Uniwersytet Warszawski
Wydział Nauk Ekonomicznych

International Economic Geography – New Economic Geography I

Bartlomiej Rokicki
Associate professor

Chair of Macroeconomics and Foreign Trade Theory
Faculty of Economic Sciences, University of Warsaw

From Location Theory to New Economic Geography

- Ottaviano and Thisee (2004) comment: "The space economy has to be understood as the outcome of the interplay between **agglomeration and dispersion forces**, an idea put forward by geographers and regional scientists long ago, **within a general equilibrium framework** accounting explicitly for market failures."
- They go on to state that "What was missing was a general equilibrium framework with imperfect competition connecting these various insights and allowing for a detailed study of their interactions".
- According to Brakman *et al*. (2009): "The main contribution of geographical economics is therefore to combine the existing elements into one single analytical framework, even though Krugman himself at the time remained somewhat silent on these antecedents."

New Economic Geography

- Pioneered by Krugman (1991) in „Geography and Trade and Increasing Returns" and „Economic Geography" with significant contributions by Thisse, Puga, Duranton, Fujita and others.
- Involves translation of many ideas and concepts from international economics to location within a country
- Krugman has argued that similar processes operate at all levels of space:
  - International
  - Interregional
  - Intra metropolitan?

New Economic Geography framework

Fundamental bases (after Brakman *et al*. 2009):

a) Increasing returns to scale that are internal to the firm

b) Imperfect competition (following Dixit-Stiglitz approach)

c) Positive transportation or trade costs

d) Endogenous firm locations

e) Endogenous location of demand through either mobile workers (Krugman, 1991) or firms using their sector output as intermediate inputs (Venables 1996, Krugman and Venables 1995).

New Economic Geography framework (2)

Head and Mayer (2004) conclude that:

- Ingredients (*a-d)* all appeared in the new trade literature, and in particular gave rise to the *home market effect* identified by Krugman (1980).
- With these assumptions, agglomeration can arise but only through the magnification of initial region size asymmetries.
- The key innovation of new economic geography relative to new trade is assumption *(e)*.
- Without *(e),* symmetric initial conditions can be expected to lead to symmetric outcomes.
- With all five assumptions, initial symmetry can be broken and agglomerations can form through a process of circular causation.
- Stress important role of new trade theory.

New Economic Geography framework (3)

Fundamental principles and implications:

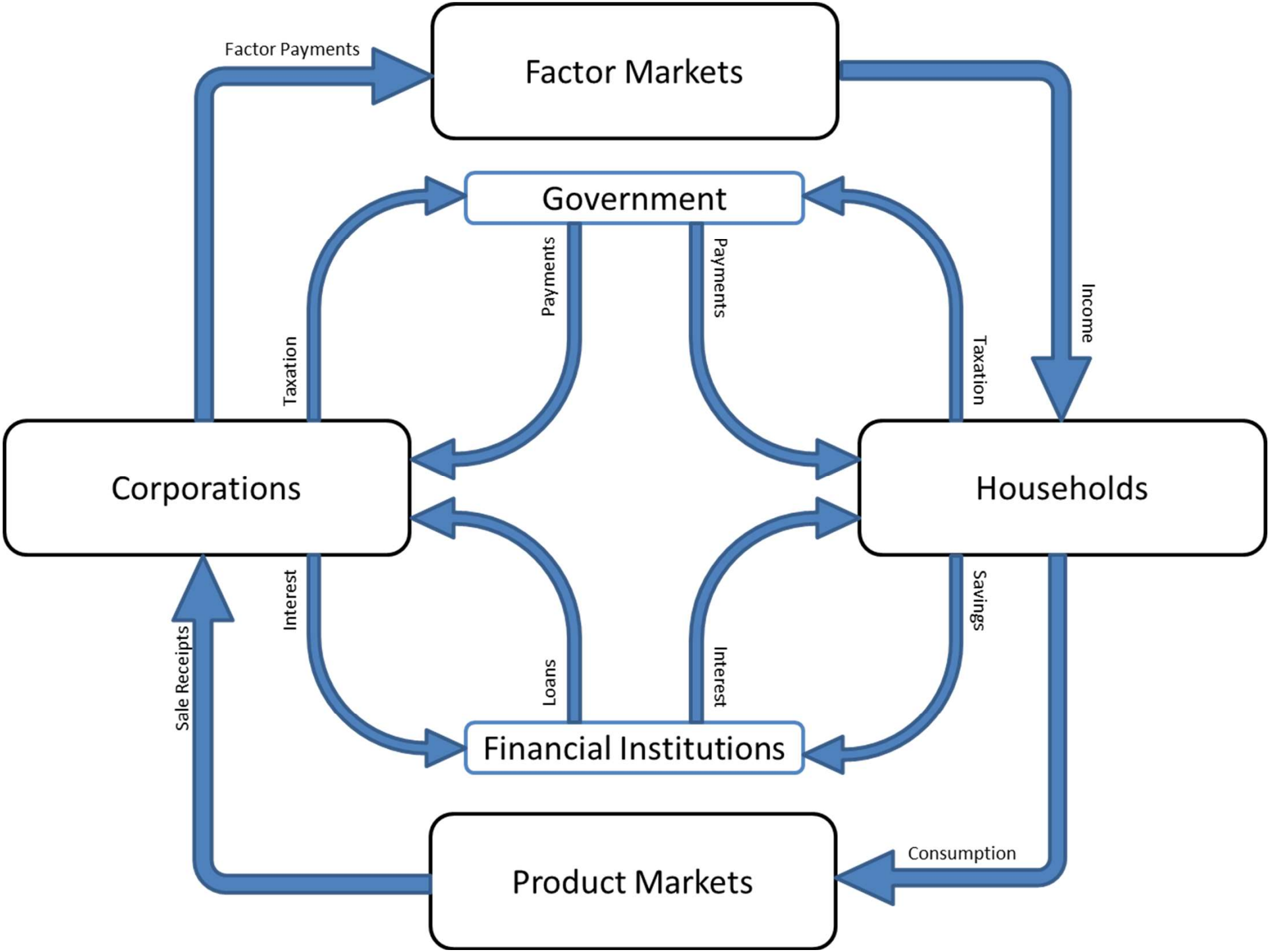
- Product diversity increase individual welfare by increasing choice ("love of variety")
- From the firm's perspective, offers opportunity for enhanced efficiency (exploiting economies of scale and scope)
- Larger cities with more variety offer more attractions and hence potential for growth
- Labor and other factors are assumed to be mobile (exceptions apply)

