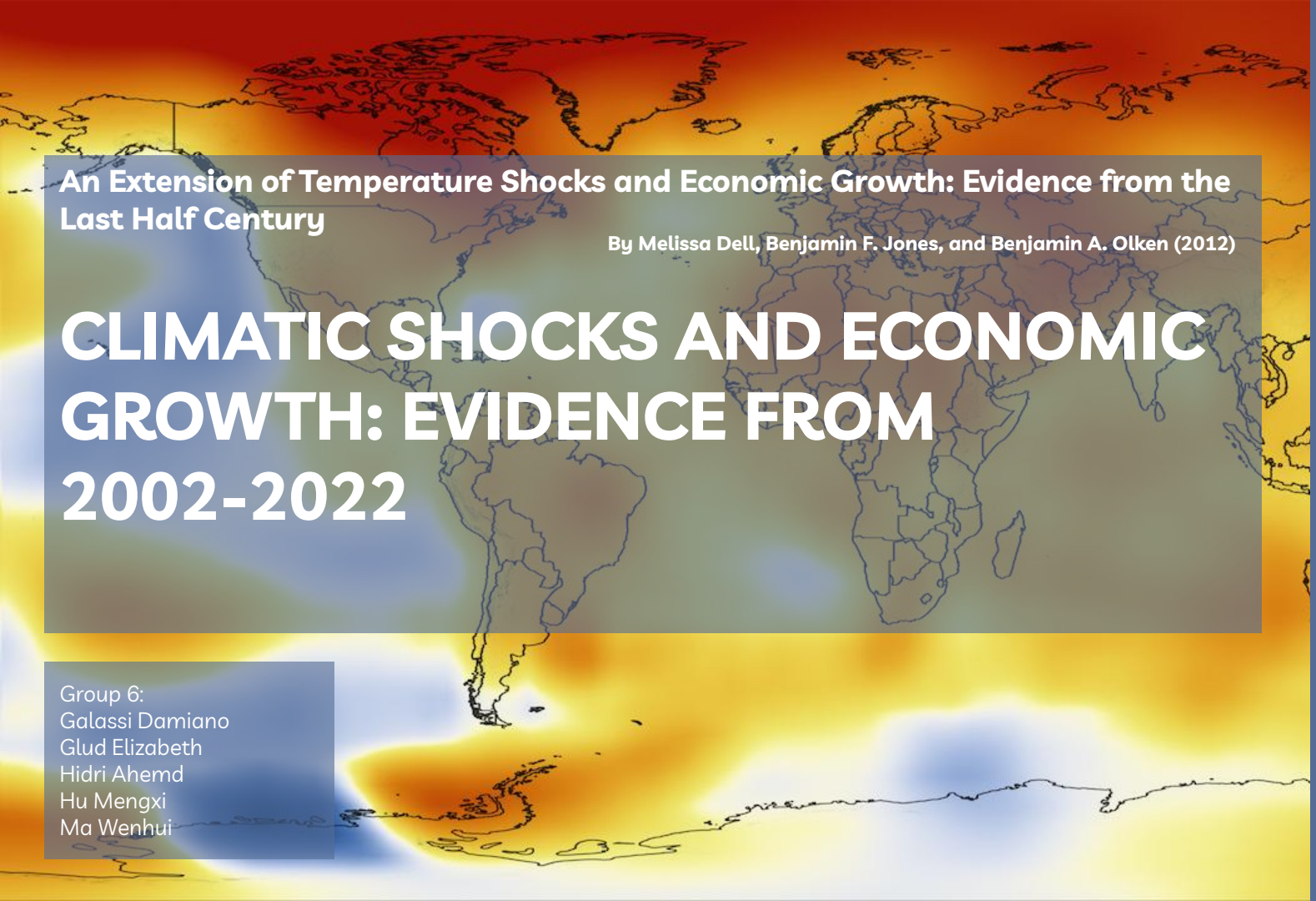

An Extension of Temperature Shocks and Economic Growth: Evidence from the Last Half Century

By Melissa Dell, Benjamin F. Jones, and Benjamin A. Olken (2012)

CLIMATIC SHOCKS AND ECONOMIC GROWTH: EVIDENCE FROM 2002-2022

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REPLICATION

01

Introduction

Research Question

How does temperature affect national economic development, and what are the implications for future global warming?

Data

- GDP: Panel dataset covering 125 countries, each with at least 20 years of data (1950-2003) from the World Development Indicators (WDI).
- Weather: Monthly gridded terrestrial air temperature and precipitation data spanning 1900–2006, sourced from a high-resolution time series.

