



Econ 137

Urban Economics

Lecture Notes III

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Questions for Lecture Notes III

- Is there a land use pattern?
- What is it like?
- What determines the price of land?
- What determines the pattern in the use of land?



The Leftover Principle

- From Ricardo
- From competition (and since land is fixed), households, manufacturers, offices, etc, would be willing to pay for land up to the profits of their activities in the land.

The Monocentric City

- City with a Central Business District (CBD)
- Assumptions:
 - 3 type of land uses (offices, manufacturing firms, residential)
 - Central Export Node (Railroad terminal)
 - Horse drawn wagons (goods from factory to railroad terminal)
 - Hub-and-spoke streetcar system (for workers to factory)
 - Agglomeration Economies (office industry)

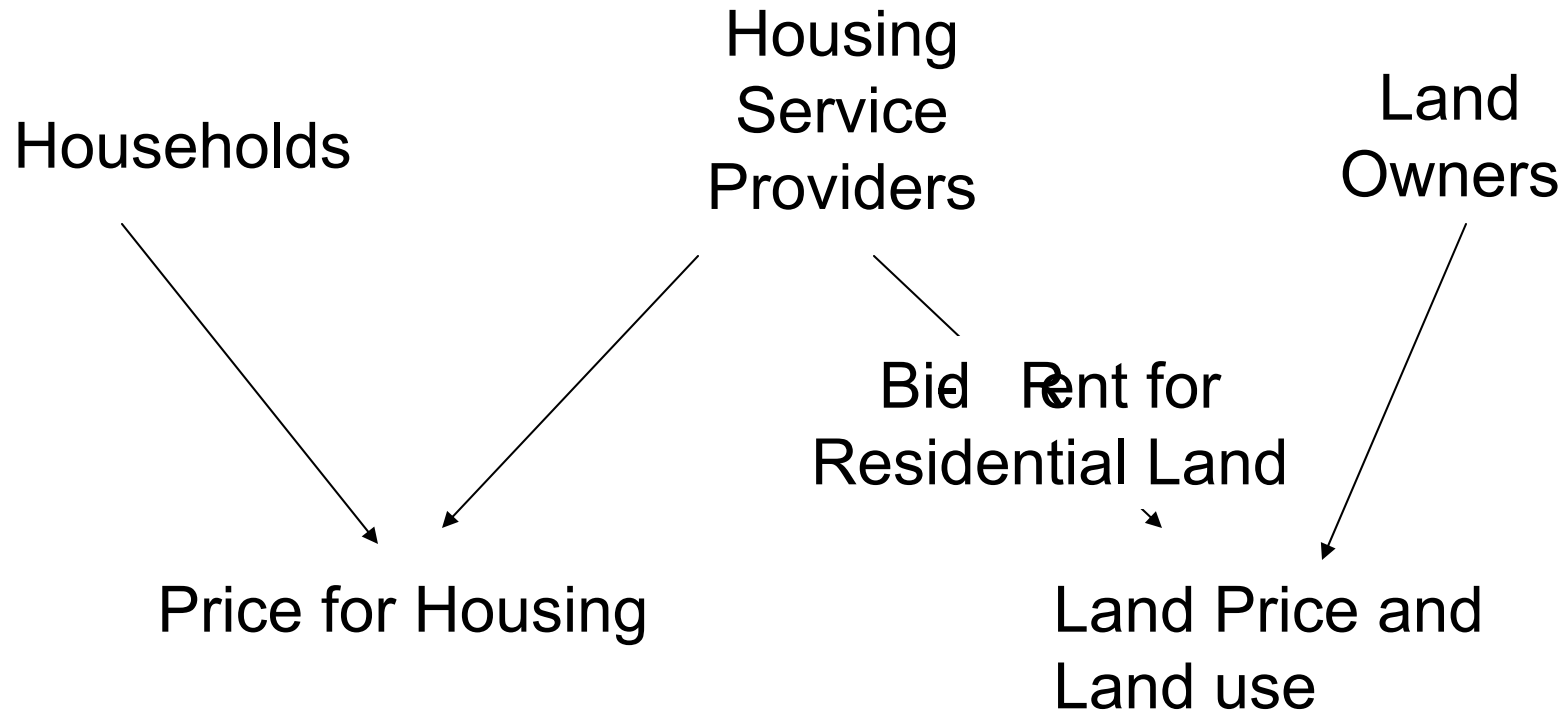
Transport Technology is Key

The Monocentric City

What determine land prices?

