Urban Economics (ECO333Y1Y) Midterm Exam

June 26, 2012 – 2:00-5:00pm

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(Examination aids: non-programmable calculators, drawing instruments.)

Questions 1 and 2 are MANDATORY questions, and there is a CHOICE of EITHER Question 3 or Question 4. Only three questions should be answered in total. (Answers combining part of Question 3 and part of Question 4 are not acceptable.)

5 MARKS of the 100-mark total for this exam will be allocated to exam answers complying with the instructions outlined in this paragraph. You must use separate books for each question: for example one book for Question 1, a second book for Question 2, and a third book for whichever optional question you choose. You may use additional books if needed, but no book may contain answers to more than one question. In addition to your name and student number, the cover page of each book must identify the question number answered in that book. The "Book No." line on the cover page can be used for this purpose, but you must write "Q1", "Q2", "Q3" or "Q4" on that line – not just a number without the "Q". Alternatively you can write "Q1", "Q2", "Q3" or "Q4" elsewhere on the cover page. Either way, the question number answered in a book must be immediately identifiable by looking at the book's cover page. One last instruction already appears on the cover page (right under the "Name" line): Your last name must be printed legibly on the left side of the line (where you see "surname" under the line). Your first name must be printed legibly on the right side (where you see "given names" under the line), and must be the same first name shown on the registration list next to your surname.

All answers should be briefly and clearly explained, using diagrams where appropriate. Correct numerical answers will not earn full marks without an appropriate explanation. If you are not able to answer a numerical question, provide a brief description of the relevant theory to obtain partial credit. Questions 1 and 2 are each worth 33 marks; questions 3 and 4 (answer either one, but not both) are each worth 29 marks. As was noted in the preceding paragraph, the remaining 5 marks are allocated to exam answers complying with instructions outlined in that paragraph.

Question 1 (33 marks)

Consider a rectangular city model. Identical businesses manufacture bicycles that are exported out of the City via a port located along the City's western edge; this will be the location where land rents paid by businesses are highest. Businesses face constant marginal freight costs per mile as they transport their product from their location to the city port. The land occupied by manufacturing firms is called the central business district (CBD).

Residents are employed by manufacturing businesses at a common wage, face constant commuting costs per mile, and rent housing from housing firms at the market housing price. The output of housing firms is residential floor area in square feet. Commuting is costless for workers once inside the CBD.

The city has four boundaries. The western boundary is where land ends and water begins (the port). The northern and southern boundaries are fixed by zoning, and the eastern edge can move inward or outward depending on conditions in the land market.

The wage rate is endogenous in the model. There is no factor substitution and no consumer substitution in the entire question. Throughout the question, let x be the distance in miles to the city port. Consider the following data, where all numbers with a time dimension are on a monthly basis:

Business Sector

The following data apply to each manufacturing firm; a firm:

- Produces a fixed output of q = 400 units
- Faces an exogenous output price of p = \$295/unit
- Incurs constant freight costs of T = \$15/unit of output/mile
- Hires E = 10 employees at market wage \$w/employee
- Occupies L_b = 0.25 hectares of land for production
- Has a bid rent function $\$R_b(x,w)$/hectare
- Incurs capital cost of C = \$63,500 (including any costs not already listed)

Residential Sector

The following data apply to each housing firm; a firm:

- Produces a fixed output of Q = 40,000 sq.ft. of floor area
- Faces a market housing price function of \$P(x,w)/sq.ft.
- Builds housing on L_r = 5 hectares of land
- Has a bid rent function for land $\$R_r(x,w)$/hectare
- Incurs capital cost of K = \$52,000 (including any costs not already listed)

The following data apply to each resident; a resident:

- Earns the market wage \$w via employment at a manufacturing firm
- Faces a market housing price function of \$P(x,w)/sq.ft.
- Incurs a commuting cost of t = \$200/mile
- Consumes housing h = 1,000 sq.ft. and non-housing goods worth G = \$250
- Spends all wage income \$w on housing, non-housing goods and commuting

Other Variables

- Agricultural bid rent per hectare is constant at R_a = \$2,000/hectare
- The CBD/residential boundary (also known as the zero-commute location) is $x_1(w)$
- The residential/agricultural boundary (also known as the city limit) is $x_2(w)$

Note: Parts (a) and (b) give you the answers and ask you to show they are correct. If you can't show they are correct, you can still use the answers given for Part (c). All of the equilibrium values you are required to derive in this question are either whole numbers

or non-repeating decimals. You will <u>NOT</u> need the conversion factor of 1 mile^2 = 260 hectares.

a) Show that business bid rent as a function of x and w is:

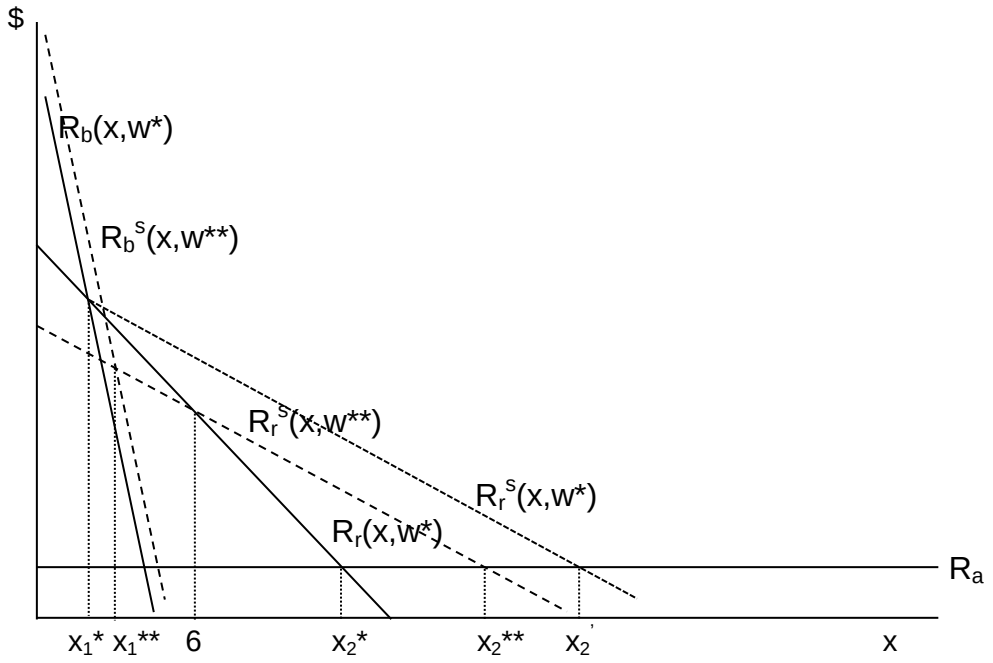
$$R_b(x,w) = 218{,}000 - 24{,}000x - 40w$$

b) Show that residential bid rent as a function of x and w is:

$$R_r(x,w) = 2{,}960 - 1{,}600x + 4.8w$$

c) Find the equilibrium wage w*, CBD/residential boundary x_1*, and residential/agricultural boundary x_2*.

d) Suppose a streetcar is introduced which cuts the exogenous per-mile commuting cost t down to t^s. Consider the land market diagram appearing below, which illustrates adjustment to the streetcar. Not all areas of the diagram are necessarily drawn to scale. Functional labels refer to the nearest function appearing to the left of the labels. The superscript "s" indicates a post-streetcar function or exogenous value, and the superscript double asterisk (**) indicates a post-streetcar endogenous value. As shown in the diagram, the adjustment has taken place in two stages: Stage 1 assumed the wage remained unchanged while Stage 2 allowed the wage to change.



The values of x_1* and x_2* are those you were asked to find in Part (c). Assume after full adjustment that total manufacturing output exported out of the city has increased by 50%. Clearly showing your work, find the following values: x_1**, x_2**, w**, x_2', and t^s.

Question 2 (33 marks)

a) The following information is given about firms in a bicycle manufacturing model (the usual assumptions apply):

- Output of a firm per day (b) = 10 bicycles.
- Land input of a firm (L) = 6 hectares
- Freight cost per km per bicycle (t) = \$12
- Non-land production cost: per firm per day (NLPC) = \$220
- North-south dimension of the rectangular city = 1.44 km.
- Agricultural land rent R_a = \$30 / hectare per day.
- Demand curve equation is P = 124 – 0.02 B.

i. Calculate equilibrium price and output, explaining your answers briefly.

ii. What is the equation of the bid rent function? Explain your answer briefly.

iii. Use a diagram to show total freight cost, total cost of non-land production inputs, and total land cost (you should calculate dollar amounts for these variables).

b) In this part of the question there is no change to the exogenous variables in part (a) except y, which is no longer 1.44 km. You are told that total output is now 4200 bicycles per day. What is the equation of the bid rent function? If each firm occupies 50 metres of linear distance along the highway, calculate a minimum value for y.

Reminder: Answer Question 3 or Question 4 (not both)

Question 3 (29 marks)

In this question you are to consider a rectangular city's housing market in which there is an exogenous wage and where residents commute to a port located on the western edge of the city (x = 0). Specifically, residents consume housing h in square feet and \$G per month worth of other goods, pay a monthly commuting cost of \$t/mile per month, and earn an exogenous wage \$w per month. Residents work for firms located at x = 0 (the business land area is zero). Let P_a be the exogenous minimum house price that allows a housing firm to remain in business, and let x_a be the endogenous city limit. Answers to this question require the use of symbols like w, P_a and so on rather than numerical calculations.

a) Derive an equation for the house price function P(x).

b) Now suppose that the monthly commuting cost for a resident living at x is given by $\alpha t x^2$ instead of tx, where $\alpha > 0$. Let P*(x) be the house price function under this new commuting cost structure. At which locations does the change in commuting cost structure leave house prices unchanged?

c) For what value of α do the two commuting cost structures yield the same city limit x_a?

Question 4 (29 marks)

Answers to part (a) should be 2 pages or less double spaced. Answers to part (b) should be one page or less double spaced.

a) Assuming that consumer substitution is possible, use an indifference curve diagram to explain why budget lines must be tangent to the indifference curve providing equilibrium utility. Your answer should refer to the open city model, assume an exogenous wage and exogenous monthly commuting cost per mile.

b) Residents in a model face a housing price function as follows:

$$P(x) = [w - G(x)] / h(x) - [t / h(x)] x$$

The wage variable w is exogenous at $3000 per month (labour market equilibrium is not involved in this question). The commuting cost variable t is exogenous at $200 per mile per month. Residents' utility level is exogenous (open city model assumption).

P (x) is the housing price in dollars per square foot floor area per month, G (x) is consumption of non-housing goods in dollars per month, and h (x) is housing consumption in square feet floor area. These variables are all functions of x, which is commuting distance in miles.

What is the slope of the housing price function at each of the three locations shown in this table? Are these slopes consistent with the numbers given in the table?

X	P	G	h
2	2.00	1000	800
4	1.50	925	850
6	1.00	700	1100