GDP and utility relative to no warming for RCP 6.0 and 8.5.
    - emiCO2_total_RCP, temp_globall_RCP: global CO_2 emissions and temperature for RCP 6.0 and 8.5.
    - beta: discount factor.

- plots_unc_agg.m

  Function that generates the maps and figures of uncertainty of Section 4.4, Online Appendix E and Supplementary Materials Sections L.1, J.1 and J.2.

  - Inputs:
    - realgdp_w_dam, util_w_dam: global real GDP and utility relative to no warming, for every level of the damage function.
    - PDV_realgdp_dam, PDV_util_dam: cell-level PDV of real GDP and welfare relative to no warming, for every level of the damage function.
    - beta: discount factor.
    - name_unc: source of uncertainty: damage function or energy substitution.
  - Generates the kernels for the distribution of PDV real GDP and welfare.

- plots_source_agg.m

  Function that generates the maps and figures of Online Appendix F.

  - Inputs:
    - realgdp_w_source, util_w_source: global real GDP and utility relative to no warming, for every damage source (only amenities, only productivity and both).
    - PDV_realgdp_source, PDV_util_source: cell-level PDV of real GDP and welfare relative to no warming, for every damage source (only amenities, only productivity and both).
    - beta: discount factor.
  - Generates the kernels for the distribution of PDV real GDP and welfare.

- plots_adap_agg.m

  Function that generates the maps and figures of adaptation in trade, migration, and innovation of Section 5, Online Appendices G.1, G.3 and G.4, and Supplementary Materials Section J.3.

  - Inputs:
    - realgdp_w_dam, util_w_dam: global real GDP and utility relative to no warming in the baseline scenario.
    - realgdp_w_adap, util_w_adap: global real GDP and utility relative to no warming, for different degrees of adaptation.
    - lbar_w_dam, lbar_w_adap: global population in the baseline scenario and for different degrees of adaptation.
    - PDV_realgdp_dam, PDV_util_dam: cell-level PDV of real GDP and welfare relative to no warming in the baseline scenario.
    - PDV_realgdp_adap, PDV_util_adap: cell-level PDV of real GDP and welfare relative to no warming, for different degrees of adaptation.
    - names_adap, long_names_adap: labels for adaptation levels.
    - beta: discount factor.
  - Constructs the maps for the difference-in-differences comparison.

- plots_migr_agg.m

  Function that generates the maps and figures of adaptation in migration with border frictions of Section 5.1, Online Appendix G.2 and Supplementary Materials Section J.3.

  - Inputs:
    - realgdp_w_dam, util_w_dam: global real GDP and utility relative to no warming in the baseline scenario.
    - realgdp_w_adap, util_w_adap: global real GDP and utility relative to no warming, for different border frictions.
    - PDV_realgdp_dam, PDV_util_dam: cell-level PDV of real GDP and welfare relative to no warming in the baseline scenario.
    - PDV_realgdp_adap, PDV_util_adap: cell-level PDV of real GDP and welfare relative to no warming, for different border frictions.
    - names_adap, long_names_adap: labels for border frictions.
    - beta: discount factor.
  - Constructs the maps for the difference-in-differences comparison.

- plots_taxsub_agg.m

  Function that generates the maps and figures of carbon taxes, abatement, and clean energy subsidies of Section 6, Online Appendix H and Supplementary Materials Sections J.4, N.2, and O.

  - Inputs:
    - ind_dam: level of the damage function, with values from 1 to 9, 9 is the baseline.
    - emiCO2_total_Warm, temp_global_Warm: climate variables with no environmental policy.
    - emiCO2_total_Warm_tax, temp_global_Warm_tax: climate variables with environmental policy.
    - realgdp_w_Warm_tax_vect, realgdp_w_Warm_tax, util_w_Warm_tax_vect: global real GDP and utility relative to no environmental policy.
    - taxCO2_vect, name_tax_growth, subclean_vect, names_taxes, names_abat: labels for carbon taxes, growth rate of carbon taxes, clean energy subsidies and abatement.
    - ind_tax_pct: indicator for *ad-valorem* tax.

- plots_temp_var_agg.m

  Function that generates the maps of temperature variability of Online Appendix B.2.