- Rural sector: Fertility of the land
- Households: Accessibility to workplaces (i.e. commuting costs).
- Manufacturing sector: Accessibility to consumers or suppliers. (i.e. distance to consumers or suppliers)
- Information sector: Accessibility to information

Residential land



Housing Prices (without substitution)

- **NO** consumer substitution:
 - 1000 square foot houses
 - \$300/month budget for typical HH
 - Commuting cost = \$20/mile per month

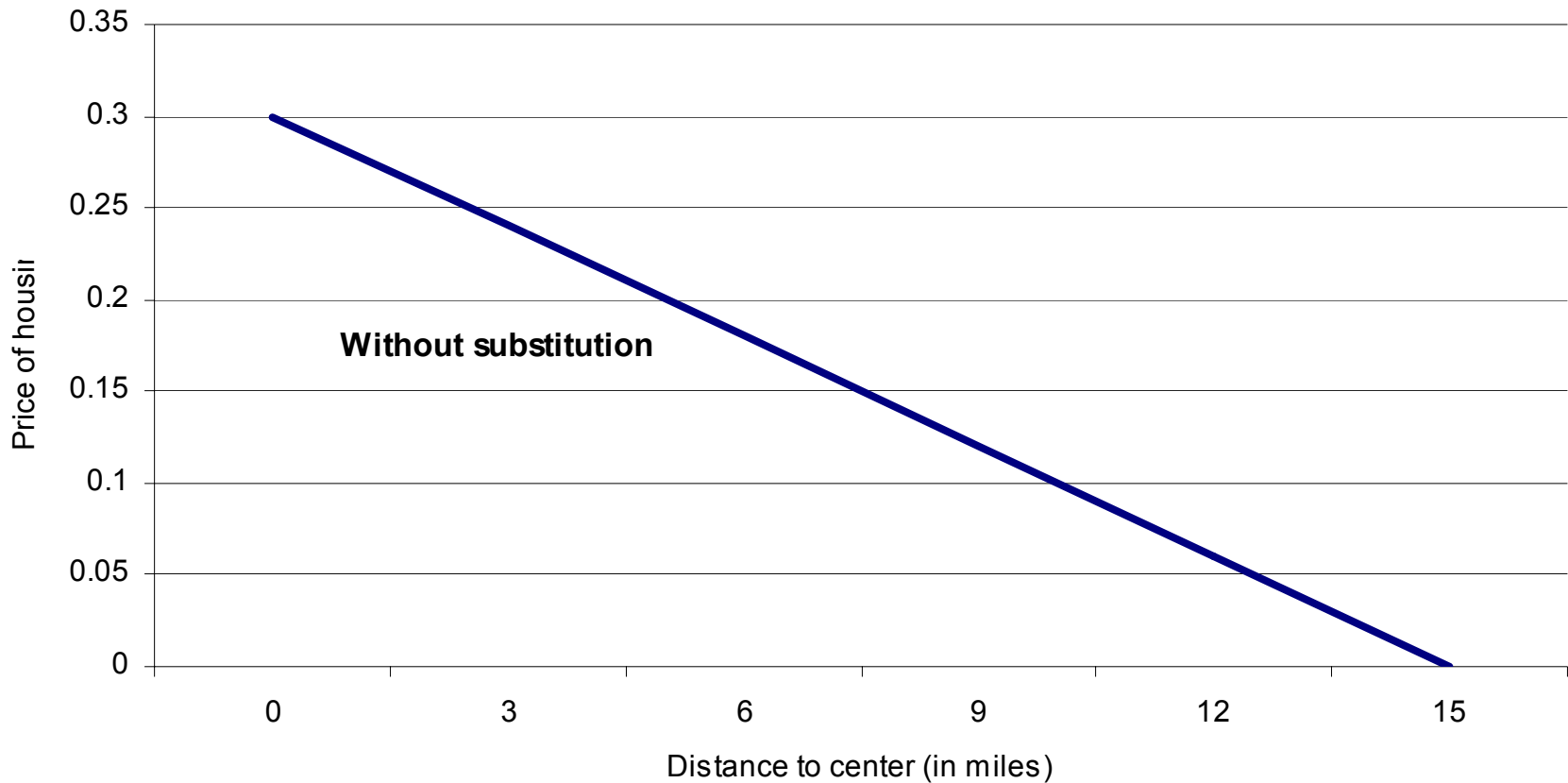
Assumed Consumption Pattern

i) Distance to city center (miles)	3	6	9	12	15
ii) Housing consumption (square feet)	1000	1000	1000	1000	1000
iii) Net income/month (300-(i)*20)	240	180	120	60	0
Price per Square-foot (iii/ii)	0.24	0.18	0.12	0.06	0

Linear housing price function [slope = -0.02\$/sq. foot]

