International and Spatial Economics

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Presentation for M1 students

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Roadmap

1. Common approaches in Trade & Spatial Econ

2. Trade and Spatial at Sciences Po

3. Two of my ongoing projects

    3.1 Adaptation to Climate Change in Pakistan (w/ C. Balboni & M. Waseem)
    3.2 Trade and the End of Antiquity (w/ T. Chaney)

Research in Trade & Spatial

A range of outcomes have a spatial structure:

- Bilateral trade flows between countries/regions
- Bilateral migration flows between countries/regions
- Bilateral commuting flows within cities

Sometimes space is not (just) about geography:

- Sourcing from different suppliers or industries
- Make-or buy decision of firms
- Which workers to hire
- ...etc

Gravity: Generic Structure

- A single *stylized* model, the "gravity" model.
- Can make sense of many spatial equilibria on "stuff":

$$s_{ij} = \frac{\alpha_i \beta_j \gamma_{ij}^{-\delta}}{\sum_k \alpha_k \beta_j \gamma_{kj}^{-\delta}} = \frac{\alpha_i \gamma_{ij}^{-\delta}}{\sum_k \alpha_k \gamma_{kj}^{-\delta}}$$

  - s_{ij}: share of "stuff" arriving in j originating from i (endogenous)
  - α_i: some feature of origin i (exogenous + endogenous)
  - β_j: some feature of destination j (exogenous + endogenous)
  - γ_{ij}: some cost of moving from i to j (exogenous and/or endogenous)
  - δ some elasticity (exogenous or endogenous)

Gravity Applied to Trade

- Equilibrium trade share

$$\pi_{ij} = \frac{L_i (d_{ij} w_i / A_i)^{-\theta}}{\sum_k L_k (d_{ij} w_k / A_k)^{-\theta}}$$

  - π_{ij}: (expected) share of j's imports originating from i
  - L_i: workforce at origin (exogenous)
  - A_i: efficiency/TFP at origin i (exogenous)
  - w_i: wage at origin i (exogenous)
  - d_{ij}: trade cost from i to j (exogenous)
  - θ: trade elasticity (exogenous)

Gravity Applied to Economic Geography

- Equilibrium trade share

$$\pi_{ij} = \frac{L_i (d_{ij} w_i / A_i)^{-\theta}}{\sum_k L_k (d_{ij} w_k / A_k)^{-\theta}}$$

  - Endogenous L_i:
    $\Rightarrow$ allow for migration/factor mobility
  - Endogenous A_i:
    $\Rightarrow$ allow for agglomeration forces
    $\Rightarrow$ allow for congestion forces
  - Endogenous d_{ij}:
    $\Rightarrow$ allow for endogenous design of transportation network
    $\Rightarrow$ allow for congestion along transportation routes

Gravity Applied to (Dynamic) Migration

- Equilibrium migration share

$$\mu_{ij} = \frac{\exp\left[(\beta V_{i,t+1} - \tau_{ij})^{1/\nu}\right]}{\sum_k \exp\left[(\beta V_{k,t+1} - \tau_{kj})^{1/\nu}\right]}$$

  - μ_{ij}: share of j's immigrants from i
  - $V_{i,t+1}$ expected value of residing in i at time $t+1$ (endogenous)
  - β: discount factor (exogenous)
  - τ_{ij}: migration cost from i to j (exogenous)
  - ν: migration elasticity (exogenous)

Gravity Applied to Outsourcing

- Equilibrium share of firms outsourcing production

$$\pi_{ij} = \frac{(\tau_{ij} p_i)^{-\theta}}{(\tau_{ij} p_i)^{-\theta} + (R_j^{\alpha} w_j^{1-\alpha})^{-\theta}}$$

  - π_{ij}: (expected) share of firms outsourcing production to i
  - p_i: price offered by i
  - R_j: rental rate of capital
  - w_j: wage
  - τ_{ij}: transaction cost
  - θ: outsourcing elasticity

Trade & Spatial at Sciences Po

- **Thierry Mayer:** Firm heterogeneity, spatial/econ geography, IO of trade
- **Isabelle Mejean:** Production Networks, Firm Heterogeneity, Intl. Macro
- **Johannes Boehm:** Production Networks, Growth, Industrial Development
- **Kevin O'Rourke:** Trade and Intl. Macro in History
- **Pierre-Philippe Combes:** Econ geography, Urban economics
- **Florian Oswald:** Spatial/Housing/Migration
- **Clara Santamaria:** Urban/Spatial economics

