ECON3021
Urban Economics

Lecture 1:
Course Overview:
What is a city? How do we model it?

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Econ 3021
Urban Economics
(0.5 units, Winter 2009)

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Time and Location:	Thursday 2:00 – 4:00 Jevons Lecture Theater (Drayton House)
Office Hours:	Wednesday 1:00 – 3:00 or by appointment

Aims: This course has two primary aims. The first aim is to show students the most important ways in which economic theory and applied methods have been used to analyse urban economies. The second aim is to enable students to analyse key issues in the markets for land, housing, and transportation using economic tools.

Objectives: After completing the course students should:

- have a clear understanding of the main topics of the course including the theory of location choice, spatial equilibrium and land rents, local externalities, the theory of housing investment, and congestion and transportation economics.
- be able to use standard models from urban economics to analyse questions related to location choice, housing markets, transportation, land use, and local public finance.

Course Website:
http://www.homepages.ucl.ac.uk/ uctpln0/ECON3021/ECON3021.htm

Primary Texts

- Nesheim, L. ECON3021 Lecture Notes
- Nesheim, L. ECON3021 Homework Solutions

Supplementary reading

- E. Mills and B. Hamilton, *Urban Economics*, 1994.
  - Out of print.
  - On reserve in library, 3 copies.

Prerequisites: The course uses economic theory and empirical models at a level appropriate for third year Economics undergraduates. Knowledge of algebra and calculus is required.

Overview: This third-year Economics course draws on economic theory and applied methods to analyse the factors underlying urban economies and the markets for land, housing, and transportation. A key feature of the analysis will be the importance of spatial interactions in urban economies. A number of key topics in urban economics will be considered: the theory of location choice and land rents; agglomeration, congestion and other local spillovers; housing investment and the evolution of the housing stock; land use and land use regulation; and local public finance.

Coursework: There will be 4 written assignments. These must be in the class pigeon hole by noon on the Monday the week the assignment is due.

Exams: The final examination will be a 2 hour examination based on material covered in lectures, assigned readings, and tutorial class assignments.

Course Outline

1. Introduction – Lecture 1
   (a) What is urban economics?
   (b) What is a city?
   (c) How to model it?

2. Location choice, spatial equilibrium in a simple city, and extensions – Lectures 2-6
   (a) Residential and business location choice
   (b) Spatial equilibrium and land rent
   (c) Spatial equilibrium and city size

3. Transportation – Lectures 7-10
   (a) Congestion and peak-load pricing
   (b) Transportation infrastructure investment
   (c) Consumer choice of mode of transportation

4. Housing markets – Lectures 11-15
   (a) Consumer and landlord decision problems
   (b) Tenure choice, housing investment, and credit constraints
   (c) Evolution of the housing stock
   (d) Rent control

5. Urban public economics – Lecture 16-20
   (a) Property taxes
   (b) Land use and land use regulations
   (c) Public facility location choice
   (d) Pollution, crime and other externalities
   (e) Local public services and public goods

Notes on requirements

- Mathematical level: basic algebra and calculus.
  - Solve utility maximisation subject to a budget constraint.
  - Compute simple integrals.
- Required readings from lectures, homework, and possibly some supplementary readings to be handed out.

