Lecture 3

Economic Geography of Urbanization

3.1 Classical Models of Cities in Geography and Economics
“agglomeration effects” and the core-periphery model

IUS 2.1

Two important concepts from Economics

Externalities: **unpriced outcomes**

In economics, an **externality** is the cost or benefit that affects a party who did not choose to incur that cost or benefit.

When there is no externality, allocative efficiency is achieved; however, this rarely happens in the free market.

Economists often urge governments to adopt policies that will "internalize" an externality, so that costs and benefits will affect mainly parties who choose to incur them

Spillover Effects: **unintended outcomes**

Spillover effects are economic events in one context that occur because of something else in a seemingly unrelated context. For example, externalities of economic activity are non-monetary effects upon non-participants.

Odors from a rendering plant are negative spillover effects upon its neighbors;

The beauty of a homeowner's flower garden is a positive spillover effect upon neighbors.

Cities

are all about

these “extra” effects

These are signs of incomplete theory: c.f. Physics or Biology

credit: wikipedia

https://en.wikipedia.org/wiki/Spillover_(economics)

Principles of Economics — Alfred Marshall (1890)

(from the observation of “industrial districts”, not cities)

When an industry has chosen a locality for itself, it is likely to stay there long: so great are the advantages which people following the same skilled trade get from near neighborhood to one another.

Agglomeration Effects

The mysteries of the trade become no mysteries; but are as it were in the air, and children learn many of them unconsciously.

Innovation, Growth

Good work is rightly appreciated, inventions and improvements in machinery, in processes and the general organization of the business have their merits promptly discussed: if one man starts a new idea, it is taken up by others and combined with suggestions of their own; and thus it becomes the source of further new ideas.

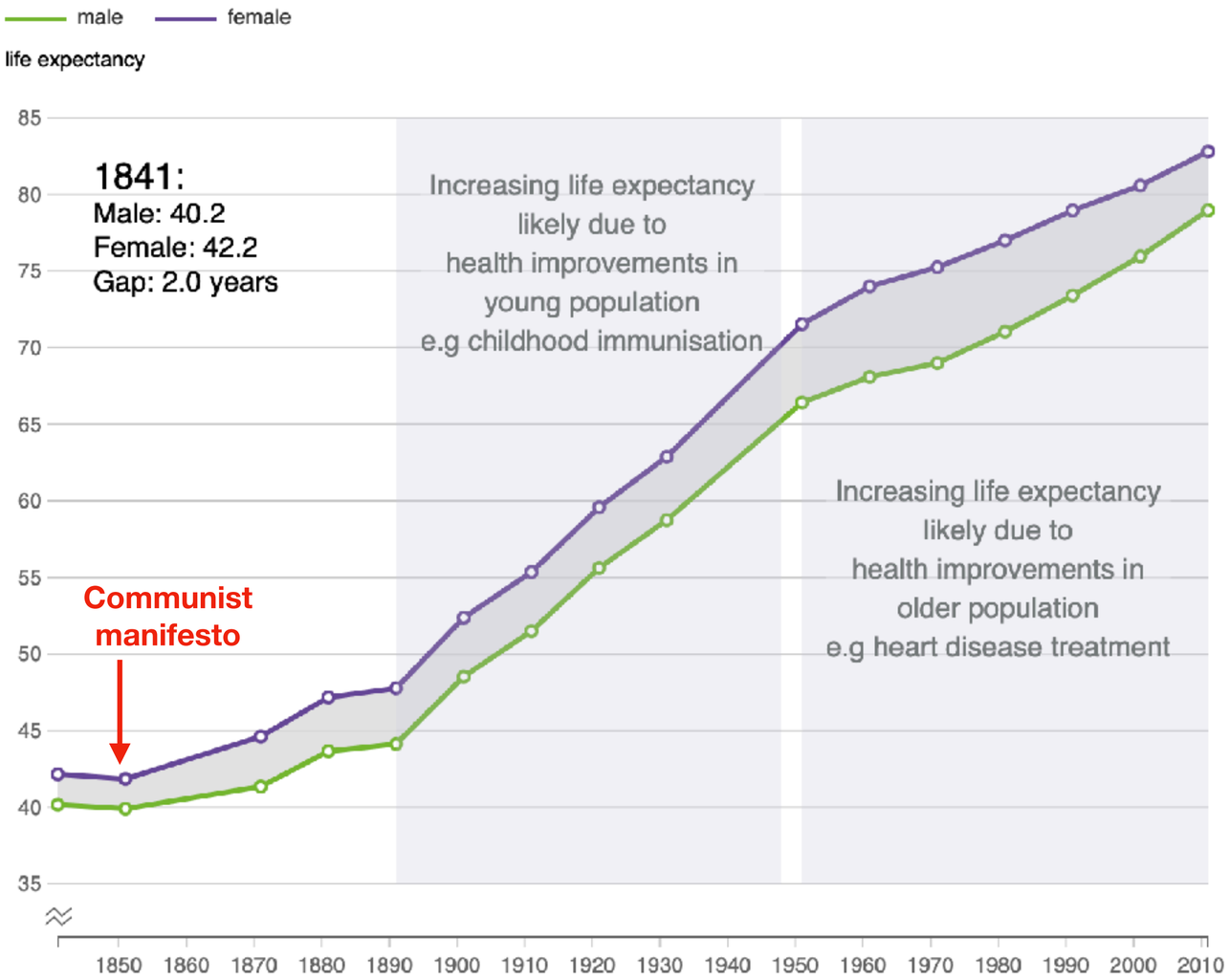
And presently subsidiary trades grow up in the neighborhood, supplying it with implements and materials, organizing its traffic, and in many ways conducing to the economy of its material.

