Increasing Returns and Economic Geography

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Krugman claims that the study of economic outcomes across space had been largely ignored in “standard” economic analysis.

Yet, “…facts of economic geography are surely among the most striking features of real-world economies…” E.g., nighttime satellite photos of Europe suggest a center-periphery pattern.

Motivation: Provide a formal model to incorporate insights from economic geography.

Research Question: Why does manufacturing become concentrated (agglomerated) in few regions?
The paper

- Presents a model of geographical concentration.
- **Key Ingredients:**
  - *Economies of scale* (agglomerating, attractive force)
  - *Transportation costs* (centrifugal force)
- The paper presents “possibility” results, rather than a tight characterization.
- **Outline.**
  - Quick review “old” economic geography.
  - Set-up of the model.
  - Equilibrium.
  - Concluding comments.
Ideas from “Old” Economic Geography

- Positive feedback (Myrdal, Hirschman and others).
  - Manufactures tend to concentrate in large markets, and markets become larger where manufactures production is concentrated.
  - The paper captures this feedback in a (static) model.

- Marshall’s exposition of external economies applied to industry localization (other reasons for concentration)
  - Pooled market for workers with specific skills.
  - Nontradable specialized inputs.
  - Informational spillovers across firms.
Set-up of the Model: Fundamentals I

- World is divided in two regions, 1 and 2.
- Two goods, agricultural (A) and manufacturing (M).
- **Preferences** Share $\mu$ of income spent in consumption of manufactured goods, $C_M$,

$$U = C_M^{\mu} C_A^{1-\mu}.$$ 

- Consumption of manufactured goods $C_M$ is a CES composite of manufacturing intermediates, $c_i$,

$$C_M = \left[ \sum_{i=1}^{N} c_i^{\sigma-1} \right]^{\frac{\sigma}{\sigma-1}} \quad \text{with} \quad \sigma > 1.$$
The only endowment is labor. World population is 1, divided into
- Workers: mobile across regions, representing a fraction \( \mu \) of world pop.,
\[
L_1 + L_2 = \mu.
\]
- Peasants: cannot migrate, fraction \((1 - \mu)/2\) in each region,

**Manufacturing Technology** The production of intermediate \( x_i \) involves a marginal cost and a fixed cost,
\[
\begin{aligned}
    x_i &= \frac{L_{Mi}}{\beta} - \frac{\alpha}{\beta} \\
    \text{and} \quad L_i &\geq \alpha \quad \implies \quad L_{Mi} = \alpha + \beta x_i.
\end{aligned}
\]
This fixed cost is the source of economies of scale.

**Agricultural Technology** is CRS. Peasants are the only input to produce agricultural goods, with unit labor requirement equal to one.
Transportation Costs between regions

- Iceberg cost $\tau(<1)$ for manufactured goods.
- Costless transportation for agricultural goods.

Market Structure

- Assume monopolistic competition à la Dixit-Stiglitz in the suppliers of manufacturing intermediates.
- Competitive behavior in the agricultural sector.
Manufacturing Firm Behavior in Region $i$

- Elasticity of demand of a $M$-firm is $\sigma$. Marginal cost is $\beta w_i$.
- Profit-maximizing price of an intermediate producer implies
  \[ p_i = \frac{\sigma}{\sigma - 1} \beta w_i. \]

- Free entry drives profits to zero, $p_i x_i - w_i(\alpha + \beta x_i) = 0$.
- Thus, all the firms produce the same regardless of the wage rate,
  \[ x_1 = x_2 = \frac{\alpha(\sigma - 1)}{\beta}. \]

- This implies only extensive margin adjustments. The number of manufactured goods produced in each region is proportional to the number of workers,
  \[ \frac{n_1}{n_2} = \frac{L_1}{L_2}. \]
Equilibrium

- Normalize price of agricultural goods to 1.
- Let $p_i$, denote the price of an intermediate produced (and purchased) in region $i$, and $w_i$, wage in region $i$.

Competitive Equilibrium

Set of prices $p_i$, $w_i$, consistent with agent utility maximization (including a migration decision for manufacturing labor) and firm profit maximization for $i = 1, 2$.

