Climate Change Concerns and Information Spillovers from Socially Connected Friends

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This paper....

- **Research Question:** Understand the role of social interactions in shaping awareness of the challenges and costs of mitigating adverse consequences of climate change. Fact
  - ⇒ Especially for those not (yet) suffering from these consequences.
  - ⇒ Important role of information transmission via peers (Bernard et al., 2022) and effects of social values (Falk et al., 2022) and percepections (D'Acunto, 2022).
- Combine European survey data on **climate change concerns** with granular regional **social network** data and high-resolution dataset of **global temperatures**.
  - Direct exposure: Change in temperatures from 1990 to 2010.
  - Indirect exposure: Climate change experienced by friends connected via social networks.

Main Results

- Exploit **regional** variation in temperature changes experienced by socially connected friends to document **positive information spillover effects** via social networks.
  - ⇒ Individuals living in regions with Facebook friends in regions more exposed to changes in climate
    become **more concerned** about climate change
    - Effect about **50% larger** relative to a direct exposure to changes in temperature.
    - Social ties to regions exposed to climate change serve as a powerful **substitute for direct exposure** to changes in local climate.
    - Robust to different restrictions on regional resolution, more granular FEs, time-varying exposure to disasters.
    - Consistent effects for individuals *more likely to be treated*.
- Evidence is consistent with a **learning channel** and highlights important role of **social norms and preferences**

Data

1. Social Network Connections
   - Friendship links based on active interaction on *The Facebook* in April 2016.
   - Aggregated to region r & u (counties):

$$SCI_{r,u} = \frac{\text{\# Facebook Connections}_{r,u}}{\text{\# Facebook Users}_r \times \text{\# Facebook Users}_u}$$

2. Granular Global Temperature Data

$\Rightarrow$ Combine with Social Network data to compute measure of **indirect exposure** to changes in climate experienced by friends.

- Compute %-change in maximum monthly average temperature from 1990 to 2010 in regions $u \neq r$ connected via Facebook friendships.
- Compute 75th percentile of temperature changes in connected regions u using the *SCI* as relative weights.

$\Rightarrow$ Define **direct exposure** as temperature change in region r.

Data

3. Survey Data
   - Repeated cross-sectional survey fielded across 24 countries from **Eurobarometer** surveys 2013, 2015, 2017, and 2019.
     - *"Which of the following do you consider to be the single most serious problem facing the world as a whole? Which others do you consider to be serious problems?"*

$\Rightarrow$ Identification at the regional level

Empirical Strategy

- Estimate the following equation at the level of individual survey respondents i:

$$\begin{aligned} \textit{Climate Change Concerns}_{it} = & \beta \left(\Delta \textit{Temperature - Distant Friends}_{r(i)} \right) + \\ & \gamma \left(\Delta \textit{Temperature - Own Exposure}_{r(i)} \right) + \\ & \mathbf{c} X_{i,t} + \mathbf{d} W_{r(i),t-1} + \delta_t + \rho_{c(i)} + \epsilon_{i,t}. \end{aligned}$$

  - *Climate Change Concerns* $\Rightarrow$ Dummy variable
  - Δ*Temperature - Distant Friends*$_{r(i)}$ $\Rightarrow$ Indirect exposure.
  - Δ*Temperature - Direct Exposure*$_{r(i)}$ $\Rightarrow$ Direct exposure.
  - X: age, marital status, income, education, employment, occupation, children.
  - Regional controls W: population density, GDP, unemployment, heating-degree days, demographics (all measured year before survey wave).

$\Rightarrow$ Coefficient of interest $\beta \rightarrow$ Information spillovers via social networks.

Baseline Results

Dep. Variable	Concerned about Climate Change			
	(1)	(2)	(3)	(4)
Δ Temperature - Distant Friends	9.692**	10.984**	10.831**	9.984**
	(4.714)	(4.711)	(5.075)	(4.756)
Δ Temperature - Direct Exposure		20.867**		18.895*
		(10.464)		(11.269)
Year FE	Yes	Yes	Yes	Yes
Regional FE (NUTS 0)	Yes	Yes	Yes	Yes
Individual Controls	Yes	Yes	No	Yes
Regional Controls	No	No	No	Yes
Observations	93,588	93,588	93,588	87,099
R^2	0.09	0.09	0.08	0.10

- Effect of 1 SD increase in indirect exposure 50% larger than equiv. increase in direct exposure (at mean).