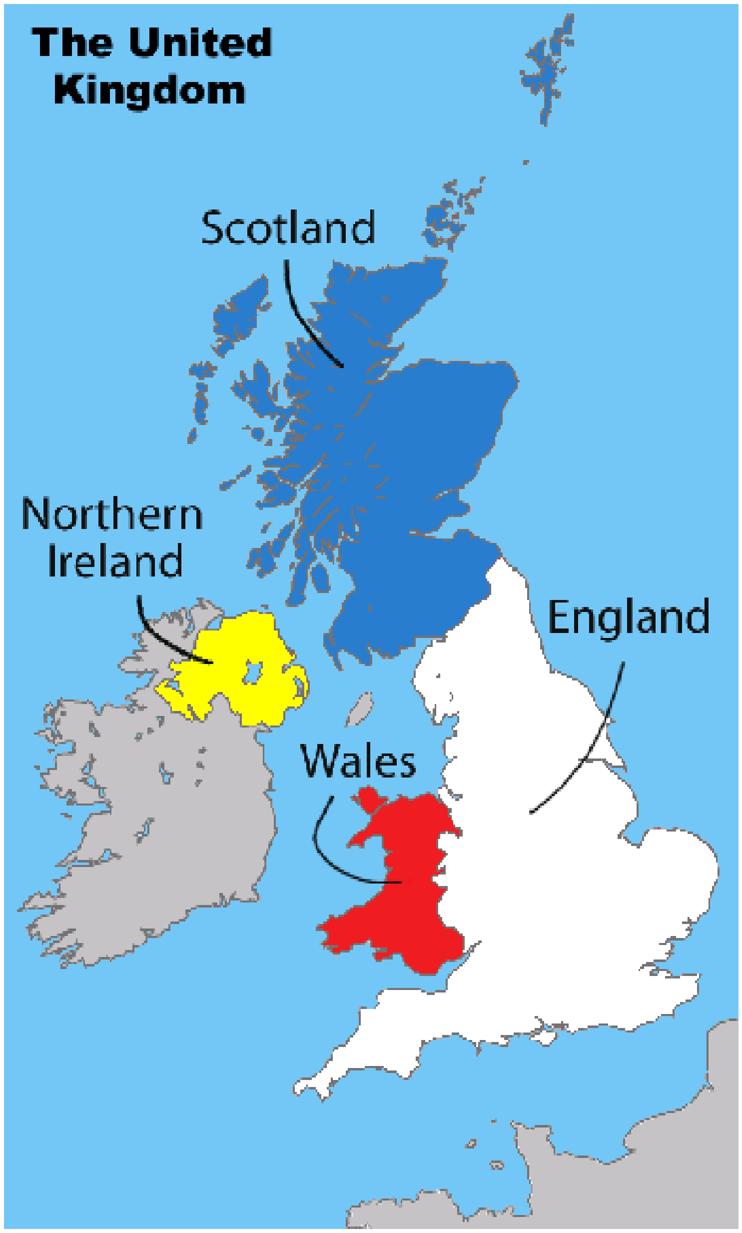
What is a city

1. What is a city?
    - London is a city
        - It is a place with a large group of people
    - Indonesia? Canada? Holland? New Jersey? Camden? The internet? Are they cities?
    - A city is a large group of people concentrated in a small area of land.
    - How big is large and how small is small?
    - What is the boundary of:
        - the City of London
            * It is bounded by the medieval walls.
            * It now is largely composed of people working in a single industry.
            * Population is roughly 10,000 people.
        - Greater London
            * It had a population of 7,512,400 people in 2006.
            * It has a population density of roughly 12,331 people per square mile.
        - London Urban Area
            * It has a population of 8,278,251.
        - London Metropolitan Area
            * It has a population of 12-14 million people.

2. Urban places – how defined – not-trivial.
    (a) Political definition – political boundaries.
        i. Change over time.
        ii. Ignore economic effects that spill over political boundaries.
        iii. Often have important economic effects since different political jurisdictions have different policies.
    (b) Statistical definition – Metropolitan Statistical Area (MSA)
        i. Somewhat arbitrary, requires care.
        ii. Place where population density is relatively high.
        iii. Place where people live and where they don't farm.
        iv. Urban place >2,500 people.
        v. Urbanized area, central city >50,000 people + surrounding high density population area.
        vi. MSA – contains central city >50,000 people + contiguous counties with large portion non-agricultural workforce.
        vii. PMSA and CMSA : if two MSA's grow together.
    (c) Economic definition – abstract, approximation for purposes of analysis.
        i. Based on land use, predominant land use, and population density.
        ii. Definition will change depending on application.
        iii. Area of land used for housing or business. i.e. not agricultural.
            A. In practice, "predominant land use."
        iv. Model with three sectors.
            A. Agriculture.
            B. Housing.
            C. Business (central business district).Many definitions of city

Why are there cities?