- Solve the equilibrium in two steps.
  - “Short-Run equilibrium”: Take allocation of workers as given, and find equilibrium prices (as a function of $L_i$).
  - “Long-Run equilibrium”: Allow workers to migrate to equalize real wages.
Denote by $c_{ij}$ consumption in region $i$ of a representative region $j$ product. The price for country 1 of imports is $p_2/\tau$, relative demand is

$$\frac{c_{11}}{c_{12}} = \left(\frac{p_1\tau}{p_2}\right)^{-\sigma} = \left(\frac{w_1\tau}{w_2}\right)^{-\sigma}.$$ 

Let $z_{11}$ denote the ratio of region 1 expenditure on local manufactures to that on manufactures from the other region,

$$z_{11} = \left(\frac{n_1}{n_2}\right)\left(\frac{p_1\tau}{p_2}\right)\left(\frac{c_{11}}{c_{12}}\right) = \left(\frac{L_1}{L_2}\right)\left(\frac{w_1\tau}{w_2}\right)^{1-\sigma}. \quad (1)$$

Similarly, the spending of region 2 on region 1 products is

$$z_{12} = \left(\frac{L_1}{L_2}\right)\left(\frac{w_1}{w_2\tau}\right)^{1-\sigma}. \quad (2)$$
Short-Run equilibrium: Wage determination

- Regional output is (wage rate of peasants is the numérarie)
  \[ Y_i = \frac{1 - \mu}{2} + w_i L_i, \quad i = 1, 2. \]  
  (3)

- Total income of region \( i \) workers is equal to total spending,
  \[ w_1 L_1 = \mu \left[ \left( \frac{z_{11}}{1 + z_{11}} \right) Y_1 + \left( \frac{z_{12}}{1 + z_{12}} \right) Y_2 \right], \]  
  (4)
  \[ w_2 L_2 = \mu \left[ \left( \frac{1}{1 + z_{11}} \right) Y_1 + \left( \frac{1}{1 + z_{12}} \right) Y_2 \right], \]  
  (5)

- As \( Y_i(w_i) \) and \( z_{1i}(w_1/w_2) \), (4) and (5) define implicitly wages consistent with a particular labor allocation.

- If \( L_1 = L_2 \), then \( w_1 = w_2 \). If \( L_1 > L_2 \), no robust prediction. 2 forces: home market effect versus competition for the local peasant market.
Long-Run equilibrium: Determination

- Look at migration decision for workers: real wage equalization.
- Let $f = L_1/\mu$ denote the share of manufacturing labor in region one, the price index of manufactured goods are

$$P_1 = \left[ fw_1^{1-\sigma} + (1 - f) \left( \frac{w_2}{\tau} \right)^{1-\sigma} \right]^{\frac{1}{1-\sigma}}, \quad (6)$$

$$P_2 = \left[ f \left( \frac{w_1}{\tau} \right)^{1-\sigma} + (1 - f) (w_2)^{1-\sigma} \right]^{\frac{1}{1-\sigma}}. \quad (7)$$

- Denote real wages by $\omega_i$, then

$$\frac{\omega_1}{\omega_2} = \frac{w_1}{w_2} \left( \frac{P_1}{P_2} \right)^{-\mu}.$$

- If $w_1 = w_2$, a shift of workers from region 2 to 1, lowers $P_1$ and raises $P_2$. This raises relative real wages in 1. Additional force for agglomeration: workers in the region with larger population face a lower price for manufactured goods.
Analysis of Symmetric Equilibrium

- Is the equilibrium $f = 1/2$ stable? Depends on how $\omega_1/\omega_2$ changes with $f$.
  - If $\omega_1/\omega_2$ increases, agents will tend to migrate to the region that tends to have more population.
  - If $\omega_1/\omega_2$ decreases with $f$, we have regional convergence.

- Two forces working towards divergence (home market effect and price index effect) and one working toward convergence, competition for local peasant market.

- This is a local statement. Cannot show that $\omega_1/\omega_2$ is monotonic in $f$.

- Stability depends on the three structural parameters of the model
  - The share of expenditure on manufactured goods, $\mu$.
  - The elasticity of substitution among products, $\sigma$.
  - Iceberg cost $\tau$. Numerical example in which for high $\tau$, $\omega_1/\omega_2$ decreases in $f$, while it increases for low $\tau$.

