Geographical Advantage: Home Market Effect in a Multi-Region World

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1. Introduction

- Importance of geographical factors in shaping spatial patterns of development
  - Obvious to most business people and policymakers
  - Economic historians also emphasize the geographical factors: Braudel (1972), Hicks (1969), McNeill (1974), Pirenne (1939), and many others

- Formal models of trade pay limited attention to geographical factors, except factor endowments.

- We propose a framework that allows us to identify different mechanisms through which geographical factors affect the distribution of industries across regions.

- A multi-region extension of the 2-region Home Market Effect model of Helpman-Krugman (1985; Ch.10.4) with IRS, monopolistic competition, and iceberg.

- Equilibrium distribution of firms across regions, a non-negative vector, determined by
  - Exogenous distribution of resources across regions, a positive vector
  - Proximity between each pair of regions, a non-negative symmetric matrix.

- Flexible enough to accommodate different types of geographical factors as special cases.

Why Home Market Effect in a Multi-region Model?

Home Market Effect: The larger country/region has disproportionately more producers of differentiated goods and becomes the net exporter of these goods.

Two-Region Assumption in most studies
Some exceptions: e.g., Baldwin-Venables (1995), 3-country model applied to preferential trade agreements

Multi-Region allows us to ask the effects of geographical asymmetry across regions.

For example,

- Incentive for firms to be "near" the big market, as opposed to "in" the big market?
- Advantages for regions to be *centrally* located?
- How does a change in trade costs might magnify or overturn (possibly small) geographical (dis)advantage?
  - ➢ *Internal* trade costs (domestic infrastructure) on cross-country distributions of industries
  - ➢ *External* trade costs on within-country distribution of industries
  - ➢ Global impacts of creating or improving a trade route connecting two regions

etc.

First Nature vs Second Nature: Relation with New Economic Geography

NEG is about **Second Nature**

- **Endogenous** market size through demand & cost linkages → **strategic complementarities** in firms entry decisions → **circular mechanism**
- **Multiple equilibria or self-fulfilling** nature of aggolomeration) "They are there because they are there!"
- **Path-dependence**
- **(Spontaneous) Symmetry-Breaking**: As trade costs change, core-periphery patterns emerging even across **inherently identical** regions ("featureless plain") through such agglomeration. (If geographical factors are introduced, the goal is to show that agglomeration can occur in spite of geographical disadvantages.)

This model is about **First Nature**

- **Exogenous** market size; **No strategic complementarities**; **No circular mechanism**
- **Unique equilibrium, No path-dependence**
- **(Explicit or "Induced") Symmetry-Breaking**, how small geographical asymmetries across regions are amplified by changes in trade costs
- # of regions greater than two is essential.

Also, this is a trade model with factor mobility playing no role, in contrast to most NEG models (exceptions, Krugman-Venables (1995), Matsuyama (1996, Lorenz curve paper)

2. Framework

One Nontradeable Factor: Labor

R* Regions; *r* = 1, 2, ... , *R

***L^r* Households:** each supplies one unit of labor at w^r with the budget constraint:

$$w^r = (p_o^r)^{1-\alpha}(P^r)^{\alpha}U^r \qquad \text{where } P^r \equiv \left\{\int_{\Omega}\left[p^r(z)\right]^{1-\sigma}dz\right\}^{\frac{1}{1-\sigma}} \qquad \text{with } \sigma > 1$$

w^r:	wage rate in Region r
p_o^r:	Price of Outside good
$p^r(z)$:	Price of good z in Region r;
Ω:	Range of differentiated goods produced in equilibrium;
P^r:	Price index for differentiated goods in Region r.

Individual Demand:

$$c^r(z) = \left(\frac{p^r(z)}{P^r}\right)^{-\sigma}\frac{\alpha w^r}{P^r}; \qquad z \in \Omega; \quad r = 1, 2, \ldots, R.$$

Technology:

- **Homogeneous Outside Good;** competitive, CRS (one-to-one), and zero trade cost, the law of one price.

By selecting it as the numeraire, $p_o^r = 1$ for all $r = 1, 2, \ldots, R$.

$w^r \geq 1$ for all r ;
$w^r = 1$ if Region r produces the outside good.

- **Differentiated Goods**: monopolistically competitive, IRS.

Total Factor Requirement, $T(x)$: $xT'(x)/T(x)$ is strictly increasing in x,

$\Omega = \sum_j \Omega^r$, where Ω^r is the set of differentiated goods produced in Region r, with its measure denoted by N^r

Iceberg Trade Costs: from Region c to d, only a fraction $1/\tau_{cd} \leq 1$ of the good shipped arrives. → $p^d(z) = p^c(z)\tau_{cd} \geq p^c(z)$

Total Demand for a good produced in Region *c*, if its producer charges *p(z)*:

$$x(z) = \sum_d \tau_{cd} c^d(z) = \sum_d \frac{\tau_{cd}(p(z)\tau_{cd})^{-\sigma}\alpha w^d L^d}{(P^d)^{1-\sigma}} = \alpha\left[\sum_d \frac{\rho_{cd} w^d L^d}{(P^d)^{1-\sigma}}\right](p(z))^{-\sigma}$$

where

$$0 \le \rho_{cd} \equiv (\tau_{cd})^{1-\sigma} \le 1$$ ***Proximity*** between *c* and *d.*

For simplicity, assume $\tau_{cc} = 1$ and $\tau_{dc} = \tau_{cd}$, hence $\rho_{cc} = 1$ and $\rho_{dc} = \rho_{cd}$.

