Spatial Economics

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Lectures 3 and 4

Lent Term
2011

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Market Area Analysis: Hotelling

- Market areas frequently differ over space due to differences in population densities, consumer demands, income distributions among other things.

- Space can confer monopoly power to the firms, which encourage firms to engage in spatial competition through location

Market Area Analysis: Hotelling

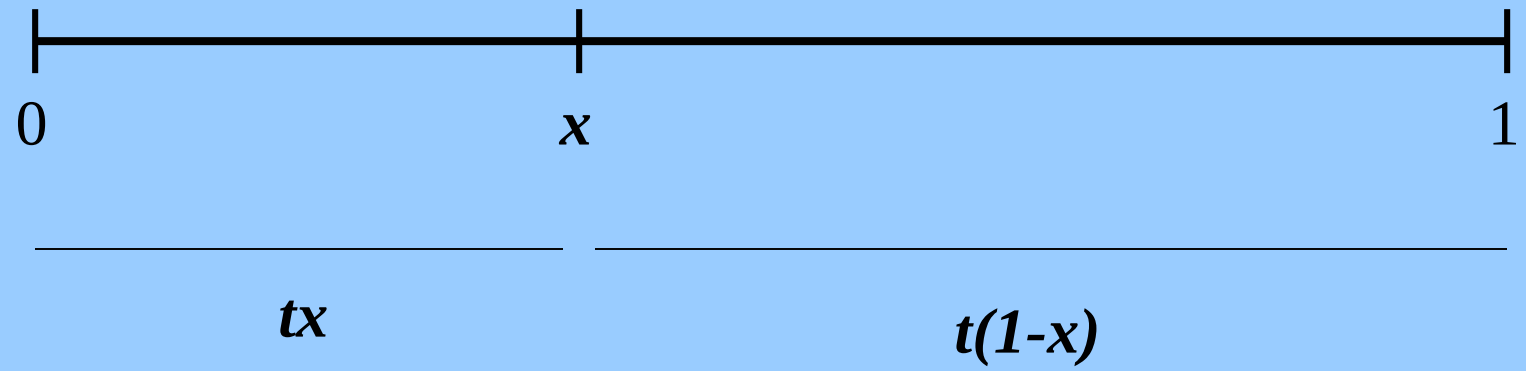
- In imperfect market structures, such as oligopolies, the interdependence between firms in the determination of output produced and market share is also a result of locational considerations, as well as interdependence in terms of pricing decisions

- Hotelling (1929) provided a simple model to address these issues within a context of a locational or pricing game

Assumptions

- Consider a "linear city" of length 1
- Consumers are distributed uniformly along the city
- There are two identical firms located in the city producing the same physical good
- Consumers have transport costs *t* per unit of length
- Consumers have unit demand
- Consumers consume the cheapest good

