Economics C44: Urban Economics

There are two sections to the exam. Part A has five questions. Answer three questions in Part A. Each question in Part A is worth 20 points. The maximum score in Part A is 60 points.

Part B has four questions. Answer two questions in Part B. Each question in Part B is worth 30 points. The maximum score in Part B is 60 points.

The maximum total score is 120 points.

You have two hours to complete the exam.

Part A

1. Imagine a circular city with two types of consumers. Both types have the same income I £, the same transport cost t £ per mile, but may have different utility functions. Both types maximise utility by choosing C, a quantity of a composite consumption good, L, a quantity of land, and u, distance of their residence from the centre. Prices are p £ per unit of consumption and $R(u)$ £ per unit of land. Suppose the city is in spatial equilibrium and type 1 strictly prefers living closer to the centre than type 2. What is a bid rent function? What must be true about type 1's bid rent function and type 1's preferences relative to type 2's?

2. Suppose a city with fixed population N of identical residents and fixed boundary rent R_F £ is initially in spatial equilibrium with equilibrium rent function $R(u)$ £, equilibrium boundary $u_{B,}$ and equilibrium utility level attained by each household V_0. Each of the residents has income I £, consumes C (the consumption good) and L (land), lives at some distance u miles from the centre, and commutes to the centre paying transport costs of t £ per mile. Assume both C and L are normal goods (i.e. demand increases with income). Explain using words and graphs how the equilibrium values of $R(u)$, $u_{B,}$ and V_0 in a new equilibrium would differ from the initial equilibrium values if each resident's income were 10% higher in a new equilibrium.

3. John drives from his suburban residence to the city centre for work five days a week. When asked his opinion of a proposed increase in the congestion charge from £5 per day to £10 per day, "Of course I am against the congestion charge increase. It will make me worse off by £25 per week." Explain under what conditions John's statement is true and under what conditions it is false.

4. Suppose a railroad can run either 0 trains or 1 train on its rail line and earns profits of £0 and £100 respectively. Farmers can either invest £50 pounds producing £100 of crops or invest £130 producing £200 of crops. However, if the train runs, 25% of the crops are destroyed by fire caused by sparks emitted by the train. Suppose bargaining costs are very high so that the railroad and the farmers cannot reach private agreements to regulate each other's activities. Two legal rules are under consideration. Under the "no liability" rule, the railroad pays no compensation for crop damage. Under the "full liability" rule, the railroad must pay full compensation for all damage. Under these conditions, and assuming the railroad chooses the option that maximises profits net of damage payments, what outcomes would be predicted under each of the legal rules and which of the two legal rules maximises social surplus? How would the solution change if bargaining costs were reduced to zero?

5. Why is housing subsidized to such a large degree? What are some economic arguments for and against subsidization?

Part B

There are four questions in Part B. Answer two questions in Part B. Each question in Part B is worth 30 points. The maximum score in Part B is 60 points.

1. Suppose the commercial district in a city is a circle with fixed radius of u_B miles. The supply of land in every ring at a distance of u miles from the centre is $2\pi u$. Firms are prohibited from renting land outside this circle. Households are prohibited from renting land inside the circle. All firms choose a location u, a quantity of capital K, and an amount of land L to maximise profits. Total output of a firm is given by

$$q = K^{0.75} L^{0.25}$$

The price of capital is r £ per unit. The price of land is $R(u)$ £ per unit for a firm located at distance u from the centre. Firms must transport each unit of output to the market at the centre of the city. The transport cost is t £ per mile per unit of output. The firms sell their output at the centre for p £ per unit of output. Assume there is free entry so that all firms earn zero profits in equilibrium. Further assume that in equilibrium, there is one firm at each location and all land is consumed. Assume p is greater than tu_B.

a) What is the profit function for each firm?

b) For a firm at location u, write down the first order conditions for choice of K and L, and solve for the equilibrium optimal choices of K and L. Explain the conditions these optimal choices satisfy and draw on a graph.

c) Write down the first order condition for each firm's location choice problem. What is the differential equation that the equilibrium land price function must satisfy? Explain.

d) Is the price function increasing or decreasing? Is it convex? Why?

e) Solve for the equilibrium price of land at the boundary u_B.

