



Research Fund



UNIVERSITÀ  
DI FOGGIA



# Climate Change, Trade and Inequalities in the Economic Growth Between Regions

*Emilia Lamonaca*

*SEMinario in Scienze Economiche e Sociali (SEME)*

*DEMeT Department, University of Foggia – July 5, 2023*

# AXA-funded project

**Focus:** nexus climate change (CC)–trade–development

**Aim:** evaluating how trade and regulations allow regions to adapt to CC

**Research objectives** (and *methodological approach*):

1. Understand how CC affects export capacity of regions  
(*Climate Ricardian model*)
2. Explore how regions adapt to CC by reshaping trade patterns  
(*Gravity model*)
3. Investigate co-benefits and side-effects of trade and climate regulations  
(*Gravity model*)

# AXA-funded project – Outputs & Collaborations

## Research objectives 1 and 2

Bozzola M, Lamonaca E, Santeramo FG  
(2023) *Impacts of climate change on global agri-food trade*

- [Ecological Indicators](#)
- [EUI RSC Working Paper](#)

Lamonaca E, Bozzola M, Santeramo FG  
(2023) *Climate, Distance, Trade Routes*  
[Working Paper]

## Collaborations



## Collaborations



Bozzola M, Lamonaca E, Santeramo FG (2023). Impacts of climate change on global agri-food trade. [\*Ecological Indicators\*](#), 154, 110680

## **RESEARCH OBJECTIVE 1**

**EFFECTS OF CLIMATE CHANGE ON EXPORT CAPACITY OF REGIONS**

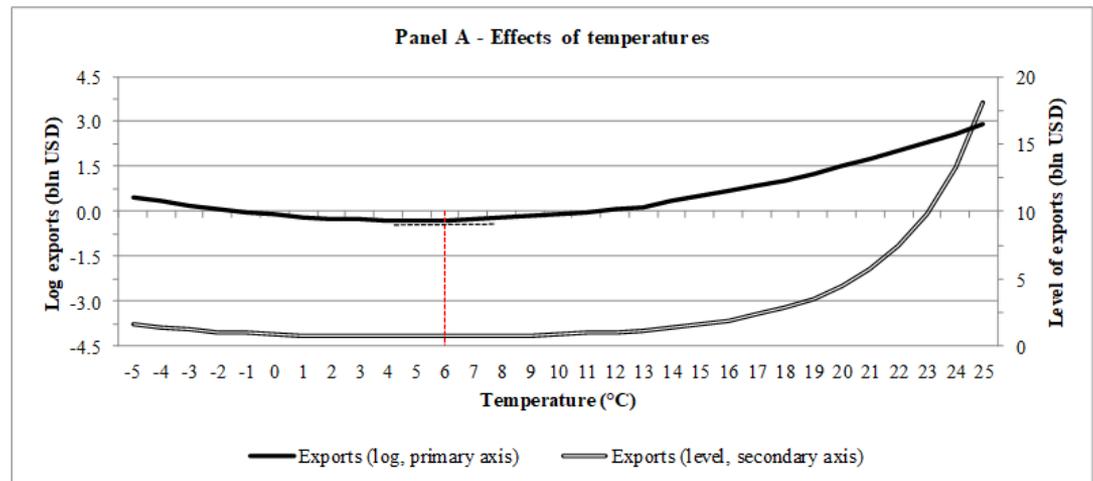
# Main evidence

- Higher temperatures tend to increase exports
- Impacts about 11% higher in developing than developed exporters:

✓ agri-food products from developing countries generally better suited to warmer climates

✓ most of net-exporters of agricultural produce (i.e., developing exporters in our sample) may benefit from climate change

*(Gouel and Laborde, 2021)*



Notes: Dep. var. is value of exports (log and level) in food and beverage sector; annual temperature in °C. **Turning points:** 5-6 °C for temperatures of exporter.

- Similar impact for developed and developing exporters in monetary terms (about +2 billion USD of agri-food exports)

Lamonaca E, Bozzola M, Santeramo FG (2023). *Climate, Distance, Trade Routes*. Working Paper.

