Climate change and income inequality. An empirical analysis

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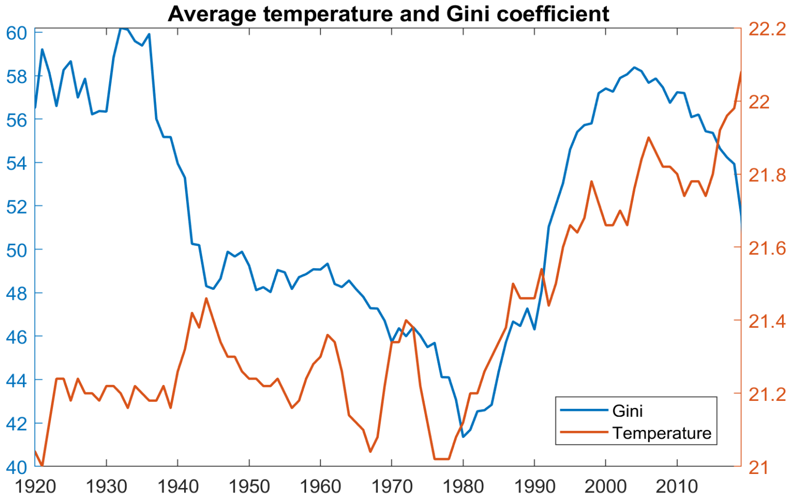
Introduction

- The notion that climate change affects economic performance has been widely researched.
- Combined scientific techniques (IAMs) estimate the social cost and damage functions by CO_2 emissions.
- IAMs predict global warming in a range of 3°–5°C, by 2100 if policy inaction to CO_2 emissions.
- For example, the 2016 IAM DICE model predicts a fall in global output by 2% and 8% to a global warming of $3C^0$ and $6C^0$ respectively. (Nordhaus, 2019)
    - Significant climate effects on the level of national output and growth rates through channels of transmission (e.g. economic development and structure, political stability, energy, geography, etc.)
- How does climate change affect the way income is distributed among the households within a country?
- *Does it affect inequality?*

Global Income Gini Coefficient and Temperature



1980 - 2020: $\rho = 0.56^{***}$

Related Literature

- Large number of studies examining the relationship between climate change and economic performance. No study on distributional income effects and inequality.
    - The literature is vast: We exclude IAMs, studies on the short run effects and extreme weather events.
- Surveys: Tol (2009) and Dell, Jones and Olken (2014). The summary of papers reviewd commonly agree to a loss of output in EMEs while there is more controversy on the developed economies (e.g. Europe, Former Soviet Union countries, and South Asia).

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    - Khan et al (2021) find that a persistent increase in average global temperature by 0.04°C per year reduces world real GDPpc by more than 7% by 2100 in the absence of mitigation policies, while abiding by the Paris Agreement reduces the loss to 1%.

Summary

- We collect annual *climate data* (temperature and precipitation), *real GDP pc* and *inequality measures* (Gini, P10th ,P50th and P90th) for 153 countries and the longest periods available for each country.
- To estimate the impact of climate shocks on inequality, we use a *Panel VAR*.
- We identify the climate shock as the one which explains the highest variation of the climate variables in very low frequencies.
- Our findings indicate a rise of the inequality measures to a climate shock.The 10th percentile of income is mostly affected.
- We investigate channels of transmission (income, temperature/location, agriculture, energy).

Data

- Our panel data-set covers 153 countries.
- The annual time-series are unbalanced. The longest time span covers the period 1901-2020. The shortest is restricted to be at least 20 years.
- Climate variables: Temperature and Precipitation from Climatic Research Unit gridded Time Series (CRU TS) dataset by the UK's National Centre for Atmospheric Science (UEA)
  - Country-level aggregation based on area rather than population weights.
- Real GDP per capita from Jordà-Schularick-Taylor data set and World Bank's World Development Indicators.
- Inequality: Gini coefficient of pre-tax national income from World Inequality Database (WID) and the log income of P10, P50 and P90 and their ratios.