New Economic Geography framework (4)

- In summary, three main features:
  - Low transportation costs
  - Economies of scale
  - Love of variety
- Low transportation costs allow for enhanced trade and the gains from trade
- But tendency for larger regions to gain more and thus enhance disparities between larger and smaller regions (core-periphery)
- Outcome from NEG is that it is possible to have concentrations in space (cities) with intermediate areas with a smaller range of goods and services
- Generates a very “spiky” landscape – larger cities tend to grow more rapidly in large part from exploitation of scale economies and the attractions to labor for living in areas with a greater variety of goods and services

Core Model of Geographical Economics/NEG

- Draw on Brakman *et al*. (2009) and Ottaviano and Thisee (2004) for this exposition
- Some disagreements about the structure, foundations and interpretations
- Most agree on the general principles, as articulated earlier
- Structure of a two-region economy shown next – parallel to circular flow of income for single economy

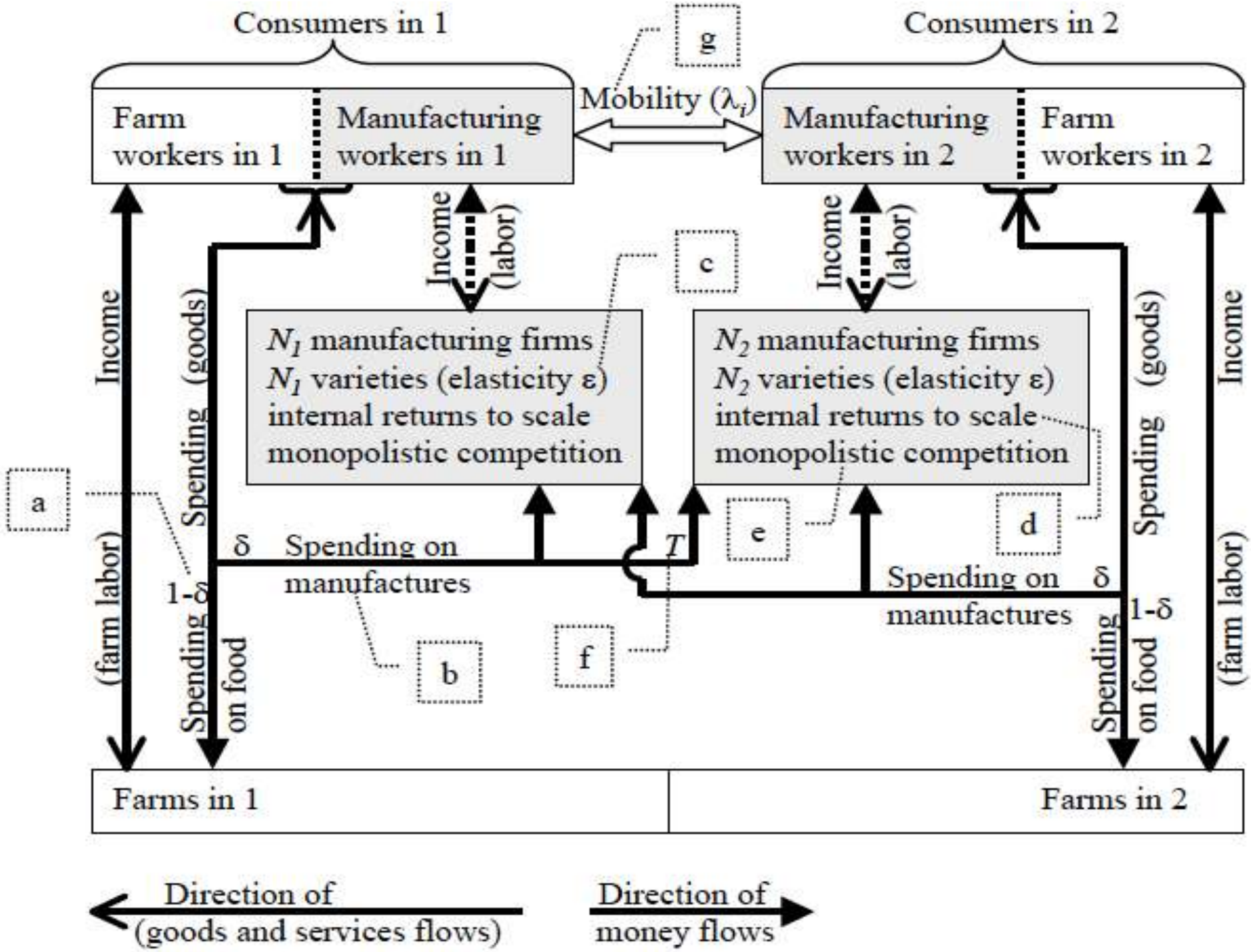

Factor Payments
Factor Markets
Government
Payments
Payments
Taxation
Taxation
Income
Corporations
Households
Interest
Sale Receipts
Loans
Interest
Savings
Financial Institutions
Consumption
Product Markets

Model Assumptions

- There are two sectors in the economy, the manufacturing sector and the agricultural (food) sector.
- Consumers in region 1 and 2 each consist of farm workers and manufacturing workers.
- The agricultural workers earn their income by working on farms in their region.
- Labor inputs and income flow in opposite directions
- The farmers in both regions produce food under constant returns to scale and perfect competition; food sold to the consumers, either in region 1 or in region 2.
- By assumption, there are no transport costs for food (later versions of the model assume an iceberg transportation cost)