  - Inputs:
    - index_vect: vector of thresholds for the extreme temperature index.

- plots_agri_agg.m

  Function that generates the maps and figures of sectoral composition of Online Appendix B.3 and Supplementary Materials Section M.1.

  - Inputs:
    - realgdp_w_agri, util_w_agri: global real GDP and utility relative to no warming with and without differentiated effects by sectoral composition.
    - PDV_realgdp_agri, PDV_util_agri: cell-level PDV of real GDP and utility relative to no warming with differentiated effects by sectoral composition.
    - emiCO2_total_agri, temp_globall_agri: global CO_2 emissions and temperature with and without differentiated effects by sectoral composition.
    - beta: discount factor.

- plots_append_agg.m

  Function that generates the maps and figures for different elasticities of substitution between fossil fuels and clean energy and sizes of carbon deposits of Supplementary Materials Sections L.2 and L.3.

  - Inputs:

    - ind_dam: level of the damage function, with values from 1 to 9, 9 is the baseline.
    - taxCO2_val, subclean_val, names_taxes, names_abat: labels for carbon taxes, clean energy subsidies and abatement.
    - name_app, app_vect, ind_app_bench: labels for values of elasticities of energy substitution or sizes of fossil fuel deposits.
    - realgdp_w_app, util_w_app: global real GDP and utility relative to no warming.
    - PDV_realgdp_app, PDV_util_app: cell-level PDV of rela GDP and utility relative to no warming.
    - emiCO2_total_app, temp_global_app: total CO_2 emissions, temperature and clean energy use.
  - Generates the kernels for the distribution of PDV real GDP and welfare.

- plots_sigma_agg.m

  Function that generates the maps and figures of concavity on the utility function of Supplementary Materials Section L.4.

  - Inputs:
    - util_w_sigma: global utility relative to no warming for every value of sigma.
    - PDV_util_sigma: cell-level PDV of utility relative to no warming for every value of sigma.
    - sigma_vect: vector of elasticities of utility to real income.
    - ind_dam: level of the damage function, with values from 1 to 9, 9 is the baseline.
    - ind_type: source of damages, 0 indicates no damages, 1 RCP 8.5 damages on both amenities and productivities, 2 RCP 8.5 damages only on amenities, 3 RCP 8.5 damages only on productivity, 4 RCP 6.0 damages on both amenities and productivities, 5 RCP 8.5 damages by sectoral composition.
    - beta: discount factor.

- plots_lbar0_agg.m

  Function that generates the maps and figures of no endogenous population growth of Supplementary Materials Section L.5.

  - Inputs:
    - realgdp_w_labor0, util_w_labor0: global real GDP and utility relative to no warming, with and without endogenous population growth.
    - PDV_realgdp_labor0, PDV_util_labor0: cell-level PDV of real GDP and utility relative to no warming, without endogenous population growth.
    - emiCO2_total_labor0, temp_globall_labor0: global CO_2 emissions and temperature with and without endogenous population growth.

        * beta: discount factor.

- plots_naive.m

  Function that generates the maps and figures of the naive estimation of the damage function on endogenous objects of Supplementary Materials Section M.3.

  - Inputs:
    * nbins: number of bins of the histograms.
    * ind_dam: level of the damage function, with values from 1 to 9, 9 is the baseline.
    * ind_type: source of damages, 0 indicates no damages, 1 RCP 8.5 damages on both amenities and productivities, 2 RCP 8.5 damages only on amenities, 3 RCP 8.5 damages only on productivity, 4 RCP 6.0 damages on both amenities and productivities, 5 RCP 8.5 damages by sectoral composition.
    * beta: discount factor.
  - Simulates reallocation of population and losses in real GDP according to the naive specification.

5 Figures and Tables

A description of the process to generate each figure and table is presented below. All the figures of the paper are automatically stored in the predefined folder *Maps and Figures* and all the tables are automatically stored in the predefined folder *Output*.

5.1 Figures

- Figure 1

  Run Section 13 of main.m to produce and store `extraction_cost.png`.

- Figure 2

  Run damage_function.do to produce and store `amen_damage_10y_1h_20b_550d.pdf` and `prod_damage_10y_1h_20b_550d.pdf`.