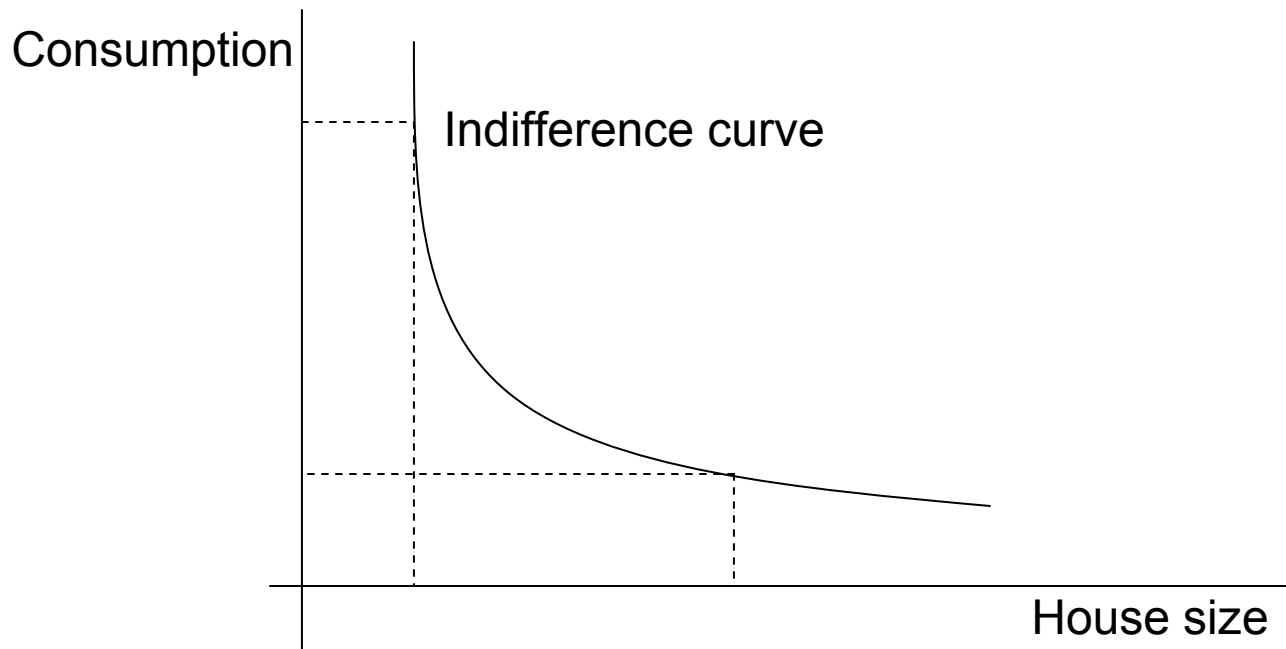
Housing price function (w/o substitution)