Model Assumptions (2)

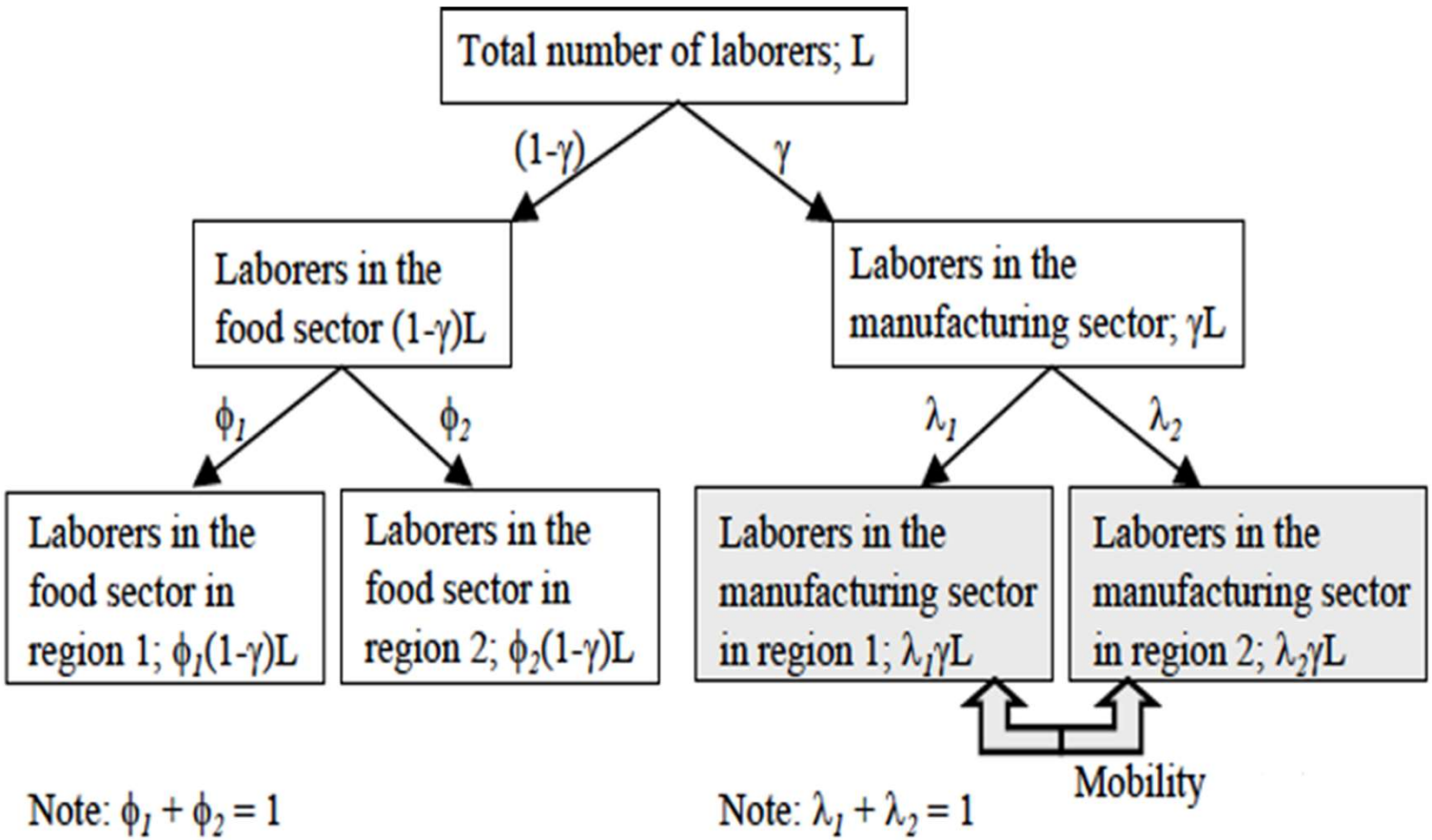
- There are N_1 and N_2 manufacturing firms in each region, each producing a differentiated good (unique variety)
- Use only labor inputs and there are internal economies of scale
- Firms have monopolistic power (differentiated good) to determine price
- Transport costs involved in selling good in other region but not in the home region (gives rise to the "home market" effect)
- Manufacturing workers earn income in home region only
- Consumers spend income on food and manufacturers;
  - Food is undifferentiated and earning same price in both regions (there are no transport costs)
  - Manufactured varieties are consumed (from both regions) but addition of transport costs makes imported goods more expensive. It is assumed that consumers buy at least some non-zero amount of all goods


Consumers in 1
Consumers in 2
g
Mobility (λ_i)
Farm workers in 1
Manufacturing workers in 1
Manufacturing workers in 2
Farm workers in 2
Income (labor)
Income (labor)
c
Income (farm labor)
Spending (goods)
N_1 manufacturing firms
N_1 varieties (elasticity ε)
internal returns to scale
monopolistic competition
N_2 manufacturing firms
N_2 varieties (elasticity ε)
internal returns to scale
monopolistic competition
Spending (goods)
Income (farm labor)
a
δ
Spending on manufactures
T
e
d
Spending on manufactures
δ
1-δ
1-δ
Spending on food
b
f
Spending on food
Farms in 1
Farms in 2
Direction of (goods and services flows)
Direction of money flows

Model Assumptions (3)

- Parameters, ε, δ and λ to be discussed
- Call-outs *a, b, f,* refer to demand, c, *d* and *e* to supply, and *g* to model dynamics
- Shaded boxes refer to mobility:
  - Only manufacturing workers can move between regions. They make their migration decisions taking into account the real wage differentials
  - Yet, labor is supposed to be immobile between sectors
  - In addition, manufacturing firms can move
  - Possible for all firms to move from one to another region
- In contrast, farm workers remain in the region (assumption that they need land and thus are non mobile)
- Assume no money illusion – so set price of one good (agricultural) to 1 and express all prices relative to this *numéraire*