- Figure 3

  Run Section 13 of main.m to produce and store `natal_fct_realgdp_dots_med.png` and `natal_fct_temp_dots_med.png`.

- Figure 4

  Left panel: Run Section 14 of main.m to produce and store `temp_2000_med.png`.

  Right panel: Run Section 13 of main.m to produce and store `temp_scaler.png`.

- Figures 5-9

  Run Section 14 of main.m to produce and store `emiCO2_RCP.png`, `temp_global_RCP.png`, `amen_2200_med.png`, `prod_2200_med.png`, `pop_2200_med.png`, `pop_med.png`, `PDV_util_med_beta965.png`, `PDV_util_hist_med_beta965.png`, `PDV_util_RCP6.0_med_beta965.png`, `PDV_util_hist_RCP6.0_med_beta965.png`, `cor_welf_inc2000_countries_med_beta965.pdf` and `cor_welf_inc2000_countries_RCP6.0_med_beta965.pdf`.

- Figure 10

  Upper panels: Run section 15 of main.m to produce and store `util_area_dam.png` and `PDV_util_kernel_dam_beta965.png`.

  Lower panels: Run section 16 of main.m to produce and store `util_area_eps.png` and `PDV_util_kernel_eps_beta965.png`.

- Figure 11

  Run section 18 of main.m to produce and store `PDV_util_DiD_Mi1.25_beta965.png` and `util_adap_Mi.png`.

- Figure 12

  Run section 19 of main.m to produce and store `PDV_util_DiD_endBrAfri1.25_beta965.png` and `util_adap_BrAfri.png`.

- Figures 13 and 14

  Run section 20 of main.m to produce and store `emiCO2_med_tax200p_sub0p.png`, `temp_global_med_tax200p_sub0p.png`, `realgdp_med_tax200p_sub0p.png` and `util_med_tax200p_sub0p.png`.

- Figures 15 and 16

  Uncomment lines 436 and 1270-1271 and run Sections 8 and 20 of main.m to produce and store `emiCO2_med_tax50p_3pct_sub0p.png`, `temp_global_med_tax50p_3pct_sub0p.png`, `realgdp_med_tax50p_3pct_sub0p.png` and `util_med_tax50p_3pct_sub0p.png`.

- Figure 17

  Run Section 21 of main.m to produce and store `temp_eti4.png` and `temp_std.png`.

- Figure 18

  Uncomment lines 273 and 861-959 and run damage_function.do to produce and store `amen_damage_final_eti4_10y_1h_20b_550d.pdf` and `prod_damage_final_eti4_10y_1h_20b_550d.pdf`.

- Figures 19, 21 and 22.

  Run Section 22 of main.m to produce and store share_agri_GDP.png, PDV_util_agrimed_beta965.png, PDV_util_hist_agrimed_beta965.png, util_agri.png and realgdp_agri.png.

- Figure 20

  Uncomment lines 273 and 861-959 and run damage_function.do to produce and store amen_damage_agri_10y_1h_20b_550d.pdf and prod_damage_agri_10y_1h_20b_550d.pdf.

- Figures 23 and 24

  Run Section 14 of main.m to produce and store amen_2200_RCP6.0_med.png, prod_2200_RCP6.0_med.png, pop_2200_RCP6.0_med.png and pop_RCP6.0_med.png.

- Figure 25

  Upper panels: Run section 15 of main.m to produce and store util_area_dam_RCP6.0.png and PDV_util_kernel_dam_RCP6.0_beta965.png.

  Lower panels: Run section 16 of main.m to produce and store util_area_eps_RCP6.0.png and PDV_util_kernel_eps_RCP6.0_beta965.png.

- Figures 26-28

  Run section 17 of main.m to produce and store PDV_realgdp_kernel_source_beta965.png, PDV_util_kernel_source_beta965.png, PDV_util_onlyAm_med_beta965.png, PDV_util_onlyPr_med_beta965.png, realgdp_source.png and util_source.png.

- Figures 29, 31 and 32

  Run section 18 of main.m to produce and store PDV_util_DiD_Om0.25_beta965.png, util_adap_Om.png, PDV_util_DiD_Tr2_beta965.png, util_adap_Tr.png, PDV_util_DiD_In0.5_beta965.png and util_adap_In.png.

