

Practice Problems for the Economic Structure of Cities
(These are homework problems from earlier years.)

1) In the pumpkin model discussed in class and section (December 7), there was only one use for land – growing pumpkins. We can develop a more complete model of land use by recognizing that each acre of land has several alternative uses and that the value of a given piece of land may differ for different uses.

Consider the city of Hastings that forms around a central place denoted by the city hall. All land is divided into 1 acre lots that are owned by landlords. The landlords rent each lot to the highest bidder and there are three groups of bidders: business people, households and farmers. The demand curves for the three groups can be written as follows:

Business people $R_B = \$500 - 50d$

Households $R_H = \$400 - 25d$

Farmers $R_F = \$25$

Where R = the dollar rental that a group member is willing to pay for a given lot

d = the number of miles between the given lot and the city center

a) Giving as much detail as the possible, describe the pattern of land use in Hastings - what land is used for business, for households and for farming. Illustrate your description with a diagram.

Answer: We know at the absolute center that business will offer more per lot (\$500) than households or farmers. As we move out from the center, business will continue to offer higher rents than households until the following equation holds:

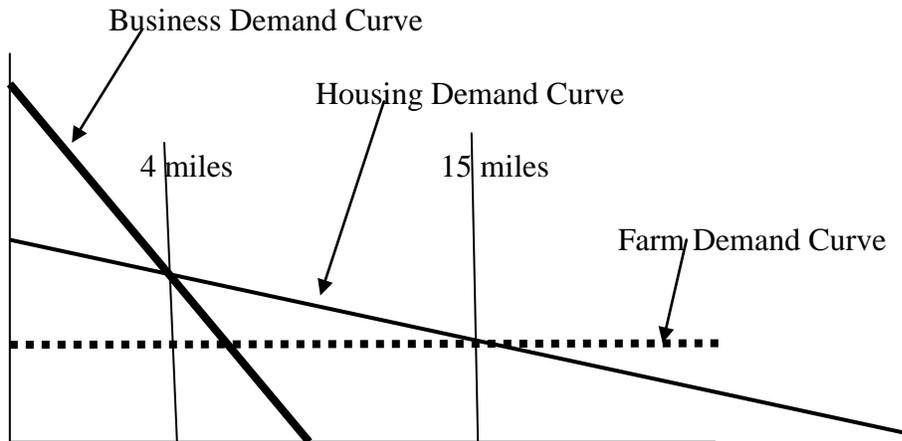
$$500 - 50d = 400 - 25d \quad \text{I solve this equation to get } d = 4 \text{ miles.}$$

So if we think about a “map” of the region, we want a series of concentric circles. Business use runs from the city hall to the edge of a circle with a 4 mile radius.

Anything further out than 4 miles radius, households offer a higher rent than agriculture until the following equation holds:

$$\$400 - 25d = \$25.00 \text{ or } 25d = 375, d = 15$$

So households occupy a “doughnut” that runs from radius of 4 miles to a radius of 15 miles. Agriculture then occupies a space that begins at radius 15 miles and extends out (not clear from the problem where agriculture ends) (see graph below).



b) In U.S. metropolitan regions, many of the urban poor live in central cities rather than the cheapest land at the edge of the region. What additional factors could we add to the model above that might explain how very low income people live on very valuable, close-in land?

Answer: One possible missing factor is density: If a building holds high numbers of low income people, it may be able to generate an amount of rent per building that compares favorably with what other uses can pay. A different possible missing factor is externalities – if a low income area is viewed as unsafe, housing values will be depressed as people who can afford to live elsewhere do so. The process of gentrification is, in part, a reversal of these externalities – home prices rise in part because the housing stock is rehabbed but in part because the neighborhood is now seen as a safer place to live and the houses attract greater demand. A third possibility is the availability of public transportation in (some) central cities which is far less present in suburbs.