Methodology

The study employs a dynamic fixed effects panel regression to estimate the impact of temperature on economic growth. The main specification regresses annual GDP per capita growth on current and lagged values of temperature, allowing for both immediate (level) and persistent (growth) effects.

Main Results

Table 2—Main Panel Results

Dependent variable is the annual growth rate	Temperature × Poor	Temperature × Poor, control precipitation
Temperature effect in poor countries	−1.394***	−1.347***
	(0.408)	(0.408)

Table 3—Models with Lags

	No lags	1 lag	5 lags	10 lags
Sum of all temp. coeff. in poor countries	−1.394***	−1.096***	−1.235**	−1.171*
	(0.408)	(0.418)	(0.527)	(0.611)

Table 5—Components of Output Growth

Temperature	Growth in agriculture value added	Growth in industrial value added	Change in political stability
Temperature effect in poor countries	−2.666***	−2.036**	0.027*
	(0.948)	(0.878)	(0.015)

EXTENSION

02

Motivation & Research Question

Climate change is increasingly affecting global economic dynamics

Why Study Temperature and Economic Growth?

Earlier research (e.g., Dell, Jones & Olken, 2012) showed:

- Increasing temperature reduces economic growth, mainly in poor countries.
- Effects go beyond immediate shocks—potentially impact long-run growth.
- Impacts spread across agriculture, industry, and political stability.

What's new in this study?

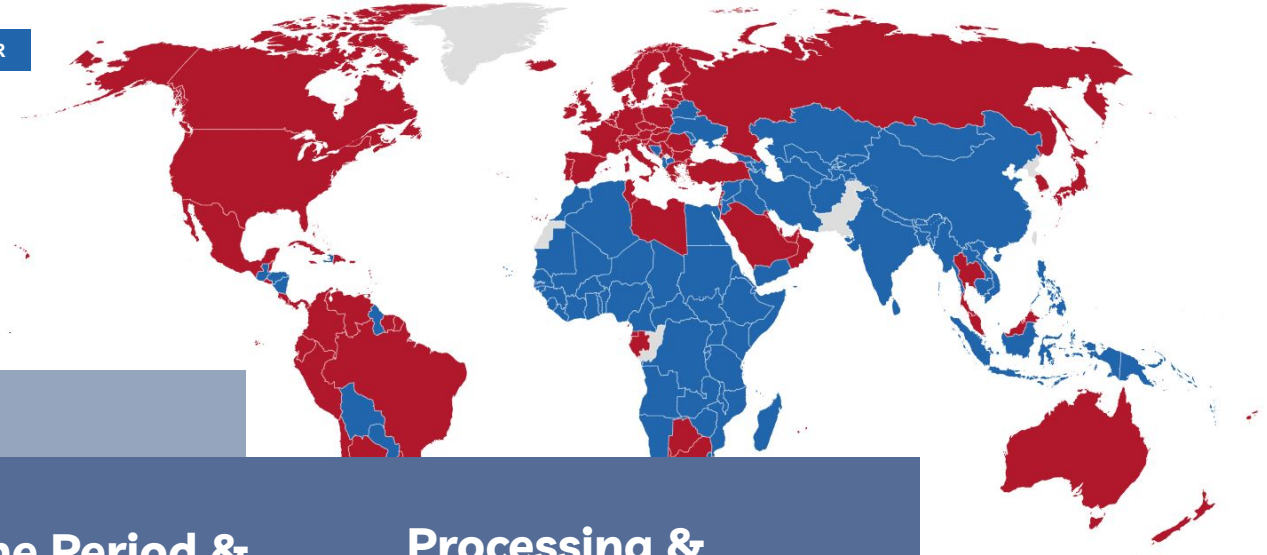
Extends analysis to the **2002–2022 period**, reflecting recent conditions. By exploring:

- **Persistence over time**
- **Non-linear effects**
- **Regional and income-based difference**

Do climate shocks still significantly affect GDP growth in the modern era, and are poor countries still more vulnerable?