Robustness

- Reverse causation as social networks form due to assortative matching across regions with similar beliefs or socioeconomic characteristics.
  1. Manifest at lower regional levels than accounted for at NUTS0.
     - Restrict analysis to countries with higher regional resolution and include more granular regional fixed-effects.
  2. Matched sample from boosted regression tree to address potential confounding influences from observable differences across respondents in different regions. Results
     - Form 4 groups as quartiles of direct & indirect exposure $\rightarrow$ 16 treatment arms.
     - Solve high-dimensional estimation of *generalized* propensity scores with ML.
- Leverage data on natural disasters as further evidence.
  - Exploit exogenous time-variation in exposure to natural disasters within regions.
  - Control for unobserved heterogeneity at granular regional level. Results
- Consistent effects for more frequent social media users with higher trust in social media (*more likely to be treated*). Results

Fixed Effects & Matched Sample

Back

Dep. Variable	Concerned about Climate Change				
	Baseline	Different regions		Matched Sample	
		NUTS 3	NUTS 2&3		
	(1)	(2)	(3)	(4)	(5)
Δ Temperature - Distant Friends	10.984**	18.716**	12.690***	14.488***	12.611**
	(4.711)	(9.057)	(4.096)	(5.314)	(5.385)
Δ Temperature - Direct Exposure	20.867**	11.547	24.816*	34.499***	30.795**
	(10.464)	(18.440)	(13.153)	(12.291)	(12.934)
Year FE	Yes	Yes	Yes	Yes	Yes
Regional FE	NUTS 0	NUTS 2	NUTS 1	NUTS 0	NUTS 0
Individual Controls	Yes	Yes	Yes	Yes	Yes
Regional Controls	No	No	No	No	Yes
Observations	93,588	21,479	78,889	93,588	87,099
R^2	0.09	0.07	0.10	0.09	0.09

Information Spillovers and Disaster Experiences

Back

Dep. Variable	Concerned about Climate Change				
	All Disaster Types	Extreme Temperatures	Droughts	Floods	Storms
	(1)	(2)	(3)	(4)	(5)
# Disaster - Distant Friends	2.837***	16.245***	20.234***	4.278	2.725***
	(0.711)	(4.621)	(7.525)	(2.959)	(0.836)
# Disaster - Own Region	0.492*	1.417	5.957***	0.091	1.328**
	(0.262)	(1.115)	(1.799)	(0.468)	(0.612)
Year FE	Yes	Yes	Yes	Yes	Yes
Regional FE	Yes	Yes	Yes	Yes	Yes
Individual Controls	Yes	Yes	Yes	Yes	Yes
Observations	89,491	89,491	89,491	89,491	89,491
R^2	0.10	0.10	0.10	0.10	0.10

- Exploit time variation in exposure to cumulated past disaster experience.
  - $\Rightarrow$ Robust to different measures of changes in climate and more granular regional fixed effects.

Internet and Social Media Use

Back

Dep. Variable	Concerned about Climate Change				
	Social Media Use	Internet Use	Internet Use		Social Media Trust
			Daily	Infrequent	
	(1)	(2)	(3)	(4)	(5)
Δ Temperature - Distant Friends	3.093	19.891***	-5.507	5.794	5.996
	(6.708)	(7.242)	(7.774)	(9.942)	(7.418)
Socal Media Use - Weekly	1.585*		0.402	0.597	
	(0.822)		(0.946)	(2.776)	
Social Media Use - Weekly × Δ Temperature - Distant Friends	7.421		15.837*	34.394	
	(6.711)		(9.300)	(23.566)	
Use of Internet - Daily		3.786***			
		(0.726)			
Use of Internet - Daily × Δ Temperature - Distant Friends		-15.306**			
		(7.384)			
Social Media Trust					-2.301
					(1.840)
Social Media Trust × Δ Temperature - Distant Friends					34.132**
					(16.409)
Year FE	Yes	Yes	Yes	Yes	Yes
Regional FE (NUTS 0)	Yes	Yes	Yes	Yes	Yes
Individual Controls	Yes	Yes	Yes	Yes	Yes
Observations	23,529	66,299	15,967	7,562	13,394
R^2	0.10	0.09	0.10	0.06	0.10

- Identification only at regional level
  - $\Rightarrow$ Respondents that use social media more likely to be treated.
- 2017 survey item on . . .

