Increasing Returns and Economic Geography

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Introduction

- 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 μ 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,

$$C_M = \left[\sum_{i=1}^{N} c_i^{\frac{\sigma-1}{\sigma}} \right]^{\frac{\sigma}{\sigma-1}} \quad \text{with} \quad \sigma > 1.$$

Fundamentals II: Endowment and Technology

- The only **endowment** is labor. World population is 1, divided into
  - Workers: mobile across regions, representing a fraction μ 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,

$$x_i = \frac{L_{Mi}}{\beta} - \frac{\alpha}{\beta} \quad \text{and} \quad L_i \geq \alpha \quad \Longrightarrow \quad L_{Mi} = \alpha + \beta x_i.$$

  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.

Fundamentals III

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 σ. Marginal cost is βw_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.

Short-Run Equilibrium: preliminaries

- Denote by c_{ij} consumption in region i of a representative region j product. The price for country 1 of imports is p_2/τ, 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)

$$Y_i = \frac{1-\mu}{2} + w_i L_i, \quad i = 1, 2. \tag{3}$$

- Total income of region i workers is equal to total spending,

$$w_1 L_1 = \mu \left[\left(\frac{z_{11}}{1+z_{11}} \right) Y_1 + \left(\frac{z_{12}}{1+z_{12}} \right) Y_2 \right], \tag{4}$$

$$w_2 L_2 = \mu \left[\left(\frac{1}{1+z_{11}} \right) Y_1 + \left(\frac{1}{1+z_{12}} \right) Y_2 \right], \tag{5}$$

- 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

$$P_1 = \left[f w_1^{1-\sigma} + (1-f) \left(\frac{w_2}{\tau} \right)^{1-\sigma} \right]^{\frac{1}{1-\sigma}}, \tag{6}$$

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

- Denote real wages by ω_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 ω_1/ω_2 changes with f.
  - If ω_1/ω_2 increases, agents will tend to migrate to the region that tends to have more population.
  - If ω_1/ω_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 ω_1/ω_2 is monotonic in f.
- Stability depends on the three structural parameters of the model
  - The share of expenditure on manufactured goods, μ.
  - The elasticity of substitution among products, σ.
  - Iceberg cost τ. Numerical example in which for high τ, ω_1/ω_2 decreases in f, while it increases for low τ.
- Turn to other equilibrium in which we can do comparative statics.

Complete Agglomeration Equilibrium

- 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 ($Y_1 - Y_2 = w_1 L$) has to serve all demand ($\mu(Y_1 + Y_2)$),
- Let n be the number of manufacturing firms. Each firm has value.

$$V_1 = \frac{\mu}{n}(Y_1 + Y_2)$$

Complete Agglomeration Equilibrium II

- 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

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

- τ 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, $V_i \propto w_i\alpha/\beta \equiv$ 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.

Complete Agglomeration, Comparative Statics 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 τ.
  - Conversely, we have that $\partial\nu/\partial\tau < 0$ (around the relevant range $\nu = 1$). Higher transportation costs militate against regional divergence.
- Elasticity parameter σ,

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

  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.