Data & Sample Overview

RICH POOR



LINK FOR DYNAMIC MAP

Data Sources

Three starting **datasets** matched by country, yea and region:
- **Temperature and Precipitation** data from ERA5 via GlobalDataLab
- **GDP growth** from World Bank

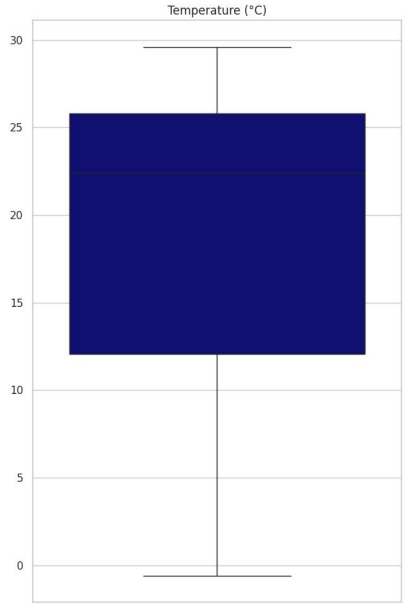
Time Period & Coverage

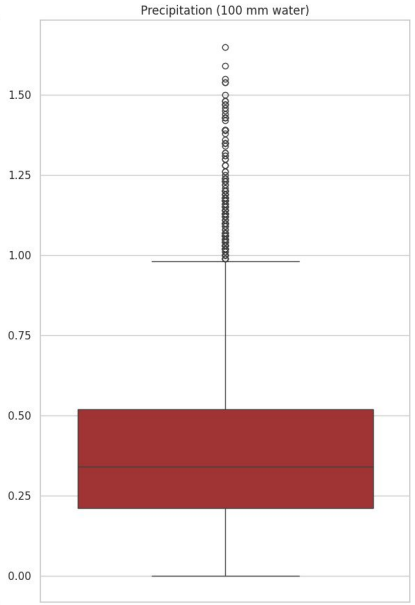
The merged dataset contains:
- Spanning from **2002 to 2022**
- Containing **181 countries**
- Around **3750 observations**

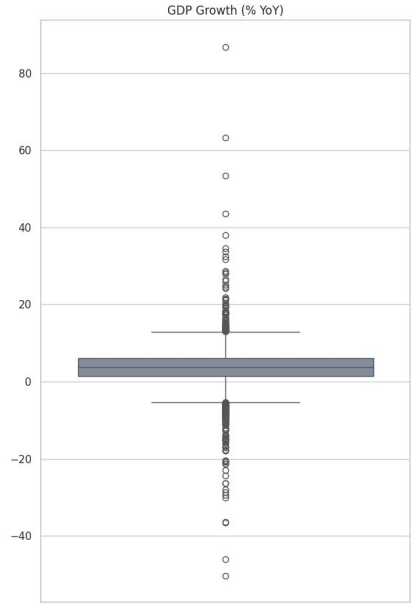
Processing & Classification

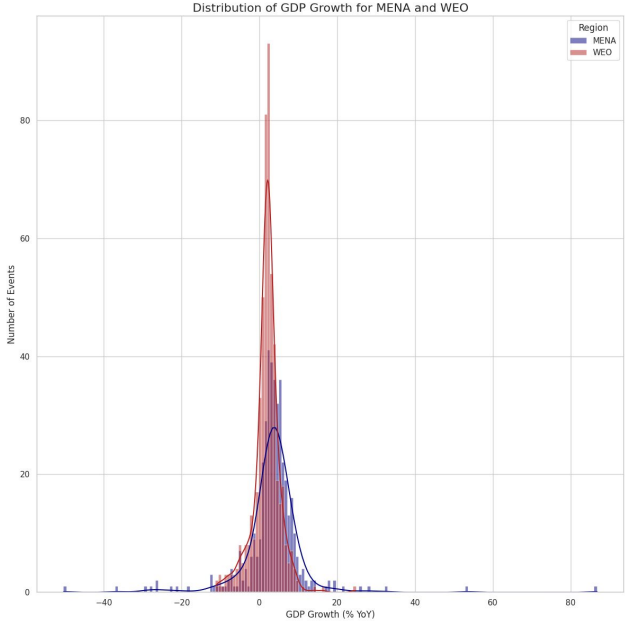
Countries have been **classified** into:
- **Poor vs Rich** (median GDP per capita in 2002)
- **Subregions** as MENA, SSA, LATAM, API, EECA, and WEO

Summary Statistics









Temperature
- Stable distribution, no extreme outliers
- Gradual increase over time across all 6 regions

Precipitation
- Skewed distribution: some countries experience much higher rainfall than the 75th percentile
- Suggests large heterogeneity in climatic exposure

GDP Growth
- Mean ≈ 3.5% per year, but heavy tails observed
- Ranges from –50% to +86.8%, reflecting severe economic shocks or rebounds
- Distribution of WEO vs MENA shows the greater variance for poorer countries