Monopoly Pricing: $p(z)(1-1/\sigma) = w^r T'(x(z))$

Zero profit/Free Entry:

$p(z)x(z) = w^r T(x(z))$ $\quad z \in \Omega^r$ if $N^r > 0$.

$p(z)x(z) < w^r T(x(z))$ $\quad z \in \Omega^r$ if $N^r = 0$.

➔

$x(z) = x$ $\quad z \in \Omega^r$ if $N^r > 0$.

$x(z) < x$ $\quad z \in \Omega^r$ if $N^r = 0$,

where $\dfrac{xT'(x)}{T(x)} \equiv 1 - \dfrac{1}{\sigma}$.

Equilibrium is given by two complementary slackness conditions:

$$\alpha\left[\sum_d \frac{\rho_{cd} w^d L^d}{\sum_k N^k (w^k)^{1-\sigma} \rho_{kd}}\right](w^c)^{-\sigma} \leq T(x) \qquad \& \qquad 0 \leq N^c \qquad \text{for } c = 1, 2, \ldots, R.$$

$$w^c \geq 1 \qquad \& \qquad T(x)N^c \leq L^c \qquad \text{for } c = 1, 2, \ldots, R.$$

For a sufficiently small α, all the regions produce the outside good and $w^r = 1$. Thus,

$$\alpha\left[\sum_d \frac{\rho_{cd} L^d}{\sum_k N^k \rho_{kd}}\right] \leq T(x) \qquad \& \qquad 0 \leq N^c \qquad \text{for } c = 1, 2, \ldots, R.$$

$$T(x)n^c < L^c \qquad \text{for } c = 1, 2, \ldots, R.$$

Since $\alpha \sum_c L^c = T(x) \sum_k N^k$,

(*) $\sum_d \frac{\rho_{cd} v^d}{\sum_k n^k \rho_{kd}} \leq 1$ and $n^c \geq 0$ for $c = 1, 2, ..., R,$

$\alpha n^c < v^c$ for $c = 1, 2, ...,R,$

where $v^c \equiv \frac{L^c}{\sum_k L^k}$ and $n^c \equiv \frac{N^c}{\sum_k N^k}$.

Given the distribution of resources,

a positive vector, $v = [\ v_j^r],$ $\sum_r v^r = 1,$

Given the proximity across regions,

a nonnegative symmetric matrix,
$M = [\rho_{ij}],$ $0 \leq \rho_{ij} \leq 1$ with 1's on the diagonal,

We could solve (*) for the equilibrium distribution of firms,

a nonnegative vector, $n = [\ n^r\ ],$ $\sum_r n^r = 1.$

3. Three Benchmarks:

A: *Autarky*: $\rho_{ij} = 0$ ($i \neq j$). (M is an identity matrix.)

→ $n = [\, n^r \,] = [\, v^r \,] = v$.

B: *World without Trade Costs:* $\rho_{ij} = 1$ for all i and j.

→ Any nonnegative vector, $n = [\, n^r \,]$, $\sum_r n^r = 1$, an equilibrium.
The location does not matter! (The indeterminacy is due to FPE.)

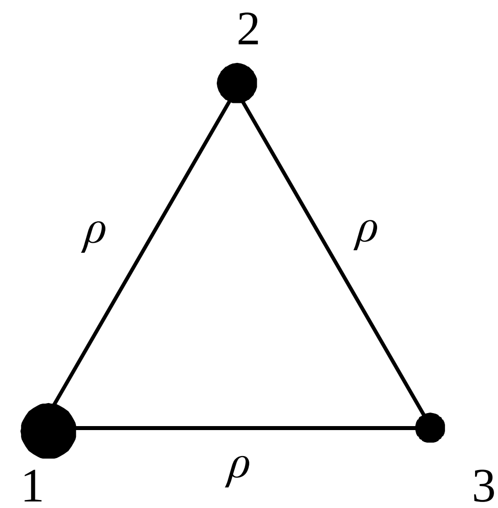
C: *World with Symmetric Regions*:

- Resources are evenly distributed: $v = [\, v^r \,] = [\, 1/R \,]$
- All regions are symmetrically located in that $\sum_i \rho_{ij}$ is independent of j. (M is a positive scalar multiple of a symmetric, stochastic matrix.)

→ $n = [\, n^r \,] = [\, 1/R \,]$.

Now we introduce some geographical asymmetry across regions by departing from these benchmarks.

4. Resource Size Effects



Example 1: $\rho_{ij} = \rho < 1$ ($i \neq j$).

→ $[\, n_j \,] = \left[\frac{\rho R}{1-\rho}\left(v_j - \frac{1}{R} \right) + v_j \right]$,

(ignoring the non-negativity constraint.)

(A coefficient on v_j is larger than one.)

- A large market serves as a base for exports. **Home Market Effect**
- A *smaller* trade cost (a higher ρ) magnifies HME.

Intuition:

- With trade costs, more firms would prefer locating in a larger market.
- As trade costs decline (but not eliminated entirely), disadvantage of exporting to other (smaller) markets gets smaller, so that even more firms would locate in a larger market.

In other words,

Smaller trade costs make the industries more "footloose," so that even tiny geographical asymmetries have big impacts of their locations.