. . . frequency of internet and social media use $\rightarrow$ larger effects.

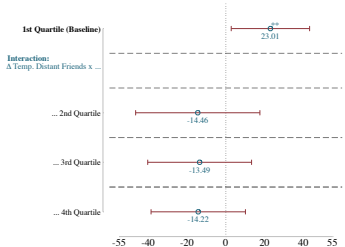
. . . trust in stories posted on social media $\rightarrow$ larger effects.

Channels

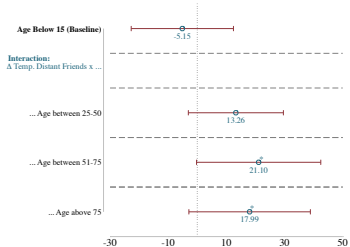
1. Learning Channel
   - Social Networks serve as a substitute source of information.
   - Heterogeneity w.r.t. personal characteristics imply stronger effects for ...
     - ... less direct exposure to climate change.
     - ... older individuals.
     - ... less educated. Results
   - Less belief updating after disasters if ex-ante exposed to larger temperature changes via distant friends.
     - Exploit time variation in disaster experience and interact with temp. changes.
     - Learning about climate change leads to consistent adjustment of expectations about climate change after realization of disasters. Results
2. Social Values and Norm
   - Important role of patience and altruism (measured at the regional level) ...
     - ... stronger response by more altruistic and patient individuals.
     - ... altruistic individuals also more likely to take personal action. Results

Heterogeneity

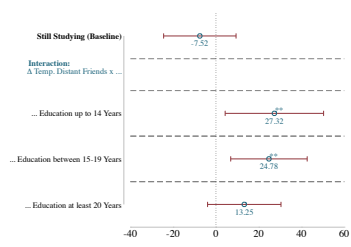
Back



(a) Quartiles of Direct Exposure



(b) Age Groups



(c) Education Groups

Social and Economic Preferences

Back

Dep. Variable	Concerned about Climate Change		
	All	NUTS 2 & 3	Matched Sample
	(1)	(2)	(3)
Δ Temperature - Distant Friends	-5.802	3.420	10.630
	(13.691)	(16.787)	(18.301)
Δ Temperature - Distant Friends × High Trust	19.762	10.198	16.356
	(12.414)	(16.690)	(15.133)
Δ Temperature - Distant Friends × High Patience	-40.961***	-27.122	-50.900***
	(15.024)	(20.485)	(18.233)
Δ Temperature - Distant Friends × High Risk-Taking	4.730	-16.231	3.308
	(16.288)	(14.284)	(19.658)
Δ Temperature - Distant Friends × High Reciprocity (pos.)	-9.567	22.241*	-21.047
	(13.046)	(11.592)	(15.203)
Δ Temperature - Distant Friends × High Reciprocity (neg.)	-5.507	-21.126**	-4.214
	(11.018)	(10.076)	(12.003)
Δ Temperature - Distant Friends × High Altruism	57.005***	62.271**	62.912***
	(18.283)	(23.918)	(21.000)
Δ Temperature - Direct Exposure	19.864	29.175*	30.665**
	(12.765)	(16.278)	(14.294)
Year FE	Yes	Yes	Yes
Regional FE	NUTS0	NUTS1	NUTS0
Individual Controls	Yes	Yes	Yes
Observations	66,744	52,342	66,744
R^2	0.09	0.10	0.09

- Add interactions with regionally-aggregated preference data from the *Global Value Survey* (highest vs. lowest tertile).
- High Altruism:
  - Internalize externalities on others and adjust their beliefs to exposure of distant friends.
- High Patience:
  - Incentives to acquire information about about future costs of CC.
  - Negative coefficient $\rightarrow$ more patient individuals already informed.
  - Information spillovers are free source of new information for less patient.