Here is the UK



The UK has 61 million people. Why are they not evenly spread throughout country? Some locations are more desirable than others. They have amenities or natural advantages. In addition, because of transport costs, to enjoy those natural advantages, it is cheaper to live close to the desirable locations. The economic force that leads to concentrations of population is a natural advantage combined with transport costs. The transport costs lead to a kind of increasing returns to scale because it is cheaper for many people to located close to the city than far away,

More generally, the economic force that leads to the formation of cities or concentrations of population is **increasing returns to scale**. These increasing returns to scale can take many forms. They can be due to transport costs. Or there may be increasing returns to scale in production or in defense. The increasing returns to scale may be generated by a single industry or they may be generated by specialisation and trade. If those who specialise are more productive and can trade, then specialisation and trade can lead to increasing returns to scale that can lead to larger cities.

Alternatively, increasing returns could be generated by positive external effects (that are spatially limited) across production activities. If locating near other businesses engaged in some activity increases productivity due to spillovers of ideas for example, then this is a form of increasing returns to scale that gives incentives for people to concentrate in a single location. This type of economy of scale is sometimes called and agglomeration economy.

1. Limits to returns to scale
   (a) Natural limits to returns to scale from technology
      i. Need some land, cost of land rises as demand rises
   (b) Congestion in transport
   (c) Pollution, air, water, noise, health
   (d) Price of land goes up
      i. Why?
      ii. Land is required input, no IRS without increase land.
      iii. Supply of land in city is limited.
      iv. Increased demand raises price, unless supply increases.
2. Key technological advances in the 20th century that led to massive increase in city sizes.
   (a) Architecture
   (b) Transport
      i. Automobile, trucks and lorries
   (c) Public health, water supply, and sewage
   (d) Electricity and energy
   (e) Prior to 20th century more than 90% of worlds population lived in rural areas and engaged in farming or related trades.
      i. By middle of 20th century fraction of OECD in farming <3%
      ii. 20th century first OECD then developing world moved out of farming into first manufacturing then services
      iii. Population boom fed by agricultural productivity revolution.

