

Weather and Income: Lessons from the main European regions

David García-León

Dept. Fundamentos del Análisis Económico
Universidad de Alicante

June 27, 2015
21st EAERE Annual Conference, Helsinki



Outline

1 Motivation

Outline

1 Motivation

2 Data

Outline

1 Motivation

2 Data

3 Long-term

Outline

1 Motivation

2 Data

3 Long-term

4 Short-term

Outline

1 Motivation

2 Data

3 Long-term

4 Short-term

5 Conclusion

Motivation

- (Successful?) Eco-economic decoupling

Motivation

- (Successful?) Eco-economic decoupling
- Unprecedented increase in mean air temperatures since 1960
 - More is yet to come! (various IPCC Assessment Reports)

Motivation

- (Successful?) Eco-economic decoupling
- Unprecedented increase in mean air temperatures since 1960
 - More is yet to come! (various IPCC Assessment Reports)
- Degree of exposure to environmental conditions

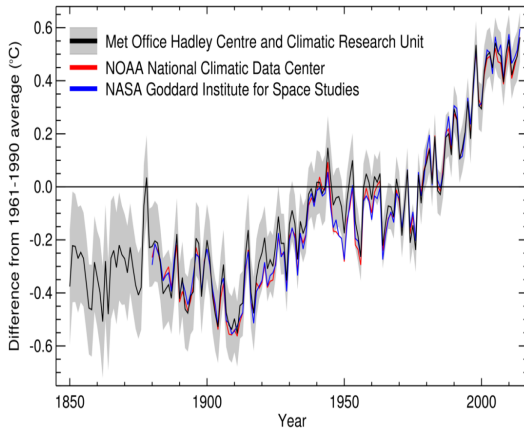
Motivation

- (Successful?) Eco-economic decoupling
- Unprecedented increase in mean air temperatures since 1960
 - More is yet to come! (various IPCC Assessment Reports)
- Degree of exposure to environmental conditions
- Important implications: cost of climate change

Motivation

- Historical behaviour

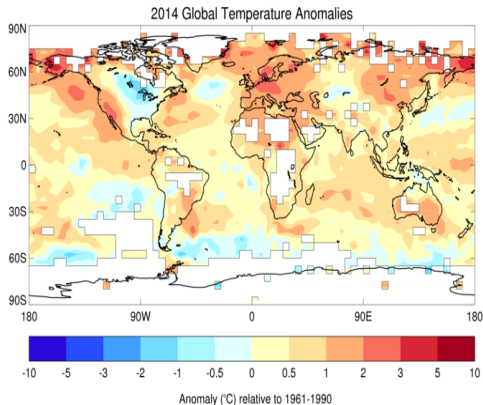
Global average temperature anomaly (1850-2014)



Source: WMO

Motivation

- Recent developments



Source: WMO

Motivation

- Quantify the relationship between temperature and aggregate economic activity

Motivation

- Quantify the relationship between temperature and aggregate economic activity
- Hedonic (Ricardian) approach \implies long-term relationship
 - Dell et al. (2009) find a negative relationship between income and temperature
 - Sub-national data for a sample of 12 countries in the Americas
 - National income falls 8.5% per degree Celsius

Motivation

- Quantify the relationship between temperature and aggregate economic activity
- Hedonic (Ricardian) approach \implies long-term relationship
 - Dell et al. (2009) find a negative relationship between income and temperature
 - Sub-national data for a sample of 12 countries in the Americas
 - National income falls 8.5% per degree Celsius
- Panel data approach (year-to-year fluctuations) \implies short-term relationship
 - Dell et al. (2012):
 - increasing temperatures hamper **only** poor countries
 - Sample of 150 countries

Motivation

Improvements on Dell et al.

- Apply both methodologies (short- and long-term) to the same sample

Motivation

Improvements on Dell et al.

- Apply both methodologies (short- and long-term) to the same sample
- Corroborate their findings for a sample of developed economies

Motivation

Improvements on Dell et al.