Empirical Model

- We estimate the following panel VAR model:

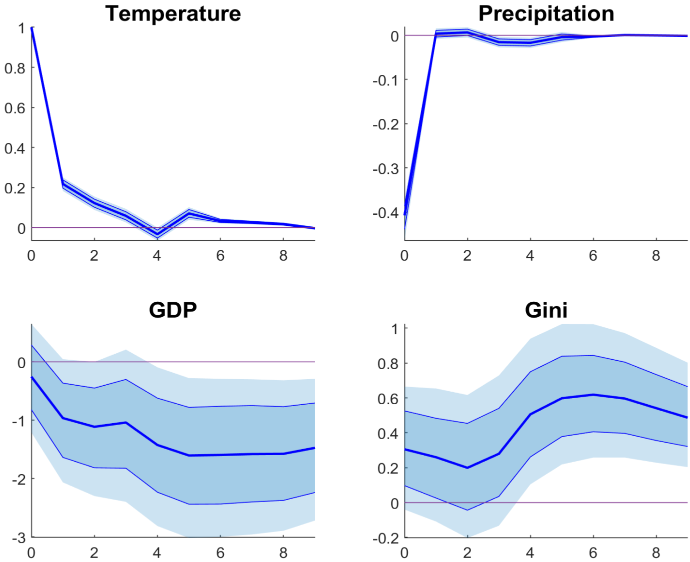
$$Y_{it} = \alpha_i + r_j + \tau_t + \sum_{p=1}^{P} B_p Y_{it-p} + v_{it}$$

- Y_{it} includes temperature, precipitation, GDP per capita and the Gini Coefficient
- We include country (α_i), region (r_j) and time (τ_t) fixed effects.
- $P = 5$ on the basis of SIC.
- 5 lags ameliorate the effects of lag truncation as we are interested in the LR (see Jordà, Singh, and Taylor, 2020)
- We use a (loose) Minnesota Prior and approximate the posterior distribution using MCMC

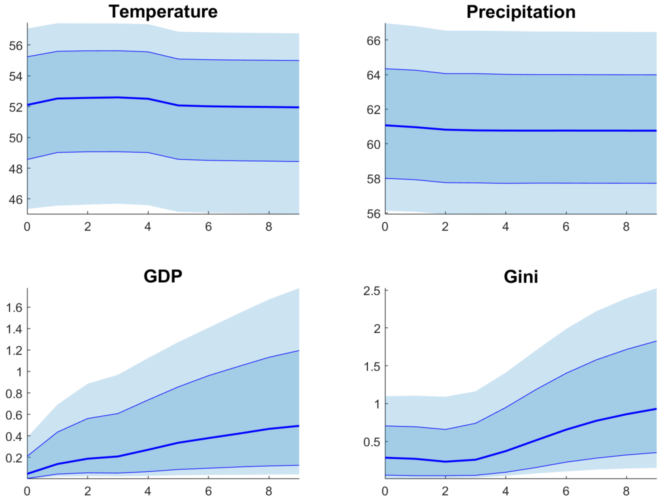
Identification of climate shocks

- Climate change is a gradual process - global average surface temperature has increased by about 1 degrees in 100 years
- Our aim is to identify shocks that drive the low frequency movements in climate variables.
- We use the scheme of Angeletos, Collard and Dellas 2020 that places restriction on the variance of endogenous variables.
- The VAR implied spectral density for Y_{it} can be used to isolate the variance in the LR (cycles greater than 20 years).
- The climate shock is identified as the innovation that explains the bulk of the variance of temperature and precipitation in the LR.

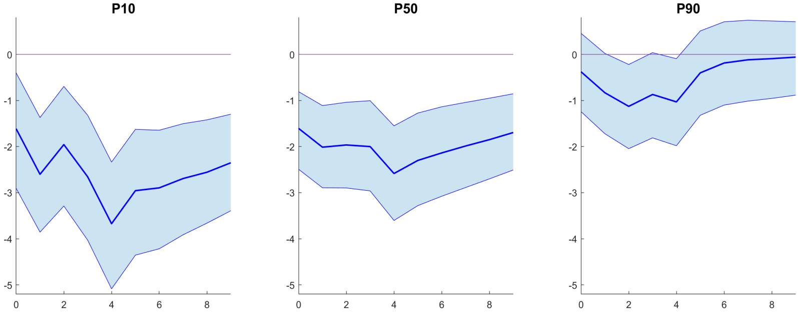
Benchmark: Impulse Responses to climate shock



Contribution of climate shock to forecast error variance



Heterogeneous responses to climate shock



- The pre-tax income of the 10^{th} percentile suffers the highest drop.