- Figure 30

  Uncomment lines 355, 1168, 1170, 1187, and run Sections 7 and 19 of main.m to produce and store PDV_util_DiD_endBrDevo2_beta965.png and util_adap_BrDevo.png.

- Figures 33-37

  Run section 20 of main.m to produce and store PDV_util_med_tax200p_sub0p_beta965.png, PDV_util_hist_med_tax200p_sub0p_beta965.png, emiCO2_med_tax200p_sub0p_abat2100_100pp.png, temp_global_med_tax200p_sub0p_abat2100_100pp.png,

realgdp_med_tax200p_sub0p_abat2100_100pp.png, util_med_tax200p_sub0p_abat2100_100pp.png, emiCO2_med_tax0p_sub75p.png, temp_global_med_tax0p_sub75p.png, PDV_util_med_tax0p_sub75p_beta965.png and PDV_util_hist_med_tax0p_sub75p_beta965.png.

- Figure 38

  Left panel: Desmet et al. (2018).

  Right panel: Run Section 13 of main.m to produce and store HDI0.png.

- Figures 39-41

  Run Section 14 of main.m to produce and store temp_2000_med.png, temp_2200_med.png, amen_hist_2200_med.png, prod_hist_2200_med.png, PDV_realgdp_med_beta965.png and PDV_realgdp_hist_med_beta965.png.

- Figure 42

  Upper panels: Run section 15 of main.m to produce and store realgdp_area_dam.png and PDV_realgdp_kernel_dam_beta965.png.

  Lower panels: Run section 16 of main.m to produce and store realgdp_area_eps.png and PDV_realgdp_kernel_eps_beta965.png.

- Figures 43 and 44

  Run Section 14 of main.m to produce and store amen_hist_2200_RCP6.0_med.png, prod_hist_2200_RCP6.0_med.png, PDV_realgdp_RCP6.0_med_beta965.png and PDV_realgdp_hist_RCP6.0_med_beta965.png.

- Figure 45

  Upper panels: Run section 15 of main.m to produce and store realgdp_area_dam_RCP6.0.png and PDV_realgdp_kernel_dam_RCP6.0_beta965.png.

  Lower panels: Run section 16 of main.m to produce and store realgdp_area_eps_RCP6.0.png and PDV_realgdp_kernel_eps_RCP6.0_beta965.png.

- Figures 46, 47, 50 and 51

  Run section 18 of main.m to produce and store PDV_realgdp_DiD_Mi1.25_beta965.png, realgdp_adap_Mi.png, PDV_realgdp_DiD_Om0.25_beta965.png, realgdp_adap_Om.png, PDV_realgdp_DiD_Tr2_beta965.png, realgdp_adap_Tr.png, PDV_realgdp_DiD_In0.5_beta965.png and realgdp_adap_In.png.

- Figure 48

Run section 19 of main.m to produce and store PDV_realgdp_DiD_endBrAfri1.25_beta965.png and realgdp_adap_BrAfri.png.

- Figure 49

  Uncomment lines 355, 1168, 1170, 1187, and run Sections 7 and 19 of main.m to produce and store PDV_realgdp_DiD_endBrDevo2_beta965.png and realgdp_adap_BrDevo.png.

- Figures 52 and 53

  Run section 20 of main.m to produce and store PDV_realgdp_med_tax200p_sub0p_beta965.png, PDV_realgdp_hist_med_tax200p_sub0p_beta965.png, PDV_realgdp_med_tax0p_sub75p_beta965.png and PDV_realgdp_hist_med_tax0p_sub75p_beta965.png.

- Figures 54-58

  Run Section 13 of main.m to produce and store m2_med.png, emiCO2_past_med.png, clean_past_med.png, global_pop_med.png, global_pop_growth_med.png, natal0_data_med.png, natal0_model_med.png, natal_fct_realgdp_scatter_med.png and natal_fct_temp_scatter_med.png.

- Figures 59 and 60

  Uncomment lines 903 and 906 and run Section 14 of main.m to produce and store PDV_util_med_beta969.png, PDV_util_hist_med_beta969.png, PDV_realgdp_med_beta969.png and PDV_realgdp_hist_med_beta969.png.

