

README

Reproducibility package for Assessing the Macroeconomic Impacts of Stochastic Climate Shocks in Paraguay

Overview

The reproducibility package contains the codes, data and instructions to reproduce the results presented in the paper titled “Assessing the Macroeconomic Impacts of Stochastic Climate Shocks in Paraguay”.

This package will import exceedance curve data for a variety of climate shocks (crops, agriculture, heatwaves and flooding) in Paraguay under different climate change scenarios. These are then incorporated into a workfile containing the World Bank MMod for Paraguay, with drought dynamics incorporated. Using this data, it will run 999 Monte Carlo simulations for each climate shock (and combined shocks) and each climate scenario, and extract confidence intervals of the resultant economic impacts to produce fan charts of possible future outcomes for the Paraguayan economy.

This package will also produce the IRF charts contained in the paper to demonstrate the dynamics of the MMod for Paraguay using the example of a 1-in-100-year drought.

Instructions

Run program **0_construct_shocks.prg**. This will:

1. Open the Paraguay MMod file **PRYMOD.wf1**.
2. Import exceedance curve data from the spreadsheet **PRY_CDFS.xlsx** and construct Monte Carlo climate shocks for crops, livestock and heatwaves. (using subroutines from the **subroutines.prg** file)
3. Import exceedance curve data from the spreadsheet **GAR15_flooding.xlsx** and construct Monte Carlo climate shocks for flooding.
4. Save this model file as **PRY_shocks.wf1**.

Next, run the program **0_run_shocks.prg**. This will:

1. Open the model solution with drought dynamics incorporated **PRYSOLN_drought.wf1**.
2. Copy over the climate shocks generated in the previous step from **PRY_shocks.wf1**.
3. Loop through 999 iterations of each type of climate shock, for each RCP scenario and store the results.
4. Construct fan charts showing confidence intervals for results within the 999 model iterations for each climate shocks.

5. Save charts to the Paper folder.
6. Save workfile as **PRYSOLN_climateresults.wf1**.

To construct the IRFs for a 1-in-100-year drought, run **0_droughts_irfs.prg**. This will:

1. Open the model solution with drought dynamics incorporated **PRYSOLN_drought.wf1**.
2. Shock crops and livestock production in line with a 1-in-100-year drought.
3. Produce charts of the resultant economic impacts.
4. Save charts to the Paper folder.

Folder structure

The main folder contains all EViews programs, and subfolders for storing data, models and results charts.

0_construct_shocks.prg

0_drought_irfs.prg

0_run_shocks.prg

subroutines.prg

Data

--- IEC

--- GAR15_flooding.xlsx

--- PRY_CDFS.xlsx

Models

--- PRYMOD.wf1

--- PRY_shocks.wf1

--- PRYSOLN_drought.wf1

--- PRYSOLN_climateresults.wf1

Paper

--- All chart files saved in here.

Data Availability (full data availability)

Figure 1: Disaggregated GDP data by sector for Paraguay is available here:

<https://www.bcp.gov.py/web/institucional/serie-historica-del-pib-base-2014>. The data was downloaded on March 1, 2025 and is updated on a yearly basis by the central bank of Paraguay. The data is publicly available and free to download.

Figures 3 and 4 are publicly available here:

<https://climateknowledgeportal.worldbank.org/country/paraguay/climate-data-projections>. This page presents climate projection data for Paraguay, which is modeled data from the global climate model compilations of the Coupled Model Inter-comparison

Projects (CMIPs), overseen by the [World Climate Research Program](#). Data presented is [CMIP6](#), derived from the Sixth phase of the CMIPs. The CMIPs form the data foundation of the IPCC Assessment Reports. CMIP6 supports the [IPCC's Sixth Assessment Report](#). Data is presented at a 0.25° x 0.25° (25km x 25km) resolution. The data is publicly available and free to download.

Figures 5 and 6: Shows exceedance curve data on crop production, livestock production and heatwaves in Paraguay. These were produced by the IEC, a consulting group contracted by the World Bank to produce this analysis. The raw data is proprietary; the processed data can be found in the Excel sheet PRY_CDFS.xlsx.

Figure 7: Shows a global exceedance curve data on flooding, which was drawn from the GAR15 dataset, which is referenced in the paper and publicly available here: <https://www.undrr.org/publication/global-assessment-report-disaster-risk-reduction-2015>

All other results in the paper can be produced using the programs described in the [Instructions](#) section, and can be found in the Paper folder.

Exhibit name	Output file	Program for production
Figure 9	Drought_graphs1.png	0_drought_irfs.prg
Figure 10	Drought_graphs2.png	
Figure 11	_graphs_cr_av.png	0_run_shocks.prg
Figure 12	_graphs_lv_av.png	
Figure 13	_graphs_drought_av.png	
Figure 14	_compare_drought_average.png	
Figure 15	_graphs_heat_av.png	
Figure 16	_compare_heat_average.png	
Figure 17	_graphs_flood_2.png	
Figure 18	_graphs_comb_av.png	
Figure 19	_compare_comb_av.png	

Requirements

Software License: A valid EViews license is required to run the code provided in this repository. Please ensure that you have access to a licensed version of EViews before attempting to reproduce the results. The results in this paper were produced using EViews 13 Enterprise Edition.