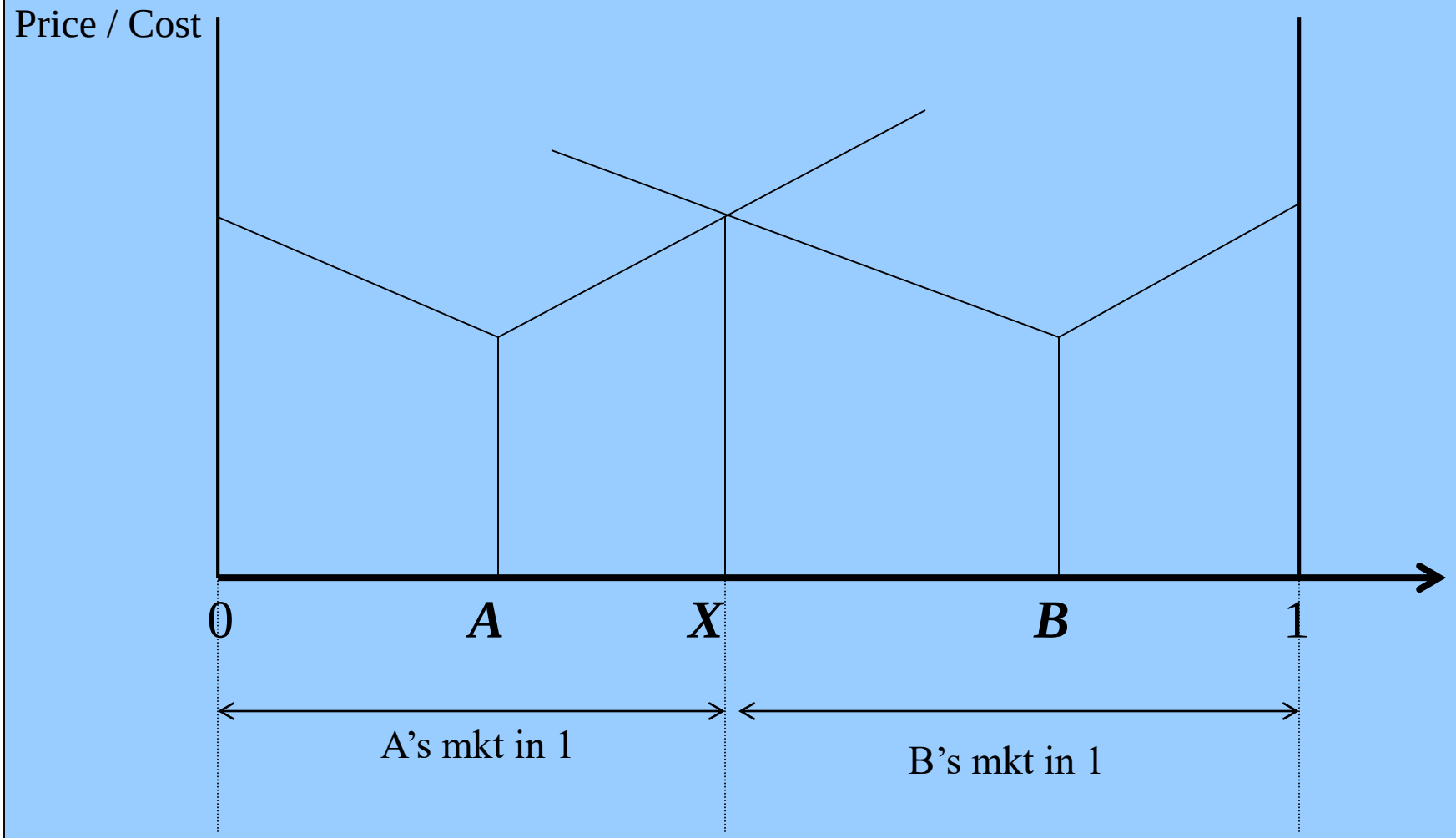
The Linear City



The Locational Game: Example

- In terms of firm strategy we assume that each firm makes a decision on the basis of the assumption that its competitor will not change its behaviour (Cournot conjecture)
- Assume that Initially firm A is located at ¼ and firm B at ¾
- In this case both firms will have identical market shares