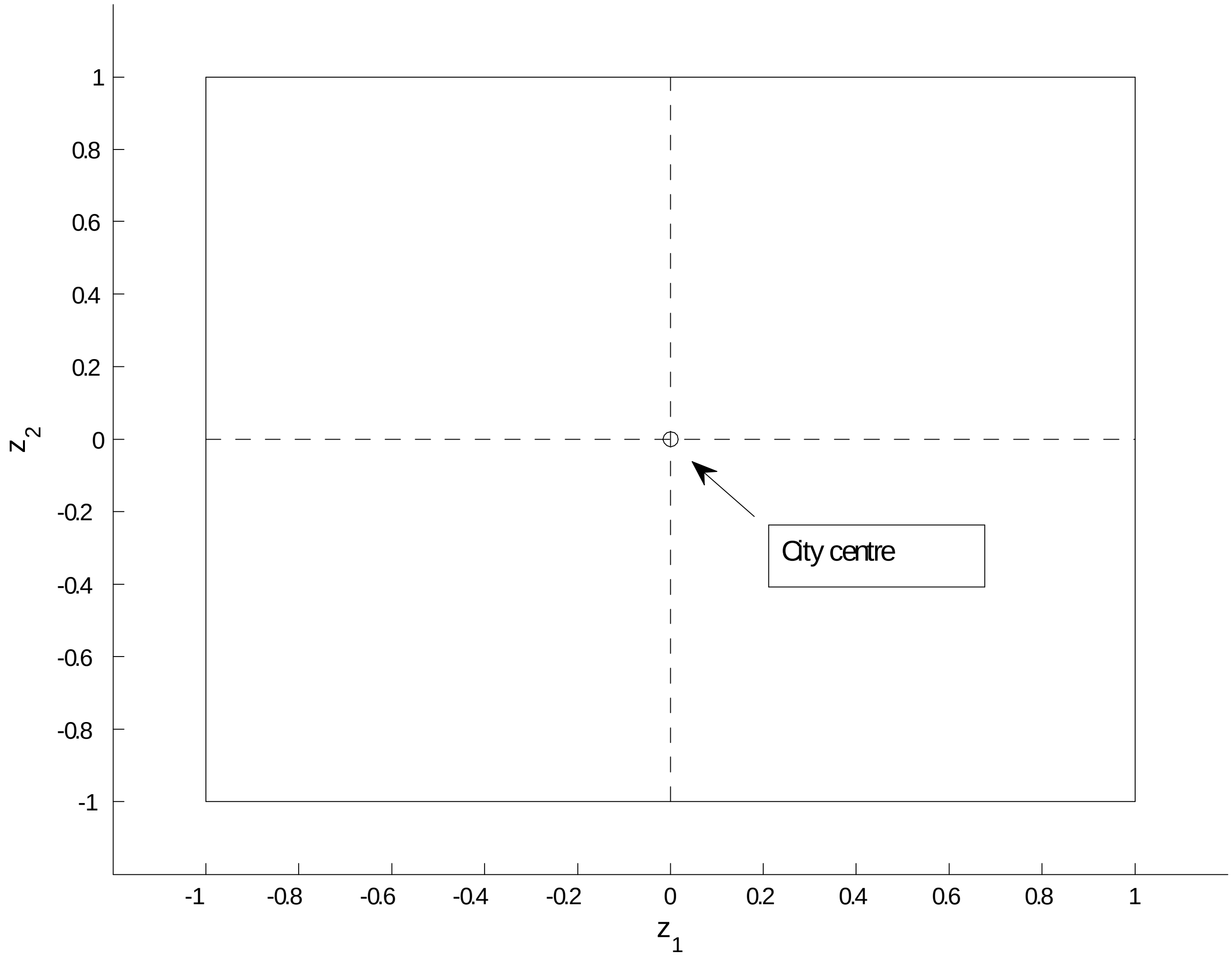
Location choices

In urban economics, one of the key problems we will be interested in is location choice. Why do people locate in cities? In an economy with several cities, how do they choose which city to live in? Within a city, how do they choose where to live? Related to these questions will be questions such as how demand for goods and prices of goods vary across locations.

To begin this analysis, we ask?

1. How do we set up a model to study these questions?
   (a) Simple simple model of a city. City is a location.
   (b) Fixed population N
   (c) Technology of transport costs
   (d) Technology of production
      i. IRS – Technology explains existence of a city
      ii. use of land in farming explains opportunity cost of urban land
   (e) Supply of land

Figure 1: The Spatial Economy with city centre



i. Varies across locations (location matters)

ii. Fixed at each location.

iii. Fixed supply + downward sloping demand = positive price of land at different locations

(f) What we want to do

i. Classical model of demand for goods and land with equilibrium prices

ii. Urban model of location choice

A. Location choice matters because of transport cost and because of IRS in production.

Simple model of a city

To see what features are required to develop a simple model of a city, start from the simplest possible setting. Let an economy be a flat featureless plain. Let $z = (z_1, z_2)$ be a point on the plain and let $z = 0$ be the centre. Here is the economy:

We want to create a model that explains why different economic activities choose different locations in this economy and why people choose different locations in the economy. We assume that there are three activities that use land, 1) farming, 2) industry, and 3) housing. We also assume that there is a fixed population of N households.

Assume that the supply of land is distributed evenly throughout the square economy. In that case, the total supply in a disk of radius x is πx^2, the total supply in a ring of radius x (the boundary of the disk) is $2\pi x$.

The total supply of land in a ring at distance x from the centre is $S(x) = 2\pi x$.

Assume all the land is owned by a single landowner who rents it out to the highest bidder.

Assume that farmers may use land to farm. When they do so, they earn r_A per unit of land. People are willing to engage in farming if net income is greater than zero. A farmer who uses one unit of land at distance x from the centre earns $y_F(x) = r_A - r(x)$ where $r(x)$ is the rent that the landlord charges for land at distance x from the centre.