## **RESEARCH OBJECTIVE 2**

**EFFECTS OF CLIMATE CHANGE ON TRADE PATTERNS**

# Background and motivation

- Climate change (CC) and international trade dynamics are closely related...
  - ✓ +3% of bilateral exports for +1°C of exporter's temperature (*Dallmann, 2019*)
- ... and their impacts on agri-food sector are relevant
  - ✓ higher temperatures reduce by 2-6% exports' growth (*Jones and Olken, 2010*)
- Trading opportunities may raise btw partners w/ different comparative advantages determined, among others, by their climate (e.g., *Conte et al., 2021*)
- Difference in climate btw partners (**climate distance**) may affect shipments
  - ✓ country A (w/ high yield of product  $k$  due to CC) may export more to country B (w/ low yield of  $k$  due to CC) (*Costinot et al., 2016*)
- HP: the larger the climate distance btw partners, the grater the trade opportunities

# Aim and contribution

We investigate:

- impacts of climate distance between partners on bilateral agri-food trade

Previous studies focus on:

- short-run effects of weather shocks on trade  
(e.g., *Jones and Olken, 2010; Dallmann, 2019; Dall'Erba et al., 2021*)
- role of trade as adaptation strategy  
(e.g., *Costinot et al., 2016; Gouel and Laborde, 2021*)

# Aim and contribution

We investigate:

- impacts of climate distance between partners on bilateral agri-food trade

Previous studies focus on: We focus on

- short-run effects of weather shocks on trade **long-run effects** of climate on trade (e.g., *Jones and Olken, 2010; Dall’Erba et al., 2021*)
- role of trade as adaptation strategy **climate distance** as driver of trade (e.g., *Costinot et al., 2016; Gouel and Laborde, 2021*)

Empirical application:

- gravity-based analysis (*Head and Mayer, 2014; Costinot and Rodriguez-Clare, 2014*)
- bilateral agri-food exports and climatologies (country’s average) from 1996 to 2015

# Marginal impact of climate distance on bilateral exports

**Table:** Trade volume effect (TVE) of climate distance and change in bilateral exports ( $\Delta$  avg exp)

	TVE (%)	$\Delta$ avg exp (bln \$)
Distance in temp. (+1 °C)	38.07%	.19
Distance in prec. (+5 mm)	82.12%	.42

Notes: TVE obtained from PPML coefficients, evaluated at avg. distances in temperature and precipitation;  $\Delta$  avg exp considers avg. bilateral exports.

- ✓ As in *Dallmann (2019)*, larger distance in climate of traders are pro-trade
  - distance in temp +1 °C  $\Rightarrow$  exports  $\uparrow$  (+38% our results; +3% *Dallmann, 2019*)
  - heterogeneous impacts due to different measures of climate distance: long-run changes in our results *versus* short-run changes in *Dallmann (2019)*
- Our results: long-run adjustments due to countries specialisation: *Gouel and Laborde (2021)* argue that trade may:
  - ✓ balance new domestic supply and demand schedules
  - ✓ induce a reallocation of productions among countries

# A simple conceptual framework

CC may alter comparative advantages and trade of partners (*Heerman, 2020*)

Beneficial or detrimental effects? If partners have:

- distant climate  $\Rightarrow$  different specialisation  $\rightarrow$  bilateral trade  $\uparrow$
- similar climate  $\Rightarrow$  similar specialisation  $\rightarrow$  bilateral trade  $\downarrow$

Assumptions:

- Trade of  $i$  (exporter) and  $j$  (importer) described by:

$$S_i - D_i = V_i = f(p^*, z_i, \mathbf{C}_i, \mathbf{X}_i) \quad \text{and} \quad S_j - D_j = V_j = f(p^*, z_j, \mathbf{C}_j, \mathbf{X}_j)$$

