INTERNATIONAL TRADE - ECON 245

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NEW TRADE THEORY

INTRODUCTION

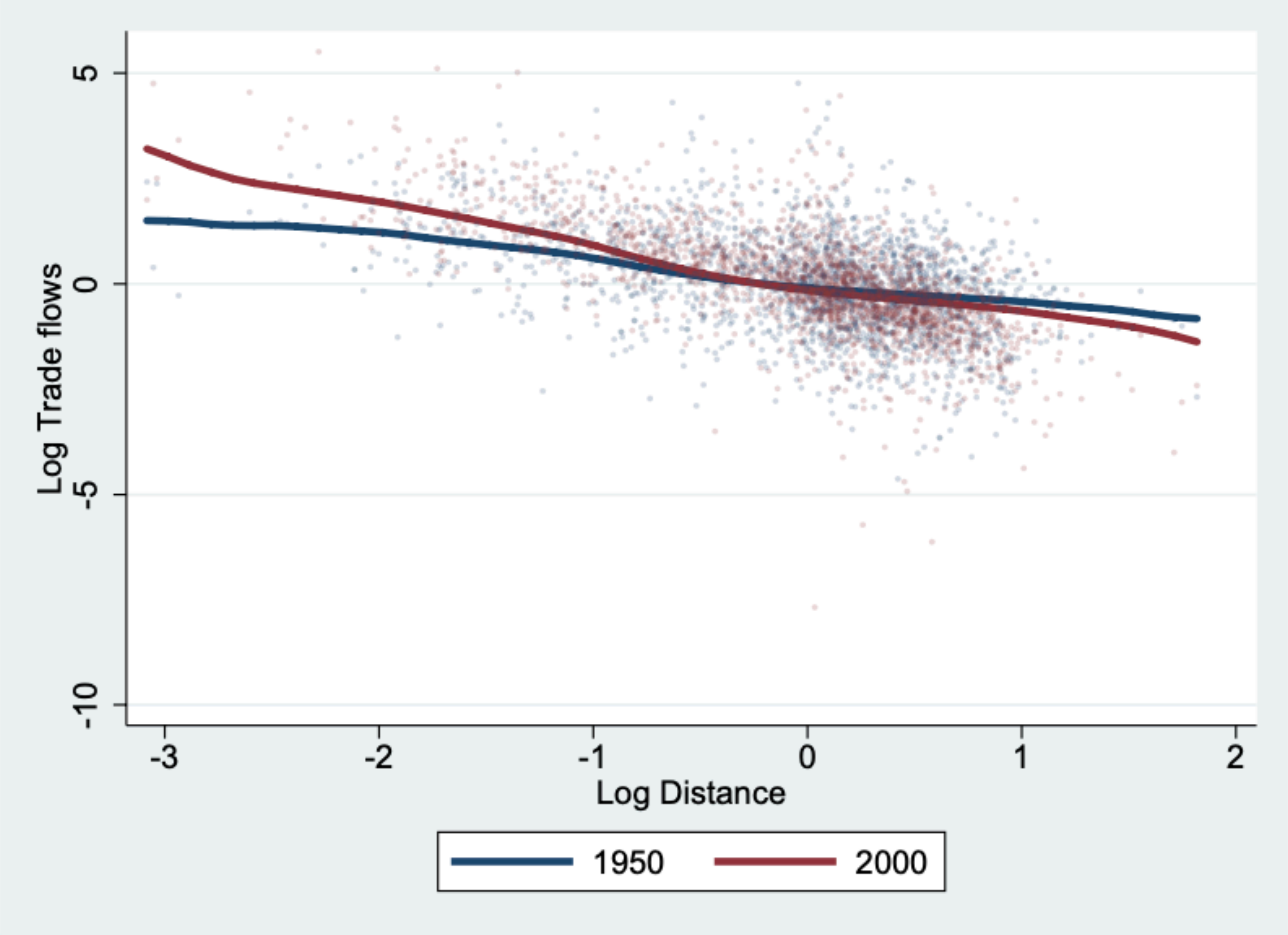
- Today: two *new* reasons for trade, *love for variety* and *increasing returns to scale*
  - With both: gains from trade even without comparative advantage differences!
- Builds on two seminal, interrelated contributions:
  - "Love for Variety": downward sloping demand for each variety
  - Monopolistic competition: continuum of firms producing differentiated varieties+free entry/exit [formalized by Dixit and Stiglitz (1977)]
- Krugman (1979, 1980, 1981) brought this intro trade and got the Nobel Prize for it!