Economies of Co-location

Principles of Economics,
book 4, ch 10: *The Concentration of Specialized Industries in Particular Localities*

In 2011 life expectancy at birth is almost double what it was in 1841

Life expectancy at birth, England and Wales, 1841 to 2011



Source: Decennial Life Tables, ONS

https://www.ons.gov.uk/peoplepopulationandcommunity/birthsdeathsandmarriages/lifeexpectancies/articles/howhaslifeexpectancychangedovertime/2015-09-09

Marshall **Three Types of External Agglomeration Economies**

In the language of Fujita, Venables & Krugman (reading)

1. Thick markets for specialized skills — **increased productivity & less risk from labor specialization in larger networks**

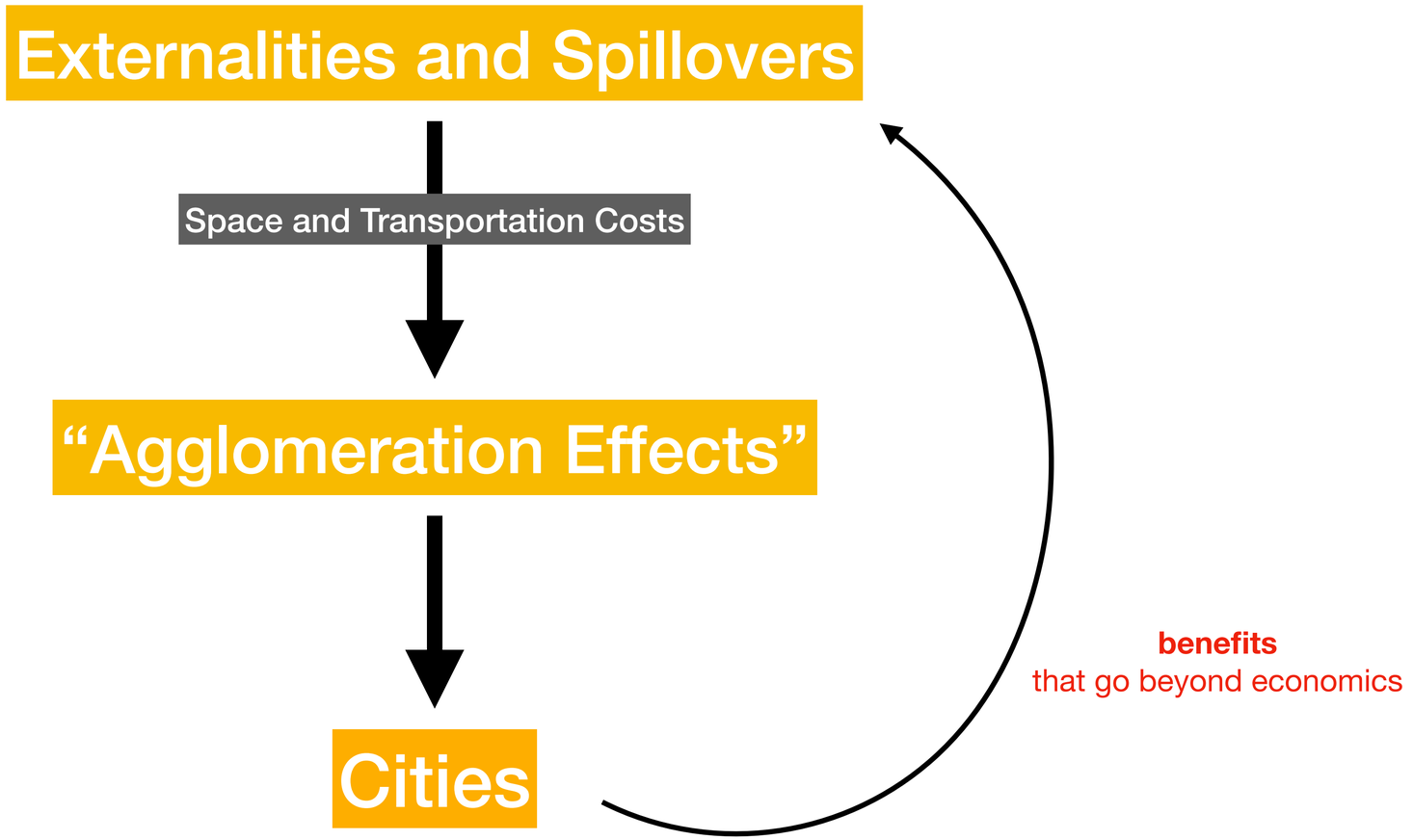
2. Backward and Forward “linkages” for larger local markets — **economies from larger consumer-producer co-locations**
“home market effect”

3. Knowledge Spillovers — **learning from others and innovation as the social basis for economic growth**

lead to (urban) **“Agglomeration Effects”**

These are mechanistic arguments that can be modeled: what do they have in common?

Why cities form and persist? (Economics)



Can we demonstrate (some of) these effects in a model?