Empirical Framework – Baseline Model

We estimate a panel regression (OLS) to find out the causal effect of temperature and precipitation on GDP rowth

$$g_{it}^{base} = \beta_1 temp_{it} + \beta_2 prec_{it} + \beta_3 (temp * poor)_{it} + \beta_4 (prec * poor)_{it} + \theta_i + \theta_{rt} + \theta_{pt} + \epsilon_{it}$$

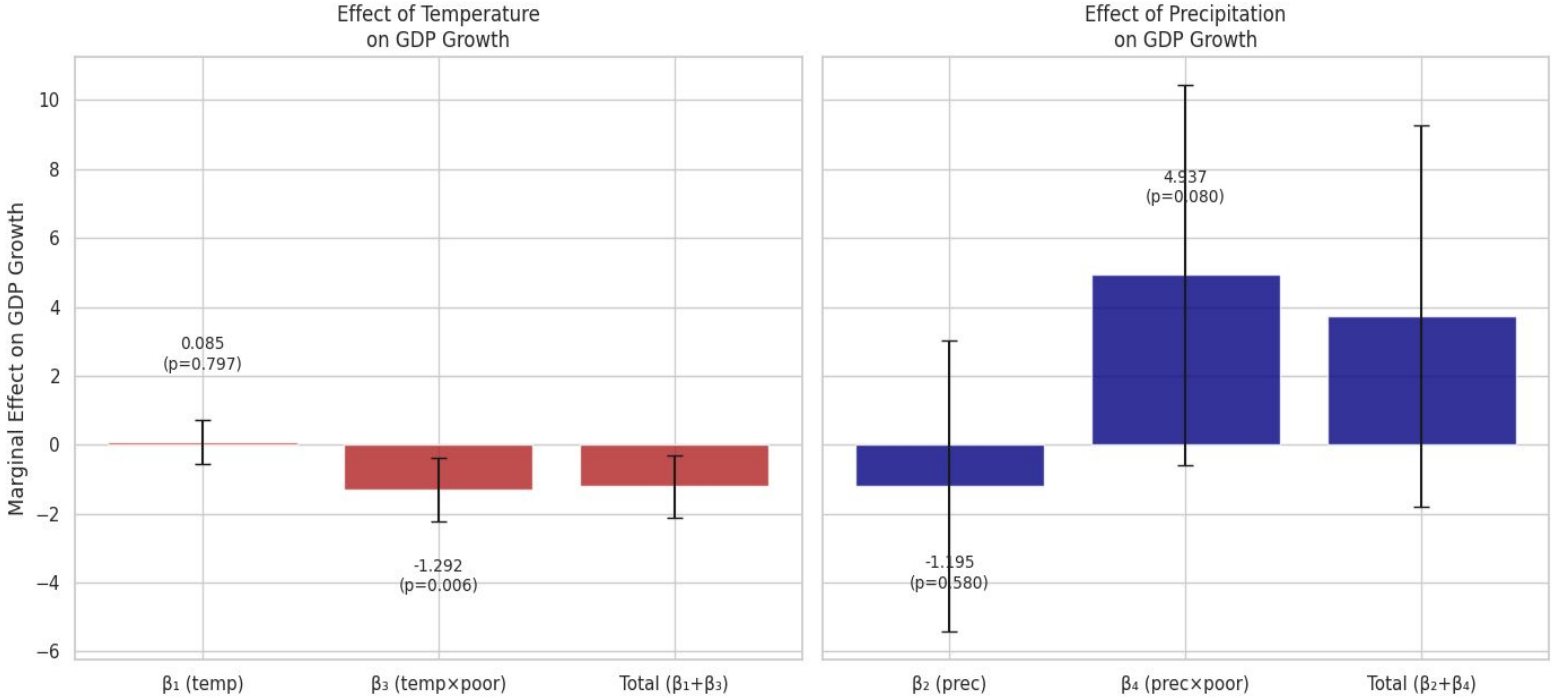
Where:
- g_{it}^{base} = GDP growth of country *i* and year *t*
- θ_i = Country fixed effects
- θ_{rt} = Region-year fixed effects
- θ_{pt} = Poor-year fixed effects

Key terms?
- β_1 = Effect of 1°C increase of temperature on GDP growth (%) of rich countries
- β_3 = Differential effect of 1°C increase of temperature on GDP growth (%) between poor and rich countries
- $\beta_1 + \beta_3$ = Effect of 1°C increase of temperature on GDP growth (%) of poor countries

θ_s = Controls for unobserved heterogeneity across countries and years

Goal? Identify whether short-run temperature and precipitation shocks affect economic growth, particularly in low-income countries, after controlling for country-specific and temporal effects.