Addressing the Geography



Income

Labor force:

$\boldsymbol{L}$ – total workers, $\boldsymbol{(1 - \gamma)L}$ – farmers ($\boldsymbol{L^A}$) and $\boldsymbol{\gamma L}$ – manufacturing workers ($\boldsymbol{L^M}$)

Φ_1 and λ_1 of labor in agriculture and manufacturing respectively in region 1

Food production in region 1 will be $\Phi_1(1\text{-}\gamma)L$ *(remind labor is the only input)*

Agricultural wages equal 1 in both regions $w_1^A = w_2^A = 1$

With transport costs, wage rates for manufacturing likely to be different in each region (we drop superscript M in following equations) $w_1^M \neq w_2^M$

All income earned in the economy of region 1 comes from wages:

$$Y_1 = \underbrace{\lambda_1 w_1 \gamma L}_{\text{manufacturing}} + \underbrace{\phi_1 (1-\gamma) L}_{\text{food}}$$

Demand

- Assume consumers have a Cobb-Douglas preference function for agricultural goods, *A* and manufactures, *M* (aggregate varieties through a price index *G*)
- Income *Y* (from agriculture or manufacturing) can be spent on different combinations of goods in accordance to utility function:

$$\mathrm{U} = A^{1-\delta} M^{\delta} \qquad\qquad 0 < \delta < 1$$

- Budget constraint in region 1 (food is *numéraire* so no price index):

$$Y_1 = A + G_1 M$$

- Use utility optimization to yield following shares:

$$A = (1-\delta) Y_1 \qquad\qquad G_1 M = \delta Y_1$$

since $MRS = \frac{Px}{Py}$ and $MRS = (\frac{a}{b})(\frac{y}{x})$ for $U = x^a y^b$

Demand (2)

- Now to address specific varieties consumers chose; refer to assumption from the Dixit-Stiglitz model of monopolistic competition
- Let N be the total number of varieties and c the consumption of each variety I
- Use CES (constant elasticity of substitution) function to make the allocation (M is the quantity index)

$$M = \left[\int_0^N c(I)^\rho di\right]^{1/\rho} \qquad 0 < \rho < 1$$

- If ρ =1 consumers are indifferent to variety so it is necessary that it is less than 1 to ensure varieties are substitutes (and thus facilitates price setting based on monopoly power)

Demand (3)

- Importance of the Dixit-Stiglitz formulation (foundation of many models of imperfect competition)
- If consumers consume equal shares of varieties, then:

$$M = \left[\int_0^N c(I)^\rho di\right]^{1/\rho} = (Nc(I)^\rho)^{1/\rho} = N^{(1/\rho)-1}Nc(I)$$

- Given constraint on ρ, $0 < \rho < 1$ this term is larger than 0, hence 100 units of 1 variety ($Nc(I) = C$, $N = 1$) provides less utility than 1 unit of 100 varieties ($Nc(I) = C$, $N = 100$) – *see the quantity index M in the utility function!*
- N represents the extent of the market and $N^{(1/\rho)-1}$ is a bonus for large markets – increase in the extent of the market increases the number of varieties that more than proportionally increase utility

Demand (4)

- How does the consumer allocate spending among the varieties?
- The budget constraint is:

$$\sum_{i=1}^{N} p_i c_i = \delta Y$$

- Now need to maximize utility across varieties subject to this budget constraint and we get:

$$c_i = p_i^{-\varepsilon}[G^{\varepsilon-1}\delta Y]$$

demand curve

where

$$M = \delta Y / G$$

$$\varepsilon = \frac{1}{1-\rho}$$

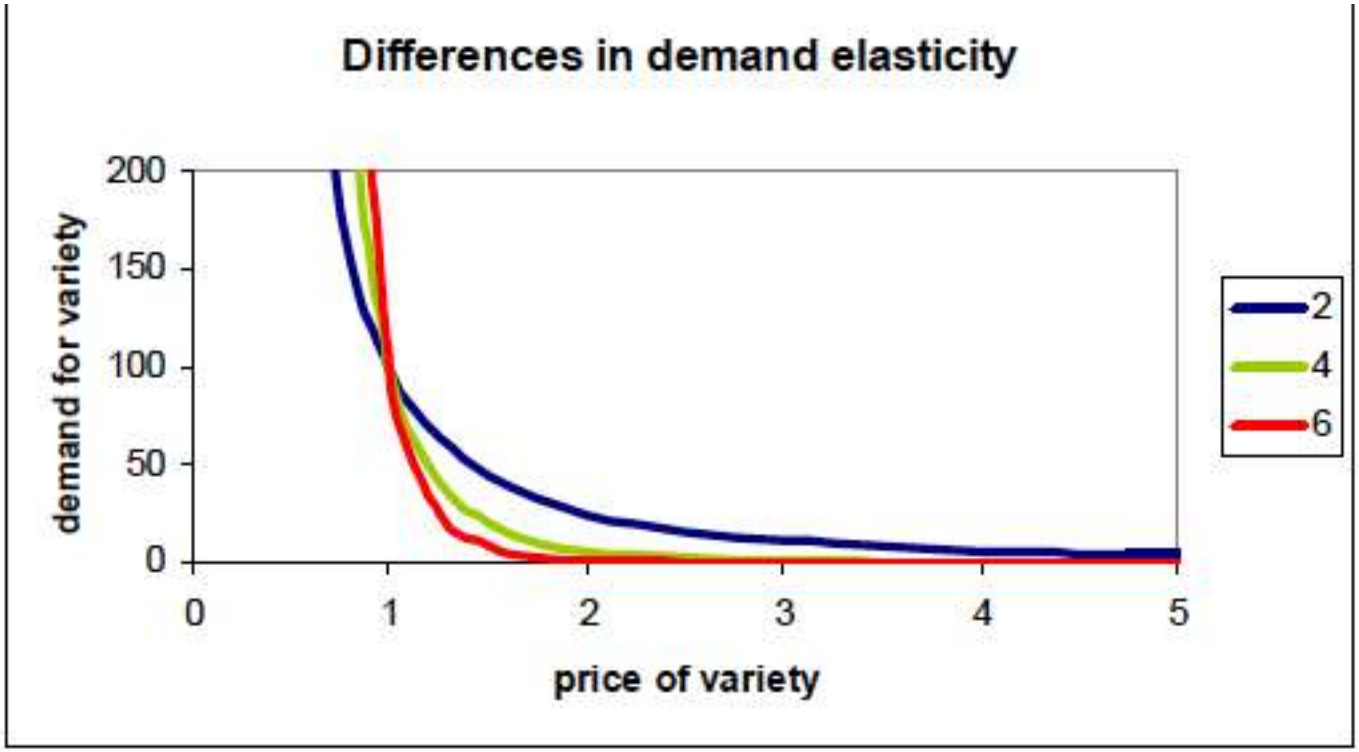
price elasticity

Demand (5)

- Consider demand for variety 1
- It is a function of:
  - Income δY - 10% increase in spending on manufacturing results in a similar increase on all varieties
  - The price of each good – assuming that price elasticity (ε) is constant
  - The price index, G. Assume that if the prices of varieties competing with variety 1 are increasing, then the demand for 1 will increase

Demand (6)

- If the elasticity of substitution for varieties is high, a small price change can have large effects (the higher ρ, the higher ε)
- Utility from consumption of manufactures will increase if and only if spending on manufactures (δY) increases faster than the price index, G



*Demand given by $c_1 = 100 p_1^{-\varepsilon}$; the value of ε varies (2, 4, and 6).

Supply

- Recall that food production assumes:
  - Constant returns to scale
  - Perfect competition
  - Immobile workers
- Fraction of workers in this sector is assumed to be $(1-\gamma)L$, where L is total labor force
- Remainder, γL is a manufacturing labor
- Since food is the *numéraire* sector, production in this sector is:

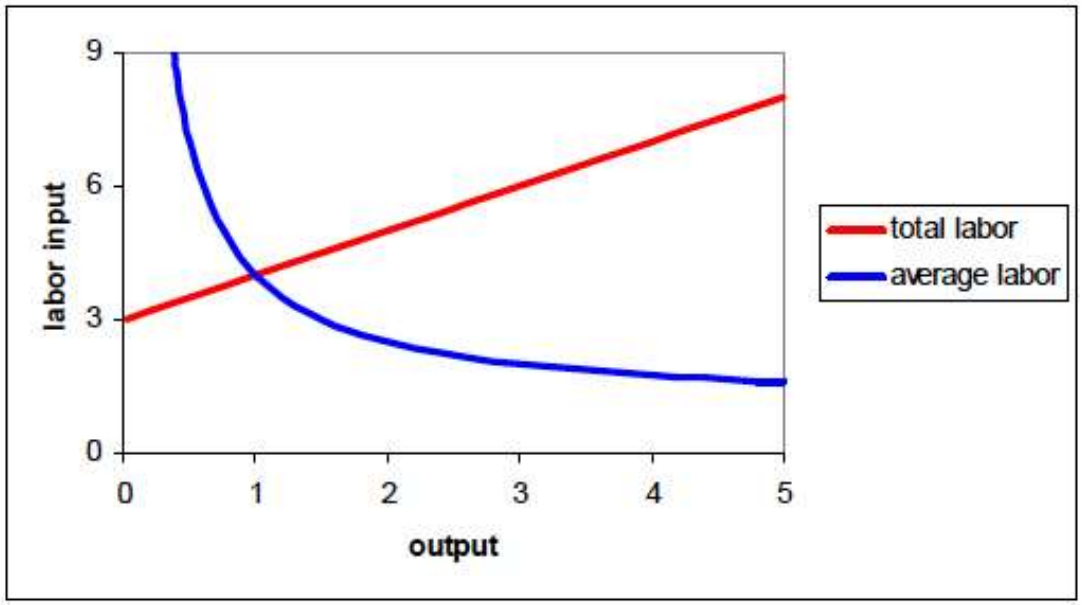
$$F = (1-\gamma)L \quad 0<\gamma<1$$

Farm workers are paid value of their marginal product, this implies that wage for labor is 1

Supply (2)

- In manufacturing, there are internal economies of scale implying imperfect competition
- Each variety is produced with the same technology
- Economies of scale introduced: $l_i = \alpha + \beta x_i$

  where l_i is the amount of labor to produce x_i of variety I
- The coefficients are the fixed and marginal labor input requirements – implying internal economies of scale



Fixed labor requirement $\alpha = 3$, marginal labor requirement $\beta = 1$.

Supply (3)

- Assumed that each manufacturing firm produces one variety under internal returns to scale ➔ each firm has monopoly power to maximize profits
- In price setting, assume:
  - Each firm takes the price setting behavior of other firms as given
  - It ignores the effects of changing its own prices on the aggregate price index (because large number of varieties, would have small impact)
- Generate following profit function:

$$\pi = px - w(\alpha + \beta x)$$

- Supposed that all production will be consumed; thus, constant price elasticity of demand assumed to hold for all consumers with the same preference structure

Supply (4)

- Use mark-up pricing (fixed increment over production costs) to generate price:

$$p\left(1-\frac{1}{\varepsilon}\right)=\beta w \qquad \text{or} \qquad p=\beta w/\rho$$

- Marginal cost of producing an extra unit is βw while the price, p, that the firm charges will be higher than this marginal cost.
- If demand is rather inelastic *(ε =2)* the mark up is high
- If demand is rather elastic, *(ε =5)* , the mark up will be lower
- Firm must charge higher price than MC in order to cover fixed costs of labor, αw
- Price is fixed if the wage rate is fixed
- Supposing (excess) profits are positive ➔ attract new entrants who will produce a different variety ➔ leading to the consumer spending income on n+1 varieties this will lead to profits of existing firms to fall
- Process will continue until profits fall to zero

Supply (5)

With some manipulation, we can calculate:

- the scale at which a firm produces a particular variety (x);
- how much labor is required (l)
- how many varieties (N) are produced as a function of the available labor in the manufacturing sector

$$x = \frac{\alpha(\varepsilon - 1)}{\beta}$$

$$l_i = \alpha\varepsilon$$

$$N = \gamma L / l_i = \gamma L / \alpha\varepsilon$$

Supply (6)

Implications

- Output per firm is fixed in equilibrium because of constant price elasticity of demand and the nature of the production function
- Manufacturing output only expands/contracts by producing more/less varieties **since output level per variety does not change**
- **As a result of internal economies of scale, it is not profitable to have the same variety produced by more than one firm**
- Hence, increased trade would only change the number of varieties

(In empirical CGE models, this is avoided by adopting the Armington assumption – namely that the same good produced in different locations are imperfect substitutes)

- Parameter ε plays an important role:

For high values of ε varieties are becoming more and more substitutes. In the limit only one variety survives.

Transport Costs

- NEG adopts Samuleson's iceberg assumption
- Idea that to deliver T units of a good to a market, $(1.z)T$ units must be produced since units will be "consumed" in the transportation
- This avoids having a separate transportation sector offering a margin service – and the accounting for its profits and also its location
- Existence of shipping costs generates the uneven structure of markets and avoids the outcome of the spatial impossibility theorem

Locational Implications

- Price charged to a consumer will be a function of
  - Location of the firm (determining the wage rate the firms have to pay workers)
  - Location of the consumer (whether consumer has to pay transport costs)
- Implies: price index will vary between regions
- Further, impact of location on consumption decisions in different locations requires knowledge of income level
- Hence need to move towards equilibrium formulation

Price index

- Since the shipping costs may differ among locations we can also expect the price of goods to differ according to the formula:

$$p_2^M = p_1^M \tau_{12}$$ where p_1^M is the domestic price

- Thus, due to the concentration of industry in one region, prices decreases in the latter and rises in the others.
- It allows the price index to differ from location to location. In particular, in the case of the 2 region world, the price index in region 1 assumes the form:

$$G_1 = [\lambda_1 w_1^{1-\sigma} + \lambda_2 (w_2 \tau_{21})^{1-\sigma}]^{1/(1-\sigma)}$$

Equilibrium

- Distinguish
  - Short-run equilibrium where factors/firms are fixed
  - Exogenous distribution of manufacturing labor force
  - Short-run equilibria
  - Long-run equilibria where factors/firms can move
- Short-run assumptions
  - Labor markets clear – all farm and manufacturing workers have jobs
  - Number of varieties determined using production function for manufacturing, price setting behavior of firms and entry/exit of firms until profits are zero
  - Farmers also earn no profit because of CRS and perfect competition

Two-region equilibrium

$$Y_1 = \lambda_1 w_1 \gamma L + \phi_1 (1-\gamma) L$$

$$Y_2 = \lambda_2 w_2 \gamma L + \phi_2 (1-\gamma) L$$

$$G_1 = [\lambda_1 w_1^{1-\sigma} + \lambda_2 (w_2 \tau_{21})^{1-\sigma}]^{1/(1-\sigma)}$$

$$G_2 = [\lambda_1 (w_1 \tau_{12})^{1-\sigma} + \lambda_2 w_2{}^{1-\sigma}]^{1/(1-\sigma)}$$

$$w_1 = \left[Y_1 G_1^{\sigma-1} + Y_2 G_2^{\sigma-1} \left(\tau_{21}\right)^{1-\sigma} \right]^{1/\sigma}$$

$$w_2 = \left[Y_1 G_1^{\sigma-1} \left(\tau_{12}\right)^{1-\sigma} + Y_2 G_2^{\sigma-1} \right]^{1/\sigma}$$