Housing Price Function

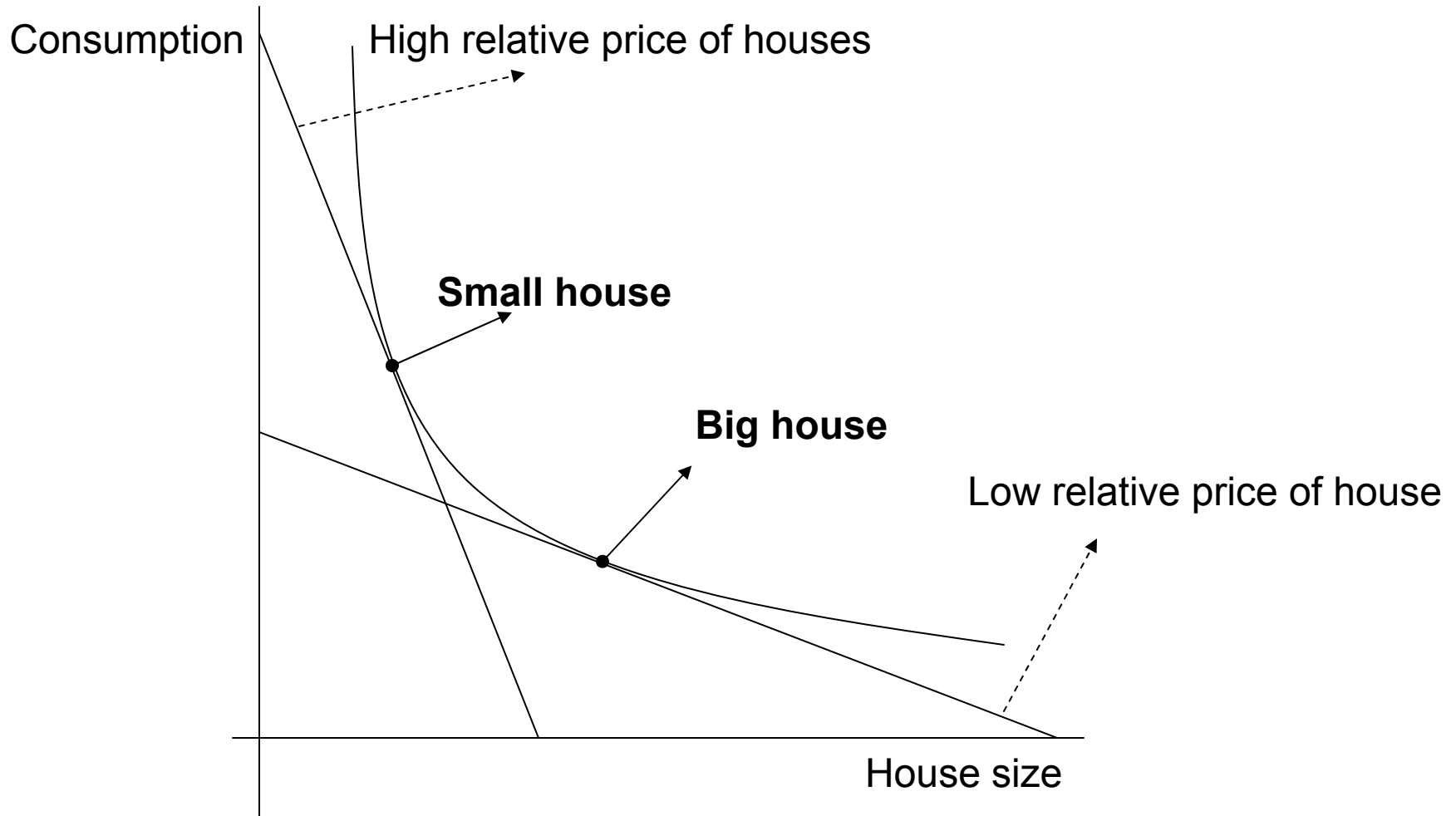


Housing Prices (with substitution)

- The household may decide whether to live at:
 - A small house (less expensive in land).
 - A big house (more expensive in land).



Housing Pricing (with substitution)



Housing Pricing (with substitution)

- Consumer substitution

- As the price of land increases, people accept smaller houses.