w/  $S$  and  $D$  aggregate agri-food supply and demand

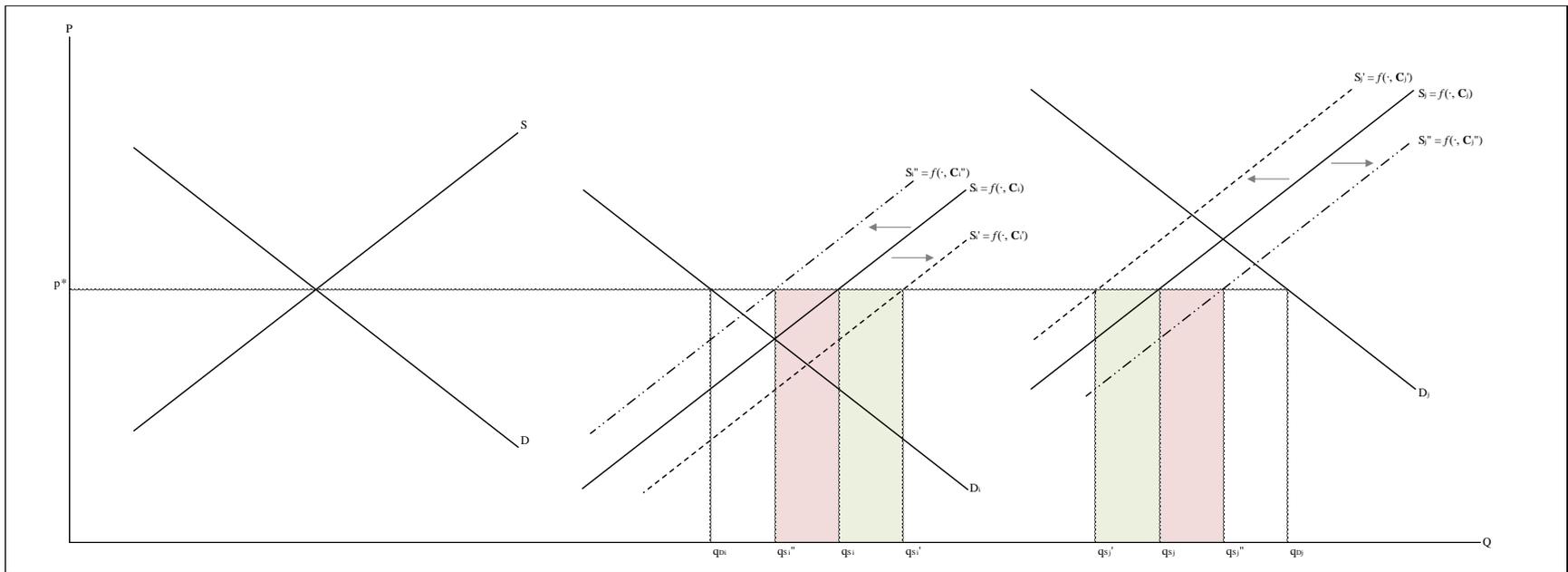
exogenous  $p^*$  > price in  $i$  and < price in  $j$

climate conditions ( $\mathbf{C}_i \neq \mathbf{C}_j$ ), technologies ( $z_i \neq z_j$ ), other characteristics ( $\mathbf{X}_i \neq \mathbf{X}_j$ )

- Excess of supply in  $i$  ( $q_{D_i} - q_{S_i}$ ) matches excess of demand in  $j$  ( $q_{S_j} - q_{D_j}$ )

# A simple conceptual framework

- If CC shifts  $S_i \mapsto$  and  $S_j \leftarrow$  (green areas)  $\rightarrow$  bilateral trade  $\uparrow$
- If CC shifts  $S_i \leftarrow$  and  $S_j \mapsto$  (red areas)  $\rightarrow$  bilateral trade  $\downarrow$



- Bilateral trade depends on how CC affects  $D$  and  $S$  in domestic and foreign markets
- Exports may increase/reduce depending on climate distance btw  $i$  and  $j$  ( $C_i - C_j$ )

# How to model climate distance? Comparative advantage vs. trade costs?

Bilateral trade explained by

$$V_{ij} = f(p^*, z_i, z_j, \mathbf{C}_i, \mathbf{C}_j, \mathbf{X}_i, \mathbf{X}_j, \cdot)$$

- country-specific drivers ( $z, \mathbf{C}, \mathbf{X}$ )
- other bilateral drivers (observed and unobserved), such as climate distance ( $\mathbf{C}_i - \mathbf{C}_j$ )

Framework related to the gravity approach (e.g., *Head and Mayer, 2014*)

$$V_i = f(p^*, z_i, \mathbf{C}_i, \mathbf{X}_i)$$

comparative advantage

$$V_{ij} = \frac{V_i E_j}{\Pi_i P_j} \tau_{ij}$$

$\mathbf{C}_i - \mathbf{C}_j$ : climate distance  
trade costs

- $V_i$  and  $E_j$ : value of output in  $i$  and total expenditure of  $j$
- $\Pi_i$  and  $P_j$ : multilateral resistances (*Anderson and van Wincoop, 2003*)
- $\tau_{ij}$ : trade costs btw  $i$  and  $j$