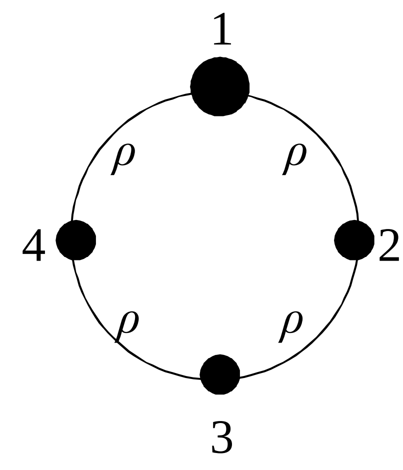
Smaller trade costs would not imply "The End of Geography"!

Next Question: Does proximity to the larger market implies a larger industrial base?

Example 2:

$$R = 4,\ v = \frac{1}{4}\begin{bmatrix} 1+3\gamma \\ 1-\gamma \\ 1-\gamma \\ 1-\gamma \end{bmatrix} \text{ for } 0 < \gamma < 1,\ M = \begin{bmatrix} 1 & \rho & \rho^2 & \rho \\ & 1 & \rho & \rho^2 \\ & & 1 & \rho \\ & & & 1 \end{bmatrix}$$

- Four regions on the circle; each region has two neighbors.
- Shipping goods to a nonneighbor is more costly, $\rho^2 < \rho < 1$.
- Region 1 is the biggest
- Regions 2, 3, and 4 are of equal size
- Regions 2 & 4 are next to the bigger Region 1, but not Region 3.



What is your guess?

$$n = v + \frac{\rho\gamma}{(1-\rho)^2}\begin{bmatrix} 2-\rho \\ -1 \\ \rho \\ -1 \end{bmatrix} \text{ if } 0 \le \rho \le \frac{1-\sqrt{\gamma}}{1+\sqrt{\gamma}}$$

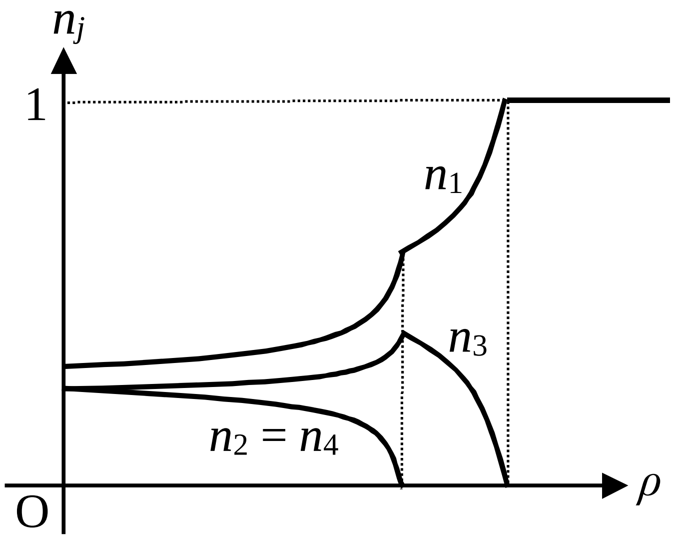
A higher ρ makes 1 & 3 bigger, and 2 & 4 smaller.

- Regions 2 & 4 are in the "shadow" of the big neighbor, 1.
- Region 3 emerges as a regional center, because its neighbors are not bigger.

Can Japan's emergence as an industrial power in the late 19th century be partially attributed to the fact that it was far away from Europe and US?

$$n = \frac{1}{2}\begin{bmatrix} 1 \\ 0 \\ 1 \\ 0 \end{bmatrix} + \frac{\gamma}{1+\gamma}\frac{1+\rho^2}{1-\rho^2}\begin{bmatrix} 1 \\ 0 \\ -1 \\ 0 \end{bmatrix} \text{ if } \frac{1-\sqrt{\gamma}}{1+\sqrt{\gamma}} < \rho < \sqrt{\frac{1-\gamma}{1+3\gamma}}.$$

Once the industries disappear from 2 & 4,
a further rise in ρ makes Region 3 smaller.
Non-monotonicity!

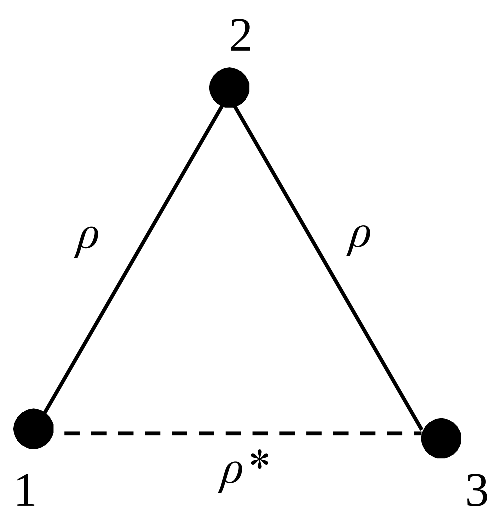


5. Three-Region World

Example 3:

$$R = 3, \qquad v = \frac{1}{3}\begin{bmatrix}1\\1\\1\end{bmatrix}, \qquad \text{and } M = \begin{bmatrix}1 & \rho & \rho' \\ & 1 & \rho \\ & & 1\end{bmatrix},$$

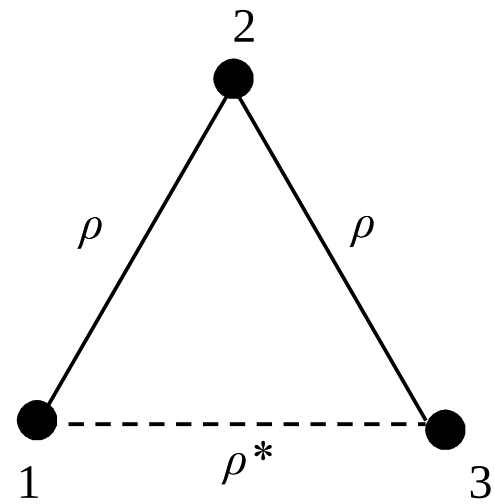
where $\rho' \equiv Max\{\rho^2, \rho^*\}$.