- Turn to other equilibrium in which we can do comparative statics.
Look to another candidate equilibrium: **complete agglomeration**.

Advantages: More tractable, can obtain comparative statics.

Suppose all workers are concentrated in region 1.

Manufacturing output in region 1 \((Y_1 - Y_2 = w_1L)\) has to serve all demand \((\mu(Y_1 + Y_2))\),

Let \(n\) be the number of manufacturing firms. Each firm has value.

\[
V_1 = \frac{\mu}{n}(Y_1 + Y_2)
\]
Is it possible for a “defecting” firm to commence production profitably in region 2? If not, concentration of production is an equilibrium.

To produce in region 2, need to compensate workers for the fact that (almost) all manufactures are imported. Real wage equalization \( \Rightarrow \)

\[
\frac{w_2}{w_1} = \left( \frac{1}{\tau} \right)^\mu.
\]

The marginal cost of producing in region 2 is higher (and \( p_2 \)).

Sales of the defecting firm vis-à-vis region 1 firm are rescaled by \((w_2/w_1 \tau)^{1-\sigma}\) when selling to region 1 and \((w_2 \tau/w_1)^{1-\sigma}\), to 2.

Value of defecting firm

\[
V_1 = \frac{\mu}{n} \left[ \left( \frac{w_2}{w_1 \tau} \right)^{1-\sigma} Y_1 + \left( \frac{w_2 \tau}{w_1} \right)^{1-\sigma} Y_2 \right].
\]

\( \tau \) is a disadvantage to sell to region 1, but advantage, to region 2.
Complete Agglomeration Equilibrium III, Comparative Statics

- This analysis has not taken into account the fixed cost.
- Zero profit conditions implies, $V_i \propto w_i \alpha/\beta \equiv \text{fixed cost}.$
- A profitable deviation has to satisfy
  \[
  \frac{V_2}{V_1} > \frac{w_2}{w_1} = \tau^{-\mu}.
  \]
- This reduces to the analysis of $\nu > 1$, where
  \[
  \nu = \frac{1}{2} \tau^{\mu\sigma} \left[ (1 + \mu)\tau^{\sigma-1} + (1 - \sigma)\tau^{1-\sigma} \right].
  \]
- First result: $\frac{\partial \nu}{\partial \mu} < 0$, the larger the share of income spent on manufactured goods, the lower the relative sales of the defecting firm.
- Interpretation: stronger home market effect, larger relative size of region 1 market. Workers demand a larger premium to move to region 2.
Transportation costs. Two cases,

- If $\sigma(1 - \mu) < 1$, then $\nu < 1$. Intuition: if goods are very complementary (in this model, this implies economies of scale in equilibrium) or the share of manufacturing in expenditure is so high, it is unprofitable to start a firm in region 2 regardless of $\tau$.
- Conversely, we have that $\partial \nu / \partial \tau < 0$ (around the relevant range $\nu = 1$). Higher transportation costs militate against regional divergence.

Elasticity parameter $\sigma$,

$$
\text{sign} \left[ \frac{\partial \nu}{\partial \sigma} \right] = - \text{sign} \left[ \frac{\partial \nu}{\partial \tau} \right],
$$

higher elasticity of substitution works against agglomeration.

Alternative view: implicit derivation on the boundary $\nu = 1$,

$$
\frac{\partial \tau}{\partial \mu} < 0, \quad \frac{\partial \tau}{\partial \sigma} > 0.
$$
Concluding Comments

- This paper proposes a framework to analyze geographical concentration from a neoclassical approach, using a trade-off between economies of scale and transportation costs.
- One virtue of this paper is that opens many doors to research ideas.
  - Test empirically comparative statics. Decrease in transportation costs (e.g., railway expansion) generate agglomeration (?).
  - Look at technological spillovers rather than pecuniary externalities as a source of agglomeration (Durlauf, coordination games).
  - Study how initial conditions matter for agglomeration (Matsuyama).
  - Incorporate dynamics in the model can be interesting. Growth model with non-homothetic preferences can generate agglomeration.
  - A more realistic extension could be to consider what happens when the transportation cost is a function of distance, and there are two sectors with different degree of economies of scale.