GRAVITY IN TRADE

IDEA OF GRAVITY EQUATIONS

- Neoclassical theories of trade (Ricardo, Heckscher-Ohlin) are hard to generalize to settings with many countries and an arbitrary trade costs matrix
  - Hard to bring them to the data and do empirical work
- Empirical trade economists started using an a-theoretical model known as the "gravity equation" due to its similarity to Newton's law of gravitation
- Huge literature on estimating gravity equations in trade data, but also migration data, commuting data, financial transactions data, social connections data.

Figure 3.1: Across country gravity: Trade flows between countries over time



Notes: Data are from Head, Mayer, and Ries (2010). Only bilateral pairs with observed trade flows in both 1950 and 2000 are included. The thick lines are from a nonparametric regression with Epanechnikov kernel and bandwidth of 0.5 after partitioning out the origin-year and destination-year fixed effects.

Figure 3.3: Within country gravity: Trade flows between U.S. states

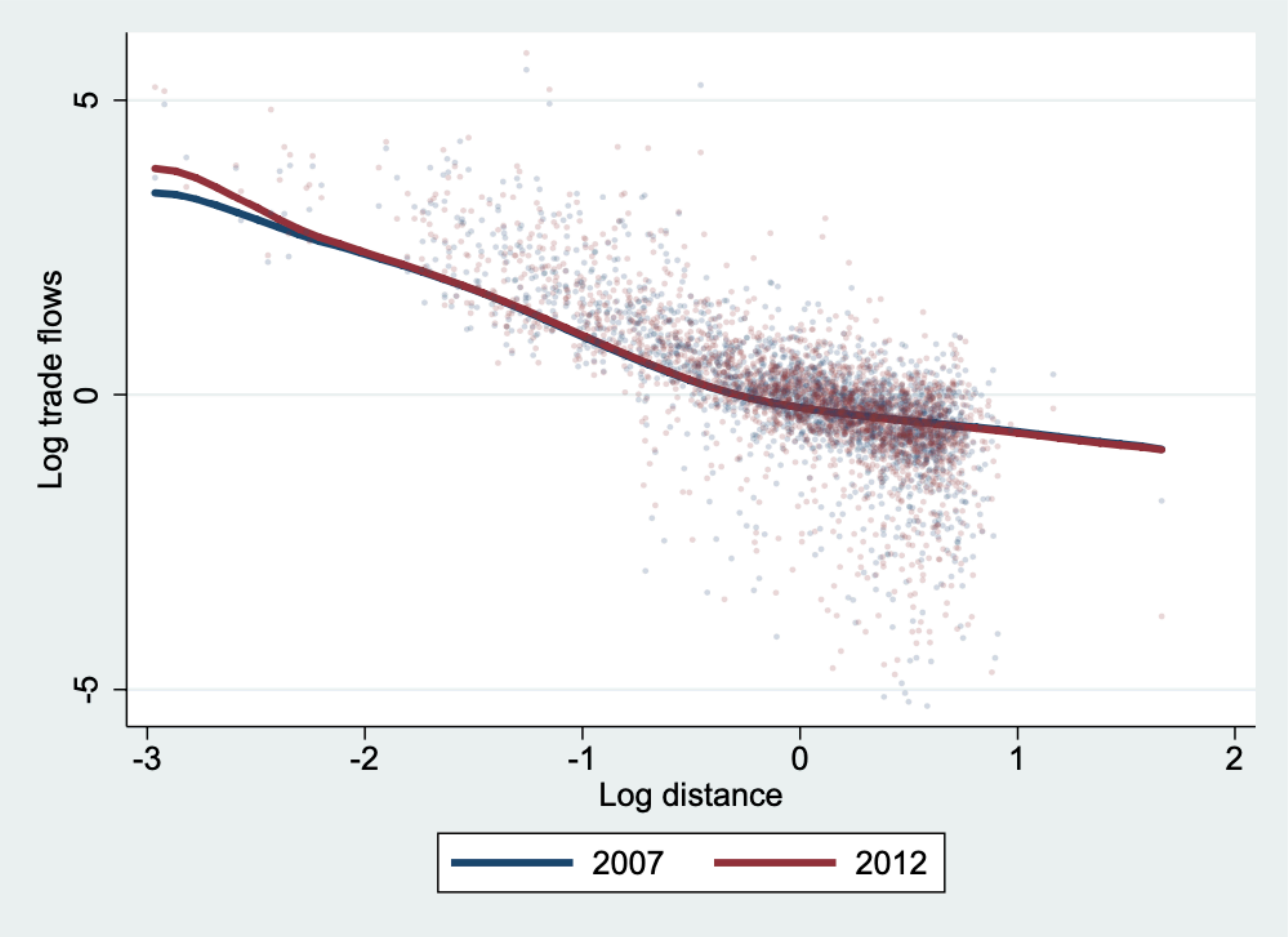
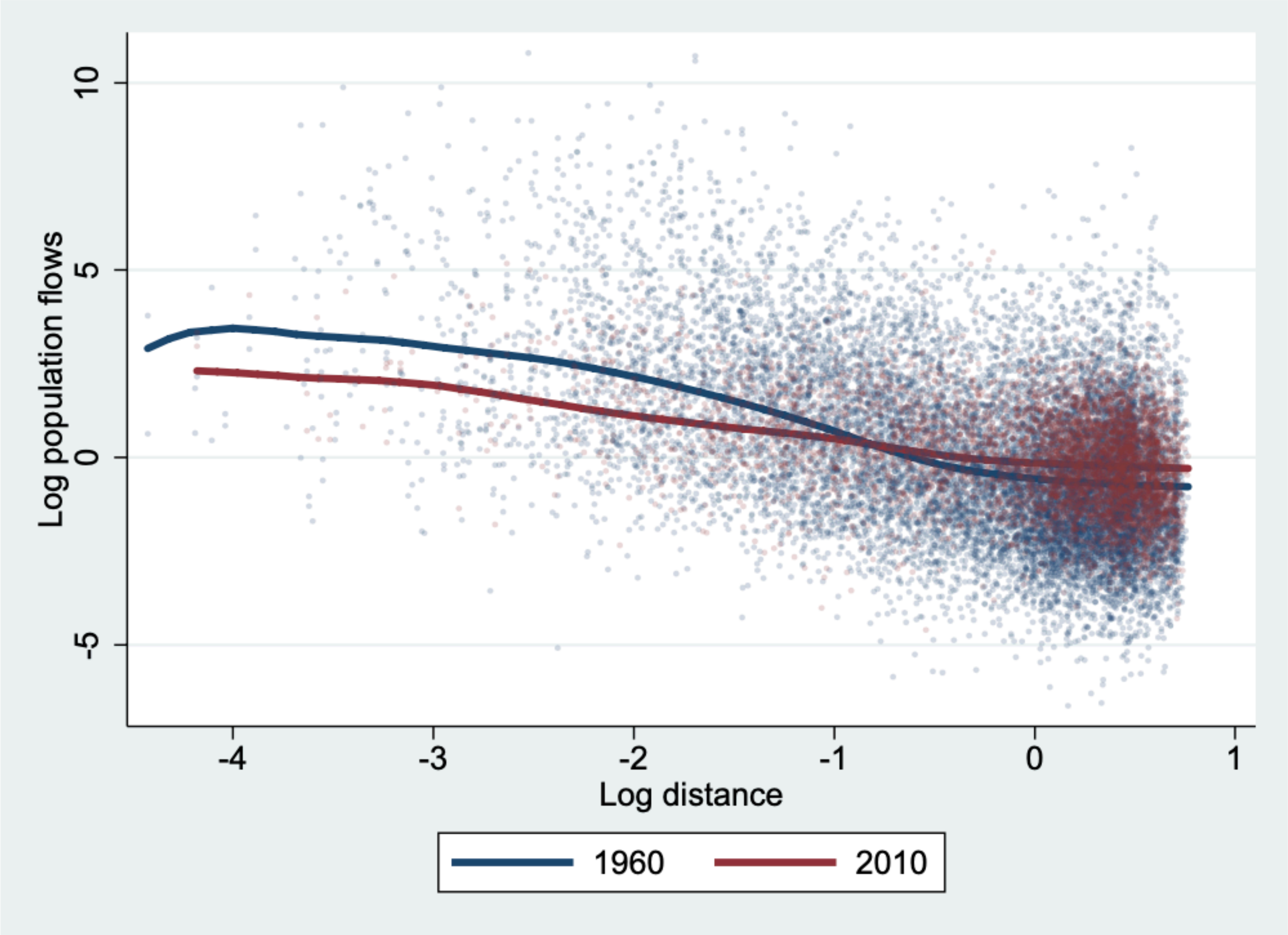
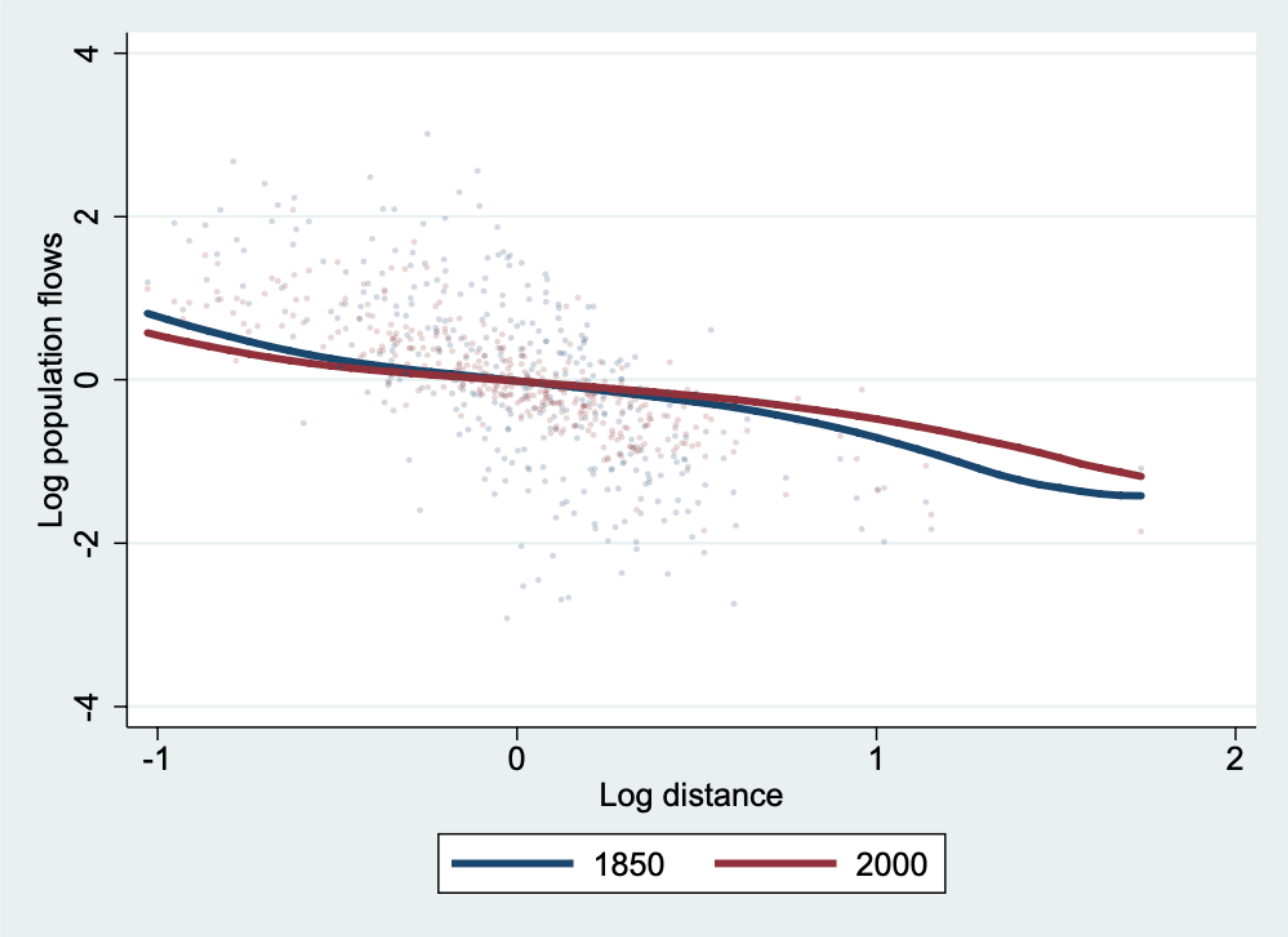