If $\rho^2 \geq \rho^*$, the indirect route is used between Regions 1 and 3.

$$\rightarrow \quad n = \frac{1}{3}\begin{bmatrix}1\\1\\1\end{bmatrix} + \frac{1}{3}\left(\frac{\rho}{1-\rho}\right)^2\begin{bmatrix}-1\\2\\-1\end{bmatrix} \quad \text{if } 0 \leq \rho < \frac{1}{2};$$

$$n = \begin{bmatrix}0\\1\\0\end{bmatrix} \quad \text{if } \frac{1}{2} \leq \rho < 1.$$



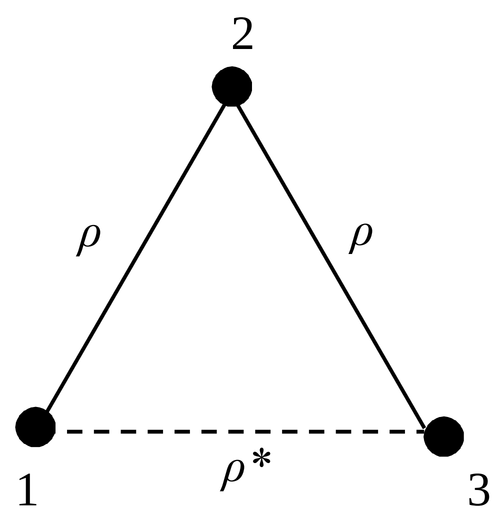
- Region 2 attracts more firms due to its central location.
- A higher ρ magnifies Region 2's geographical advantage.

- Building roads connecting the center to remote regions in an attempt to help the development at peripheries can backfire.
- A structural and technological change that make the products lighter, thinner, shorter, and smaller could lead to more agglomeration to the center.
- Failure of Japanese "Technopolis Program" in the 70s and 80s?

If $\rho^2 < \rho^*$, the direct route is used between Regions 1 and 3. For parameter values ensuring that each region attracts some firms,

$$\rightarrow n = \frac{1}{3}\begin{bmatrix}1\\1\\1\end{bmatrix} + \frac{1}{3}\frac{\rho(\rho^* - \rho)}{(1-\rho)(1+\rho^* - 2\rho)}\begin{bmatrix}1\\-2\\1\end{bmatrix}.$$

A higher ρ^* increases the share of Region 1 & 3 monotonically.

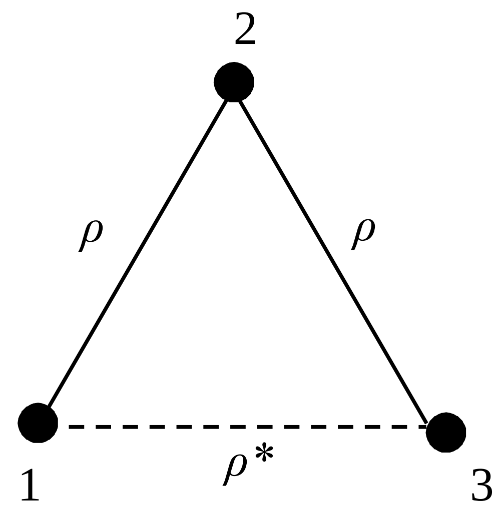


Think of the European integration. Regions 1 & 3 are in Europe; Region 2 is ROW.

Baldwin-Venables (1995)

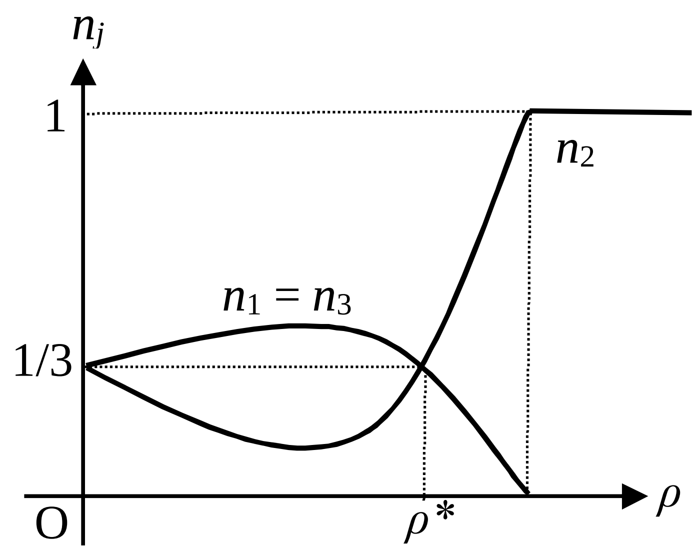
Non-monotonic effects of ρ

- n_j = 1/3 for ρ = 0 and $\rho = \rho^*$.
- For a small ρ, a higher ρ reduces the share of Region 2.
- For a high ρ, a higher ρ increases the share of Region 2.