- Apply both methodologies (short- and long-term) to the same sample
- Corroborate their findings for a sample of developed economies
- Account for heterogeneity within country using disaggregated economic and weather data

Motivation

Improvements on Dell et al.

- Apply both methodologies (short- and long-term) to the same sample
- Corroborate their findings for a sample of developed economies
- Account for heterogeneity within country using disaggregated economic and weather data
- Weather data collected from actual weather stations

Motivation

Main Results

Motivation

Main Results

- In the cross-section (**long-term**) analysis, we find:
 - significant, negative, tempered relationship between temperatures and income within our sample
 - This relationship is amplified in poor regions
 - Precipitation and geographic variables: null or residual importance
 - Quantitatively and qualitatively similar to Deryugina and Hsiang (2014) for the US

Motivation

Main Results

- In the cross-section (**long-term**) analysis, we find:
 - significant, negative, tempered relationship between temperatures and income within our sample
 - This relationship is amplified in poor regions
 - Precipitation and geographic variables: null or residual importance
 - Quantitatively and qualitatively similar to Deryugina and Hsiang (2014) for the US
- On the panel dimension (**short-term**):
 - 1°C rise in temperatures will decrease growth rates in all regions within our sample
 - Effect exacerbated in poor regions
 - First evidence, together with Colacito et al. (2014), suggesting a negative relationship between rising temperatures and economic growth in the context of developed economies

Data

NUTS classification

- 5 largest countries in the EU: UK, Germany, France, Italy and Spain
- NUTS: 161 regions
 - Combine NUTS 2-3 according to adequacy and data availability
- Weather data collected directly from national weather agencies
 - Avoid problems with gridded data
- Economic data from national statistical offices