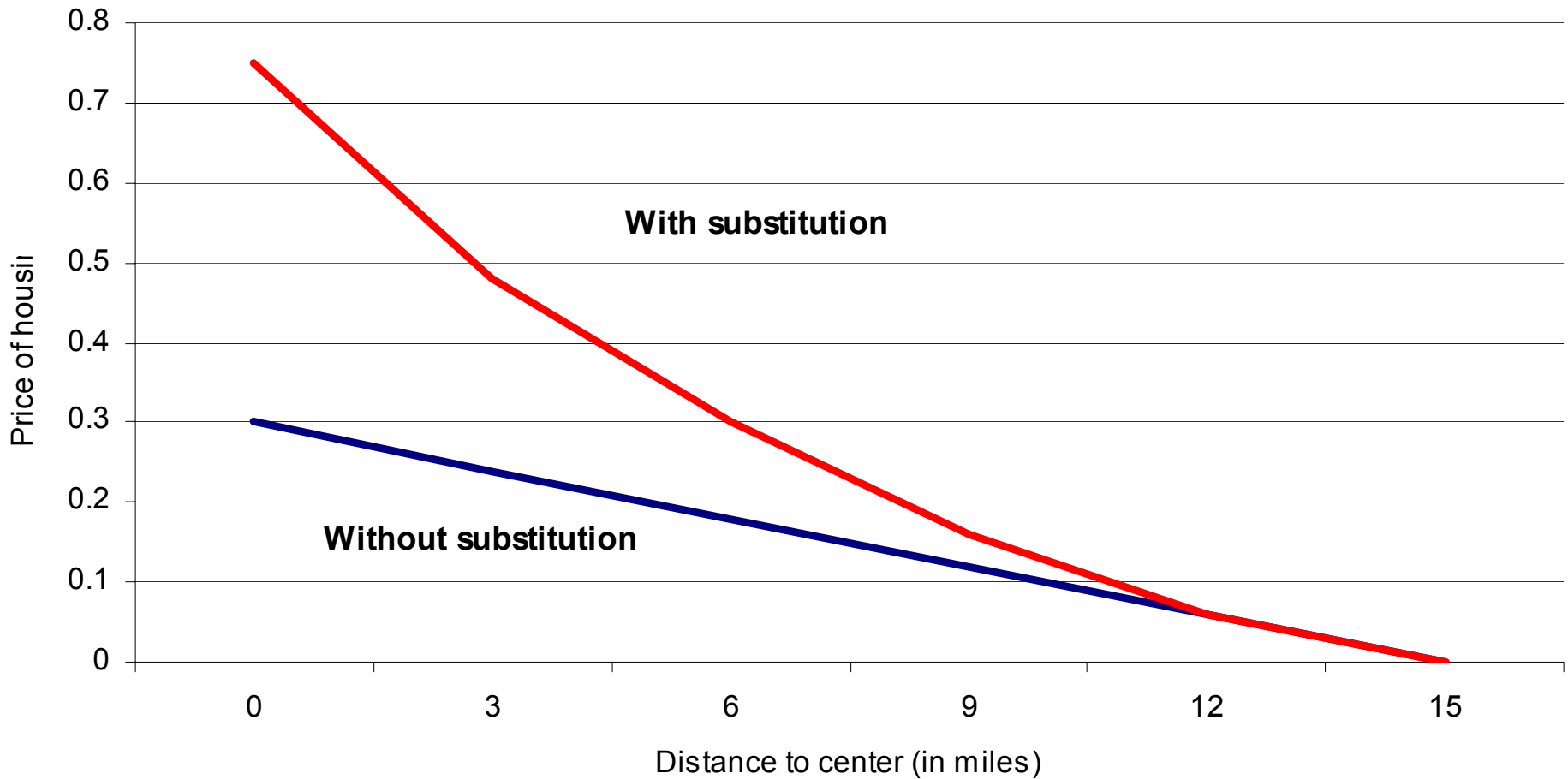
Assumed Consumption Pattern

i) Distance to city center (miles)	3	6	9	12	15
ii) Housing consumption (square feet)	500	600	750	1000	1000
iii) Net income/month ($300 - (i) * 20$)	240	180	120	60	0
Price per Square-foot (iii/ii)	0.48	0.30	0.16	0.06	0

Convex housing price function

Housing price functions

Housing Price Function



Residential land – Bid Rents (from production of houses)

Fixed proportions:

$$R_h(d) = P_h(d) H - K$$

Flexible proportions:

$$R_h(d) = P_h(d) H(d) - K(d)$$

$R_h(d)$ = Bid Rent

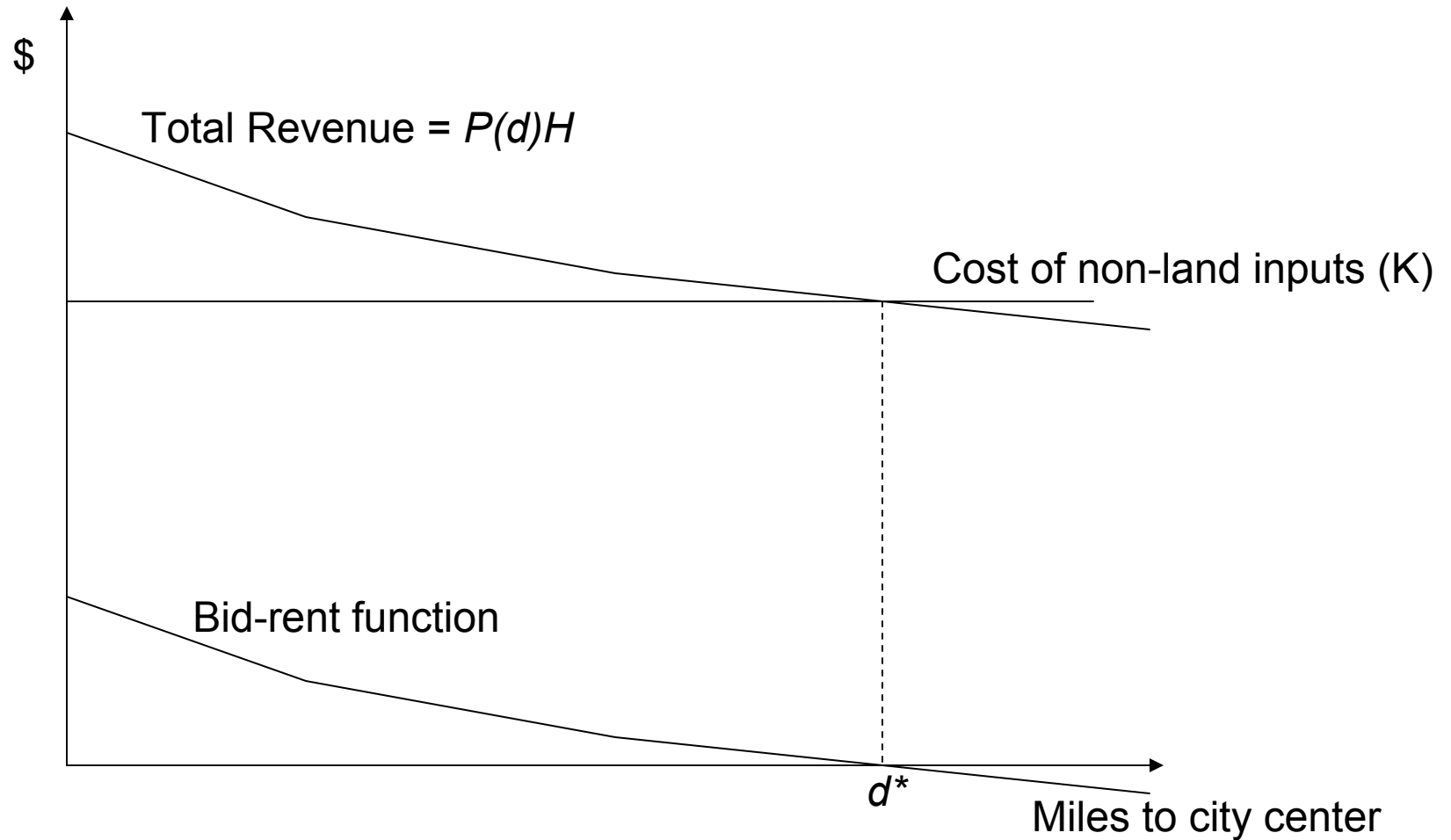
H = square feet of housing [not land!!]