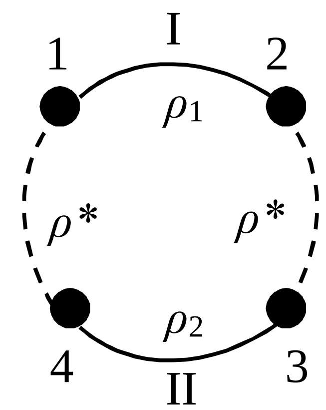
Why Non-monotonic? Two competing forces

- A higher ρ makes Region 2 attractive as a home base from which to export products.
- A higher ρ makes it easier to export to Region 2, reducing the need to locate there.



6. Internal versus External Trade Costs

6.A. Internal Trade Costs and Distribution across Superregions



Example 4: $R=4$, $v=\frac{1}{4}\begin{bmatrix}1\\1\\1\\1\end{bmatrix}$, $M=\begin{bmatrix}1 & \rho_1 & \rho'\rho^* & \rho^* \\ & 1 & \rho^* & \rho'\rho^* \\ & & 1 & \rho_2 \\ & & & 1\end{bmatrix}$,

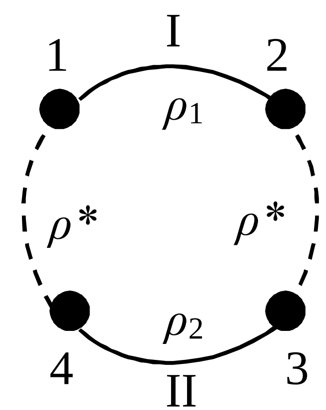
$\rho' \equiv Max\{\rho_1, \rho_2\}$, $(\rho^*)^2 < Min\{\rho_2/\rho_1, \rho_1/\rho_2\}$.

- Regions 1 & 2 form Superregion I, whose internal cost of trade is captured by ρ_1.
- Regions 3 & 4 form Superregion II, whose internal cost of trade is captured by ρ_2.
- Superregions are linked via two external routes, one connecting Regions 1 & 4, the other Regions 2 & 3. The proximity between the two Superregions is ρ^*.
- When goods are shipped between Regions 1 and 3, or between Regions 2 and 4, the route connecting Regions 1 & 2 are used when $\rho_1 > \rho_2$, while the route connecting Regions 3 & 4 are used when $\rho_1 < \rho_2$.
- The condition, $(\rho^*)^2 < Min\{\rho_2/\rho_1, \rho_1/\rho_2\}$, by making the cost across the superregions high, ensures that the internal trade always takes place directly.

$$\rightarrow \quad n = \frac{1}{4}\begin{bmatrix}1\\1\\1\\1\end{bmatrix} + \frac{1}{4}\frac{\rho^*(\rho_1-\rho_2)}{(1-\rho^*)(1+\rho_2-\rho^*(1+\rho_1))}\begin{bmatrix}1\\1\\-1\\-1\end{bmatrix} \quad \text{if } \rho_1 > \rho_2 > \rho_1(\rho^*)^2,$$

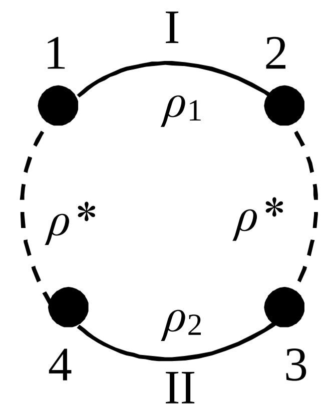
$$n = \frac{1}{4}\begin{bmatrix}1\\1\\1\\1\end{bmatrix} + \frac{1}{4}\frac{\rho^*(\rho_1-\rho_2)}{(1-\rho^*)(1+\rho_1-\rho^*(1+\rho_2))}\begin{bmatrix}1\\1\\-1\\-1\end{bmatrix} \quad \text{if } \rho_2 > \rho_1 > \rho_2(\rho^*)^2$$

- The share of Superregion I, (Region 1&2) is increasing in ρ_1, and decreasing in ρ_2.
- Superregion I accounts for a larger share if $\rho_1 > \rho_2$.
- A reduction in the cost of trade across superregions, a higher ρ^*, amplifies the existing bias in distribution.



Example: ***“***World According to McNeill”

- Superregion I = the Atlantic zone; Superregion II = the Mediterranean zone
- External routes = transalpine passes; Internal routes = the Atlantic & Mediterranean.
- For centuries, the Mediterranean zone enjoyed its “nautical advantage.”
- When the improvements in ship design and navigation made travel on the Atlantic waters as safe as on the Mediterranean, Southern Europe lost its advantage and the center of Europe shifted toward north.



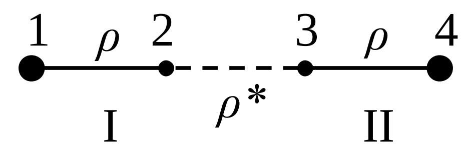
Or

Domestic Policies are Trade Policies

Building internal infrastructure within would give the country “competitive” advantage.