Results - Baseline Model



Key Findings?

- A **1°C increase leads to a 1.29% drop in GDP growth in poor vs rich countries** (β_3 = -1.292, p<0.01)
- The **effect of temperature** is low and **not significant for rich** countries (β_1 = +0.085, p>0.05)
- A 100mm **increase of precipitation has no significant effect** neither on rich or poor countries (p>0.05)

Empirical Framework – Lagged & Non Linear Models

Lags of temperature and precipitation to capture delayed or persistent impacts

$$g_{it}^{lag} = g_{it}^{base} + \sum_{j=0}^{L}(\gamma_j temp_{it-j} + \delta_j prec_{it-j} + \eta_j (temp * poor)_{it-j} + \kappa_j (prec * poor)_{it-j})$$

L = 2, 5, and *10* to capture short, medium, and long-term growth effects → Are **climatic effects transitory or persistent?**

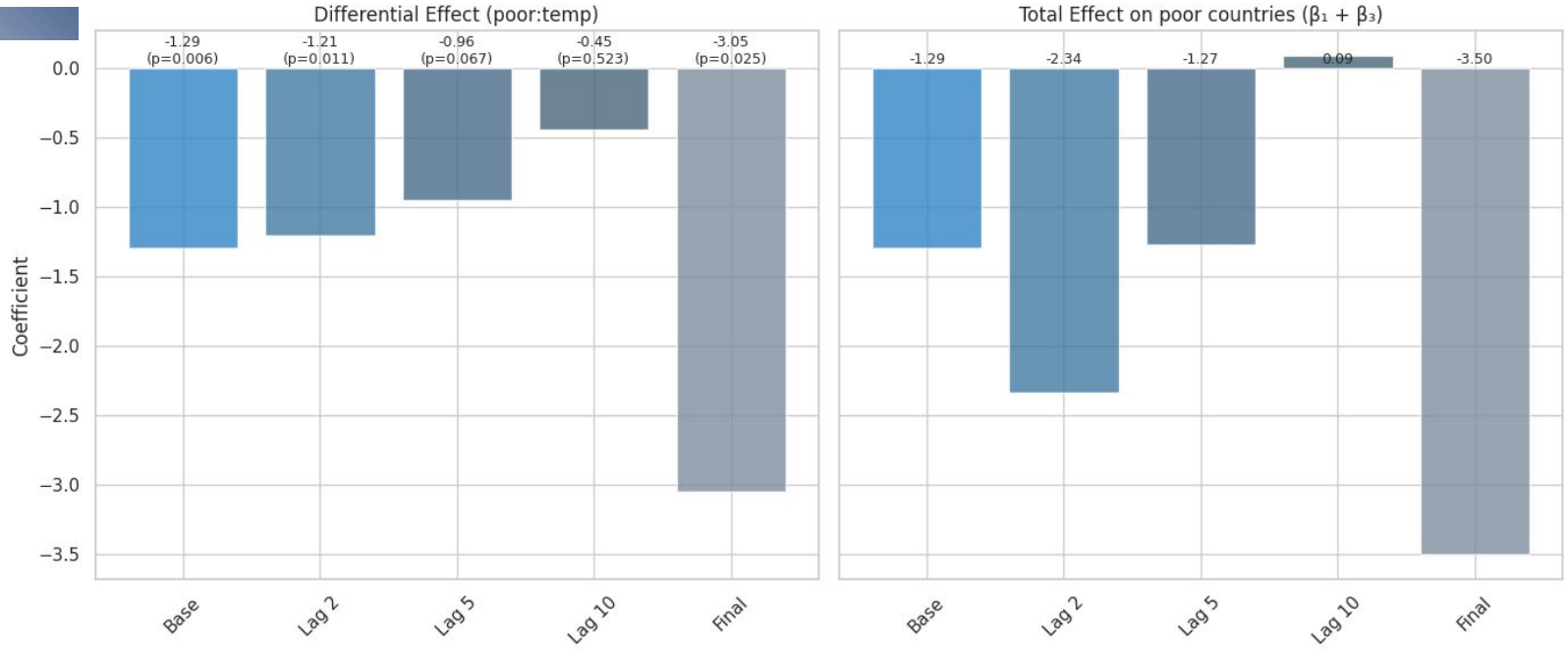
Non-linear terms to capture potential threshold effects or diminishing returns of climatic changes

$$g_{it}^{full} = g_{it}^{base} + g_{it}^{lag^*} + \lambda_1 temp_{it}^2 + \lambda_2 prec_{it}^2 + \lambda_3 (temp * poor)_{it}^2 + \lambda_4 (prec * poor)_{it}^2$$

λ_k: non-linear effects of temperature and precipitation on GDP growth → Is the **impact linear?** If not, **where** specifically?