K = nonland costs (to produce houses)

P_h = price of housing (per squared feet)

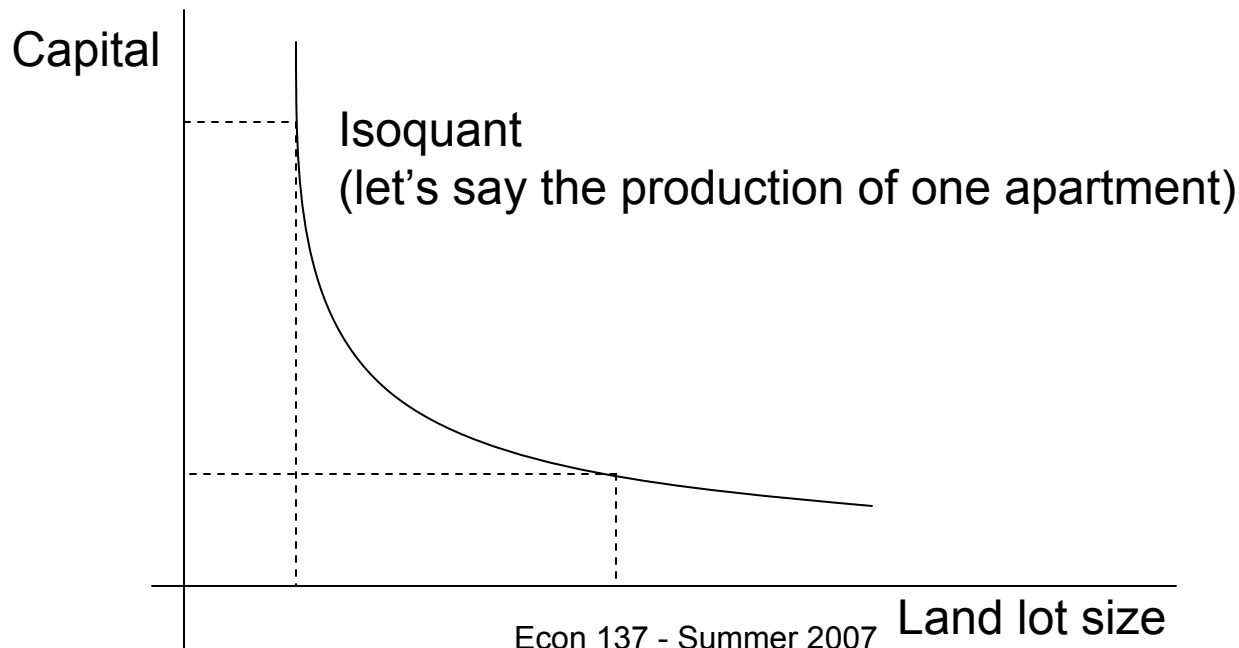
d = distance from city center (blocks)