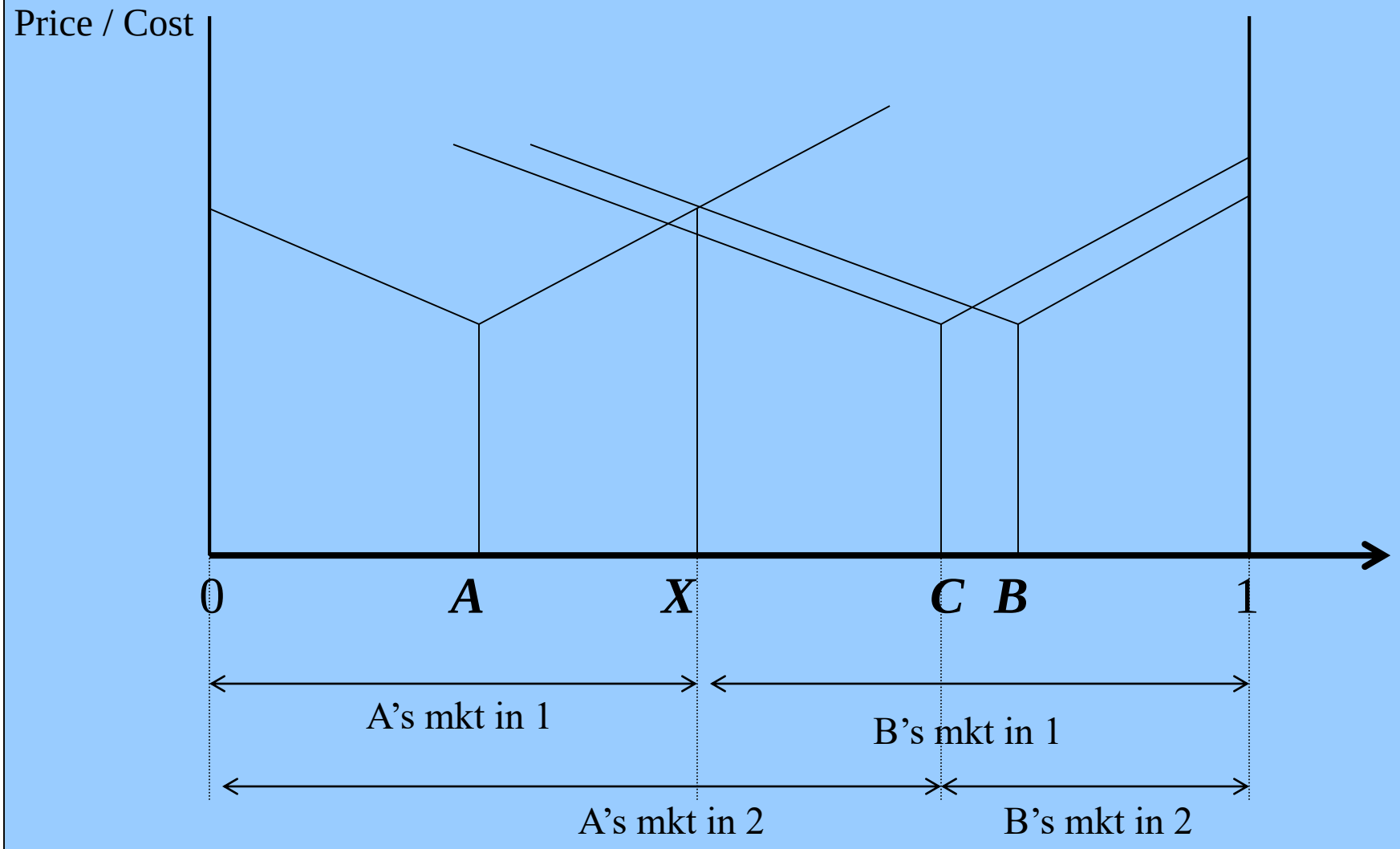
The Locational Game: Example



The Locational Game: Example

- In order to increase its market share, at period 1, firm A will move to just to the left of B (point C)

The Locational Game: Example



The Locational Game: Example

- In time 2, firm B will now assume that firm A stays at C and will move just to the left of C
- In time 3, firm A will respond by moving to the left of firm B again
- This process will continue until both firms are located at X, in the middle of the market
- There, neither firm has incentives to change its locational behaviour, because any locational change will involve a reduction in firm's market share (Nash Equilibrium)

The Pricing Game with Fixed Firms

- Firms are now fixed in the extremes of the city
- Consumers derive a surplus *s* when consuming the good
- For a consumer located at co-ordinate *x*, the generalised price is

$p_1 + tx$ to buy at firm 1 and

$p_2 + t(1-x)$ to buy at firm 2

Utility

The utility of a consumer located at x is:

$U = s - p_1 - tx$ if he/she buys at firm 1

$U = s - p_2 - t(1 - x)$ if he/she buys at firm 2

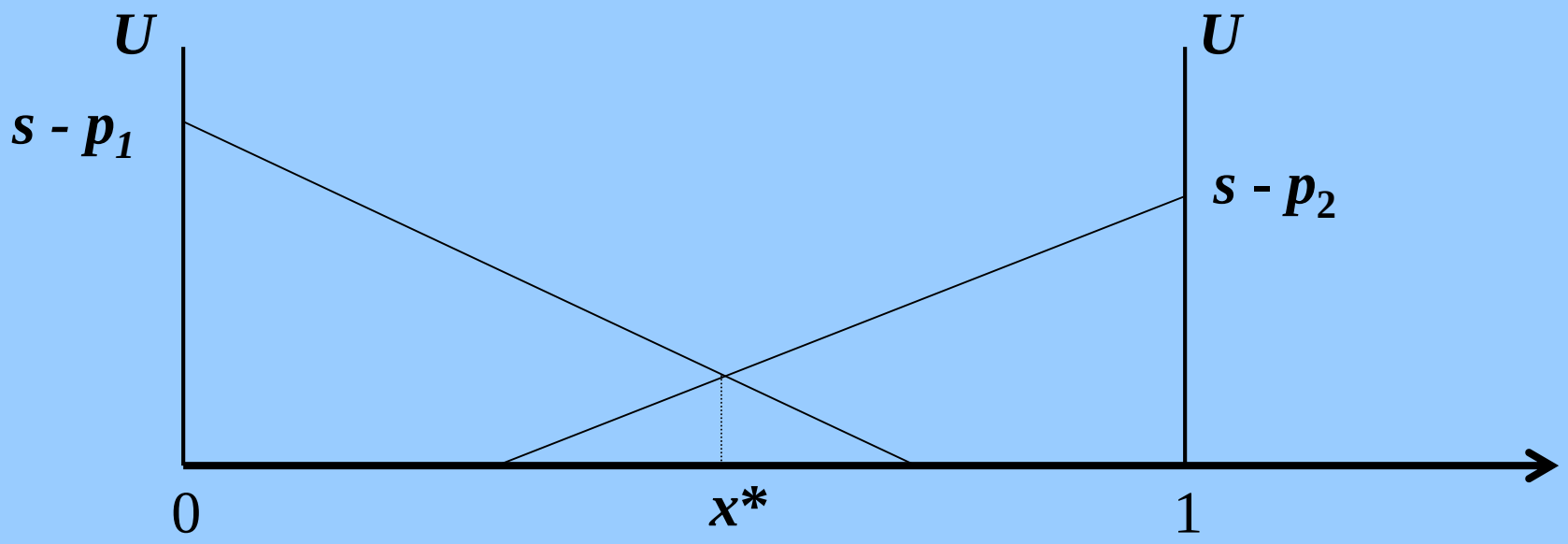
Demand

If price difference between the firms does not exceed transport costs along the whole city and the prices are not "too high", then exist a consumer at location x^* who is indifferent from buying at firm 1 or firm 2. In this case we have:

$p_1 + tx^* = p_2 + t(1 - x^*)$ or $x^* = (p_2 - p_1 + t) / 2t$

and firm's demand are $D_1 = x^*$ and $D_2 = 1 - x^*$

Demand



Price Competition

Assuming that firms choose prices simultaneously, it is possible to derive the Nash equilibrium in prices

Nash Equilibrium in Prices

"A Nash equilibrium in prices - sometimes referred to as Bertrand equilibrium - is a pair of prices (p_1^*, p_2^*) such that each firm's price maximises profits, given the other firm's price". Formally:

for all $i = 1,2$ and for all $p_i > 0$, $\pi^i (p_i^*, p_j^*) \geq \pi^i (p_i, p_j^*)$

Equilibrium Prices

To find the equilibrium prices we have to maximise each firm's profits given the other firm's price choice:

$$\underset{p_i}{\text{Max}}\ \pi^i\ (p_i, p_j)$$

Assuming that both firms have unit cost c, the profit function is

$$\pi^i = (p_i - c)D_i$$

From the first order conditions we find that

$$p_1 = p_2 = c + t$$

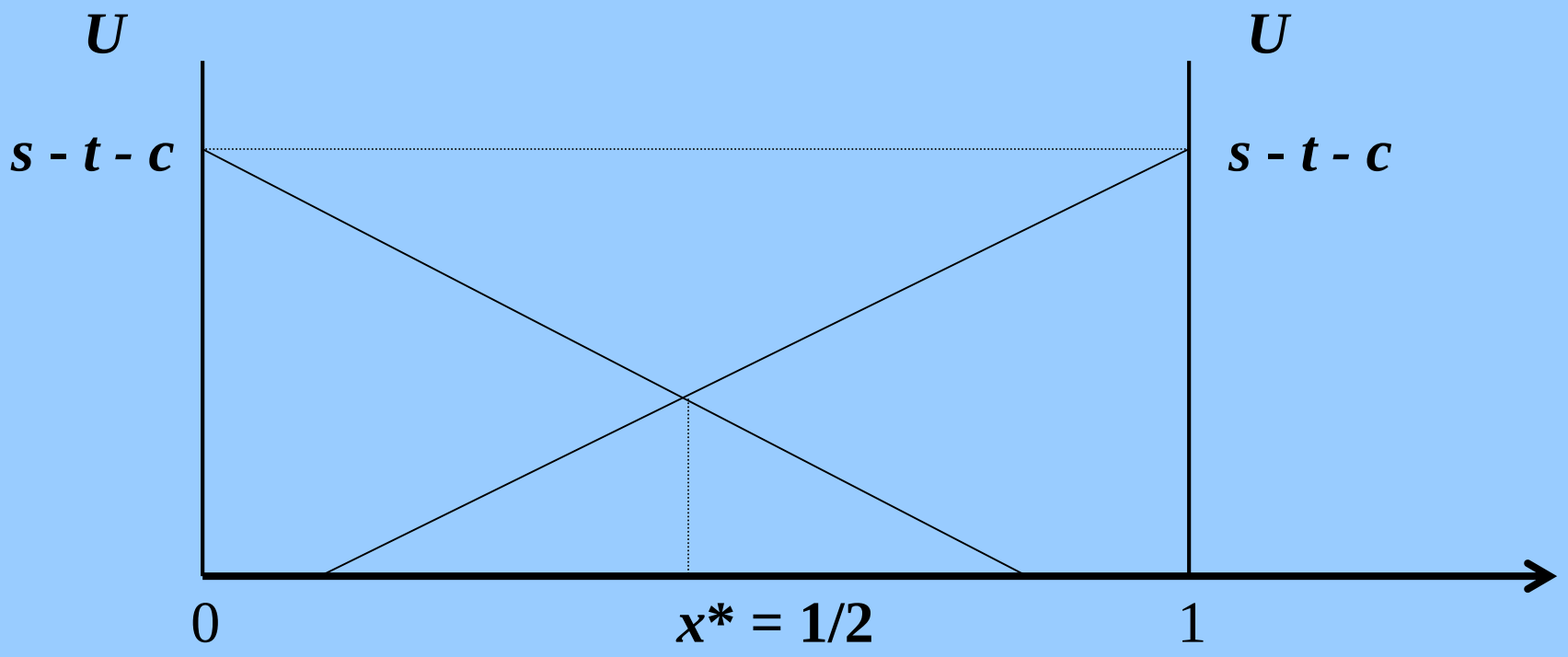
Equilibrium Prices

Substituting equilibrium prices into demand and profit functions we find that

$\pi^1 = \pi^2 = t/2$ and

$D_1 = D_2 = 1/2$

Equilibrium



Results

1. Due to transport costs, products are differentiated even being physically identical

2. Due to transport costs competition reduces and monopoly power arises with equilibrium prices above competitive levels.

3. If $t = 0$ Bertrand classic result is produced with the equilibrium characterised by

$p_1 = p_2 = c$ and

$\pi^1 = \pi^2 = 0$

Extensions

- Locational and Pricing games simultaneously
- Different production or transport costs
- Dynamic frameworks
- Advanced: IO models where space is not geographical space but the space of product characteristics

Exotic Application

- Goeschl, T. and Igliori, D. (2004) ‘Reconciling Conservation and Development: A Dynamic Hotelling Model of Extractive Reserves’, *Land Economics*, Vol. 80, No. 3, pp. 340-354.

Agglomeration Economies and Industrial Clustering

- Most industrial activities tend to be clustered in space
- Clustering may take the form of industrial parks, small towns, or major cities
- Many productive and commercial activities take place in the immediate vicinity of other such activities
- WHY?