*: All lags are added simultaneously

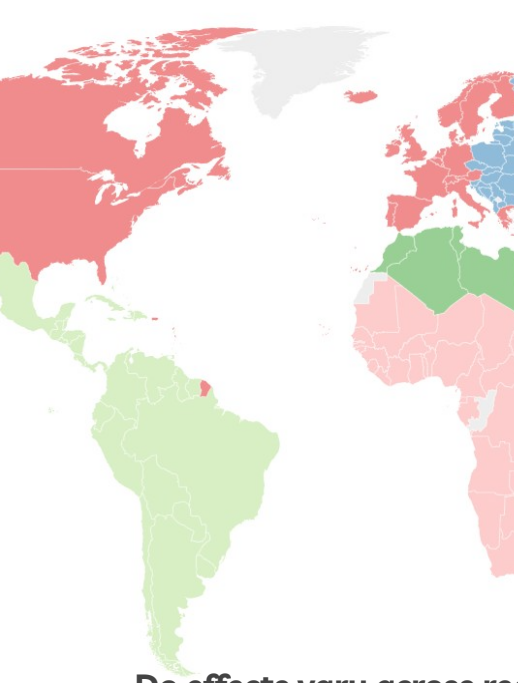
Empirical Framework – Lagged & Non Linear Models

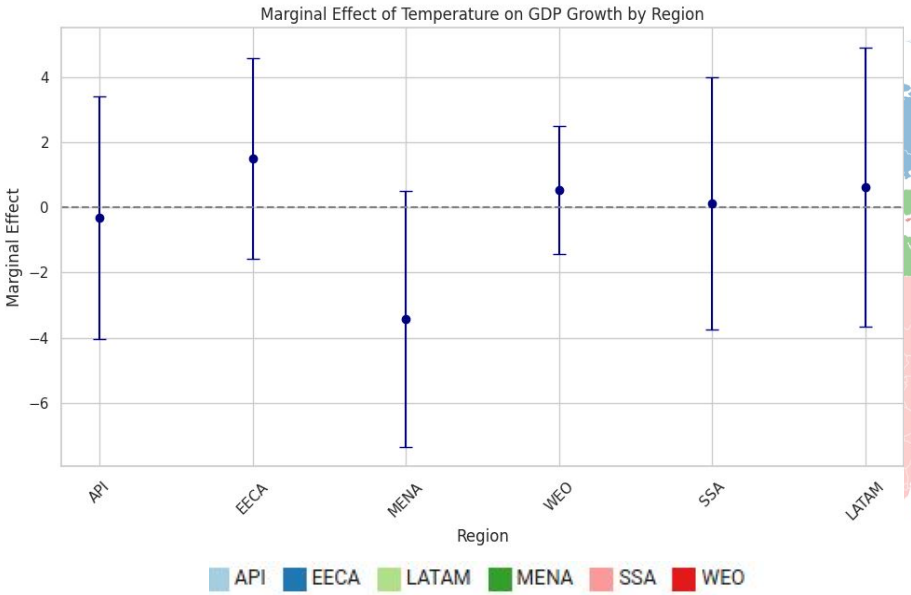


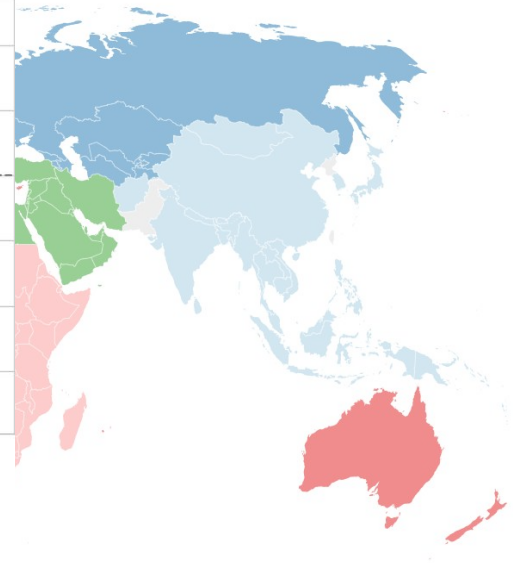
Key Findings?