6B. External Trade Costs and Internal Distributions within Superregions

Example 5: $R = 4$, $v = \frac{1}{4}\begin{bmatrix} 1+\gamma \\ 1-\gamma \\ 1-\gamma \\ 1+\gamma \end{bmatrix}$ for $0 < \gamma < 1$,



$$M = \begin{bmatrix} 1 & \rho & \rho\rho^* & \rho^2\rho^* \\ & 1 & \rho^* & \rho\rho^* \\ & & 1 & \rho \\ & & & 1 \end{bmatrix}.$$

- Regions 1 and 2 form a superregion, so do Regions 3 and 4.
- Internal trade cost is captured by ρ ; external trade cost by ρ^*.
- Regions 1 and 4 are in the interior, while Regions 2 and 3 are on the border.
- The interior regions have larger home markets. A higher γ favors the interior regions at the expense of the border regions.
- The border regions have better access to the other superregion. A higher ρ^* favors the border regions at the expense of the interior regions.

$$\rightarrow \quad n = v + \frac{\rho\{(2-\rho\rho^* + \rho^*)\gamma - (1+\rho)\rho^*\}}{4(1-\rho)(1-\rho\rho^*)}\begin{bmatrix}1\\-1\\-1\\1\end{bmatrix} = \frac{1}{4}\begin{bmatrix}1\\1\\1\\1\end{bmatrix} + \frac{(1+\rho)(\gamma-\rho\rho^*)}{4(1-\rho)(1-\rho\rho^*)}\begin{bmatrix}1\\-1\\-1\\1\end{bmatrix}$$

A decline in ρ^* is against the border regions; A higher ρ^* favors the border regions;

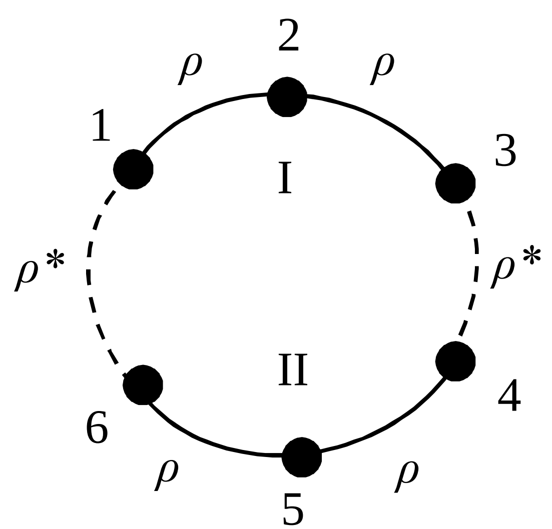
- *(Back to McNeill; also Braudel), the Turkish expansion to the Balkan and North Africa (and the discovery of the New World) lead to a relative decline of Southern Europe.*
- *After WWII, the loss of the colonial markets in Asia, as well as a reduction in trans-Pacific transport costs, shifted the industrial center of Japan from the West (i.e., kitakyushu and hanshin areas) to the East (chukyo and keihin areas).*
- *European integration favored the border regions such as Baden-Württemberg, Rhone-Alpes, Catalunya, and Lombardia (the so-called Four Motors of Europe).*

The effect of ρ is more subtle.

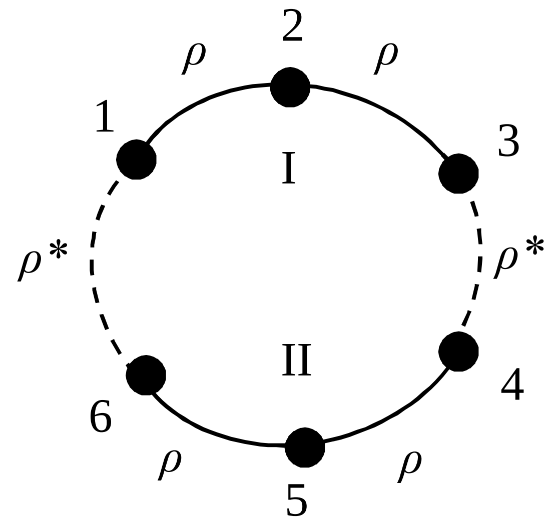
- If $\gamma > \rho^*$, a higher ρ magnifies the advantage of the internal regions
- If $\gamma < \rho^*/(2+\rho^*)$, it magnifies the advantage of the border regions.
- If $\rho^*/(2+\rho^*) < \gamma < \rho^*$, it first causes a shift towards the internal regions, and then a shift towards the border regions.

Example 6: Due to greater symmetry, this example is easier than Ex. 5, even though it has more regions.

$$R{=}6, \qquad v = \frac{1}{6}\begin{bmatrix}1\\1\\1\\1\\1\\1\end{bmatrix}, \qquad M = \begin{bmatrix} 1 & \rho & \rho^2 & \rho^2\rho^* & \rho\rho^* & \rho^* \\ & 1 & \rho & \rho\rho^* & \rho^2\rho^* & \rho\rho^* \\ & & 1 & \rho^* & \rho\rho^* & \rho^2\rho^* \\ & & & 1 & \rho & \rho^2 \\ & & & & 1 & \rho \\ & & & & & 1 \end{bmatrix}.$$



$$\rightarrow \quad n = \frac{1}{6}\begin{bmatrix}1\\1\\1\\1\\1\\1\end{bmatrix} + \frac{\rho(\rho^* - \rho)}{6(1-\rho)^2(1-\rho\rho^*)}\begin{bmatrix}1\\-2\\1\\1\\-2\\1\end{bmatrix}.$$



Monotone effects of ρ^*

- At $\rho^* = 0$, I & II are in autarky. Interior regions 2&5 are bigger than border regions.
- As ρ^* rises, the borders grow and the interiors shrink.
- At $\rho^* = \rho$, all regions become equal in size.
- At $\rho^* > \rho$, the border regions become larger than the interior regions.