Increasing Returns

- Recent work emphasise that in order to explain agglomeration we need to assume that increasing returns (or economies of scale) exist and are place specific

von Thunen and Hotelling

- Note that the 2 models discussed previously do not assume increasing returns.
- Spatial heterogeneity is introduced in an *ad hoc* fashion.

Increasing Returns and Agglomeration Economies

- Internal Returns to Scale
- Economies of Localisation (Marshall, Porter)
- Economies of Urbanisation (Jacobs)

Internal Economies of Scale

- Internal economies of scale means that the decrease in average costs is due to an increase in the production level of the firm itself.

- Since this implies some advantage accruing from size, the implied market structure is imperfect rather than perfect competition.

Cobb-Douglas Production Function

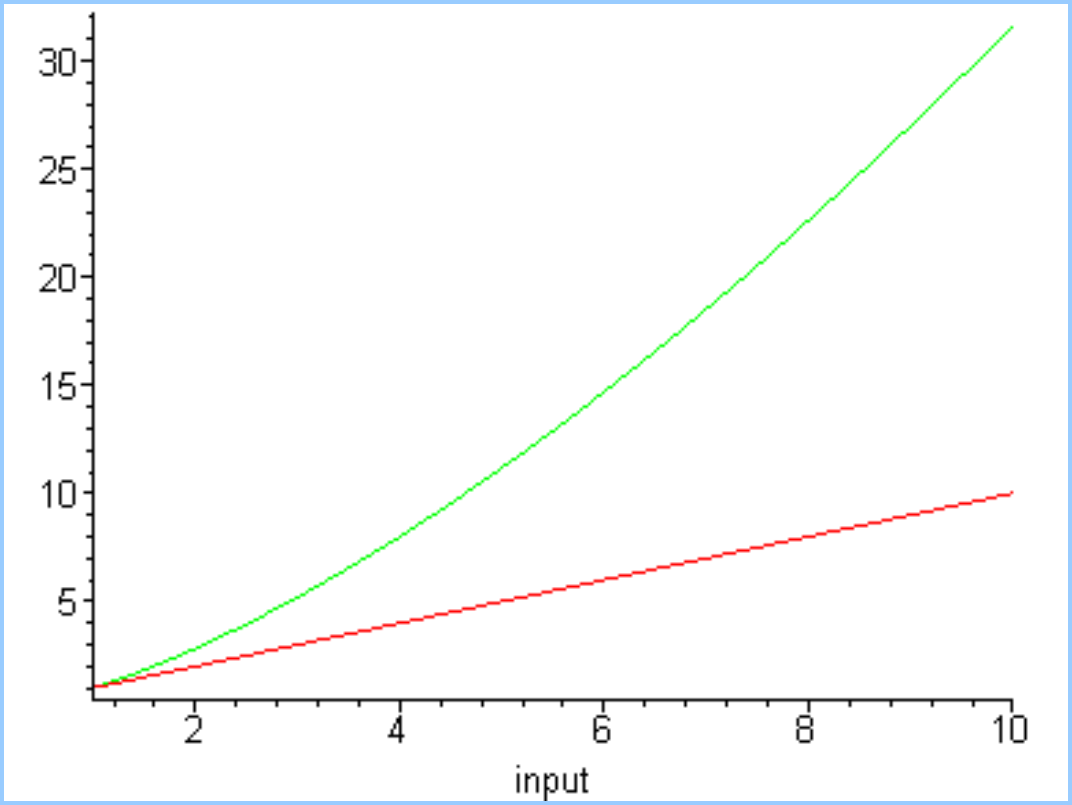
$$Q = AK^{\alpha} L^{\beta}$$

Q – output
K - capital
L – labour
β and α - control how important capital and labour are to output production

Returns to Scale in Cobb-Douglas

- When $\alpha + \beta = 1$ we have constant returns, so that doubling inputs doubles output. But when $\alpha + \beta > 1$ then we have increasing returns, doubling inputs more than doubles output. We see this from the following graph.