2) Many of the ideas we have talked about last Thursday and this week can be summarized in an economic model based on a difference equation of the form:

$$E_{T+1} = a + bE_T$$

Where: E_T is the area’s level of economic activity in year T (e.g. 2010), E_{T+1} is the level of economic activity in year T + 1 (e.g. 2011) and a, b are constants.

You can see the evolution of this model by setting it up on an Excel Spreadsheet. Fill in the first cells as follows:

	A	B	C
	Current Year	Economic Activity in Current Year	Formula to calculate Next Year's Economic Activity
Row #			
1	2009	(choose a value for $E_{2009} = B1$)	$C1 = a + b*B1$
2	2010	Set $B2 = C1$	$C2 = a + b*B2$
3	2011	Set $B3 = C2$	$C3 = a + b*B3$
4	(use copy formula to keep filling in the columns)		

In plain English, column A lists the years over which the model evolves. Cell B1 contains a starting value for year 2009 economic activity. The formula in cell C1 then applies the formula that transforms this 2009 economic activity into 2010 economic activity. B2 is then set to this 2010 economic activity and so on. Copy these formulae down the columns so you can run the model for 30 years

Specifically, set up this model for values of a and b: $E_{T+1} = -10 + 1.05E_T$. Beginning with an E_{2009} of 190, run the model with different starting values and answer the following questions:

a) Find the model's equilibrium - the value of E_T that stays constant from one period to the next.

Answer: The model should have an equilibrium at economic activity = 200.

b) A model is said to have a stable equilibrium if it converges to the equilibrium value of E_T from a starting value that is higher or lower. Explain whether this model has a stable equilibrium? If not, how would you describe the model's behavior?

Answer: The model does not have a stable equilibrium. Rather, for starting values above 200, economic activity grows indefinitely while for starting values below 200, economic activity declines indefinitely.

c) Using words, briefly write down two economic stories. In the first story, explain the model's behavior that you observe when it starts from above the equilibrium value. In the second story, explain the model's economic behavior when it starts from below the equilibrium value.

Answer: For starting values above 200, an economic story might focus on the increasing returns to concentrated economic activity: the more firms that move into an economic region, the greater

the attractiveness of the region both to workers and other firms, a process which continues indefinitely.

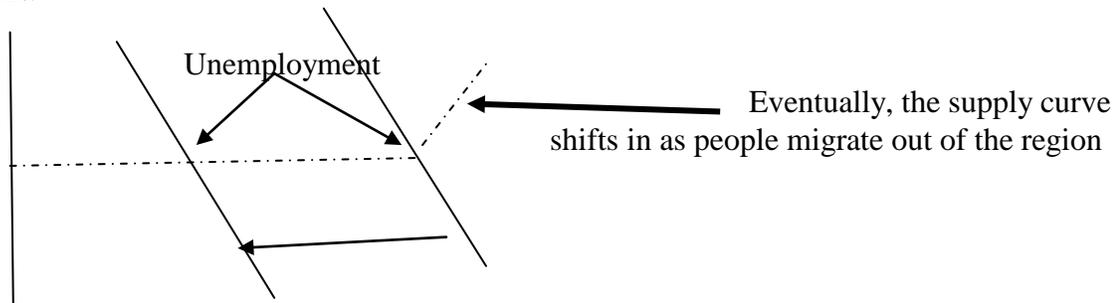
For starting values below 200, an economic story might focus on the reverse process: industry starts to leave, the region becomes less attractive both because the concentration of activity is smaller and tax rates may be rising, etc., still more industry leaves, and so on.

3) When an economic region experiences a large plant closing or similar large, negative event, the unemployment rate first rises and then slowly returns to its original rate. Roughly speaking, this return can occur through either of two mechanisms:

- Wages fall and people are rehired as the region moves down its post-plant-closing labor demand curve.
- Wages stay constant and labor supply shrinks as people move out of the region.

In a famous paper – ‘Regional Evolutions’ (*Brookings Papers in Economic Activity*, 1992) Olivier Blanchard and Lawrence Katz show that regions are much more likely to adjust through the second mechanism than the first though the adjustment takes significant time.