Figure 3.8: Across country gravity: Migration flows between countries over time



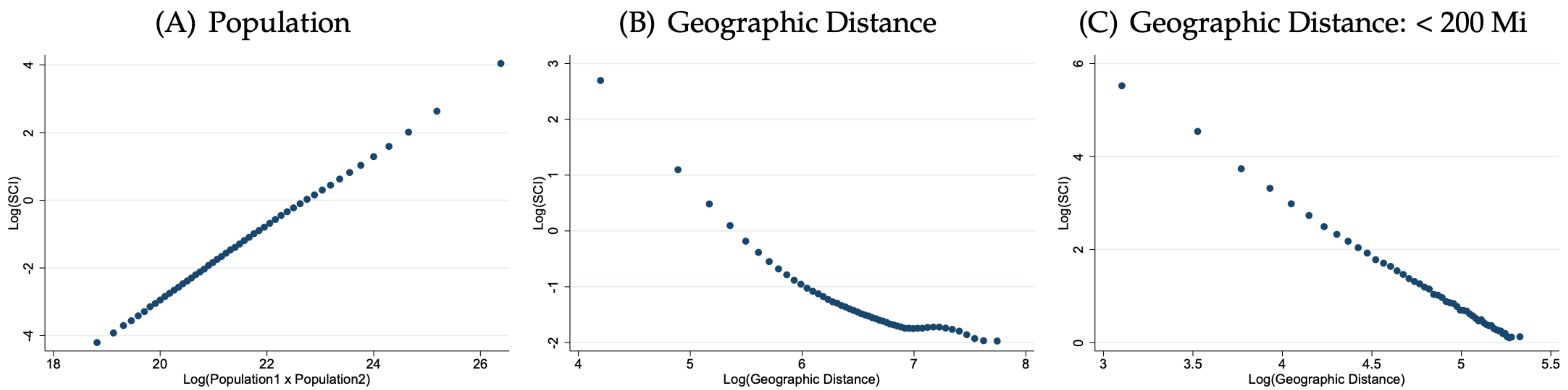
Notes: Data are from Yeats (1998). Excludes own country population shares (i.e. non-migrants). The thick lines are from a nonparametric regression with Epanechnikov kernel and bandwidth of 0.5 after partitioning out the origin-year and destination-year fixed effects.