All industry is located at the city centre and uses no land (or a very small amount). Why? There are two main economic reasons. First, it may be that the city centre offers **natural advantages**. For example, there may be a port or an airline hub, or a cheap source of electricity. Second, it may be that there are increasing returns to scale in industry so that labour employed in industry is more productive if it is all located at a single location. Assume that each worker working in industry earns y.

All workers who work in industry, must rent one unit of land for housing at some distance x from the centre. Since the supply of housing at each distance is limited to $S(x)$, they cannot all live at the same location. A worker who works in the city centre and lives at distance x from the centre must pay transport costs of $t > 0$ pounds per mile and must pay rent of $r(x)$ per unit of land. So the net income of a worker living at location x is $y_I = y - tx - r(x)$.

Farmer's location choice

The location choice of the farmers is easy. A farmer chooses location to maximise

$$y_F(x) = r_A - r(x).$$

Since income doesn't depend on location (all locations are equally productive in farming), farmers simply chooses any location that has a rent equal to the lowest rent in the economy. Let

$$r_L = \min_x \{r(x)\}.$$

If a location has $r(x) > r_L$, then no farmers are willing to farm at location x. If a location x has $r(x) = r_L$, then farmers are willing to work there if $r_A - r_L \geq 0$. The farmer's income is

$$y_F = r_A - r_L.$$

Minimum rent

Farmers are only willing to rent land if $r_A \geq r_L$. However, if $r_A > r_L$, then farmers can earn positive profits. If this is the case, then the landlords are not maximising profits because they could increase r_L until $r_A = r_L$ without losing any tenants. Thus,

$$r_L \geq r_A.$$

If all households choose to work in the city so that there are no farmers, then $r_L > r_A$. If some people choose to farm in equilibrium then $r_L = r_A$.

We will assume that, in equilibrium the number of farmers is positive and therefore that $r_L = r_A$.

Workers location choice

A workers chooses location to maximise

$$y_I(x) = y - tx - r(x)$$

subject to $x \geq 0$.

The first order conditions for this problem are

$$-t-\frac{\partial r(x)}{\partial x}=0. \tag{1}$$

If

$$-t-\frac{\partial r(x)}{\partial x}<0 \text{ for all } x\geq 0$$

then $x=0$ is optimal. Why? In this case, $x=0$ is optimal because the marginal benefit from moving farther away is negative. In other words, moving further away increases transport costs more than it decreases rent.

If equation (1) has a solution at some $x>0$ or if it has many solutions, then these solutions are candidates for an optimal location choice. In other words, if $x>0$ is optimal, then it must be the case that equation (1) is satisfied at x. We come back to these points below.

Let x^* be an optimal location choice for a household working in industry and let

$$y_I^*=y-tx^*-r(x^*)$$

be the income earned.

Income maximisation by households

Since $r_A=r_L$,

$$y_F=r_A-r_A=0.$$

Suppose households choose between working in the city and farming and seek to maximise net income. Then given a rent function $r(x)$, each worker solves the problem

$$\max\{y_I^*,0\}.$$

Equilibrium with no industry

Suppose that $y<r_A$. In this case, no one will be willing to work in industry because income in industry will always be less than income in farming. In this case, the equilibrium is

$$r(x)=r_A$$

for all x. Any allocation of households to locations is an equilibrium as long as the density in any location is positive. For example, if households are randomly allocated to locations so that the the distribution of households across locations is uniform, then that allocation is an equilibrium.

This equilibrium is a kind of trivial spatial equilibrium. In this trivial equilibrium, no location has any intrinsic value over and above any other location and the model has no power to predict the location choices of people.

Equilibrium with industry

Suppose $y>r_A$. How will the equilibrium change? The previous equilibrium is no longer an equilibrium. Why? Suppose it where an equilibrium. Then a farmer could move to location $x=0$, rent a piece of land at price $r(0)=r_A$ and switch from farming to industry. His new income would be

$$y_I(0)=y-r_A>0=y_F.$$

The new equilibrium must involve a positive fraction of households switching from farming to industry, buying land for housing, and working in the city. We have a prediction, the industrial revolution will lead to the growth of cities.