Common Methodology

Compared to many other fields, Trade and Spatial are more methodologically homogeneous:

- Most papers have theory and empirics
- Microdata, reduced-form regressions
- Quantitative model, estimation of key parameters
- Counterfactuals

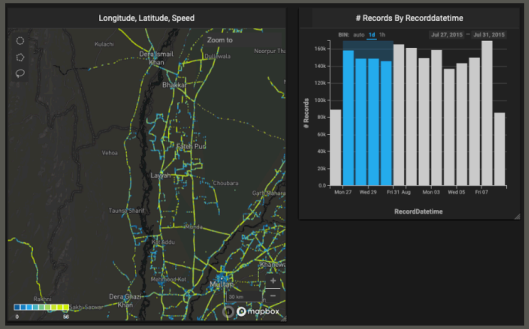
Approach has also entered other fields, in particular development and environment

1. Adaptation to Climate Change in Pakistan (w/ C. Balboni, M. Waseem)

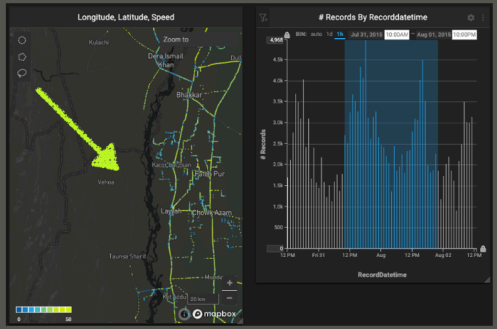
- Research Question: to what extent are firms adapting to climate change? How much do adaptive decisions matter?
- Context: Pakistan
  - Annual Monsoon rainfalls, which lead to floods of varying magnitudes. Become more extreme and frequent with climate change
  - Floods destroy capital and disrupt transportation network (roads, bridges
- Data:
  - VAT transactions data: near-universe of firm-to-firm sales, by month, 2011-2019
    - To capture firms' adaptation decisions: location, supplier mix, buyer mix
  - Panel of all movements of ∼16,000 trucks equipped with GPS trackers (∼6bn obs), 2011-2019
    - To measure disruptions to road network (slow trucks/no trucks close to flooded area → disruption)

N-55 Indus Highway, between Dera Ghazi Khan, and Dera Ismail Khan

Jul 27-30, 2015: normal traffic

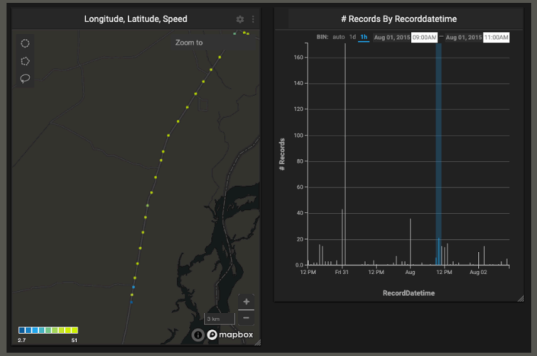


Jul 31, 10:00 - Aug 1, 10:00: no traffic

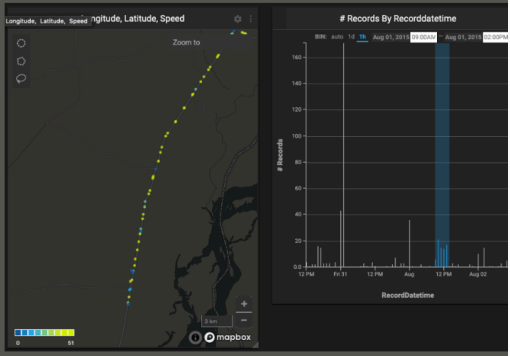


According to the NDMA's situation reports from 2nd August 2015 and 7th August 2015, on 09:15 local time on 31 July 2015, "Floodwater coming from Koh-e-Suleman Range hill torrents hit Vehova Bridge on N-55" and damaged the approach road. The high flood "swept away a 300-foot portion of the highway" (Dawn.com, 2015).

At 09:15 of 31 Jul (day of closure, a vehicle approaches the closed bridge from the north

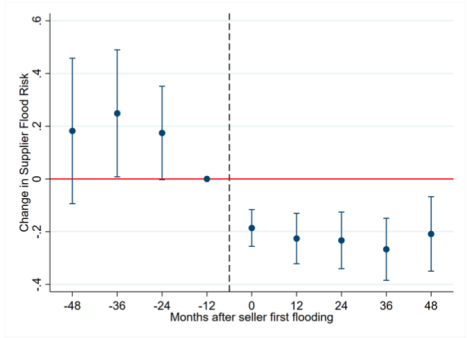


At 11:00 it is about halfway between Dera Ismail Khan and the river northeast of the closed bridge. The car slows down (blue dots).