Figure 3.10: Within country gravity: Migration flows between U.S. states



Notes: Data are from the 1850 and 2000 U.S. Censuses Ruggles, Fitch, Kelly Hall, and Sobek (2000), where migration flows are comparing current state of residence of 25-34 year olds to their state of birth. The thick lines are from a nonparametric regression with Epanechnikov kernel and bandwidth of 0.5 after partitioning out the origin-year and destination-year fixed effects.

Figure 3: County-Level Social Connectedness



Note: Figure shows binned scatter plots with county-pairs as the unit of observation. In Panel A, the log of the product of the county populations is on the horizontal axis, and the log of the SCI is on the vertical axis. Panel B shows a conditional binned scatter plot, where we flexibly condition on the log of the product of the populations in the two counties; on the horizontal axis is the log of the distance between the two counties, measured in miles, and on the vertical axis is the log of the SCI. Panel C shows a subset of Panel B focused on county-pairs that are less than 200 miles apart.

IDEA OF GRAVITY EQUATIONS

- The gravity equation takes the following form:

$$X_{ij} = \alpha \frac{Y_i \times Y_j}{D_{ij}} \equiv K_{ij}\gamma_i\delta_j$$

Where Y_i is country i's GDP and D_{ij} is the physical distance between the two countries. The latter equation is a "generalized" gravity equation with bilateral resistance" term and fixed effect for origin and destination size.

- The most successful empirical relationship in all of economics?

- Yet, for a long time a-theoretical and so no ability to do counterfactuals!

CONSTANT ELASTICITY MODELS

GENERAL SETUP

- Set of S discrete countries (locations); i for origin, j for destination
- Denote by X_j the total spending of country j
- Denote by L_j the population of country j
- Each consumer inelastically supplies one unit of labor
- Labor is the only unit of production
- "Iceberg Trade Cost" τ_{ij}: when ship good $\tau_{ij} - 1$ is lost on trip.

DEMAND: CONSTANT ELASTICITY OF SUBSTITUTION

- Remarkably simple yet versatile demand system:
  1. Homothetic
  2. Nest other demand systems (e.g., Cobb-Douglas)
  3. Highly tractable
- Pervasive in trade literature
  - Even if "unrealistic" at times, their tractability makes them very widely used

DEMAND: CONSTANT ELASTICITY OF SUBSTITUTION

- Representative consumer in country j derives utility U_j from the consumption of a set of varieties Ω shipped from all countries $i \in S$:

$$U_j = \left(\sum_{i \in S} \int_{\omega \in \Omega_i} a_{ij}(\omega)^{1/\sigma} q_{ij}(\omega)^{\frac{\sigma - 1}{\sigma}} \right)^{\frac{\sigma}{\sigma - 1}}$$

Where a $\sigma \geq 0$ is the elasticity of substitution and $a_{ij}(\omega)$ is an exogenous preference shifter.

- **Note**: $q_{ij}(\omega)$ is the quantity of a good shipped from i that *arrives* in j, the quantity shipped is $\tau_{ij} q_{ij}(\omega)$

DEMAND: CONSTANT ELASTICITY OF SUBSTITUTION

Solve the representative consumer maximization problem:

$$\max_{q_{ij}(\omega)_{\omega\in\Omega}} \left(\sum_{i\in S}\int_{\omega\in\Omega_i} a_{ij}(\omega)^{1/\sigma} q_{ij}(\omega)^{\frac{\sigma-1}{\sigma}}\right)^{\frac{\sigma}{\sigma-1}} \quad \text{s.t.} \quad \sum_{i\in S}\int_{\omega\in\Omega_i} q_{ij}(\omega)p_{ij}(\omega) \le X_j$$