The Core-Periphery Model

The general structure of economic models (general equilibrium)

Jacobs : “Simple Models”

-Consumers:

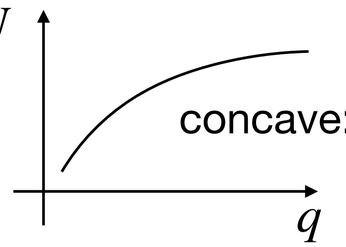
Maximize “Utility” : $U(q, \dots)$

happiness, “subjective value”

The choice of U determines the outcome

q : quantity of goods consumed

price of q: $p_q = \dfrac{dU}{dq}$



concave: $\dfrac{d^2U}{dq^2} < 0$

subject to given budget: $y = p_q q + c$

income = cost of q plus all other costs

budget constraint; ~ law of energy conservation

-Firms:

Maximize Profit …

but assume perfect competition → zero profit

“free entry, free markets” → no growth

labor + other production costs = sales

match

consumption=production

“offer=demand”

to get economy in

“equilibrium”
(nothing else happens)

↓ cities

spatial equilibrium

Economics Models about Cities

Urban Economics

Monocentric City

Remember Alonso

how land rents and transportation costs shape the city **internally**

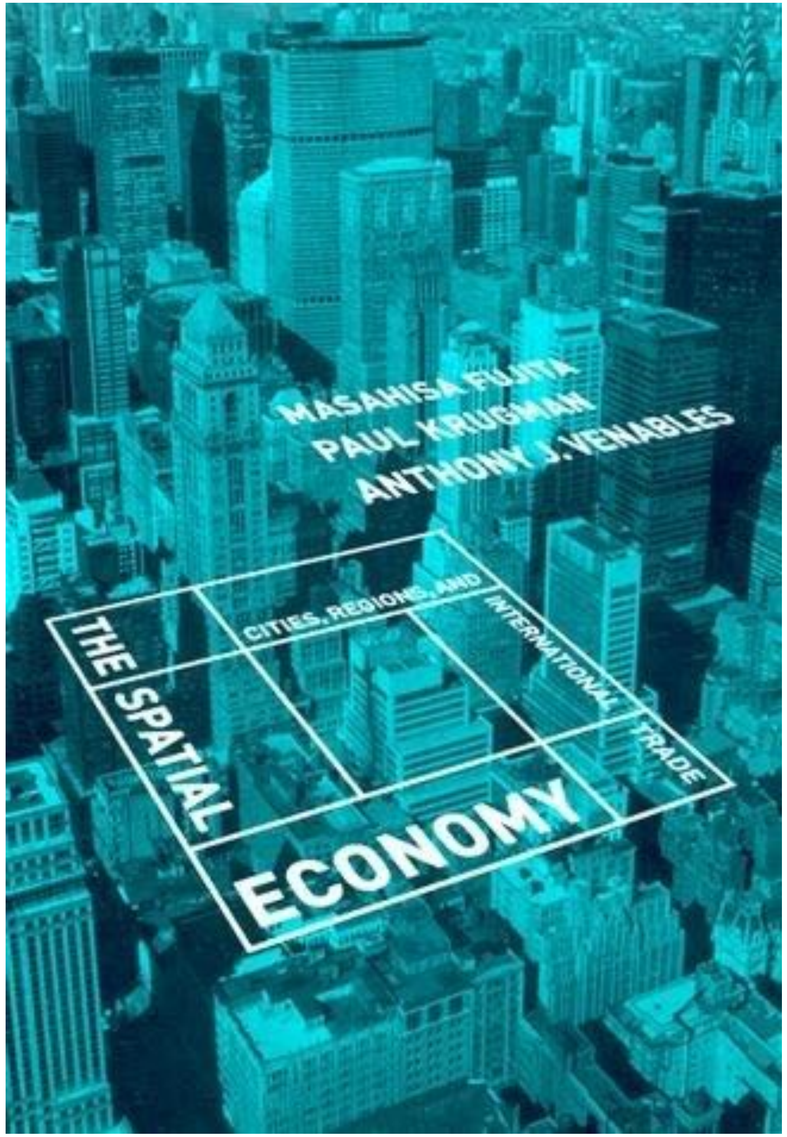
tries to explain

Economic Geography

Core-Periphery Model

how sector concentration, trade and transportation costs vary between spatial **regions**

different scales: city versus regions (rural areas + cities)