Social and Economic Preferences

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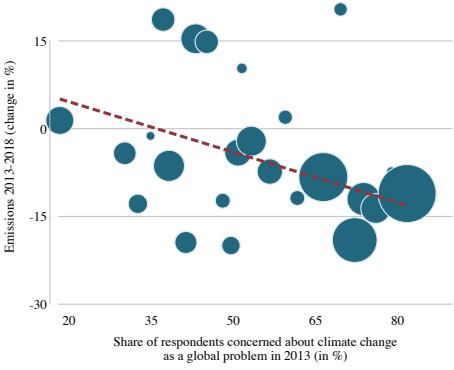
Conclusion

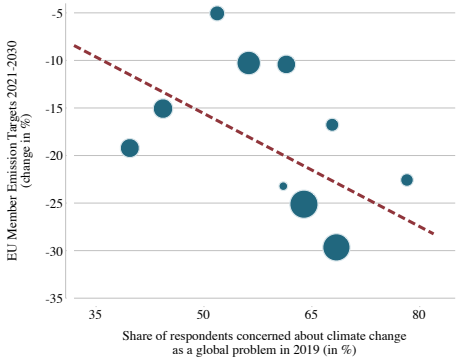
- Information spillovers via social networks shape concerns about climate change.
  - Effects consistent with individuals not yet exposed to climate risk learning about climate change risks from the experiences of their distant friends.
  - Especially for individuals not directly affected, for older and less educated individuals.
- Important interplay between peers, social norms, and beliefs about climate change.
  - Effects are more prominent for individuals living in regions characterized as more altruistic and less patient.
  - Similar results on personal actions.

Climate Change Concerns and CO_2 Emissions

Back



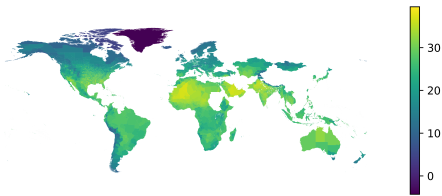
(a) CO_2 Emissions and Climate Change Concerns



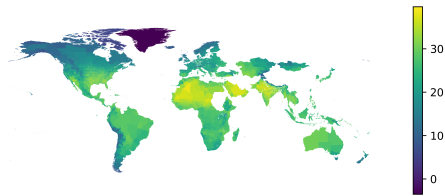
(b) Planned CO_2 Reductions and Climate Change Concerns

$\Rightarrow$ Awareness/concerns about these challenges correlates positively with observed patterns of reductions in carbon emissions today.

Exposure to Temperature Changes

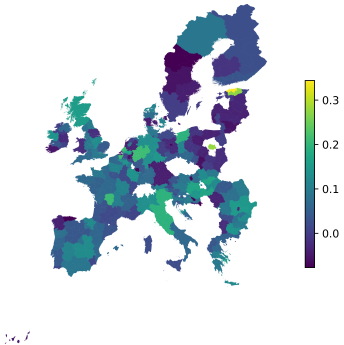


(a) Max. of Average Monthly Temp. - 1990

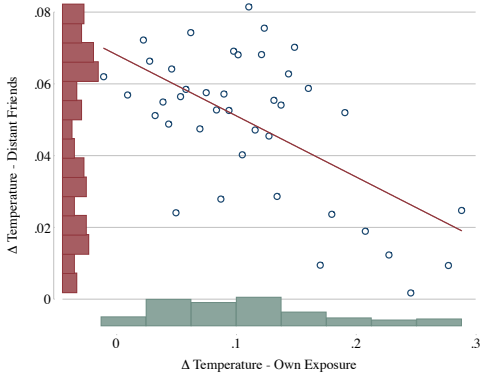


(b) Max. of Average Monthly Temp. - 2010

Exposure to Temperature Changes



(a) Distant Friends' Exposure to Temperate Changes (in %)