2. Suppose greater London has a population of 10 million each of whom decides either to stay at home, or commute to the centre by car or by train. Each person obtains a gross income (before paying transport costs) of 60£ per trip if they commute to the centre and receives *0*£ otherwise. Each maximises income net of transport cost. The commuting cost (in pounds per trip) for a consumer who drives is $C_D = 10N_D$ where N_D (measured in millions) is the equilibrium number of people who drive. The commuting cost of the train differs across people because different people live at different distances from the train station. Travel costs by train (in pounds per trip) equal F_i where F_i ranges from 0 to 100. The variable F_i is distributed uniformly. That is F percent of the population has a value of F_i less than F for every F between 0 and 100.
   a. If travel costs on the road are C_D, how many people would prefer driving to taking the train or staying at home?
   b. Calculate the equilibrium number of people who drive, N_D, the equilibrium cost per person for each driver, C_D, the equilibrium number who use the train, N_T, the total social costs of car travel and the total social costs of train travel.
   c. What is the equilibrium total amount of income earned?
   d. Why is the above not socially efficient?
   e. Write down the total social surplus for this city (total income minus total cost) as a function of N_D and N_T. Find the values of N_D and N_T that maximise social surplus. Explain in words (briefly) the conditions that the optimum numbers satisfy. Describe a pricing scheme that would lead the socially optimal numbers of individuals to choose to commute by train and car? What is the value of the optimal price?

3. Suppose you are deciding between renting and buying a flat. If you rent, you pay £12,000 per year plus £1,200 per year council tax. All payments are made at the beginning of the year. If you buy you pay £200,000 plus a £10,000 transaction cost to move into the flat. Additionally, if you buy you must pay £1,200 per year in council tax and £1,000 per year in maintenance costs. All payments are made at the beginning of the year. If you buy the flat, you may resell it any future date for the same price but must pay a transaction cost to sell. The selling transaction cost is £10,000. Assume you can borrow and lend freely at a real rate of interest of 5% and there is no inflation and no uncertainty about future prices.
   a) What is the net present value of the cost of renting the flat forever?
   b) What is the net present value of the cost of purchasing the flat assuming you never sell it?
   c) What is the net present value of the cost of renting the flat for 2 years?
   d) What is the net present value of the cost of buying the flat and then selling after two years? Is it cheaper to rent or buy if you must move and sell after 2 years?
   e) What are the answers to c) and d) if the period of tenancy is 3 years?

4. There are two modes of transportation, automobile and train. Suppose utility for individual *i* if they commute by automobile is

$$U_{iA} = -5.0 + 4.0A_i - 0.04t_{Ai} - 2.0c_{Ai}$$

where A_i is one if the individual owns an automobile and zero if they do not, t_{Ai} is the amount of time (in hours) it requires to get to work by car, and c_{Ai} is the monetary cost (in pounds) of commuting to work by car. Assume those who do not own a car can commute by car by sharing a ride with someone else. Utility from commuting by train is

$$U_{Ti} = -0.2w_i - 0.04t_{Ti} - 2.0c_{Ti} + \varepsilon_i$$

where w_i is the amount of time (in hours) it takes to walk to the train station and wait for the train, t_{Ti} is the amount of time (in hours) it takes to get to work by train excluding walking and waiting time, c_{Ti} is the monetary cost (in pounds) of commuting by train, and ε_i subsumes all other factors that affect the utility from taking the train. Suppose 75% of the population owns a car, while 25% does not. Further suppose that for everyone in the city $t_{Ai} = 0.75$, $c_{Ai} = 2.5$, $w_i = 0.3$, $t_{Ti} = 1.5$, and $c_{Ti} = 4.0$. Assume ε_i varies in the population and is distributed uniformly between -3.0 and 3.0. That is, if x is a number between -3.0 and 3.0, then the fraction of the population with values of ε_i between -3.0 and x equals $\frac{x+3.0}{6.0}$.

a) If consumers choose transport modes to maximise utility, what fraction of the individuals who own cars choose to drive? What fraction of those who do not own cars commute by car, i.e. share a ride? What fraction of the total population commute by car, i.e. drive or share a ride?
b) If the cost of gasoline rises by 50% causing the cost of automobile travel to increase 30%, how do the answers to a) change?
c) In the above utility function, the coefficient on w_i does not equal the coefficient on $t_{Ti.}$ Why might this be the case?
d) Suppose the transit authority could build a new station at a cost of £1 million. It is known that building the station will reduce w_i from 0.3 to 0.1 since people will live closer to the station. However, building the station will increase t_{Ti} from 1.5 to 2.5. How will building the station affect people's choices and their utility levels? Should the transit authority build the station?