in your reading materials, especially ch 4-5; IUS 2.1

detailed derivation of the math in this lecture

2008 Nobel in Economics

NYtimes columnist

The Spatial Economy

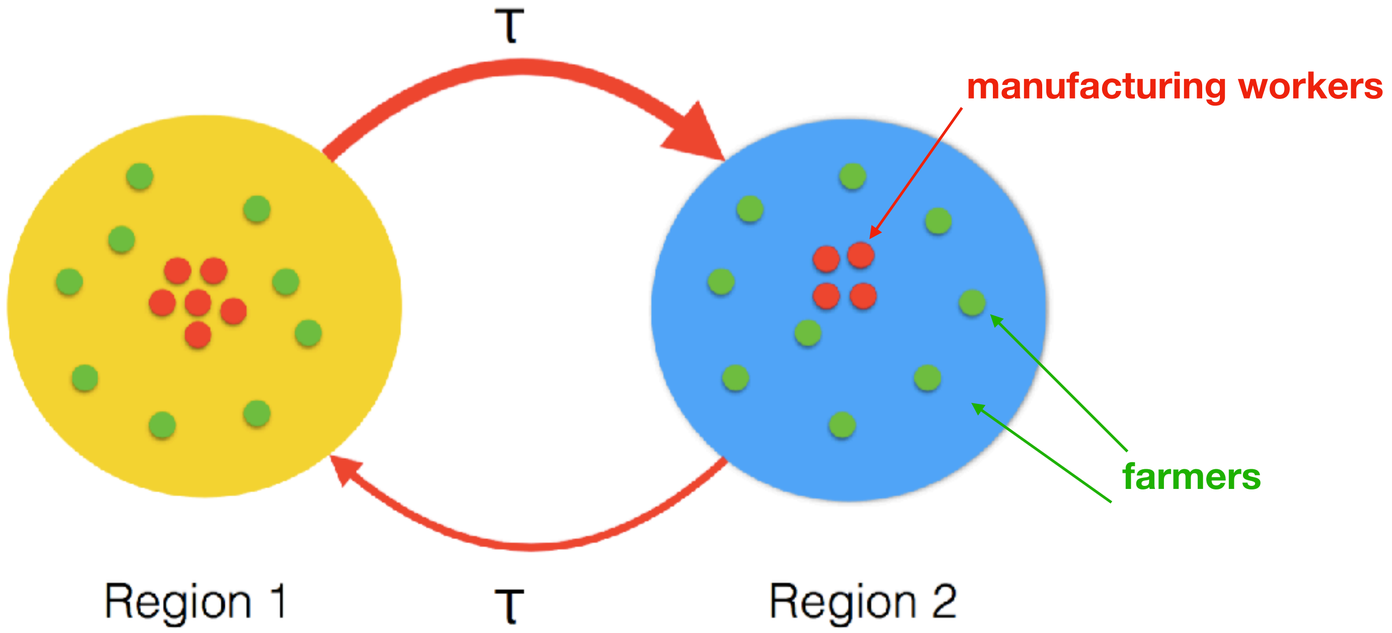
[Regional Economics ~ International Trade Theory]

IUS 2.1.2

UChicago Expert

Esteban Rossi-Hansberg (Econ Dept)

"We would argue that the defining issue of **economic geography** is the need to explain concentrations of population and of economic activity: the distinction between manufacturing belt and farm belt, the existence of cities, the role of industry clusters. "



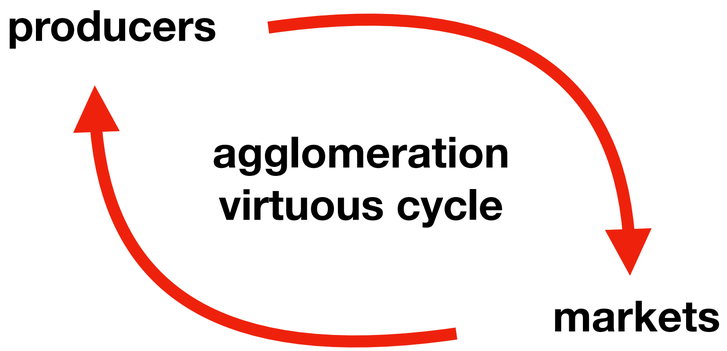
As we vary transportation costs, will all the manufacturers concentrate (in the same region)?

Modeling Production-Consumption Linkages

(feedback loops)

Industrial producers want to choose locations that have good access to large markets and to supplies of goods that they and their workers need.

However, a place that for whatever reason already has a concentration of producers tends to offer a large market (because of the demand the producers and their workers generate) and a good supply of inputs and consumer goods (made by the producers already there).



The Core Periphery Model

Krugman 1991

Nobel Prize Economics 2008

**"By having integrated economies of scale into explicit general equilibrium models,
Paul Krugman has deepened our understanding of the determinants of trade and the location of economic activity."**

Ingredients:

Agriculture	+	**Manufacturing**
single good workers tied to the land same wage everywhere		diversity of n goods *N* workers can move real wages ω_r vary between regions

$y_{w_F} = 1$ "numeraire"

sets the units of income

agglomeration: $\dot{f}_1 = (y_{\omega_1} - y_{\omega_2}) f_1$

workers go to where they can consume more goods

$f_1 =$ fraction of workers in region r

n_{MF} fraction of overall manufacturing workers to farmers

Problem: How to compute *real wages* in each region?

“Dixit-Stieglitz” Model with Space + Transportation Costs

Region 1 | **Region 2**

Objective :

$$y_{\omega_1} = y_{w_1}\bar{p}_1^{-n_{MF}}$$

real wage — nominal wage

$$y_{\omega_2} = y_{w_2}\bar{p}_2^{-n_{MF}}$$

real wage — nominal wage — share of expenditure in manufacturing — cost of living index