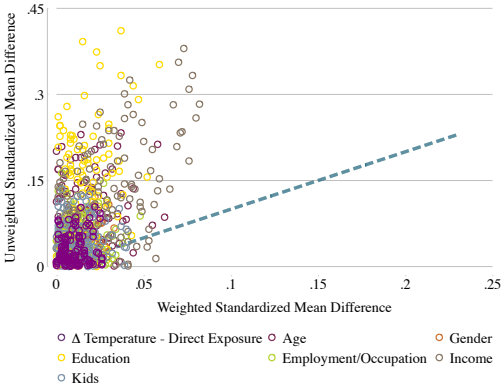


(b) Individual Exposure and Exposure of Distant Friends

Regional Aggregation

Country	Aggregation	Number of Unique Regions	Average # Obs. per Region×Year
AT - Austria	NUTS level 2	9	154.71
BE - Belgium	NUTS level 2	11	113.41
BG - Bulgaria	NUTS level 2	34	156.29
DE - Germany	NUTS level 1	16	136.61
DK - Denmark	NUTS level 2	5	222.20
EE - Estonia	NUTS level 3	5	255.46
ES -Spain	NUTS level 2	17	107.37
FI - Finland	NUTS level 2	21	232.82
FR - France	NUTS level 2	21	81.10
GB - Great Britain	NUTS level 1	12	140.19
GR - Greece	NUTS level 2	10	209.37
HR - Croatia	NUTS level 3	19	95.81
HU - Hungary	NUTS level 2	7	175.29
IE - Ireland	NUTS level 3	8	161.46
IT - Italy	NUTS level 1	5	206.73
LT - Lithuania	NUTS level 3	10	139.11
LV - Latvia	NUTS level 3	5	155.64
NL - The Netherlands	NUTS level 2	12	125.00
PL - Poland	NUTS level 2	16	74.96
PT - Portugal	NUTS level 2	5	277.51
RO - Romania	NUTS level 2	8	129.17
SE - Sweden	NUTS level 2	8	175.01
SI - Slovenia	NUTS level 3	11	146.46
SK - Slovakia	NUTS level 2	4	271.75

Standardized Bias and p-Values across Treatment Groups



(a) Standardized Bias

(b) p-Values

Information Spillovers and Disaster Experiences

Back

Dep. Variable	Concerned about Climate Change				
	All Disaster Types	Extreme Temperatures	Droughts	Floods	Storms
	(1)	(2)	(3)	(4)	(5)
# Disaster - Distant Friends	2.012**	16.352***	27.099***	2.414	1.592*
	(0.820)	(5.241)	(8.202)	(3.380)	(0.888)
# Disaster - Own Region	1.918***	1.670	9.706***	2.507**	4.027***
	(0.572)	(2.228)	(1.617)	(1.192)	(0.927)
Δ Temperature - Distant Friends × # Disaster - Distant Friends	5.511	-17.354	-46.335	5.648	9.634**
	(4.785)	(32.218)	(53.577)	(18.855)	(4.789)
Δ Temperature - Direct Exposure × # Disaster - Distant Friends	2.925	-28.432	-111.885***	-6.552	3.486
	(3.253)	(29.779)	(42.541)	(13.682)	(2.953)
Δ Temperature - Distant Friends × # Disaster - Own Region	-8.681**	11.119	-53.950***	-8.489	-18.790***
	(3.599)	(11.819)	(16.324)	(7.096)	(6.316)
Δ Temperature - Direct Exposure × # Disaster - Own Region	-8.625*	-4.829	38.737	-24.286**	-20.415**
	(4.729)	(10.449)	(33.649)	(10.891)	(10.333)
Year FE	Yes	Yes	Yes	Yes	Yes
Regional FE	Yes	Yes	Yes	Yes	Yes
Individual Controls	Yes	Yes	Yes	Yes	Yes
Observations	89,491	89,491	89,491	89,491	89,491
R^2	0.10	0.10	0.10	0.10	0.10

- Add interactions with more salient climate change experiences.
  - Exploit time variation in disaster experience
  - Inclusion of granular regional FEs wash out baseline coeffiencts
- Individuals update beliefs after exposure to disasters:
  - Less belief updating if ex-ante exposed to larger temperature changes via distant friends.
  - Learning about climate change leads to consistent expectations about climate change after realization of disasters