Housing-Price and Bid-Rent Functions

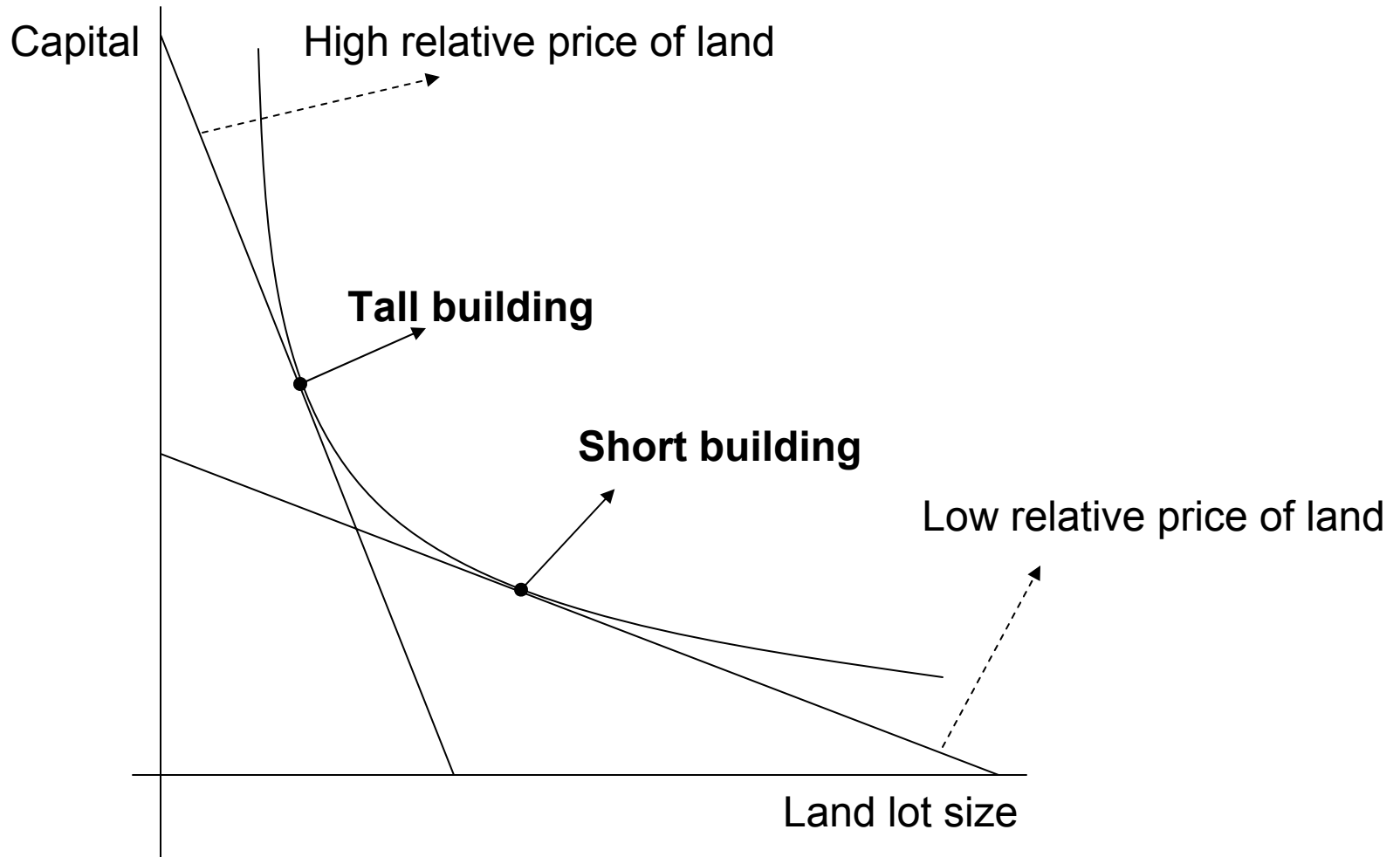


House production with input substitution

- The house producer may decide whether to build:
 - A tall building (less expensive in land and more expensive in capital).
 - A short building (more expensive in land and less expensive in capital).



House production with input substitution



Consumer density

- Consumer substitution
 - Price of houses is high around the center, so people prefer smaller houses.
- Factor substitution
 - Producers of houses substitute land by capital (relatively cheaper), producing tall buildings.

People packed in tall buildings and small apartments !!!

Important point !!!

- The big effect is given by lot sizes.
- If people accept to live in small houses in downtown (because the price of the houses), then real estate agents increase even more the price per square feet to extract all the surplus from the workers !!!!!