Solving this (homework!) yields the CES demand function:

$$q_{ij}(\omega) = a_{ij}(\omega)p_{ij}^{-\sigma}(\omega)X_jP_j^{\sigma-1}$$

Where $P_j = \left(\sum_{i\in S}\int_{\omega\in\Omega_i} a_{ij}(\omega)p_{ij}^{1-\sigma}(\omega)\right)^{\frac{1}{\sigma}}$ is the "Dixit-Stiglitz" price index., i.e., the true cost of living index in the sense that $e(P_j, u_j) = P_ju_j = X_j$ [verify!]

DEMAND: CONSTANT ELASTICITY OF SUBSTITUTION

- The *value* of total trade between i and j in variety ω is then simply:

$$X_{ij}(\omega) = p_{ij}(\omega)q_{ij}(\omega) = a_{ij}(\omega)p_{ij}^{1-\sigma}(\omega)X_jP_j^{\sigma-1}$$

- We can integrate over all varieties produced in origin i to get total bilateral flows:

$$X_{ij} = X_jP_j^{\sigma-1}\int_{\omega\in\Omega_i} a_{ij}(\omega)p_{ij}^{1-\sigma}(\omega)d\omega$$

- We next discuss how to solve for the optimal price - which requires an assumption on market structure.

MARKET STRUCTURE

- There are three common assumptions on market structure:
  - *Armington*: markets in every country are perfectly competitive, so the price of a good is simply equal to its marginal cost. [Armington 1969, Anderson 1979, Anderson and VanWincoop 2003]
  - *Krugman [Monopolisitic Competition]*: production is monopolistically competitive so that the firm does not perceive any immediate competitor but it is affected by the overall level of competition [Krugman (1979, 1980, 1981)]
  - *Betrand*: price of a good depends on the marginal cost of the least cost producer as well, potentially, on the cost of the second cheapest producer. [need firm heterogeneity, so postpone this till later]

ARMINGTON

ARMINGTON (1969) AND ANDERSON (1979): CENTRAL PREMISE

- *Premise*: each country produces its own “variety” or good and consumers in each country have a “love for variety” which makes them want to buy each country’s good.
  - Ad-hoc and not based on comparative advantage: assume reasons for trade
- Formulation with CES preferences (see Anderson 1979) important since it provided the first theoretical justification for the gravity equation
- Counterfactual predictions of Armington model are very robust to changes in microstructure of model (see Arkolakis, Costinot, Rodriguez-Clare 2008)

ARMINGTON (1969): SETUP

- Each country produces a distinct variety: index country and its variety by i
- Market for each good is perfectly competitive: price of good = marginal cost
- Each worker can produce A_i of her country's final good
  - "Factor door" price for variety i is then given by $p_i = w_i/A_i$
  - Price of variety i in country j is: $p_i = \tau_{ij} w_i/A_i$
  - "No arbitrage" condition: $p_{ij}/p_i = \tau_{ij}$
    - Usually also assume "triangle inequality" holds: for all $i, j, k \in S$, $\tau_{ij} \times \tau_{jk} \geq \tau_{ik}$ holds

ARMINGTON (1969): GRAVITY

- Substitute expression for price into the CES demand equation to obtain:

$$X_{ij} = a_{ij}\tau_{ij}^{1-\sigma}(\frac{w_i}{A_i})^{1-\sigma}X_jP_j^{\sigma-1}$$

Where assume that $\sigma > 1$ so that trade flows decline in distance

- Total income in country i can then be expressed:

$$Y_i = \sum_j X_{ij} \leftrightarrow (\frac{w_i}{A_i})^{1-\sigma} = \frac{Y_i}{\sum_j a_{ij}\tau_{ij}^{1-\sigma}X_jP_j^{1-\sigma}} \equiv \frac{Y_i}{\Theta_i}$$