- Figure 61

  Uncomment line 953 and run Section 15 of main.m to produce and store PDV_realgdp_kernel_dam_beta969.png and PDV_util_kernel_dam_beta969.png.

- Figures 62-69

  Run Section 24 of main.m to produce and store emiCO2_med_eps.png, temp_global_med_eps.png, realgdp_med_eps.png, util_med_eps.png, PDV_util_med_eps.png, kernel_util_med_eps.png, emiCO2_med_tax200p_sub0p_abat2100_100pp_eps.png, temp_global_med_tax200p_sub0p_abat2100_100pp_eps.png, realgdp_med_tax200p_sub0p_abat2100_100pp_eps.png, util_med_tax200p_sub0p_abat2100_100pp_eps.png, PDV_util_med_tax200p_sub0p_eps.png, kernel_util_med_tax200p_sub0p_eps.png, emiCO2_med_tax0p_sub75p_eps.png, temp_global_med_tax0p_sub75p_eps.png, realgdp_med_tax0p_sub75p_eps.png and util_med_tax0p_sub75p_eps.png.

- Figures 70-77

  Run Section 25 of main.m to produce and store extraction_cost_maxCO2.png, extraction_cost_time_maxCO2.png, emiCO2_med_maxCO2.png, temp_global_med_maxCO2.png, realgdp_med_maxCO2.png, util_med_maxCO2.png, PDV_util_med_maxCO2.png, kernel_util_med_maxCO2.png, emiCO2_med_tax200p_sub0p_abat2100_100pp_maxCO2.png, temp_global_med_tax200p_sub0p_abat2100_100pp_maxCO2.png, realgdp_med_tax200p_sub0p_abat2100_100pp_maxCO2.png, util_med_tax200p_sub0p_abat2100_100pp_maxCO2.eps, emiCO2_med_tax0p_sub75p_maxCO2.png, temp_global_med_tax0p_sub75p_maxCO2.png, realgdp_med_tax0p_sub75p_maxCO2.png and util_med_tax0p_sub75p_maxCO2.png.

- Figure 78

  Run Section 26 of main.m to produce and store PDV_util_kernel_sigma_med_beta965.png and util_sigma_med.png.

- Figures 79-81

  Run Section 27 of main.m to produce and store emiCO2_lbar0.png, temp_global_lbar0.png, PDV_util_kernel_lbar0_beta965.png, PDV_realgdp_kernel_lbar0_beta965.png, util_lbar0.png and realgdp_lbar0.png.

- Figure 83

  Run Section 22 of main.m to produce and store PDV_realgdp_agrimed_beta965.png and PDV_realgdp_hist_agrimed_beta965.png.

- Figures 84-87

  Uncomment lines 273 and 861-959 and run damage_function.do to produce and store amen_damage_10y_1m_20b_550d.pdf, prod_damage_10y_1m_20b_550d.pdf, amen_damage_1y_1h_20b_550d.pdf, prod_damage_1y_1h_20b_550d.pdf, amen_damage_10y_1a_20b_550d.pdf, prod_damage_10y_1a_20b_550d.pdf, amen_damage_10y_1h_50b_550d.pdf and prod_damage_10y_1h_50b_550d.pdf.

- Figures 88 (left panel) and 89

  Uncomment line 271 and run damage_function.do to produce and store pop_damage_10y_1h_20b_550d.pdf, wage_damage_10y_1h_20b_550d.pdf and realgdp_damage_10y_1h_20b_550d.pdf.

- Figures 88 (right panel) and 90

  Run Section 23 of main.m to produce and store pop_2200_naive_med.png, PDV_realgdp_naive_med_beta965.png and PDV_realgdp_naive_hist_med_beta965.png.

- Figures 91-93

  Uncomment line 893 and run Section 14 of main.m to produce and store amen_2200_low95.png, prod_2200_low95.png, PDV_util_low95_beta965.png, PDV_util_hist_low95_beta965.png, PDV_realgdp_low95_beta965.png and PDV_realgdp_hist_low95_beta965.png.

- Figure 94

  Uncomment lines 427 and 1249 and run Sections 8 and 20 of main.m to produce and store realgdp_low95_tax200p_sub0p_abat2100_100pp.png and util_low95_tax200p_sub0p_abat2100_100pp.png.