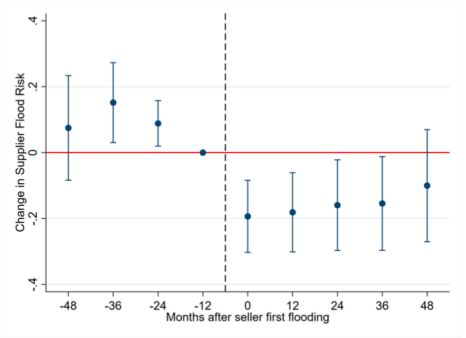


Then it turns around, going back to Dera Ismail Khan, which it reaches at 14:00.

Supplier gets hit: firms persistently reduce exposure to flood-prone suppliers

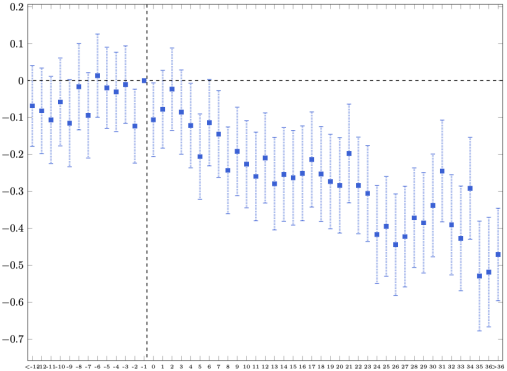


(a) Suppliers' weighted average Fathom flood risk



(b) Non-flooded suppliers' weighted average Fathom flood risk

Road gets hit: firms more likely to stop buying from supplier (and don't return)



The graph shows the response of the probability of sales being positive in the (b, s) relationship around the first time the shortest path between b and s gets flooded (after entry of b and s). Regression conditions on both b and s having entered, and includes $b \times s$, $s \times t$, and $b \times t$ fixed effects and months-since-first-sale dummies.

Adaptation to Floods in Pakistan

- Use micro-founded model of inter-regional trade in Pakistan:

$$\frac{X_{ni}}{X_n} = \frac{m_{ni} d_{ni}^{-\theta} c_i^{-\theta}}{\sum_j m_{nj} d_{nj}^{-\theta} c_j^{-\theta}}$$

- Solve in changes: sourcing decisions change in a *persistent* way following floods $\Rightarrow$ identify as changes in search efforts m_{ni}
- Counterfactual: how much do observed adaptive decisions reduce impact of subsequent floods, or risk from floods in general?

2. Trade and the End of Antiquity (w/ T. Chaney)

What caused the End of Antiquity?

- Antiquity: Roman and Greek civilizations centered around the Mediterranean
- End of antiquity circa 7th-8th Century AD:
  - Economic activity shifts away from the Mediterranean.
  - Rise of Northern Europe (Charlemagne).

↪ *Question*: What caused the End of Antiquity?

- Discussed, among others, by Montesquieu (1734), Voltaire (1756), Gibbon (1789)

Pirenne's Hypothesis

Henri Pirenne (1937), *"Mahomet et Charlemagne"*

- Rise of the Islamic Caliphate disrupts Mediterranean trade/exchanges.
- Causes a shift of economic activity away from the Mediterranean.
- Rise of the Carolingian Empire in Northern Europe.

Political changes in the Mediterranean: 600 AD

Political changes in the Mediterranean: 600 AD

Political changes in the Mediterranean: 600 AD

Political changes in the Mediterranean: 600 AD

Political changes in the Mediterranean: 632 AD

Political changes in the Mediterranean: 634 AD

Political changes in the Mediterranean: 644 AD

Political changes in the Mediterranean: 661 AD

Political changes in the Mediterranean: 661-700 AD

Political changes in the Mediterranean: 750 AD

This paper

We use data on the movement of coins to study the changing economic geography during Late Antiquity

1. Coins and goods/services travel in opposite directions:

   ↪ Ancient coins record traces of ancient trade flows.

2. Trade flows are shaped by gravity:

   ↪ (*Reconstructed*) trade flows inform:

   (a) bilateral trade frictions
   (b) origin/destination "sizes"

3. Time-varying (*estimated*) trade frictions:

   ↪ Test + quantify the Pirenne hypothesis.