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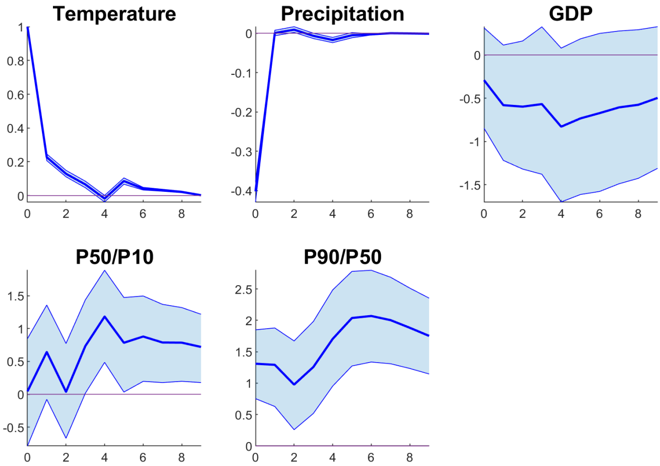
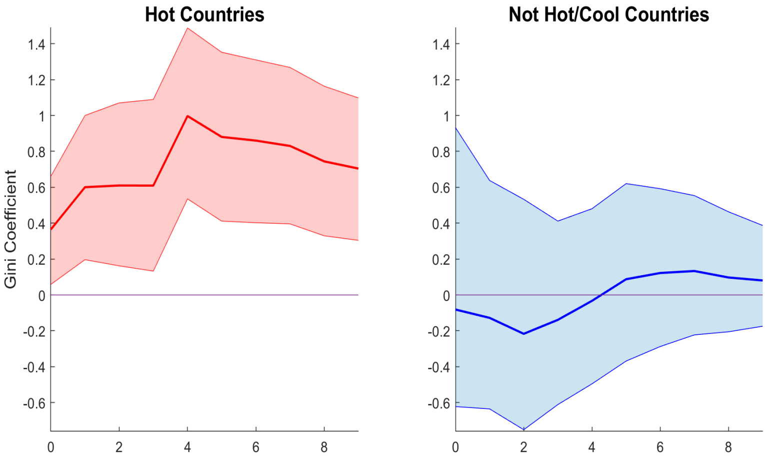


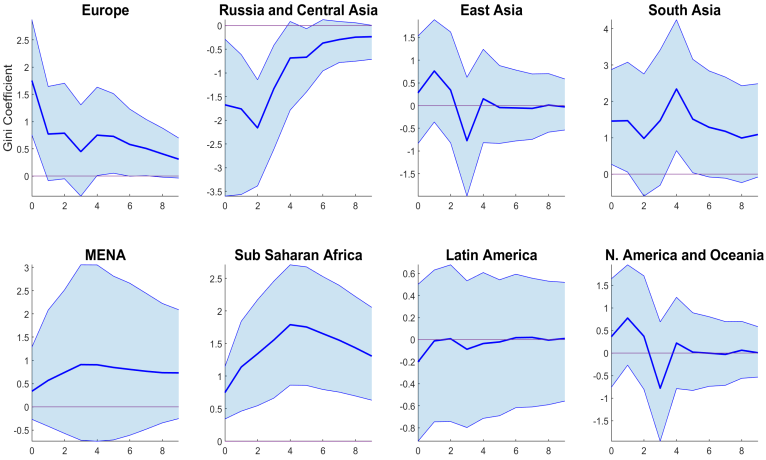
- However, the largest rise in inequality is observed in the right tail of the income distribution