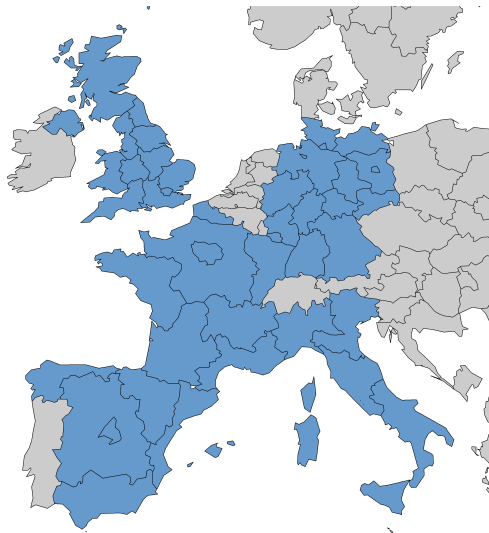
Data

- NUTS 0



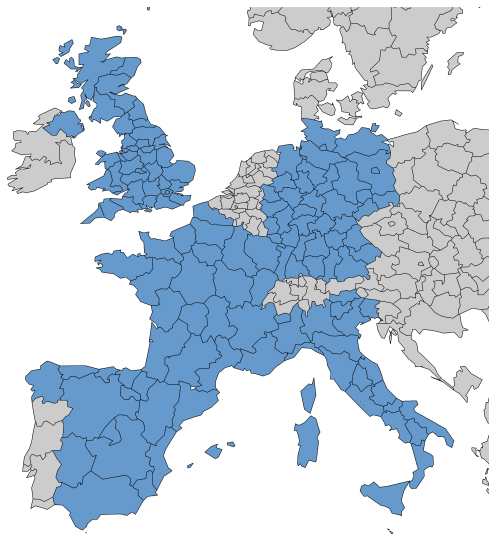
Data

- NUTS 1



Data

- NUTS 2



Data

- NUTS 3

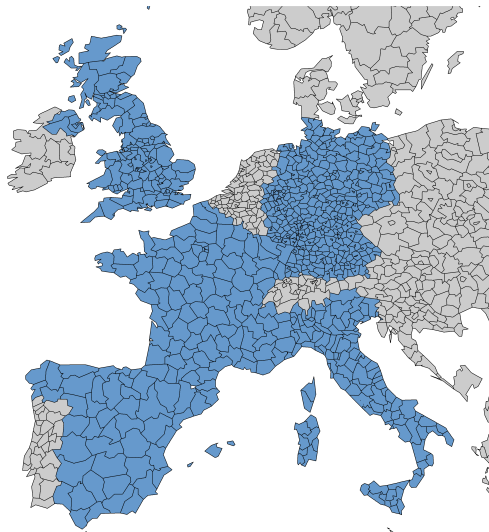


Table: NUTS summary

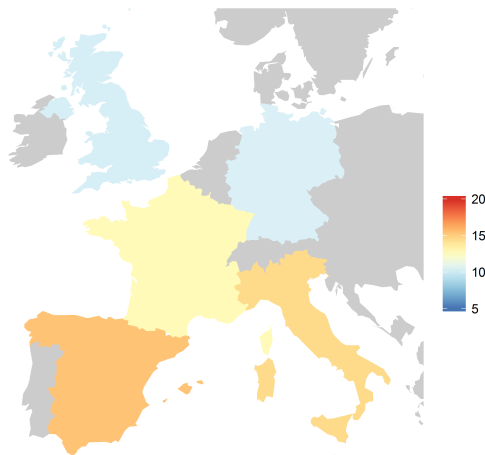
country	NUTS 2			NUTS 3		
	area	population	regions	area	population	regions
France	24340	2455	22	6328	638	100
Germany	9398	2165	39	867	200	412
Italy	14352	2829	22	2740	541	110
Spain	26631	2362	18	8576	761	51
United Kingdom	6574	1648	37	1750	438	139

Table: Data sources

country	economic variables	period	weather variables	period
France	INSEE	1990-2012	Meteo France	1949-2013
Germany	DESTATIS	1992-2013	DWD	1900-2014
Italy	ISTAT	1995-2012	METEOAM	1995-2013
Spain	INE	1980-2013	AEMET	1948-2014
United Kingdom	ONS	1995-2012	Met Office (UKCP09)	1981-2012

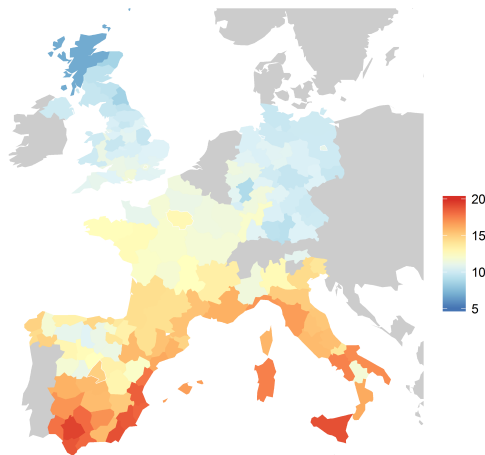
Data

- Mean air temperature ($^{\circ}\text{C}$). Year 2000



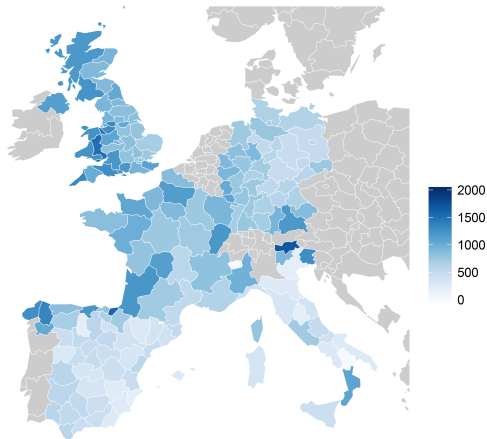
Data

- Mean air temperature ($^{\circ}\text{C}$). Year 2000



Data

- Precipitations (mm/year). Year 2000



$$V_i = \int \left[\sum P_j Q_{ij}(X_{ik}, Z_i) - \sum M_k X_{ik} \right] e^{-\varphi t} dt$$