Paper exhibits were reproduced in a computer with the following specifications:

- OS: Windows 11 Enterprise
- Processor: Intel(R) Core(TM) i5-1145G7 CPU @ 2.60GHz
- Memory available: 15.7 GB
- Software version: EViews 13 Enterprise Edition - May 7 2024 build

Excel File	Sheet	Description	Source	Access date	Notes
GAR15_flooding.xlsx	Flood Data	This sheet contains the exceedance curves showing the impact of floods of varying levels of severity (probability of 1 in a 200, 400, 600...1600 year period) on capital stock in Paraguay.	The sheet contains data from flood hazards that is publicly available from the United Nations Global Assessment Report on Disaster Risk Reduction (UNDRR, GAR 2015). The flood hazard maps are publicly available at https://risk.preventionweb.net/	1-Aug-24	The probable maximum losses from flood events over different return periods, highlighted in yellow, were extracted from the flood hazard maps (see https://www.preventionweb.net/english/hyogo/gar/2015/en/gar-pdf/Annex1-GAR_Global_Risk_Assessment_Data_methodology_and_usage.pdf for the methodology). The data was originally extracted for the World Bank Group (2017) publication, "Unbreakable", and provided to the authors by the WBG Climate Change team. The authors scaled up the baseline estimates following Myhre et al. (2019) to estimate damages in varying scenarios of climate change.
GAR15_flooding.xlsx	Temp ranges	Historical and projected temperatures for Paraguay, which is modeled data from the global climate model compilations of the Coupled Model Inter-comparison Projects (CMIPs), overseen by the World Climate Research Program. Data presented is derived from the Sixth phase of the CMIPs.	The CMIP6 data is publicly available for download at https://climateknowledgeportal.worldbank.org/country/paraguay/climate-data-projections	1-Aug-24	
PRY_CDFS.xlsx	Livestock	Contains livestock yield impacts across the no climate change reference ("all hindcast") and the top (highest yields) and bottom (lowest yields) 10 GCM runs in terms of average impacts	The sheet contains processed data; raw data is proprietary to Industrial Economics: Industrial Economics	1-Nov-24	Damages from climate change (differences between the columns) are calculated in sheet "LV".

Processed Data

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This dataset
contains

processed

impact

estimates

produced by

Industrial

Economics,

including

rainfed crop

yield impacts

and labor

productivity

impacts for

agriculture,

industry, and

services. The

results are

provided for a

no-climate-

change

reference

scenario (“all

hindcast”) and

			for the top and bottom 10 global climate model (GCM) runs based on average impacts. The raw underlying data is proprietary to Industrial Economics and cannot be shared. Only the processed outputs supplied by the authors are included in the reproducibility package.		
PRY_CDFS.xlsx	Crops	Contains rainfed crop yield impacts across the no climate change reference ("all hindcast") and the top (highest yields) and bottom (lowest yields) 10 GCM runs in terms of average impacts	The sheet contains processed data; raw data is proprietary to Industrial Economics: Industrial Economics Processed Data <i>Contact:</i> Diego Castillo (dcastillo@indecon.com), Brent Boehlert (bboehlert@indecon.com).	1-Nov-24	Damages from climate change (differences between the columns) are calculated in sheet "CR".

			Heather Ruberl, formerly at the World Bank, can be reached at heather.ruberl@gmail.com .		
PRY_CDF S.xlsx	Agriculture	Contains agriculture labor productivity impacts across the no climate change reference ("all hindcast") and the top (highest yields) and bottom (lowest yields) 10 GCM runs in terms of average impacts	The sheet contains processed data; raw data is proprietary to Industrial Economics Industrial Economics Processed Data <i>Contact:</i> Diego Castillo (dcastillo@indecon.com), Brent Boehlert (bboehlert@indecon.com). Heather Ruberl, formerly at the World Bank, can be reached at heather.ruberl@gmail.com .	30-Nov-24	Damages from climate change (differences between the columns) are calculated in sheet "Hagr".
PRY_CDF S.xlsx	Industry	Contains industry labor productivity impacts across the no climate change reference ("all hindcast") and the top (highest yields) and bottom (lowest yields) 10 GCM runs in terms of average impacts	The sheet contains processed data; raw data is proprietary to Industrial Economics Industrial Economics Processed Data	30-Nov-24	Damages from climate change (differences between the columns) are calculated in sheet "Hind".

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PRY_CDFS.xlsx	Services	Contains services labor productivity impacts across the no climate change reference ("all hindcast") and the top (highest yields) and bottom (lowest yields) 10 GCM runs in terms of average impacts	The sheet contains processed data; raw data is proprietary to Industrial Economics Industrial Economics Processed Data Contact: Diego Castillo (dcastillo@indecon.com), Brent Boehlert (bboehlert@indecon.com). Heather Ruberl, formerly at the World Bank, can be reached at heather.ruberl@gmail.com.	30-Nov-24	Damages from climate change (differences between the columns) are calculated in sheet "Hsrv".