Returns to Scale in Cobb-Douglas



$\alpha + \beta = 1$

$\alpha + \beta > 1 = 1.5$

External Economies of Scale

- With external scale economies average costs are a function of the level of output of the local industry as a whole. External economies can also apply to a sector or the whole economy

Externalities

- Externalities, also known as neighbourhood effects, involve interdependence of utility, production or profit functions.

- Agents do not aim to generate externalities (no strategic interactions). They arise because of the non-existence of markets (technological) or market interdependence (pecuniary).

Technological Externalities

- A technological externality is present whenever the well-being of a consumer or the production possibilities of a firm are **directly** affected by the action of another agent in the economy.

- The use of the word 'directly' means that we exclude any effects that are mediated by markets.

- There are many factors, which are not manifest in the market and are unpriced but which affect urban productivity.

Technological Externalities 2

Classic Example

- Assume we have a river with two activities, a fishery and an oil refinery.
- A technological externality is present if the fishery's productivity is reduced as a direct result of water pollution from emissions from the upstream the oil refinery

Pecuniary Externalities

- Affects firm's demand and profit functions through changes in (input and output) prices.

- referred to as market interdependence (backward and forward linkages).

Pecuniary Externalities 2

- The size of the city influences the price of inputs to a firm, then it is market mediated and generates a pecuniary externality.

- Likewise, the existence of the large local market for specialized services promotes service variety, enhances final goods productivity, and thus helps to maintain the manufactures market. There is market interdependence.

- Market interdependence requires imperfect competition.

Alfred Marshall

- External economies stimulate geographical concentration of economic activity.

1. The existence of thick markets for specialized labour

2. The occurrence of knowledge and technology spillovers

3. The emergence of subsidiary trades

Knowledge Spillovers

- Technological externalities often appear as benefits due to transfers of information or knowledge.
- Knowledge generated by one agent for its own benefit is not exhausted by use but persists and spreads, affecting other economic agents.
- Knowledge travels better in short distances

Knowledge Flows within a Industry: Marshall Externalities

- knowledge spills over between firms within a industry.
- The idea is that we see a boost to production due to technological externalities that involve firms picking up or somehow acquiring, at less than market cost to themselves innovations and ideas generated by other firms within their industry.
- Localization economies = Marshall Ext.

Knowledge Flows between Industries: Jacobs Externalities

- Jacobs externalities are external to the sector but internal to the city
- There are benefits to economic growth of a sector from the activities of other sectors within a city due to the ease of transmission of knowledge of any kind
- ‘The diversity of urban activities quite naturally encourages attempts to apply or adopt in one sector (or in one specific problem area) technological solutions adopted in another sector
- Urbanization economies = Jacobs Ext.

Agglomeration Effects: Production

- We can consider agglomeration economies on both the production side and the consumption side.
- On the production side, the theory emphasizes the role played by economies of scale at the level of firm, industry and market area.

Agglomeration Effects: Consumption

- On the consumption side the focus is on the utility gains that consumers can obtain by concentrating in space.
- These include economies of scale in the provision of local public goods, amenities and the access to a greater variety of goods and services in larger market areas.
- Contemporary theory integrates both