# Econometric approach

Empirical gravity equation (e.g., *Yotov et al., 2016*):

$$V_{ijt} = \beta_{it} + \beta_{jt} + \beta_{ij} + C_{ijt}\lambda + \Omega_{ijt}\mu + \varepsilon_{ijt}$$

- $i$  exporter,  $j$  importer,  $t$  year
- $V_{ijt}$ : bilateral export value
- $\beta_{it}, \beta_{jt}$ : country-year FE capture country-specific drivers, multilateral resistances
- $\beta_{ij}$ : country-pair FE capture fix bilateral drivers
- $C_{ijt}$ : **climate distance** (long-run abs. differences in temperature and precipitation)
- $\Omega_{ijt}$ : variable bilateral drivers

Trade volume effects:

$$TVE = \hat{\lambda}_c * 100$$

## How to capture the effect of climate distance?

- Climate distance ( $C_{ijt}$ )
  - high variability between country-pairs
  - slight changes within country-pairs  $\Rightarrow$  we **rely on micro-variations overtime**

Variable		Mean	Std. dev.	Min; Max
<b>Difference in temp (°C)</b>	overall	10.148	7.706	[0.001; 32.765]
	between (380 country-pairs)		7.715	[0.145; 32.513]
	within (20 years)		0.099	[9.779; 10.517]
<b>Difference in prec (mm)</b>	overall	57.910	52.214	[0.005; 232.891]
	between (380 country-pairs)		52.267	[0.858; 228.081]
	within (20 years)		1.130	[53.505; 63.466]

- “Fix distances”  $\Rightarrow$  absorb most of between but not within country-pairs variability
- Sample w/ 3-year gaps (e.g., *Trefler, 2004*) to better capture “adaptation” of flows
- Two-way vs. three-way gravity models (*Weidner and Zylkin, 2021; Shepherd, 2021*)

# Identification strategy – based on two-way gravity models

Two-way gravity model

$$V_{ijt} = \beta_{it} + \beta_{jt} + D_{ij} + C_{ijt}\lambda + \Omega_{ijt}\mu + \varepsilon_{ijt}$$

country-specific drivers

fix bilateral drivers

variable bilateral drivers

(distance, contiguity, currency)

(distance × linear trend, trade policies,  
Freeman et al., 2021)

How to model climate distance ( $C_{ijt}$ ):

- Excluding the time dimension (i.e., the within country-pairs variability)...
  - $C_{ij1997}$  (1997: start date)
  - $C_{ij2013}$  (2013: end date)
- Considering some temporal variability...
  - $C_{ij1997-2013}$  (semi-dynamic measure)
  - $C_{ijt}$  (dynamic measure)

# Identification strategy – based on three-way gravity models

Three-way gravity model

$$V_{ijt} = \beta_{it} + \beta_{jt} + \beta_{ij} + C_{ijt}\lambda + \Omega_{ijt}\mu + \varepsilon_{ijt}$$

country-specific drivers      fix bilateral drivers  
(country-pair FE)      variable bilateral drivers  
(distance × linear trend, trade policies,  
Freeman et al., 2021)

How to model climate distance ( $C_{ijt}$ ):

- Capturing all the between country-pairs variability...
  - $C_{ijt}$  (dynamic measure)

## Evidence – based on two-way gravity models

**Table:** Estimates of gravity models

Variables	Distance <sub>1997</sub>	Distance <sub>2013</sub>	Distance <sub>1997-2013</sub>	Distance <sub>t, restricted</sub>	Distance <sub>t, flexible</sub>
Distance in temperatures	0.014 (0.055)	0.008 (0.059)	0.117 (0.129)	0.011 (0.057)	<b>0.511***</b> (0.122)
Distance in precipitations	0.034 (0.089)	0.040 (0.085)	-0.001 (0.157)	0.059 (0.072)	<b>0.130**</b> (0.051)
Country-specific determinants	Yes	Yes	Yes	Yes	Yes
Variable bilateral determinants	Yes	Yes	Yes	Yes	Yes
Fix bilateral det. (restricted)	Yes	Yes	Yes	Yes	No
Fix bilateral det. (flexible)	No	No	No	No	Yes

Notes: PPML estimates of two-way gravity models; std. err. clustered at pair level.