- Figure 95

  Run Section 14 of main.m to produce and store emiCO2_2000_med.png and clean_2000_med.png.

- Figures 96-99

  Uncomment lines 459-581 and 1141-1398 of plots_central.m and run Section 20 of main.m to produce and store log_price_energy.png, price_energy_2001_med_tax200p_sub0p.png, realgdp_2001_med_tax200p_sub0p.png, util_2001_med_tax200p_sub0p.png, realgdp_2100_med_tax200p_sub0p.png, util_2100_med_tax200p_sub0p.png, realgdp_2200_med_tax200p_sub0p.png, util_2200_med_tax200p_sub0p.png.

- Figure 100

  Uncomment line 1438 and run Section 20 of main.m to produce and store realgdp_med_tax200p_sub0p_abat2100_100pp_all.png and util_med_tax200p_sub0p_abat2100_100pp_all.png.

- Figures 101 and 102

  Uncomment lines 434 and 1264-1265 and run Sections 8 and 20 of main.m to produce and store emiCO2_med_tax200p_sub0p_abat2200_100pp.png, temp_global_med_tax200p_sub0p_abat2200_100pp.png, realgdp_med_tax200p_sub0p_abat2200_100pp.png and util_med_tax200p_sub0p_abat2200_100pp.png.

- Figures 103-106

  Uncomment lines 435 and 1267-1268 and run Sections 8 and 20 of main.m to produce and store emiCO2_med_tax31usd_3pct_sub0usd.png, temp_global_med_tax31usd_3pct_sub0usd.png, realgdp_med_tax31usd_3pct_sub0usd.png, util_med_tax31usd_3pct_sub0usd.png, PDV_util_med_tax31usd_sub0usd_3pct_beta965.png, PDV_util_hist_med_tax31usd_sub0usd_3pct_beta965.png,

PDV_realgdp_med_tax31usd_sub0usd_3pct_beta965.png and PDV_realgdp_hist_med_tax31usd_sub0usd_3pct_beta965.png.

5.2 Tables

- Tables 1 and 2

  Run section 20 of main.m to produce and store table_med_tax200p_sub0p.csv and table_med_tax200p_sub0p_abat2100_100pp.csv.

- Table 4

  Uncomment lines 273 and 861-959 and run damage_function.do to produce and store reg_downscale_eti_std.tex.

- Table 5

  Run section 20 of main.m to produce and store table_med_tax0p_sub75p.csv.

- Table 6

  Run damage_function.do to produce and store utility_parameter.

- Tables 7-9

  Run Section 24 of main.m to produce and store table_eps_med_tax200p_sub0p.csv, table_eps_med_tax200p_sub0p_abat2100_100pp.csv and table_eps_med_tax0p_sub75p.csv.

- Tables 10-12

  Run Section 25 of main.m to produce and store table_maxCO2_med_tax200p_sub0p.csv, table_maxCO2_med_tax200p_sub0p_abat2100_100pp.csv and table_maxCO2_med_tax0p_sub75p.csv.

- Tables 13 and 14

  Uncomment lines 273 and 861-959 and run damage_function.do to produce and store amen_temp_vari.csv and prod_temp_vari.csv.

- Tables 15 and 16

  Uncomment lines 963-1092 and run damage_function.do to produce and store amen_se_robustness.csv and prod_se_robustness.csv.

- Tables 17-19

  Uncomment lines 427 and 1249 and run Sections 8 and 20 of main.m to produce and store table_low95_tax200p_sub0p.csv, table_low95_tax200p_sub0p_abat2100_100pp.csv and table_low95_tax0p_sub75p.csv.

- Tables 20-22

  Uncomment lines 433 and 1261-1262 and run Sections 8 and 20 of main.m to produce and store `table_PDV_realgdp_med_tax200p_sub75p.csv`, `table_PDV_util_med_tax200p_sub75p.csv` and `table_BGP_med_tax200p_sub75p.csv`.

- Table 23

  Uncomment line 1438 and run Section 20 of main.m to produce and store `table_med_tax200p_sub0p_abat2100_100pp_all.csv`.