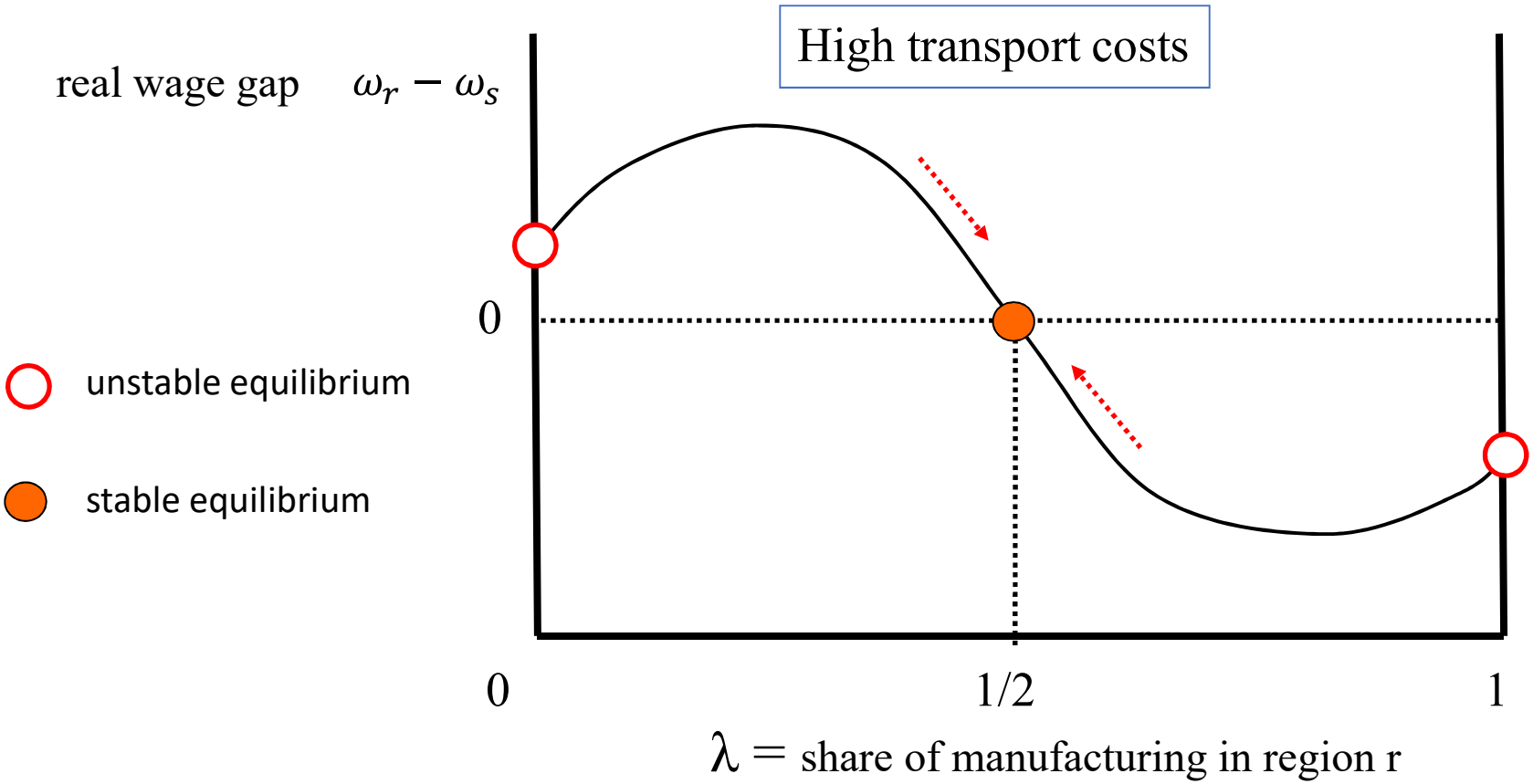
$$\omega_1 = w_1 G_1^{-\mu}$$

$$\omega_2 = w_2 G_2^{-\mu}$$

$$where\ \mu = \gamma L\ - number\ of\ manufacturing\ workers$$

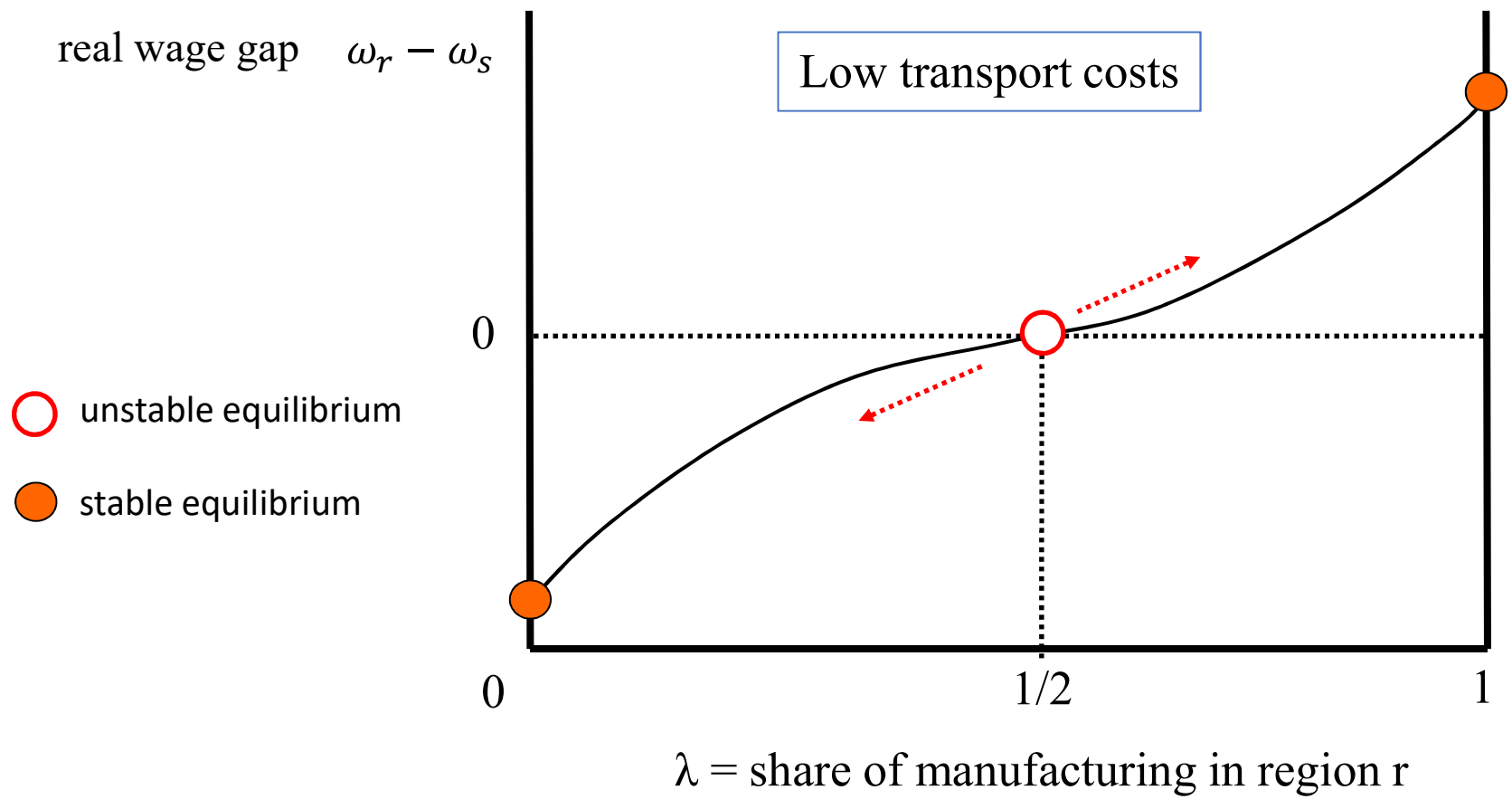
Wiggle diagram – high transport cost

- When manufacturing is more concentrated in a region r ($\lambda > 1/2$), its labor force earn less in real terms (for high transport costs dispersion forces are stronger than agglomeration forces)
- Non-symmetric equilibria are unstable. Any shock starting from $\lambda = 0$ or $\lambda = 1$ would make workers migrate to the other region.