- Effect of climate distance not detected (positive but not significant coeff.)
- W/ dynamic measures of climate distance (identification of within country-pairs variability)  $\Rightarrow$  coeff.  $\uparrow$  (e.g., from 0.008 to 0.011), std. err.  $\downarrow$  (e.g., from 0.059 to 0.057)

## Evidence – based on three-way gravity models

**Table:** Estimates of gravity models

Variables	Distance <sub>1997</sub>	Distance <sub>2013</sub>	Distance <sub>1997-2013</sub>	Distance <sub>t, restricted</sub>	Distance <sub>t, flexible</sub>
Distance in temperatures	0.014 (0.055)	0.008 (0.059)	0.117 (0.129)	0.011 (0.057)	<b>0.511***</b> (0.122)
Distance in precipitations	0.034 (0.089)	0.040 (0.085)	-0.001 (0.157)	0.059 (0.072)	<b>0.130**</b> (0.051)
Country-specific determinants	Yes	Yes	Yes	Yes	Yes
Variable bilateral determinants	Yes	Yes	Yes	Yes	Yes
Fix bilateral det. (restricted)	Yes	Yes	Yes	Yes	No
Fix bilateral det. (flexible)	No	No	No	No	Yes

Notes: PPML estimates of two-way gravity models; std. err. clustered at pair level.

Dynamic measures of climate distance:

- capture within but not between country-pairs variability in two-way gravity
- capture within and remove between country-pairs variability in three-way gravity

# Marginal impact of climate distance on bilateral exports

**Table:** Trade volume effect (TVE) of climate distance and change in bilateral exports ( $\Delta$  avg exp)

	TVE (%)	$\Delta$ avg exp (bln \$)
Distance in temp. (+1 °C)	38.07%	.19
Distance in prec. (+5 mm)	82.12%	.42

Notes: TVE obtained from PPML coefficients, evaluated at avg. distances in temperature and precipitation;  $\Delta$  avg exp considers avg. bilateral exports.

- ✓ As in *Dallmann (2019)*, larger distance in climate of traders are pro-trade
  - distance in temp +1 °C  $\Rightarrow$  exports  $\uparrow$  (+38% our results; +3% *Dallmann, 2019*)
  - heterogeneous impacts due to different measures of climate distance:  
long-run changes in our results *versus* short-run changes in *Dallmann (2019)*
- Our results: long-run adjustments due to countries specialisation:  
*Gouel and Laborde (2021)* argue that trade may:
  - ✓ balance new domestic supply and demand schedules
  - ✓ induce a reallocation of productions among countries

# Take-home message

This study

- introduces climate distance as driver of bilateral trade (methodological contribution)
  - **climate distance** modelled as **trade costs**  
(next step ...as comparative advantage, w/ approach by *Honoré and Kesina, 2017*)
  - identification isolates btw country-pair variation, captures **overtime variation**
- informs on positive association trade-climate distance (evidence-based contribution)
  - complements the literature on short-run effects of weather shocks on trade
    - ✓ agricultural exports increase w/ raise in temperature distance (*Dallmann, 2019*)
  - fosters (and adds evidence to) the debate on the role of trade in CC adaptation
    - ✓ limited (e.g., *Costinot et al., 2016*) versus crucial (e.g., *Gouel and Laborde, 2021*)
- suggests intercepting “distant” partners as win-win strategy (implications)
  - climate distance contributes to shape countries’ specialisation
    - ✓ shifting specialisation and trading is an adaptation strategy (*Conte et al., 2021*)

# Take-home message

This study

- introduces climate distance as driver of bilateral trade (methodological contribution)
  - **climate distance** modelled as **trade costs**  
(next step ...as **comparative advantage**, w/ approach by *Honoré and Kesina, 2017*)
  - identification isolates btw country-pair variation, captures **overtime variation**

Estimate the gravity equation in two steps:

1. bilateral trade =  $f(\text{unobserved country-specific drivers})$
2. bilateral trade predicted in 1 =  $f(\text{countries' climate, bilateral drivers})$

- suggests intercepting “distant” partners as win-win strategy (implications)
  - climate distance contributes to shape countries' specialisation
    - ✓ shifting specialisation and trading is an adaptation strategy (*Conte et al., 2021*)

# Thanks

*Comments are welcome*

Emilia Lamonaca

*University of Foggia (Italy)*

email: [emilia.lamonaca@unifg.it](mailto:emilia.lamonaca@unifg.it)

**Find out more about the AXA-funded project**  
[AXA Research Fund website](#) and [UniFg website](#)