Nominal wages

$$y_{w_1} = \left[y_1\bar{p}_1^{\sigma_S-1} + y_2\bar{p}_2^{\sigma_S-1}T^{1-\sigma_S}\right]^{1/\sigma_S}$$

$$y_{w_2} = \left[y_1\bar{p}_1^{\sigma_S-1}T^{1-\sigma_S} + y_2\bar{p}_2^{\sigma_S-1}\right]^{1/\sigma_S}$$

transportation

Local Price index

$$\bar{p}_1 = \left[f_1 y_{w_1}^{1-\sigma_S} + (1-f_1)y_{w_2}^{1-\sigma_S}T^{1-\sigma_S}\right]^{1/(1-\sigma_S)}$$

$$\bar{p}_2 = \left[f_1 y_{w_1}^{1-\sigma_S}T^{1-\sigma_S} + (1-f_1)y_{w_2}^{1-\sigma_S}\right]^{1/(1-\sigma_S)}$$

transportation

Region’s Nominal Income

$$y_1 = n_{MF}f_1 y_{w_1} + \frac{1-n_{MF}}{2}$$

wages of workers — wages of farmers

$$y_2 = n_{MF}(1-f_1)y_{w_2} + \frac{1-n_{MF}}{2}$$

wages of workers — wages of farmers

solve 2 coupled equations: 3 input parameters: T, σ_S, n_{MF}

What drives urbanization?

"taste for variety"

This is an **assumption** built into the model

1. Consumer behavior

What is q_i as a function of p_i?

$$U = c_M^{n_{MF}} c_F^{1-n_{MF}}$$

$$c_M = \left(\sum_i^{n_M} q_i^{(\sigma_S - 1)/\sigma_S} \right)^{\sigma_S/(\sigma_S - 1)}$$

index of diversity:
goes up with more products

$$p_i = \frac{dU}{dq_i}$$

$$q_i = n_{MF} Y \frac{p_i^{-\sigma_S}}{\bar{p}^{\sigma_S - 1}}$$

demand curve

IUS Appendix A

$$\bar{p} = \left(\sum_{i=1}^{n_M} p_i^{1-\sigma_S} \right)^{\frac{1}{1-\sigma_S}}$$

cost of living

will benefit from proximity to goods production

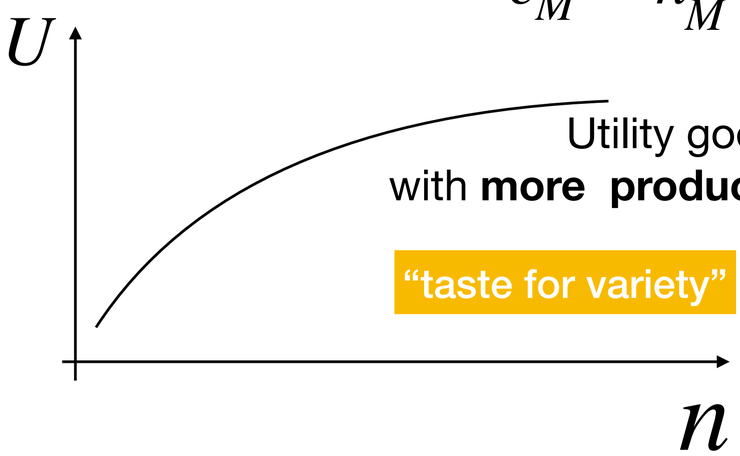
Maximize Utility (~happiness)

Maximize U subject to budget $p_A A + \sum_{i=1}^{n} p_i q_i = Y$

$$c_M = n_M^{\frac{\sigma_S}{\sigma_S - 1}} q = n_M^{\frac{1}{\sigma_S - 1}} \frac{Y}{p}$$

intuition from all q's being the same

get more c_M from
smaller σ_S, smaller price, larger budget



Utility goes up
with **more products consumed**

"taste for variety"

This is the "Agglomeration Force" in the model

2. Transportation Costs and nominal industrial incomes per region

for imported goods from other regions:

$$p_i \to p_i T, \quad T > 1$$

"iceberg transportation costs"

prices are larger if product comes from another region

$$y_1 = n_{MF} f_1 y_{w_1} + \frac{1 - n_{MF}}{2}$$

income from wages

income from farmers

$$y_2 = n_{MF}(1 - f_1) y_{w_2} + \frac{1 - n_{MF}}{2}$$

income from wages

income from farmers

Y_1, Y_2: Total expenditure in region 1 or region 2

$$\frac{e_{11}}{e_{12}} = \frac{n_{M_1}}{n_{M_2}} \frac{p_1}{p_2 T} \frac{q_{11}}{q_{12}} \qquad \frac{e_{21}}{e_{22}} = \frac{n_{M_1}}{n_{M_2}} \frac{p_1 T}{p_2} \frac{q_{21}}{q_{22}}$$

$$\frac{q_{11}}{q_{12}} = \left(\frac{p_1}{p_2 T}\right)^{-\sigma_S} \qquad \frac{q_{21}}{q_{22}} = \left(\frac{p_1 T}{p_2}\right)^{-\sigma_S}$$

$$q_{11} \propto p_1^{-\sigma_S}$$

local consumption in region 1

$$q_{12} \propto (p_2 T)^{-\sigma_S}$$

consumption of products from region 2 in region 1

e_{ij}^Y : fraction of expenditure from region i spent on j

$$Y_{W_1} = y_{w_1} n_{MF} f_1 N = n_{MF} \left[\frac{e_{11}^Y}{e_{11}^Y + e_{21}^Y} Y_1 + \frac{e_{21}^Y}{e_{21}^Y + e_{22}^Y} Y_2 \right]$$

$$Y_{W_2} = y_{w_2} n_{MF} (1 - f_1) N = n_{MF} \left[\frac{e_{12}^Y}{e_{11}^Y + e_{21}^Y} Y_1 + \frac{e_{22}^Y}{e_{21}^Y + e_{22}^Y} Y_2 \right]$$