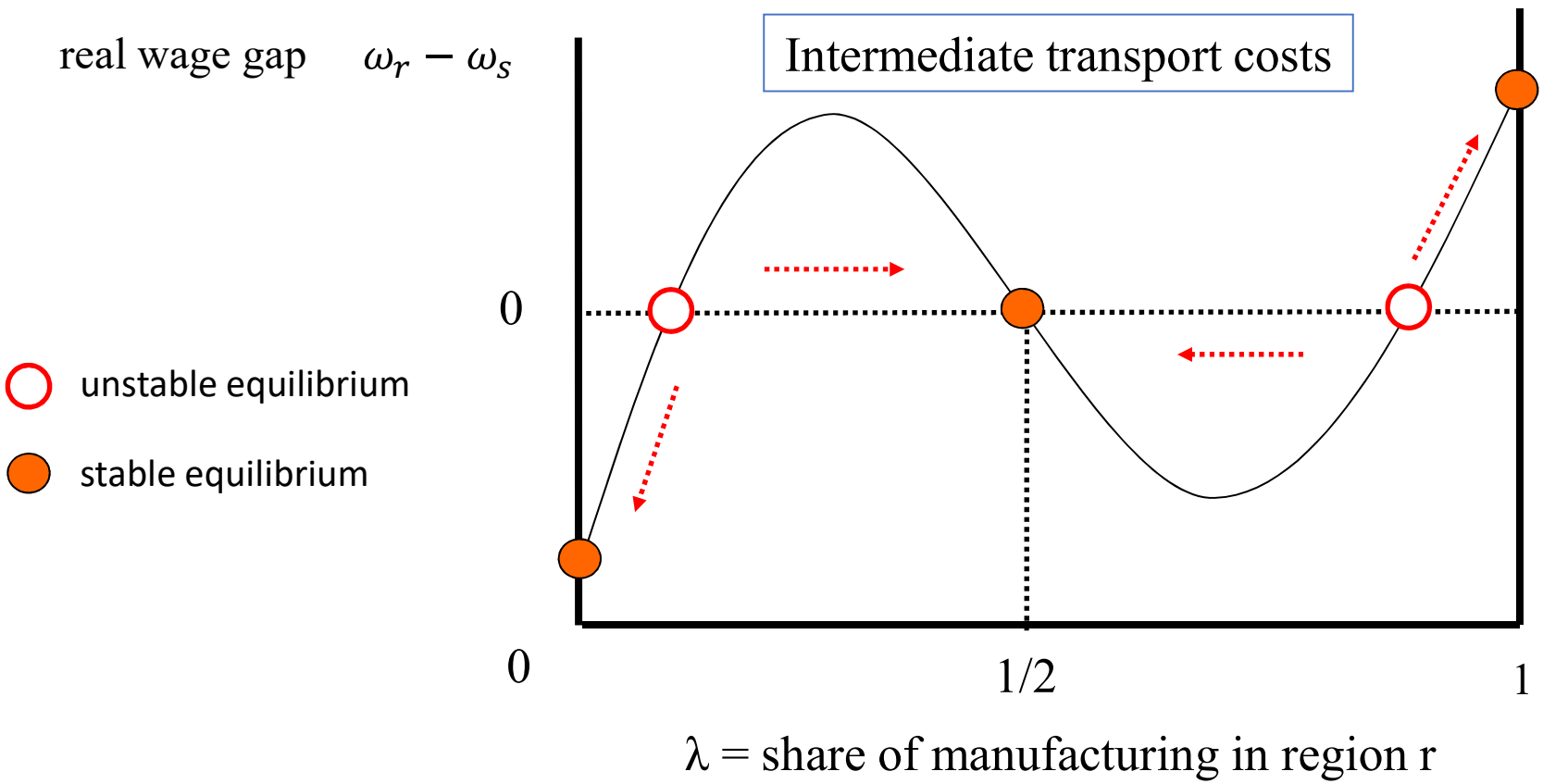
Wiggle diagram – low transport costs

- When transport costs are low, the higher share of manufacturing the more attractive a region:
  - **Backward Linkages:** the > local market, > nominal wages.
  - **Forward Linkages:** the > variety of locally produced goods, < price index**.**
- Trend to **agglomeration**. Unstable Equilibrium even when **λ = 1/2**



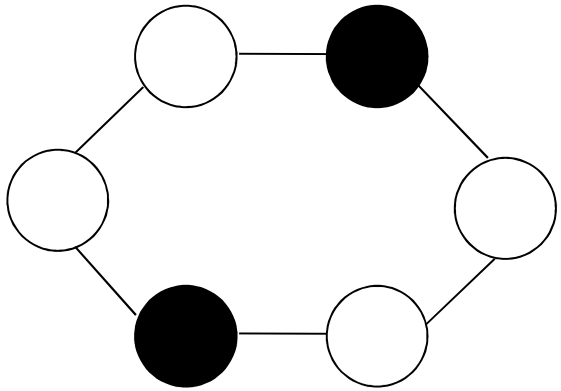
Wiggle diagram – intermediate transport costs

- For intermediate trade costs real-wage-gap curve marks 5 equilibria: 3 stable and 2 unstable
- The locally stable equilibria:
  - If the initial share is unequal, it tends to concentration.
  - If the initial share is equal, it tends to a fair share (λ = 1/2)



Multiregional equilibrium

Krugman (1991) considers the case of six initially symmetric regions laid out in a circle. He argues that for high level of trade costs economic activity will be evenly dispersed, for intermediate values of manufacturing sector will agglomerate in two regions laid out opposite to each other, and for low values of all manufacturing will cluster in a single metropolis.



This model suggests that, economic integration of a big and a small country does not necessarily lead small one to lose its industry. As countries consist of regions of different size we may assume that small country has fewer number of regions but of equal size as the big one. So integration may instead allow big region of small country to expand as it gains access to new markets.