- Table 24

  Uncomment lines 434 and 1264-1265 and run Sections 8 and 20 of main.m to produce and store `table_med_tax200p_sub0p_abat2200_100pp.csv`.

- Table 25

  Uncomment lines 435 and 1267-1268 and run Sections 8 and 20 of main.m to produce and store `table_med_tax31usd_3pct_sub0usd.csv`.

References

Bauer, N., Hilaire, J., Brecha, R. J., Edmonds, J., Jiang, K., Kriegler, E., Rogner, H.-H., and Sferra, F. (2017). Data on fossil fuel availability for shared socioeconomic pathways. *Data in Brief*, 10:44 – 46.

BP (2019). Bp statistical review of world energy.

Carrea, L., Embury, O., and Merchant, C. J. (2015). Datasets related to in-land water for limnology and remote sensing applications: distance-to-land, distance-to-water, water-body identifier and lake-centre co-ordinates. *Geoscience Data Journal*, 2(2):83–97.

Conte, B., Desmet, K., Nagy, D. K., and Rossi-Hansberg, E. (2021). Local sectoral specialization in a warming world. *Journal of Economic Geography*, 21(4):493–530.

Crippa, M., Oreggioni, G., Guizzardi, D., Muntean, M., Schaaf, E., Lo Vullo, E., Solazzo, E., Monforti-Ferrario, F., Olivier, J. G., and Vignati, E. (2019a). Fossil co2 and ghg emissions of all world countries. *Publication Office of the European Union: Luxemburg*.

Crippa, M., Solazzo, E., Huang, G., Guizzardi, D., Koffi, E., Muntean, M., Schieberle, C., Friedrich, R., and Janssens-Maenhout, G. (2019b). High resolution temporal profiles in the emissions database for global atmospheric research (edgar). *Nature Scientific Data*.

Desmet, K., Nagy, D., and Rossi-Hansberg, E. (2018). The geography of development. *Journal of Political Economy*, 126(3):903–983.

Fujino, J., Nair, R., Kainuma, M., Masui, T., and Matsuoka, Y. (2006). Multi-gas mitigation analysis on stabilization scenarios using aim global model. *The Energy Journal*, 27:343–353.

Hastings, D. A., Dunbar, P. K., Elphingstone, G. M., Bootz, M., Murakami, H., Maruyama, H., Masaharu, H., Holland, P., Payne, J., Bryant, N. A., Logan, T. L., Muller, J.-P., Schreier, G., and MacDonald, J. S. (1999). The global land one-kilometer base elevation (globe) digital elevation model, version 1.0. *National Oceanic and Atmospheric Administration*.

IEA (2019). *World Energy Outlook 2019*. IEA, Paris.

IEA (2020). Co2 emissions from fuel combustion. Technical report. Database Documentation.

Kummu, M., Taka, M., and Guillaume, J. (2018). Gridded global datasets for gross domestic product and human development index over 1990–2015. *Scientific Data*, 5:180004.

NASA (2009). Nasa ocean biology processing group: Distance to the nearest coast.

NASA (2023). Nasa earth observation.

Nordhaus, W. (2006). Geography and macroeconomics: New data and new findings. *Proceedings of the National Academy of Sciences*, 103(10):3510–3517.

Nordhaus, W. and Chen, X. (2016). Global gridded geographically based economic data (g-econ), version 4. *NASA Socioeconomic Data and Applications Center (SEDAC)*.

Riahi, K., Gruebler, A., and N., N. (2007). Scenarios of long-term socio-economic and environmental development under climate stabilization. *Technological Forecasting and Social Change*, 74:887–935.

Rohde, R. A. and Hausfather, Z. (2020). The berkeley earth land/ocean temperature record. *Earth System Science Data*, 12(4):3469–3479.

SIO (1977). Archive of geosample data and information from the scripps institution of oceanography geological collections. *NOAA National Centers for Environmental Information*.

UN (2019). *World Population Prospects 2019: Data Booklet*.

Yasuaki, H., Matsuoka, Y., Nishimoto, H., Masui, T., and Kainuma, M. (2008). Global ghg emissions scenarios under ghg concentration stabilization targets. *Journal of Global Environmental Engineering*, 13:97–108.