Use supply and demand curves to illustrate this second mechanism and give some possible reasons why out-migration, and not falling wages, appears to be the main mechanism of regional adjustment.



Answer: The graph of the Demand/Supply Curve of labor shows the first part of the process. The demand curve for labor shifts in (due to the plant closing) but wages do not fall - rather, wages stay fixed, leading to significant unemployment (the gap between supply and demand at the fixed wage). As a result, people start moving out the area and the supply curve eventually shifts in enough that supply again equals demand.

Some reasons why wages might not fall: People have fixed expenses like mortgages and so hold out for a wage similar to what they used to earn; firms are reluctant to hire additional workers at wages lower than their pay to current workers because it would lead to internal conflict, internal workers resist any wage cuts, etc.

4) Software firms thrive on two things: the free exchange of information, including information exchanged among firms (Marshall's "spillovers"), and a large degree of informality within each firm. The need for informality means that software firms are most productive when they are small. As the firm grows large and becomes bureaucratic their innovation often dries up.

a) Consider the following production function for an individual software firm:

$$Q_j = 5K_j^{.6}L_j^{.5}I^{.3}$$

where: K_j = the j 'th firm's capital, L_j = the j 'th firm's labor, and I represents the sum of all ideas produced by the j 'th firm and all other software firms that lie within a twenty mile radius of the j 'th firm. In this radius, ideas are informally exchanged through cocktail party conversations, employees changing jobs, etc.

Is this production function a good representation of the typical software firm described at the beginning of this question? If not, explain why and explain how would you change the production function to better fit the description?

Answer: The initial description contained two parts. The first described the effect of exchanging information among firms - i.e. the more information that is "out there", the more productive a firm should be. The production function **does** describe that phenomena using the I^3 term in which each firm benefits from the total quantity of ideas in the twenty mile radius.

The second part of the description says that bigger firms become more formal and less innovative they become. (This statement is independent of the number of other firms that are in the twenty mile radius). This is a description of decreasing returns to scale and so doubling labor and capital (doubling the firm's size) should result in less than double the output. But in the production function above, the exponents of labor and capital sum to more than one so doubling labor and capital will more than double output - ergo, this production function does not match the description. Matching the description would mean reducing the sum of the exponents of labor and capital so they summed to less than one.

b) Consider the following quote. "If software firms work best when they are small, a state economic development agency should not rely on software firms as a source of employment. Rather, the development agency should accept the fact that the software industry will consist of many small firms spread out over the United States such that no one state will have very many of them."

Explain why this statement is or is not consistent with the description of the typical software firm that opened this question.

Answer: The quote in (b) is not consistent with the statement at the beginning of the problem. The original statement says two things: that individual firms are best when they are small AND

that individual firms gain when they cluster together and can share information. If that is true, an economic development agency can reasonably try to build a cluster of small firms that, together, can generate a fair amount of employment.

5) Gary Hack, an urban designer, now at Penn, who used to teach at DUSP, argues that the most profitable way to redevelop lower Manhattan is not to replicate all the commercial space destroyed in 9/11 but rather to build a balanced mix of commercial space and residential space. Can Hack's argument be reconciled with the conclusions of this week's reading by Gaspar & Glaesar on broadband communication and city structure? Explain the points of agreement and disagreement between the two ideas.

Answer: On balance, Gaspar and Glaesar conclude that telecommunications is not a strong substitute for face to face communication and may be a mild complement. Hack's proposal assumes that if the office space of lower Manhattan was all reconstructed, there would not be sufficient demand to fill it. There are potentially many reasons for this but one of them is that face-to-face contact is no longer needed in many parts of Wall Street business – the business can be conducted by telecommunications and so will disperse to other locations. Thus the main thrust of Hack's plan goes against the Gaspar and Glaesar conclusion. Hack's plan also implicitly suggests that people may want to live near where they work and to an extent, that conclusion suggests face-to-face communication is important (though it may just reflect a desire for low commute times.)

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