- The **differential effect on poor vs rich countries weakens the longer the horizon** of the lag terms
- Adding **non-linearities and all the lags improves statistical power** (β_3 = -3.05, p<0.01)
- Total effect on poors increases in the short term and flips sign in the long run ($\beta_1 + \beta_3$ from -2.34 to +0.09)

Subregional Heterogeneity Analysis







Do effects vary across regions?

- Including interaction terms between region dummies and temperature
- Reference group: WEO (Western Europe & Others)

Results?

- MENA × temp interaction significant at 95% CI (ψ=−3.93, p=0.023)
- MENA × prec interaction is significant at 90% CI (χ=−43.09, p=0.063)

Channels & Mechanism

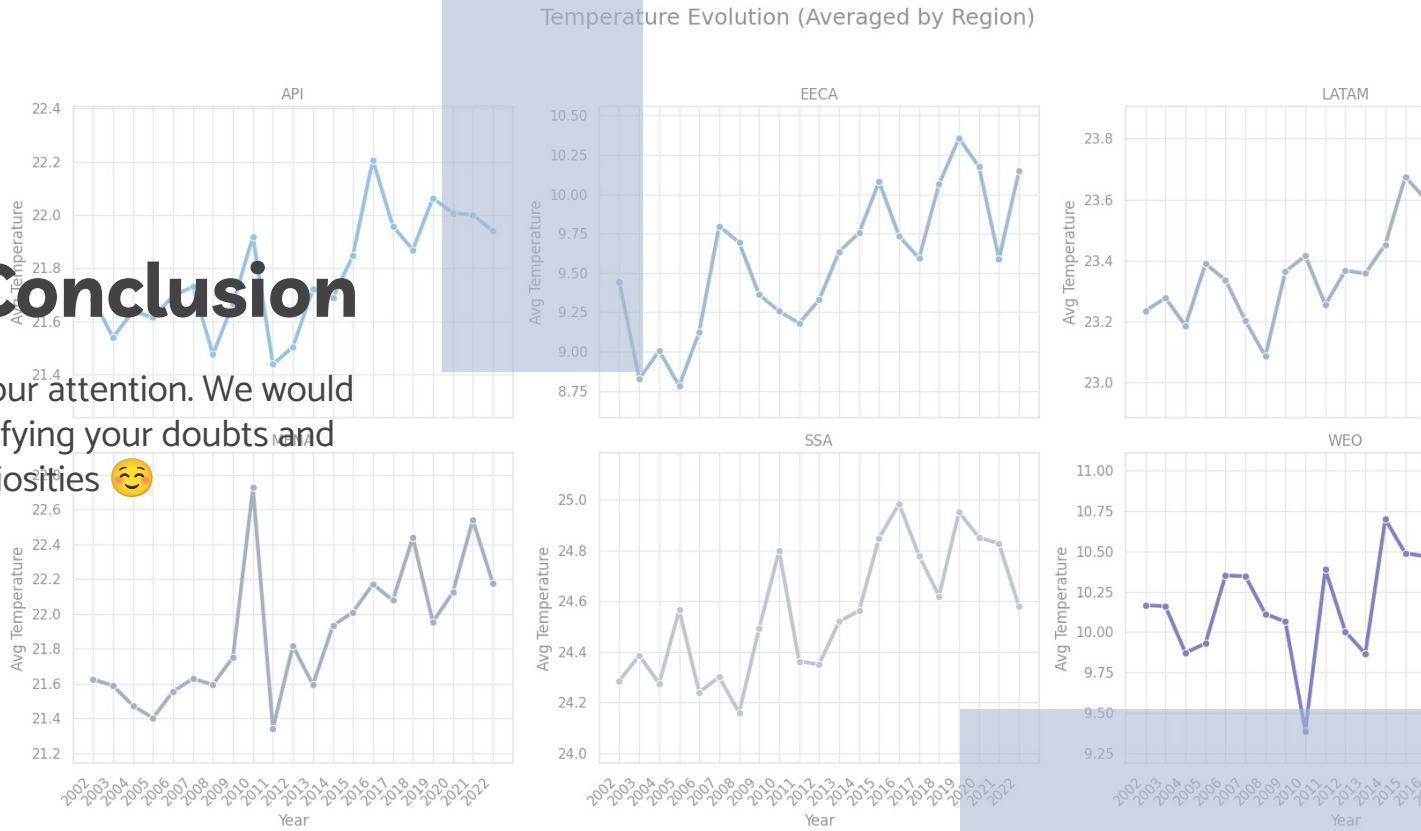
How does temperature affect GDP growth?
Although not directly tested in this extension, based on Dell et al. (2012) and the literature