Non-monotone effects of ρ: Starting at a very small ρ, when the borders are larger,

- A higher ρ makes the borders grow, the interiors shrink, magnify the existing patterns.
- A further rise in ρ reverses the direction.
- At $\rho = \rho^*$, all regions become equal in size.
- A further rise in ρ monotonically amplifies the locational advantage of the interiors.

6C. Subregions, Regions, and Superregions: A Hierarchical System

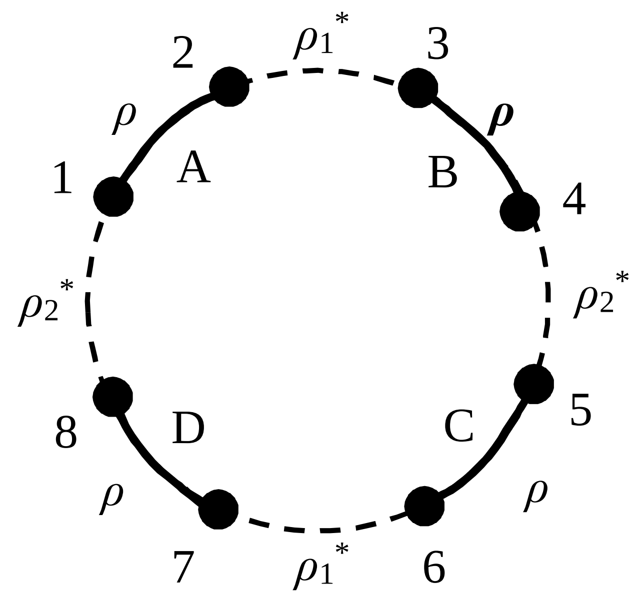
Example 7: **Conflicts of Interest in Formation of Trading Blocs**

R = 8,

$$v = \frac{1}{8}\begin{bmatrix} 1 \\ 1 \\ 1 \\ 1 \\ 1 \\ 1 \\ 1 \\ 1 \end{bmatrix}, \quad M = \begin{bmatrix} 1 & \rho & \rho\rho_1^* & \rho^2\rho_1^* & \rho^2\rho_1^*\rho_2^* & \rho\rho_1^*\rho_2^* & \rho\rho_2^* & \rho_2^* \\ & 1 & \rho_1^* & \rho\rho_1^* & \rho\rho_1^*\rho_2^* & \rho^2\rho_1^*\rho_2^* & \rho^2\rho_2^* & \rho\rho_2^* \\ & & 1 & \rho & \rho\rho_2^* & \rho^2\rho_2^* & \rho^2\rho * \rho_2^* & \rho\rho_1^*\rho_2^* \\ & & & 1 & \rho_2^* & \rho\rho_2^* & \rho\rho_1^*\rho_2^* & \rho^2\rho_1^*\rho_2^* \\ & & & & 1 & \rho & \rho\rho_1^* & \rho^2\rho_1^* \\ & & & & & 1 & \rho_1^* & \rho\rho_1^* \\ & & & & & & 1 & \rho \\ & & & & & & & 1 \end{bmatrix}$$

- Four Regions, A, B, C, D, each of which has two Sub-regions.
- If $\rho_1^* > \rho_2^*$, A&B form Super-region, AB, and C&D form another, CD. Then, Sub-regions 2 & 3 are the center of Super-region, AB, and Sub-regions 6 &7 those of CD. Sub-regions 1&4 are the peripheries of AB; 5&8 are the peripheries of CD.
- If $\rho_1^* < \rho_2^*$, B&C form Superregion BC, and D&A form another, DA. Then, positions of subregions, whether they are the centers and the peripheries, are reversed.
- The trade cost within a region is ρ.

$$\rightarrow n = \frac{1}{8}\begin{bmatrix}1\\1\\1\\1\\1\\1\\1\\1\end{bmatrix} + \frac{1}{8}\frac{\rho(\rho_2^* - \rho_1^*)}{(1-\rho\rho_1^*)(1-\rho\rho_2^*)}\begin{bmatrix}1\\-1\\-1\\1\\1\\-1\\-1\\1\end{bmatrix}$$



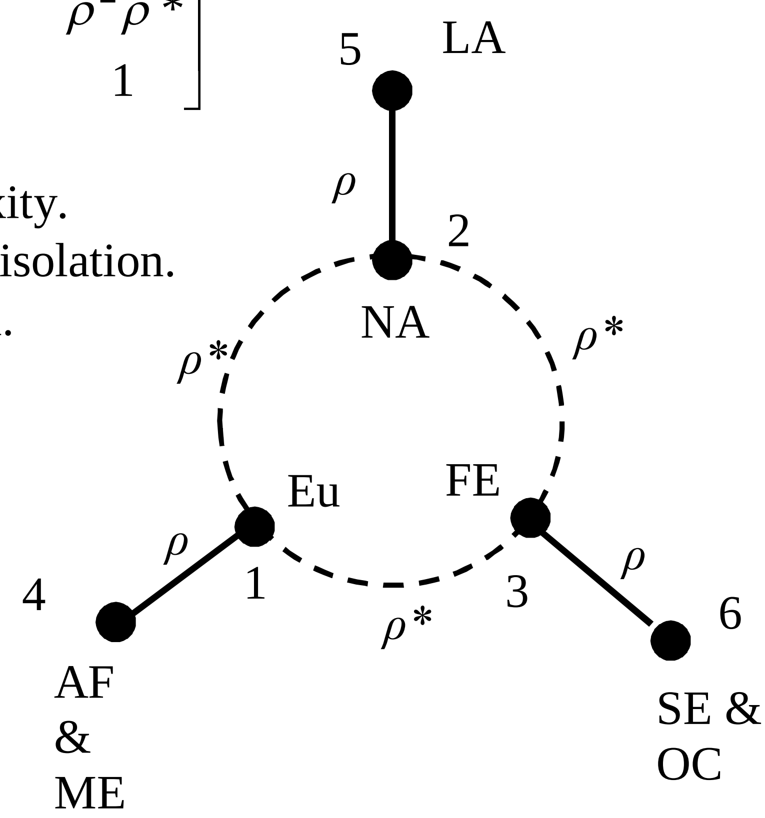
- Subregions, 2, 3, 6, and 7 would prefer the formation of AB & CD.
- Subregions, 1, 4, 5, and 8 would prefer the formation of BC & DA.
- A higher ρ amplifies uneven patterns created by the formation of superregions.