ARMINGTON (1969): GRAVITY

- Finally we can put these results together:

$$X_{ij} = a_{ij}\tau_{ij}^{1-\sigma}\left(\frac{Y_i}{\Theta_i^{1-\sigma}}\right)\left(\frac{X_j}{P_j^{1-\sigma}}\right)$$

- Gravity! Equation relates bilateral trade flows to product of the GDP of both countries
- BUT also shows that original a-theoretical equation forgot something:
  - Relative flows also depend on cost of trading between i and j *relative* to cost of trading with other countries (see Anderson, van Wincoop (2003)).

ARMINGTON (1969): IMPORTANT NOTATION FOR CODING

- We can write bilateral trade flows as follows:

$$X_{ij} = a_{ij}\tau_{ij}^{1-\sigma}(\frac{w_i}{A_i})^{1-\sigma}X_jP_j^{\sigma-1} = (\frac{p_{ij}}{P_j})^{1-\sigma}X_j = \lambda_{ij}X_j = \frac{a_{ij}\tau_{ij}^{1-\sigma}(\frac{w_i}{A_i})^{1-\sigma}}{\sum_i a_{ij}\tau_{ij}^{1-\sigma}(\frac{w_i}{A_i})^{1-\sigma}}X_j$$

where λ_{ij} is a crucial object: fraction of income in j spent on goods from i.

- In spatial models can always derive such matrices with fractions that summarize spatial flows as a function of origin/destination stocks.
- These shares summarize information about market conditions in all locations.
  - What location j buys from i depends not only on variables in *all* locations!
- Note that $\sum_j \lambda_{ij} = 1$ by construction

ARMINGTON (1969): WELFARE

- Welfare takes a very simple, "famous" form in the Armington model.
- Define λ_{ij} as the fraction of expenditure in j spent on goods arriving from location i:

$$\lambda_{ij} \equiv \frac{X_{ij}}{\sum_k X_{kj}} = a_{ij}\tau_{ij}^{1-\sigma} A_i^{\sigma-1} (\frac{w_i}{P_j})^{1-\sigma}$$

- Utility of representative agent is the real wage: $U_j = X_j / P_j$ so that

$$U_j = \frac{w_j}{P_j} = \lambda_{jj}^{\frac{1}{1-\sigma}} a_{jj}^{\frac{1}{\sigma-1}} A_j$$

- Result from Arkolakis, Costinot, Rodriguez-Clare: GFT only depend on λ_{jj}!!!

ASIDE: LABOR SUPPLY "MODULE"

- Spatial models we work with a *modular*.
- The Armington model of trade can be thought of has having a particularly boring "labor supply module:"

$$L_i = \bar{L}_i$$

- More generally the labor supply module can be written as follows:

$$L_i = \Phi_i(\{w_i\}), \{P_i\})$$

- We will consider some specifications of $\Phi_i(\cdot, \cdot)$ in the coming weeks.

GENERAL EQUILIBRIUM

CLOSING THE MODEL(S)

- We imposed goods market clearing by substituting demand into firm problem
- In the Armington model, need one additional equation: labor market clearing

$$Y_j = w_j L_j = \sum_{i \in s} \lambda_{ji} w_i L_i = \sum_{i \in s} \lambda_{ji} X_i$$

PROBLEM SET

PROBLEM SET ON ARMINGTON MODEL: PART 1

- *Task*: Solve a basic version of the Armington trade model.
- Choose the following parameters:
  - $\sigma = 2$
  - $S = 10$
  - $L_i = 1 \, \forall i, A_i = 1,2,3\ldots,10$ for $i = 1,2,...$
  - Set $\tau_{jj} = 1$ and $\tau_{ij} = 2$
- Compute welfare gains from moving from $\tau_{ij} = 2$ to $\tau_{ij} = 1$ and verify formula holds!
- I recommend using Matlab. Normalize World GDP to unity.