Data

Data: Coins around the Mediterranean, AD 325 to AD 950

- Each coin provides the following information:
  1. Mint location (“birthplace”): m
  2. Mint date (“birthdate”): τ
  3. Hoard location (“death place”): h
  4. Terminus post quem, *tpq* (“death date”): $T = \sup \tau$

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  3. Hoard location (“death place”): h
  4. Terminus post quem, *tpq* (“death date”): $T = \sup \tau$
- 286,035 coins.
- Time:
  - Mint date > AD 325
  - *tpq* < AD 950.
- Space:
  - Western Europe.
  - Southern Europe.
  - Northern Africa.
  - Middle East++.

Paper

We document 3 main stylized facts:

1. Older coins travel further.
2. Distance *and* politics impede coin travels (gravity).
3. The Arab conquest disrupts Mediterranean crossings.

Then write a model where coins diffuse across space along (and in proportion to) trade
$\rightarrow$ identification of trade flows and changes in trade costs (Pirenne)

Fact #1: within a hoard, older coins have travel farther

Table 1: Within-hoard distance travelled and age of coin at deposit

	Dependent variable: Log Distance between Mint and Hoard				
	(1)	(2)	(3)	(4)	(5)
Log Age of Coin	0.141**	0.0994***	0.0931**	0.157***	0.0672**
	(0.047)	(0.026)	(0.032)	(0.044)	(0.021)
Sample				No non-hoards	No non-hoards
Hoard FE	Yes	Yes	Yes	Yes	Yes
Mint × 50-year-interval FE		Yes			
Mint × 25-year-interval FE			Yes		Yes
R^2	0.775	0.865	0.871	0.795	0.901
Observations	276557	276346	276184	239588	239271

Standard errors in parentheses, clustered at the hoard level.
$^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$

Shows that coins diffuse across space over time.

Fact #2: distance and political borders impede coin travels

Construct $1° \times 1°$ cells for mint and hoard locations and calculate flows count_{mdh}

Table 2: Gravity and Border Effects in Coin Flows

	Dependent variable: # Coins_{mdh}			
	(1)	(2)	(3)	(4)
Log Distance	-1.162**	-1.007**	-0.764**	-0.731**
	(0.13)	(0.13)	(0.11)	(0.11)
Within border dummy		2.321**		1.598**
		(0.33)		(0.41)
Hoard Cell FE	Yes	Yes	Yes	Yes
Mint × Empire Cell FE	Yes	Yes	Yes	Yes
Sample			Int. Marg. only	Int. Marg. only
Estimator	PPML	PPML	PPML	PPML
R^2				
Observations	207184	207184	6126	6126

Standard errors in parentheses, clustered at mint cell × empire and hoard cell level.
$^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$

Estimating eqn: $\text{count}_{mdh} = \exp\left(\gamma_1 \log \text{distance}_{mh} + \gamma_2 \text{withinBorder}_{dh} + \alpha_{md} + \alpha_h + \varepsilon_{mhd}\right)$