Channels of transmission: Temperature

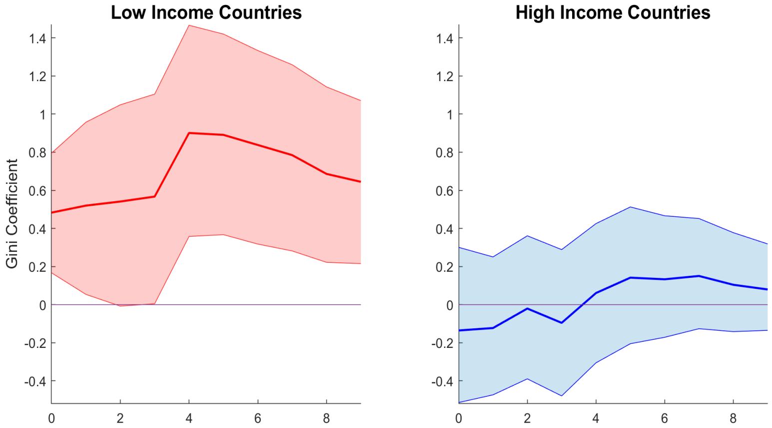


- Hot countries: temperature > median temperature for all countries = 21.3^{O}C in 1950-1960.

Channels of transmission: Geographic regions

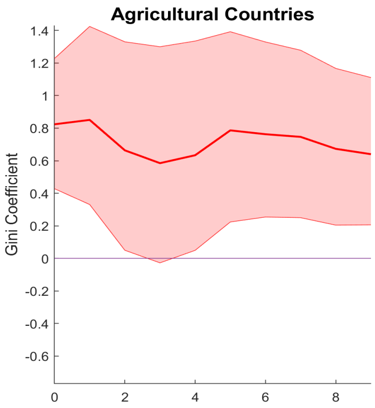


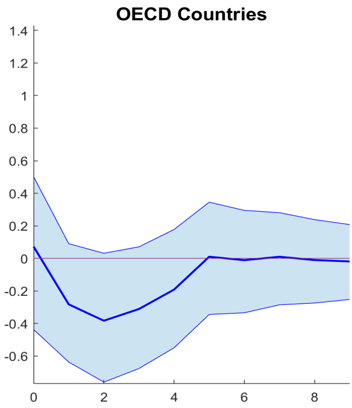
Channels of transmission: Income



- Low income countries: GNI pc < $1,045 in 2020.(World Bank)
- High income countries GNI pc > $12,696 in 2020

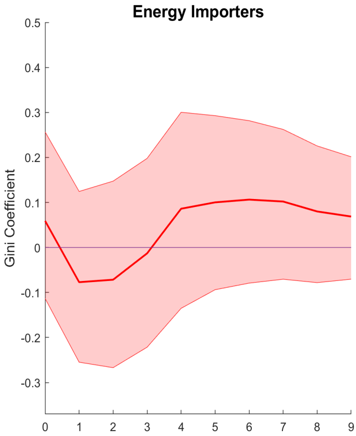
Channels of transmission: Agriculture





- Agricultural countries: share of agriculture to GDP>70% of the sample (20.53%) in 1995.

Channels of transmission: Energy balance



- Energy importers: Net energy imports as % of energy use > 0 in 2000 and on average

Robustness

1. Data: Climate data aggregated on the basis of population and inequality data from SWID (shorter series)
2. Identification: Results are similar if shock is identified as innovation that can affect level of temperature in the long-run (Blanchard Quah)
3. Specification:
    - Results are robust to shorter and longer lags (2 and 8)
    - Results are robust to transformation of data (growth rates)
4. Model:
    - Long-run in the frequency domain as corresponding to cycles greater than 10 years.
    - Panel local projection

- **Result:** the Gini coefficient increases in all cases.

Conclusions

- We examine the impact of climate change on income inequality.
- Shocks are identified as those that explain most of the variance of temperature and precipitation at long run frequencies.
- Our findings indicate that a climate shock which increases temperature by 1^{o}C is associated with an increase in the Gini coefficient by 0.63 percent after about 5 years and persists for longer.
- A stronger effect is found on low income, hot on average and agricultural economies.
- In contrast, the impact on high income, cooler on average, industrialised economies close to zero.
- Our findings also suggest that the shock has a heterogeneous impact across the income distribution affecting more low income households.