- V_i can be expressed as a function of only exogenous variables

$$V_i = f(Z_i)$$

- We estimate the linear regression

$$\text{LOGY}_r = \alpha_r + \beta_1 \text{TEMP}_r + \beta_2 \text{PRECIP}_r + X'_r \gamma + \varepsilon_r$$

- Analogous to Dell et al. (2009). Further examples of this methodology for Europe are mainly focused on agricultural output: van Passel et al. (2012), Lippert et al. (2009) or Kurukulasuriya and Mendelsohn (2008)

Long-term

Basic Results

Table: Long-term Relationship. All Regions

	(1)	(2)	(3)	(4)	(5)	(6)
temperature	-0.022*** (0.006)	-0.022*** (0.007)	-0.023*** (0.008)	-0.021** (0.010)	-0.031*** (0.009)	-0.016* (0.009)
temperature x poor regions						-0.022*** (0.004)
precipitations				0.002 (0.007)	0.005 (0.005)	0.000 (0.003)
Geographic variables	No	No	Yes	Yes	Yes	Yes
Country FE	No	No	No	No	Yes	Yes
Observations	168	168	168	168	168	168
Number of clusters	-	59	59	59	59	59
R-squared	0.085	0.085	0.196	0.197	0.599	0.712
Temp. effect on poor Nuts						-0.038*** (0.010)

Year 2000. Dependent variable: GDP pc. Errors clustered by NUTS 1 level. Poor regions defined as having below-median per-capita GDP.

Short-term

Empirical approach

- Panel data structure
- We benefit from exogenous stochastic variation in weather variables
- Effect of weather fluctuation in the economic activity
- We consider the simple economy specification from Bond et al. (2010)

$$Y_{it} = e^{\beta T_{it}} A_{it} L_{it}$$

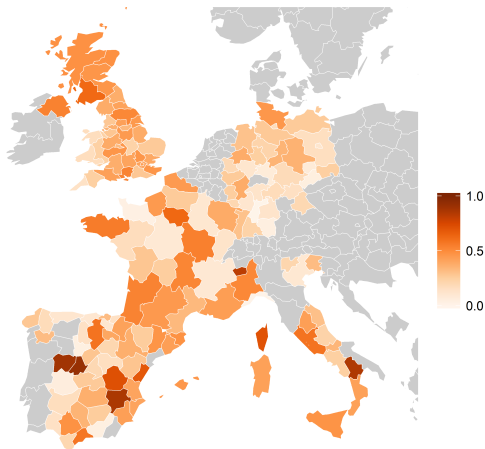
- Taking logs and differencing wrt time

$$g_{it} = \theta_i + \theta_{rt} + \sum_{j=0}^L \rho_j T_{it-j} + \varepsilon_{it}$$

Short-term

Empirical approach

- Temperature variation ($\Delta^{\circ}\text{C}$) in period 1990-2012



Short-term

Basic Results

Table: Short-term Relationship. All Regions

	(1)	(2)	(3)	(4)
temperature	0.178** (0.038)	-0.064*** (0.023)	-0.034* (0.019)	-0.022 (0.017)
temperature x poor regions			-0.052** (0.026)	-0.058** (0.026)
precipitations				0.036 (0.028)
Country FE	No	Yes	Yes	Yes
Observations	3246	3246	3246	3241
Number of clusters	59	59	59	59
R-squared	0.029	0.469	0.469	0.470
Temp. effect on poor Nuts			-0.086*** (0.029)	-0.080*** (0.026)

Sample: 1990-2012. Dependent variable: GDP pc. Errors clustered by NUTS 1 level. Poor regions defined as having below-median per-capita GDP.

Conclusion

- Negative (modest), significant statistical relationship between temperatures and income within European regions
- Amplified in poor regions: prone to suffering more from ongoing rising temperatures
- First piece of evidence suggesting a negative relation between rising temperatures and income growth in developed economies
 - Together with Deryugina and Hsiang (2014) and Colacito et al. (2014) for the US
- Follow-up when new vintages available