Y_{W_1}, Y_{W_2} : Total nominal wages in each region 1, 2

3. Manufacturing Firm Profit Maximization : relating prices to wages

labor $l = F + cq$

$r = 1,2$ $\quad \max \ \pi_r = p_r q_r - y_{w_r}(F + cq_r) \longrightarrow p_r \propto y_{w_r}$

profits ↑ labor costs ↑ fixed costs ↑ costs per product

profit maximization in each region:

$$\frac{d\pi}{dq} = \frac{dp}{dq} q + p - c y_w = 0$$

$$p \propto q^{-\frac{1}{\sigma_S}}, \quad \frac{dp}{dq} = -\frac{1}{\sigma_S}\frac{p}{q}$$ from utility function

$$p = \frac{c}{1 - 1/\sigma_S} y_w$$

zero profits ("free entry") condition

$$q = \frac{F}{c}(\sigma_S - 1)$$

$$q_1 = q_2 = \frac{F}{c}(\sigma_S - 1)$$

quantity produced per firm is the same in each region

$$l_1 = l_2 = F\sigma_S$$

labor in each firm is the same

$$\frac{n_{M_1}}{n_{M_2}} = \frac{N_1}{N_2} = \frac{f_1}{1 - f_1}$$

the manufacturing population is proportional to products in each region

“Dixit-Stieglitz” Model with Space + Transportation Costs

Objective :

Region 1

$$y_{\omega_1} = y_{w_1} \bar{p}_1^{-n_{MF}}$$

real wage

nominal wage

Region 2

$$y_{\omega_2} = y_{w_2} \bar{p}_2^{-n_{MF}}$$

share of expenditure in manufacturing

real wage

nominal wage

cost of living index

Nominal wages

$$y_{w_1} = \left[y_1 \bar{p}_1^{\sigma_S - 1} + y_2 \bar{p}_2^{\sigma_S - 1} T^{1-\sigma_S} \right]^{1/\sigma_S}$$

$$y_{w_2} = \left[y_1 \bar{p}_1^{\sigma_S - 1} T^{1-\sigma_S} + y_2 \bar{p}_2^{\sigma_S - 1} \right]^{1/\sigma_S}$$

transportation

Local Price index

$$\bar{p}_1 = \left[f_1 y_{w_1}^{1-\sigma_S} + (1 - f_1) y_{w_2}^{1-\sigma_S} T^{1-\sigma_S} \right]^{1/(1-\sigma_S)}$$

$$\bar{p}_2 = \left[f_1 y_{w_1}^{1-\sigma_S} T^{1-\sigma_S} + (1 - f_1) y_{w_2}^{1-\sigma_S} \right]^{1/(1-\sigma_S)}$$