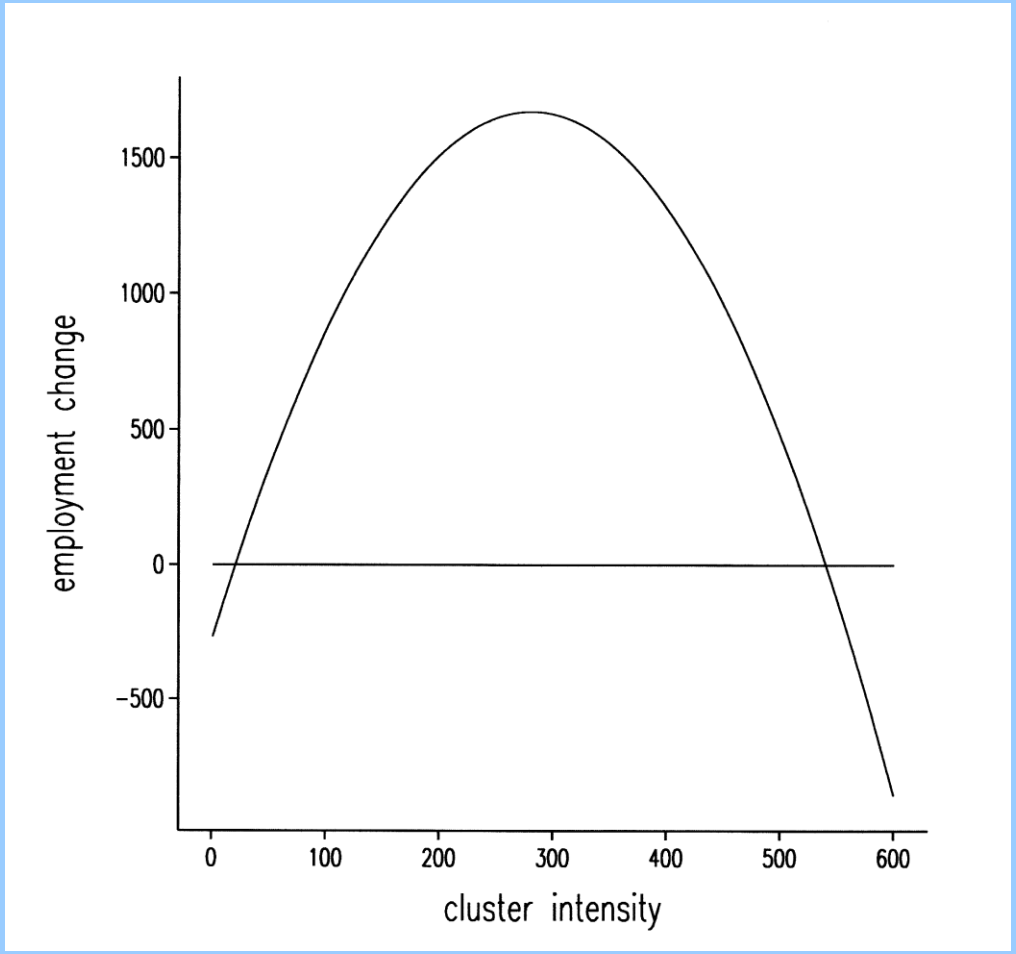
Externalities and Congestion

- On the negative side, as cities get larger, external effects due to congestion (using the term in a general sense and not simply traffic congestion) also increase.

Size Costs

- Of course the advantages of size do not go on forever.
- The land market and commuting costs means that at some point the increased cost of large cities (higher rents as a result of the competition for space and longer commuting journeys) will offset the production and consumption advantages of diversity.
- Other costs like crime rates, noise and pollution will also be higher.

Concentration and Dispersion



Modelling Cities and Agglomerations

- Increasing returns to scale and externalities highlight the role of urban size and diversity as a reason why large cities are more productive.
- In recent decades, formal models have emerged, and are still being developed, which attempt to capture these types of effects in a formal way.
- Key: Monopolistic competition

Monopolistic Competition

- Motivation: In many economic activities market structure does not appear to correspond to either of those polar cases of perfect competition or monopoly.

- Also, oligopolies only apply to a limited number of industries.

Monopolistic Competition 2

- The monopolistically competitive industry is one in which there are a large number of firms producing ‘similar’ but NOT identical products.
- The introduction of product differentiation gives firms an element of monopoly power in that each firm faces a negatively sloped demand curve

Monopolistic Competition 3

- Why should monopolistic competition be a appropriate assumption for studying urban (spatial) economies?

- Markets for services are generally highly competitive, and face relatively minor entry and exit barriers, both features of monopolistic competition theory.

Monopolistic Competition 4

- Producers (and consumers) have specialized demands so that each service firm becomes differentiated, supplying a specific product.
- The wide variety of services that are needed to keep the modern industrial complex going, creates a demand for an almost infinite number of different specialities.
- The wider the differentiation, the greater the efficiency gains for final goods.

Original contributions

- E. H. Chamberlain (1933) *The Theory of Monopolistic Competition*
- J. Robinson (1933) *The Economics of Imperfect Competition*