Fact #3: Arab conquest disrupts Mediterranean trade

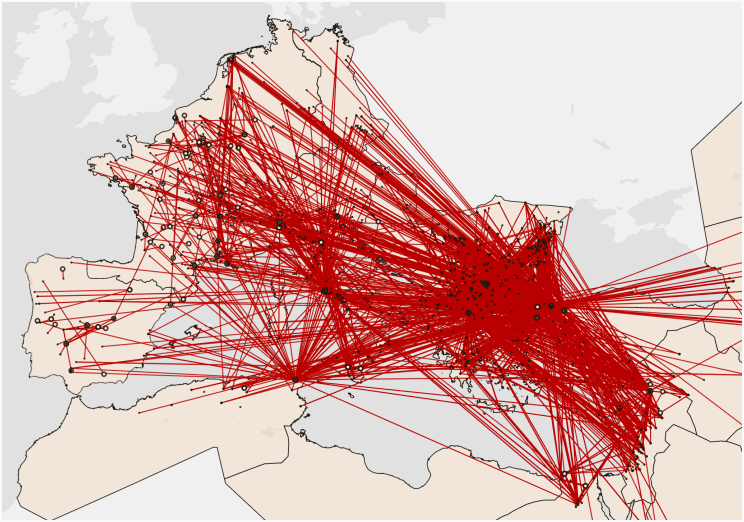

Figure 1: Before the Arab conquests: 450-630 AD

Fact #3: Arab conquest disrupts Mediterranean trade

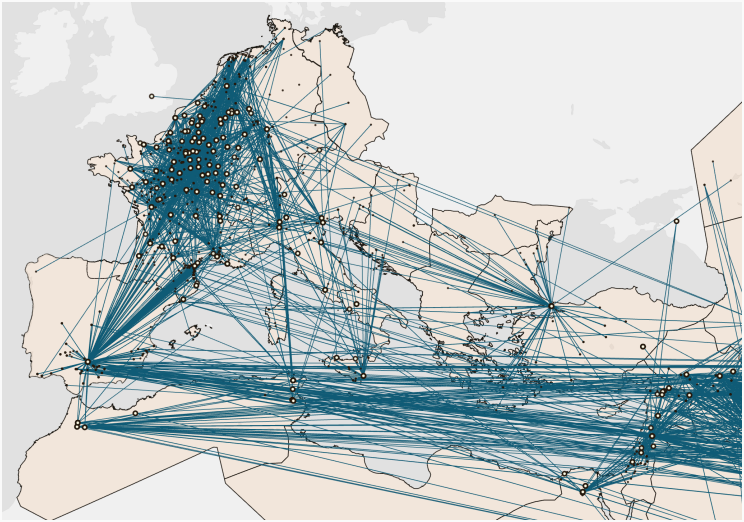

Figure 2: After the Arab conquests: 713-900 AD

Fact #3: Arab conquest disrupts Mediterranean trade

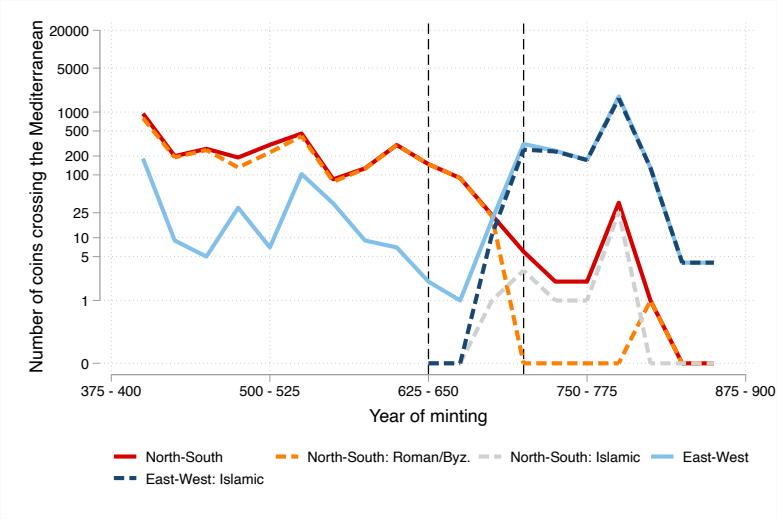

Figure 3: Number of coins flowing across the Mediterranean

Fact #3: Arab conquest disrupts Mediterranean trade

Table 3: The Mediterranean Before and After the Arab Conquest

	Dependent variable: Number of Coins			
	(1)	(2)	(3)	(4)
Crossing Mediterranean × After Conquests	-1.913**	-3.413**	-0.796	-0.479
	(0.51)	(0.62)	(0.67)	(0.97)
Crossing Mediterranean × After Conquests × Islamic Coin		6.990**	4.427**	7.219**
		(0.92)	(0.94)	(0.95)
Crossing Mediterranean × After Conquests × Roman Coin			-3.638**	-3.479**
			(0.74)	(0.77)
Mint Cell × Empire FE	Yes	Yes	Yes	Yes
Mint Cell × Hoard Cell FE	Yes	Yes	Yes	Yes
After Conquests FE	Yes	Yes	Yes	
Mint Cell × After Conquests FE				Yes
Hoard Cell × After Conquests FE				Yes
Estimator	PPML	PPML	PPML	PPML
Observations	9110	9110	9110	4795

Standard errors in parentheses, clustered at the hoard × era and mint × era level.
$^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$

Estimating eqn: $\text{count}_{mdht} = \exp\left(\gamma_1 \text{mediterranean}_{mh} \times \text{after}_t + \cdots + \alpha_{md} + \alpha_{mh} + \varepsilon_{mhdt}\right)$

Theory + Quantification

Model with N locations that trade (Ricardian) in every period.

- Locations are endowed with exogenous supply of coins (minting)
- Coins are required to make purchases with ("cash-in-advance")
- Coins diffuse proportional to trade flows

Inverting the model equations allows recovery of *trade flows*

Then: parameterize trade costs (distance, border effects) to tease apart trade costs and productivity. Do counterfactuals on trade costs to understand how changing trade costs in the Mediterranean contribute to a changing market access and changing welfare.