Suppose $N_I<N$ switch from farming to industry. Where will they live in the new equilibrium? They will live as close to the city centre as possible (to economise on transport costs). Now they can't all live at the centre because the supply of land is limited. The supply in a ring at distance x from the centre is $S(x)=2\pi x$. The supply at the centre is zero.

Instead they must spread out across a set of locations. All the workers in the new city will live at locations $x \leq x_B$ which will be the boundary of the new city.

All the workers are identical. But some of them will choose $x = 0$. Some of them will choose $0 < x < x_B$ and some of them will choose $x = x_B$. In fact, every locations $x \leq x_B$ will have some workers living there. Thus, it must be the case that

$$-t - \frac{\partial r(x)}{\partial x} = 0 \text{ for every } x \leq x_B. \tag{2}$$

Why? When this is the case, every location $x \leq x_B$ is optimal. That is, in this equilibrium the workers are indifferent between all locations $x \leq x_B$. A workers move farther out from the centre, the increased transport cost is exactly offset by reductions in rent.

We can rewrite (2) as

$$\frac{\partial r(x)}{\partial x} = -t \text{ for every } x \leq x_B.$$

This means that

$$r(x) = r_0 - tx \tag{3}$$

for all $x \leq x_B$. To see this, note that the derivative of (3) is

$$\frac{\partial r(x)}{\partial x} = -t.$$

We now have more or less worked out the character of the equilibrium. In summary it has the following features:

1. All land at locations $x \leq x_B$ is used in housing. All land at $x > x_B$ is used in farming.

2. The equilibrium rent function satisfies

$$\begin{aligned} r(x) &= r_0 - tx \text{ for } x \leq x_B \\ r(x) &= r_A \text{ for } x \geq x_B \end{aligned}$$

3. $N_1 < N$ households maximise income by working in the city. They earn

$$\begin{aligned} y_I(x) &= y - tx - (r_0 - tx) \\ &= y - r_0. \end{aligned}$$

   (a) In the equilibrium, all workers are indifferent between all locations $x \leq x_B$ because all such locations provide the same equilibrium income.

4. The remaining households work in farming, live at locations $x > x_B$, and earn income 0.

All that remains, is to work out the equilibrium values of (N_I, x_B, r_0). That is, there are three unknown variables to find. We need three equations.

First note that the land market must be in equilibrium at every location. The supply of land is $S(x) = 2\pi x$. Let $N(x)$ be the number of workers living at location x. Then it must be the case that

$$\begin{aligned} N(x) &= S(x) \\ &= 2\pi x. \end{aligned}$$

Then the total population in the city is

$$\begin{aligned} N_I &= \int_0^{x_B} 2\pi x dx \\ &= \pi x_B^2. \end{aligned}$$

Next, it must be the case that $r(x_B) = r_A$. If $r(x_B) > r_A$, then the landlord could convert some land at $x_B + \varepsilon$ from farming to housing and attract workers. Also, we know that it is not possible that $r(x) < r_A$. So,

$$r(x_B) = r_0 - tx_B = r_A.$$

Finally, it must be the case, that farmers earn the same income as workers. If not the ones with lower income would want to switch. So

$$y - r_0 = 0.$$

Putting this all together, we have

$$\begin{aligned} N_I &= \pi x_B^2 \\ r_0 - t x_B &= r_A \\ y - r_0 &= 0 \end{aligned}$$

or

$$\begin{aligned} r_0 &= y \\ x_B &= \frac{y - r_A}{t} \\ N_I &= \pi \left(\frac{y - r_A}{t} \right)^2 . \end{aligned}$$

We now have several predictions:

1. The rent at the centre of the city is completely determined by industrial productivity.
2. Both the radius of the city and its population are determined by:
   (a) The productivity differential between industry and farming $(y - r_A)$
   (b) Transport costs.
3. Households obtain no net benefit from the industrial revolution. They earn net profit of zero in every case? Who benefits from the industrial revolution in this model?

Questions

1. What happens if t falls 50%? What happens if t falls to zero?
2. What happens to city size, population and rents if agricultural productivity falls 10%?