Plausible Mechanisms:
- Agricultural productivity loss (e.g., droughts, crop failures)
- Reduced labour productivity in hot environments
- Damaged infrastructure (e.g., heat waves)
- Political instability triggered by food insecurity or economic stress

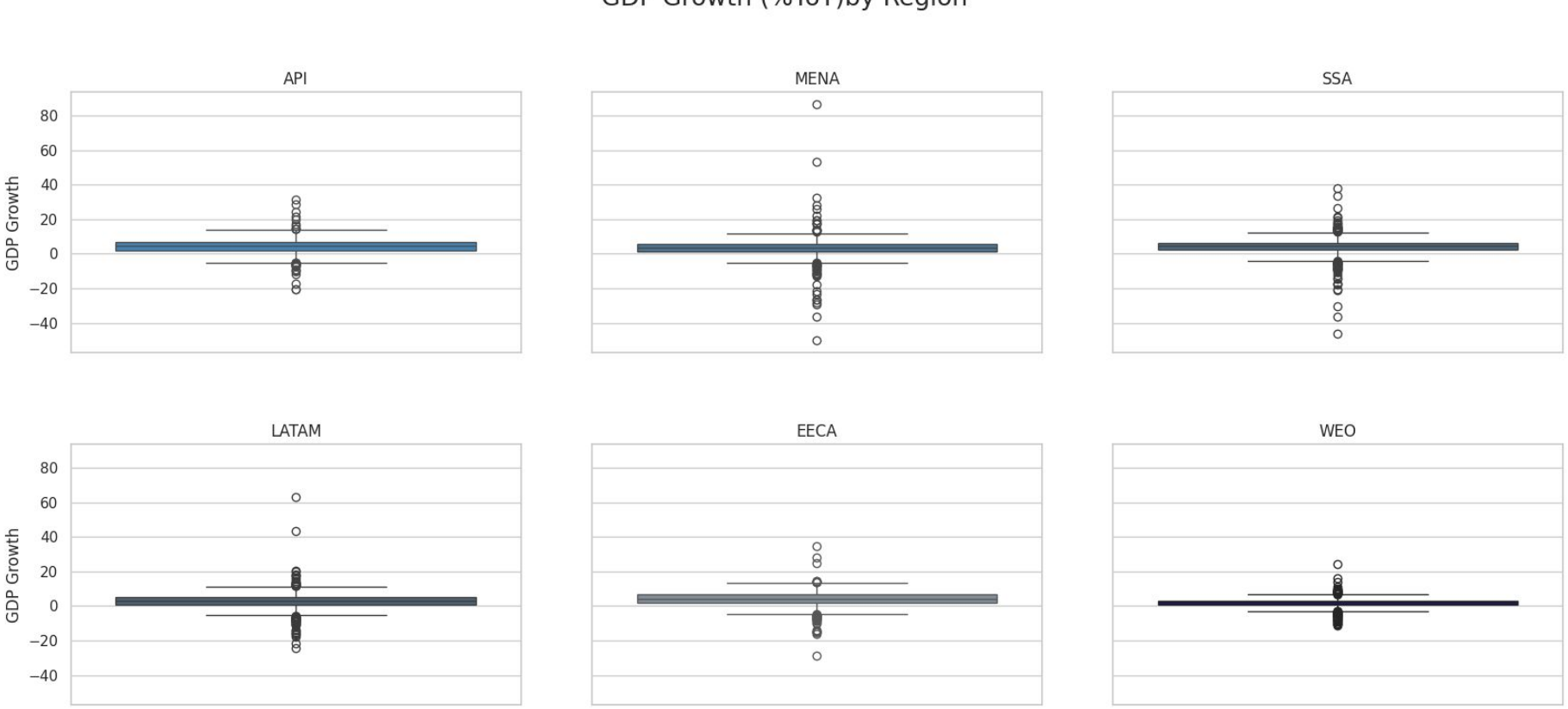
Next steps:
Disentangle specific economic channels using micro- or sectoral data

Conclusion

Thank you for your attention. We would appreciate clarifying your doubts and curiosities ☺️



BACK UP SLIDES …


GDP Growth (%YoY)by Region
API
MENA
SSA
LATAM
EECA
WEO
GDP Growth
GDP Growth
80
60
40
20
0
−20
−40

Why the IC is not zero for MENA?

Because on the right you have the total effect (sum of the coefficient on temperature and temp:region_k

Looking only at the coeff temp:region_k is it below zero but you don't have the total effect but rather the effect compared to WEO (used as a reference)