transportation

Region’s Nominal Income

$$y_1 = n_{MF} f_1 y_{w_1} + \frac{1 - n_{MF}}{2}$$

wages of workers

wages of farmers

$$y_2 = n_{MF} (1 - f_1) y_{w_2} + \frac{1 - n_{MF}}{2}$$

wages of workers

wages of farmers

solve 2 coupled equations: 3 input parameters: T, σ_S, n_{MF}

Solve for

$$y_{\omega_1} - y_{\omega_2} = g(f_1 \mid T, n_{MF}, \sigma_S)$$

difference in *real* wages between regions

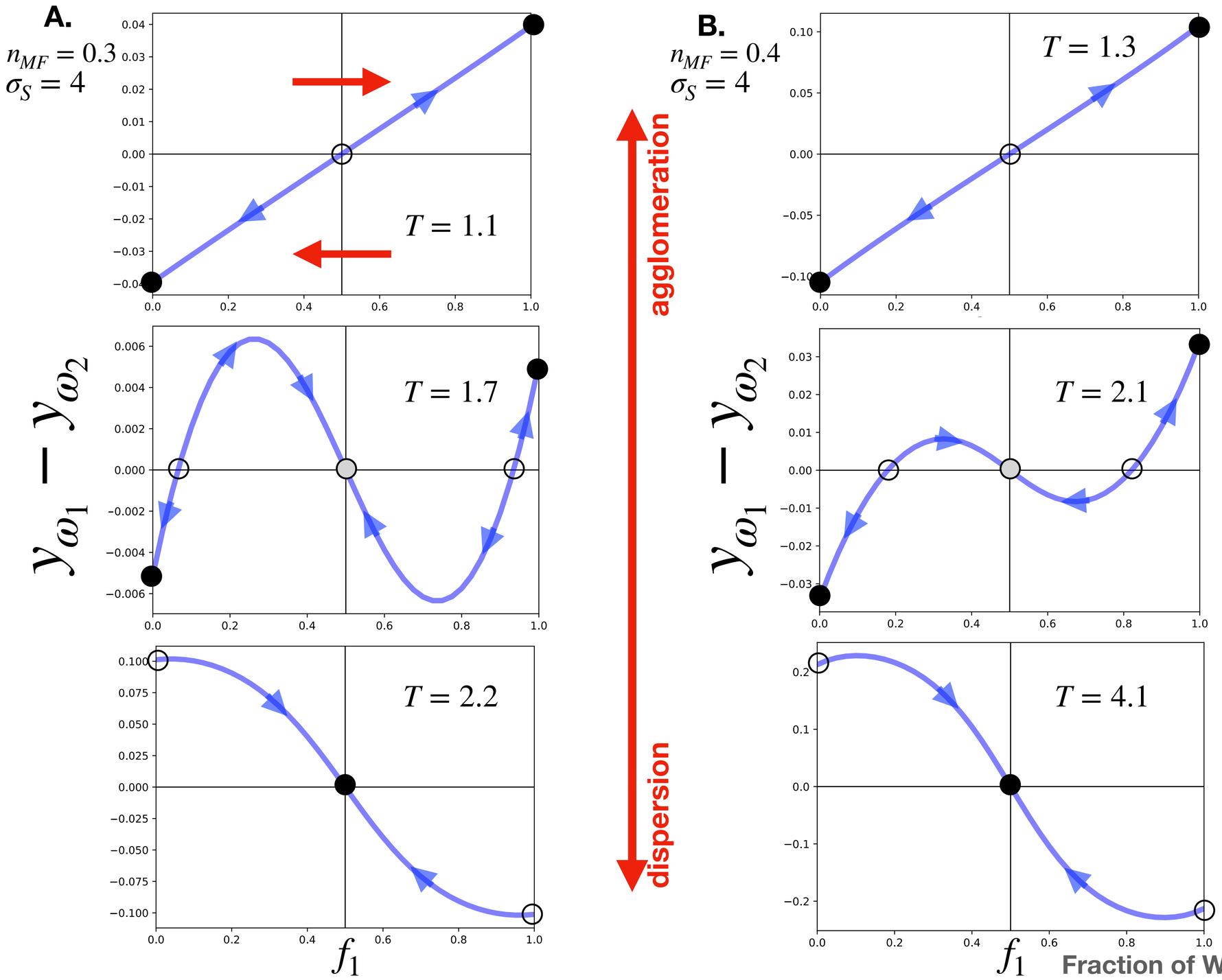
fraction of workers in region 1

transportation costs

fraction of manufacturing workers to population

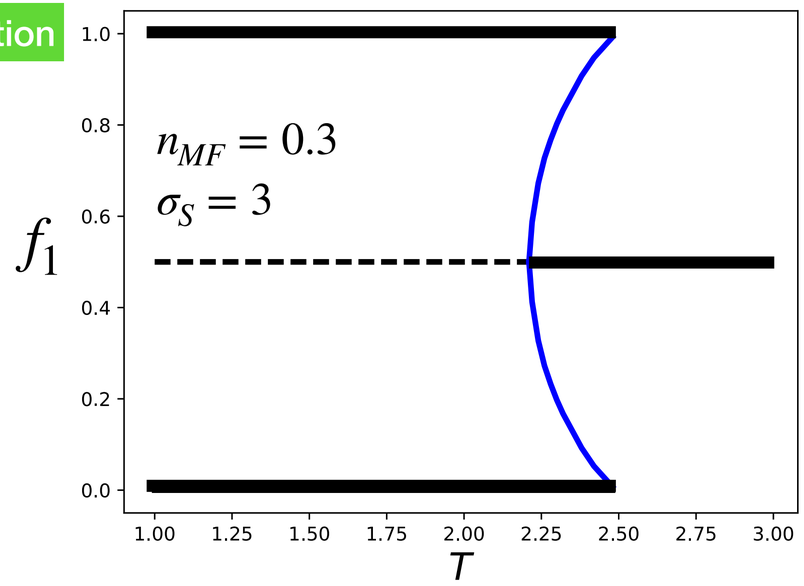
strength of taste for variety

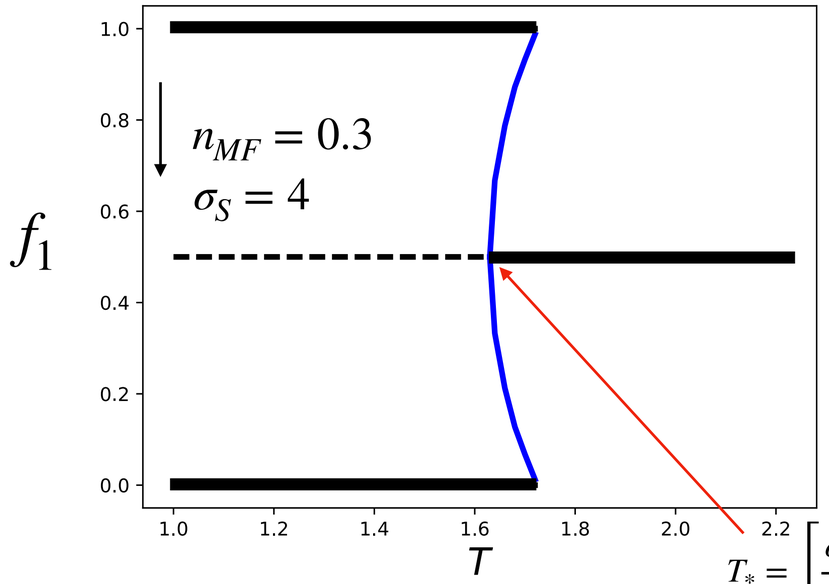
Python code provided : next weeks assignment