Example 8: "Geopolitical or Structuralist View of the World"

$$R = 6,\ v = \frac{1}{6}\begin{bmatrix}1\\1\\1\\1\\1\\1\end{bmatrix},\ \text{and } M = \begin{bmatrix}1 & \rho^* & \rho^* & \rho & \rho\rho^* & \rho\rho^* \\ & 1 & \rho^* & \rho\rho^* & \rho & \rho\rho^* \\ & & 1 & \rho\rho^* & \rho\rho^* & \rho \\ & & & 1 & \rho^2\rho^* & \rho^2\rho^* \\ & & & & 1 & \rho^2\rho^* \\ & & & & & 1\end{bmatrix}$$

- 1-2-3 in the North form the core due to their promixity.
- 4-5-6 in the South form the peripheries due to their isolation.
- A higher ρ amplifies the gap between Nouth-South.

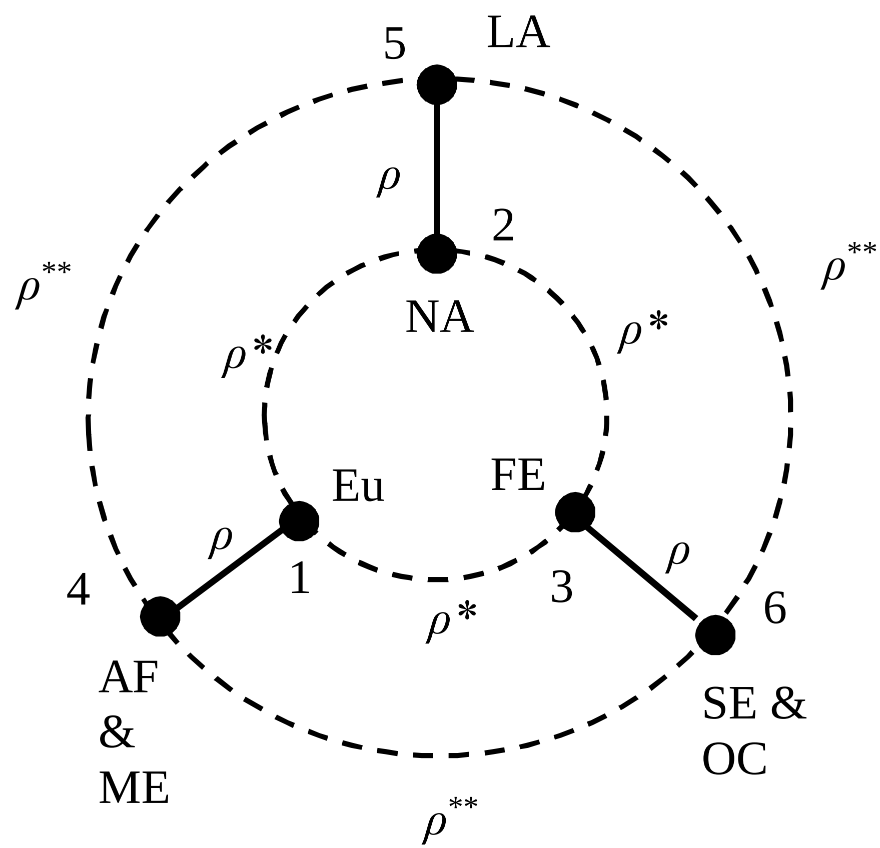
$$\rightarrow \quad n = \frac{1}{6}\begin{bmatrix}1\\1\\1\\1\\1\\1\end{bmatrix} + \frac{\rho\rho^*(1+\rho)}{3(1-\rho)(1-2\rho\rho^*)}\begin{bmatrix}1\\1\\1\\-1\\-1\\-1\end{bmatrix}$$



This figure suggests a potential response:
"New International Economic Order"

- If $\rho^{**} < \rho^{*}(\rho)^2$, ρ^{**} has no effect.
- After $\rho^{**} > \rho^{*}(\rho)^2$, a higher ρ^{**} shifts the distribution towards South monotonically.
- At $\rho^{**} = \rho^{*}$, South and North become equal.
- If $\rho^{**} > \rho^{*}$, South become richer than North.

A higher ρ merely amplifies the existing uneven patterns.



A Concluding Remark:

- The model, or the equilibrium condition (*), is sufficiently flexible that many different types of geographical factors can be accommodated.
- It should be viewed as “framework” or “template,” which one could use to investigate whatever geographical factors one might be interested.
- I have shown just eight examples here, but one could probably come up with many more interesting examples.
- Applications seem endless!