A.
$n_{MF} = 0.3$
$\sigma_S = 4$
$T = 1.1$
$T = 1.7$
$T = 2.2$
$y_{\omega_1} - y_{\omega_2}$
f_1
agglomeration
dispersion
B.
$n_{MF} = 0.4$
$\sigma_S = 4$
$T = 1.3$
$T = 2.1$
$T = 4.1$
$y_{\omega_1} - y_{\omega_2}$
f_1
Fraction of Workers in Region 1

hysteresis

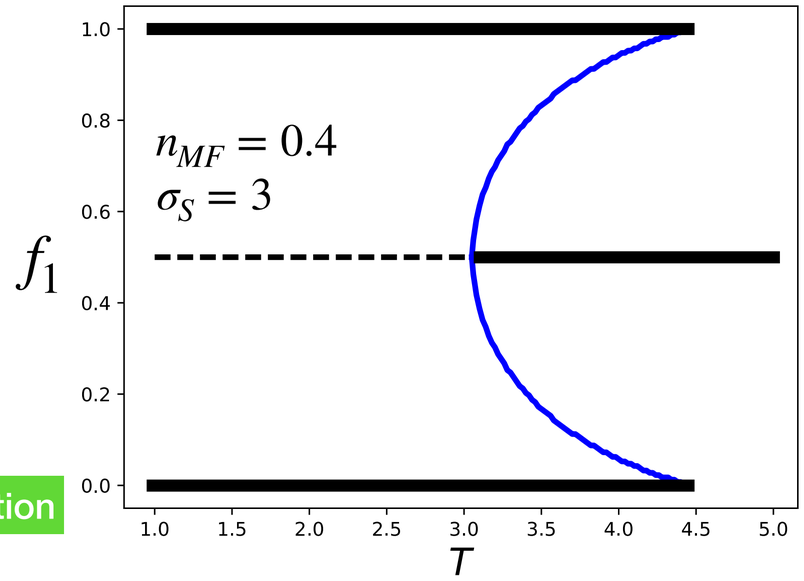
Stable: Agglomeration

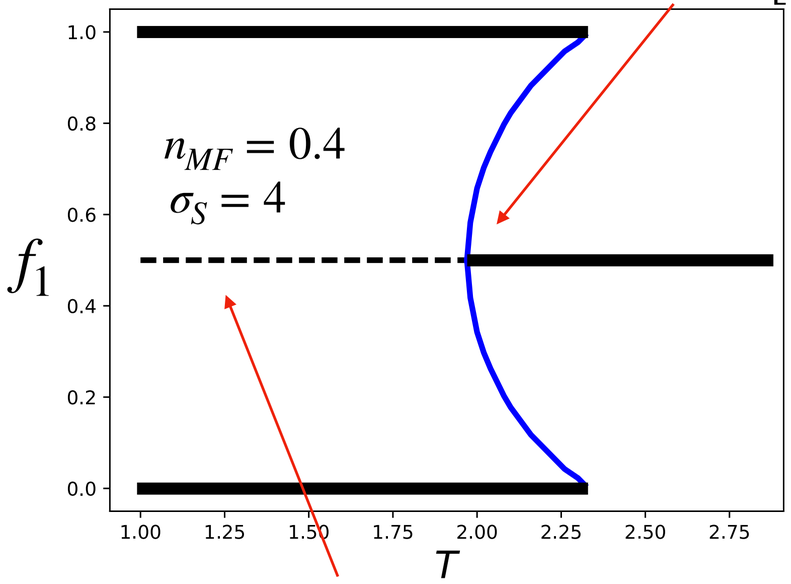




Stable: Dispersion

$$T_* = \left[\frac{\sigma_S(1+n_{MF})-1}{\sigma_S(1-n_{MF})-1}\left(\frac{1+n_{MF}}{1-n_{MF}}\right)\right]^{1/(\sigma_S-1)}$$





$$\sigma_S \geq \frac{1}{1-n_{MF}}$$

Stable: Agglomeration

below: always agglomeration

Summary

Forces that link **Production <—> Consumption** with **transportation costs**

can generate spontaneous *spatial agglomeration* via feedback loops for:

lower transport costs $T \searrow$
higher ratio of manufacturing workers to farmers $n_{MF} \nearrow$
lower substitutability $\sigma_S \searrow$

Sudden “phase transition” triggered by difference in real wages over space.

General Properties of Core-Periphery Models and Generalizations:

- ***Home-market effects***: the disproportional location of industry due to demand change,
- ***Circular causality (equilibrium):*** whereby larger industry concentrations beget higher real incomes and vice-versa,
- ***Emerging asymmetries*** between regions, in that workers and firms concentrate in one region versus another,
- ***Discontinuous agglomeration***: small changes in parameters result in sudden agglomeration in a single region,
- ***Degenerate equilibria***: which region ends up agglomerating depends on choices and history, this is connected to *path-dependence*.
- ***Hysteresis***: dispersion can persist temporarily even as transportation costs fall below the critical point, and the same is true starting with agglomeration as transportation costs rise.

Zooming out, Questions:

Think of Jacobs, Addams, Du Bois, Park + Burgess, Wirth

Think of Marshall

- What effects do these Economic Models capture?

- What effects do Economic Models NOT capture?

For example:

How can we understand specialization or diversity? — IUS Ch 5

How can we understand diversity and neighborhoods — IUS Ch 4 & 6

knowledge spillovers, innovation? — IUS Ch 5 & 9