Recall we are tracking the price per square feet

Land for the manufacturing sector

- Manufacturers

$$\pi_m(d) = P_m Q - C_m - tQd - R_m(d)$$

P_m = Price of goods

Q = Quantity produced in one acre

C_m = Production cost (noland inputs) of Q

d = distance from terminal

t = wagon transport cost per unit per mile

$R_m(d)$ = land rent per acre to bid

- Fixed Proportions and Constant Returns to Scale

Land for the manufacturing sector

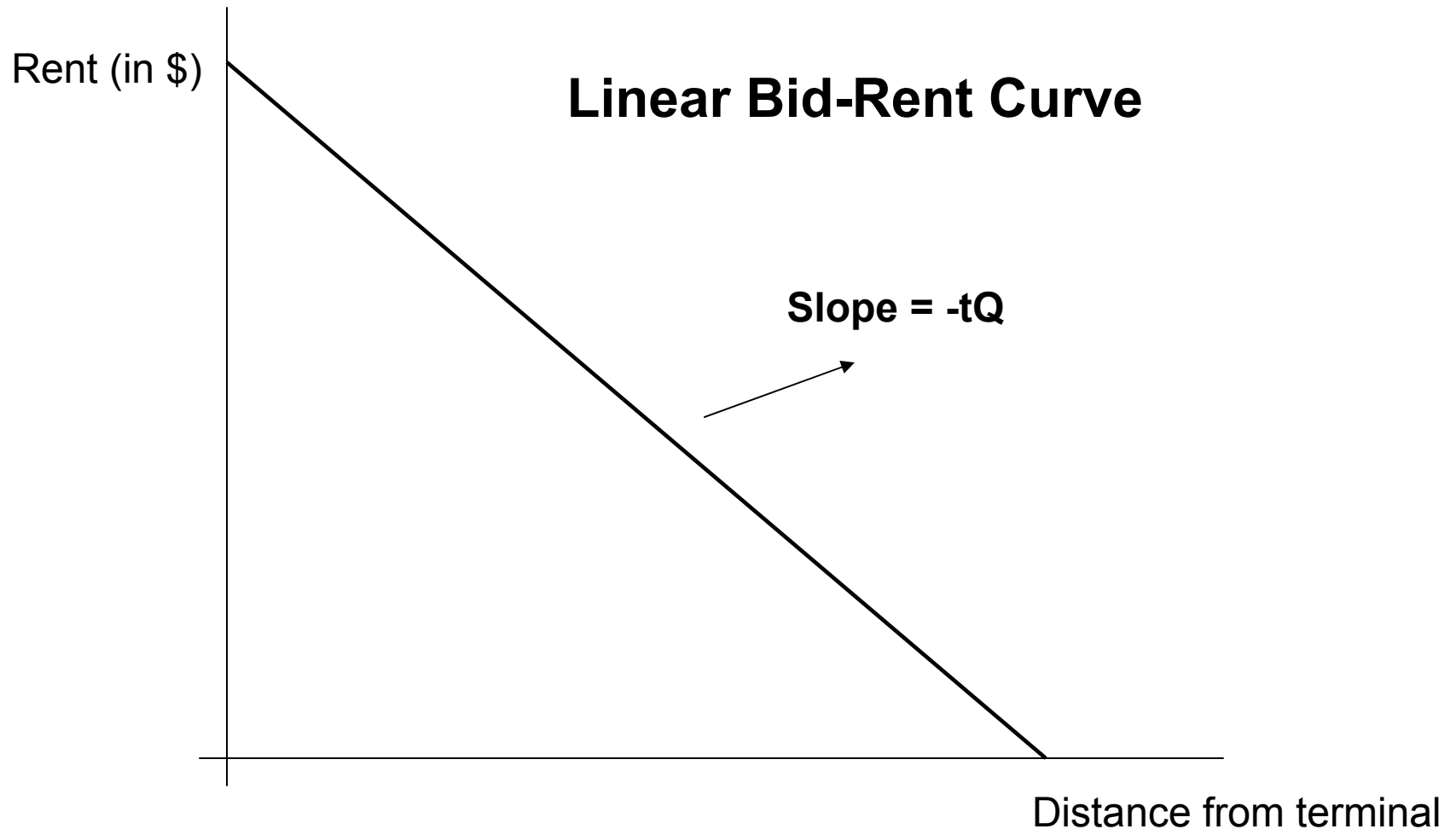
- Fixed Proportions and Constant Returns to Scale
- Profits are zero ($\pi_m(d) = 0$)

$$R_m(d) = P_m Q - C_m - tQd$$

$$\frac{\partial R_m(d)}{\partial d} = -tQ$$

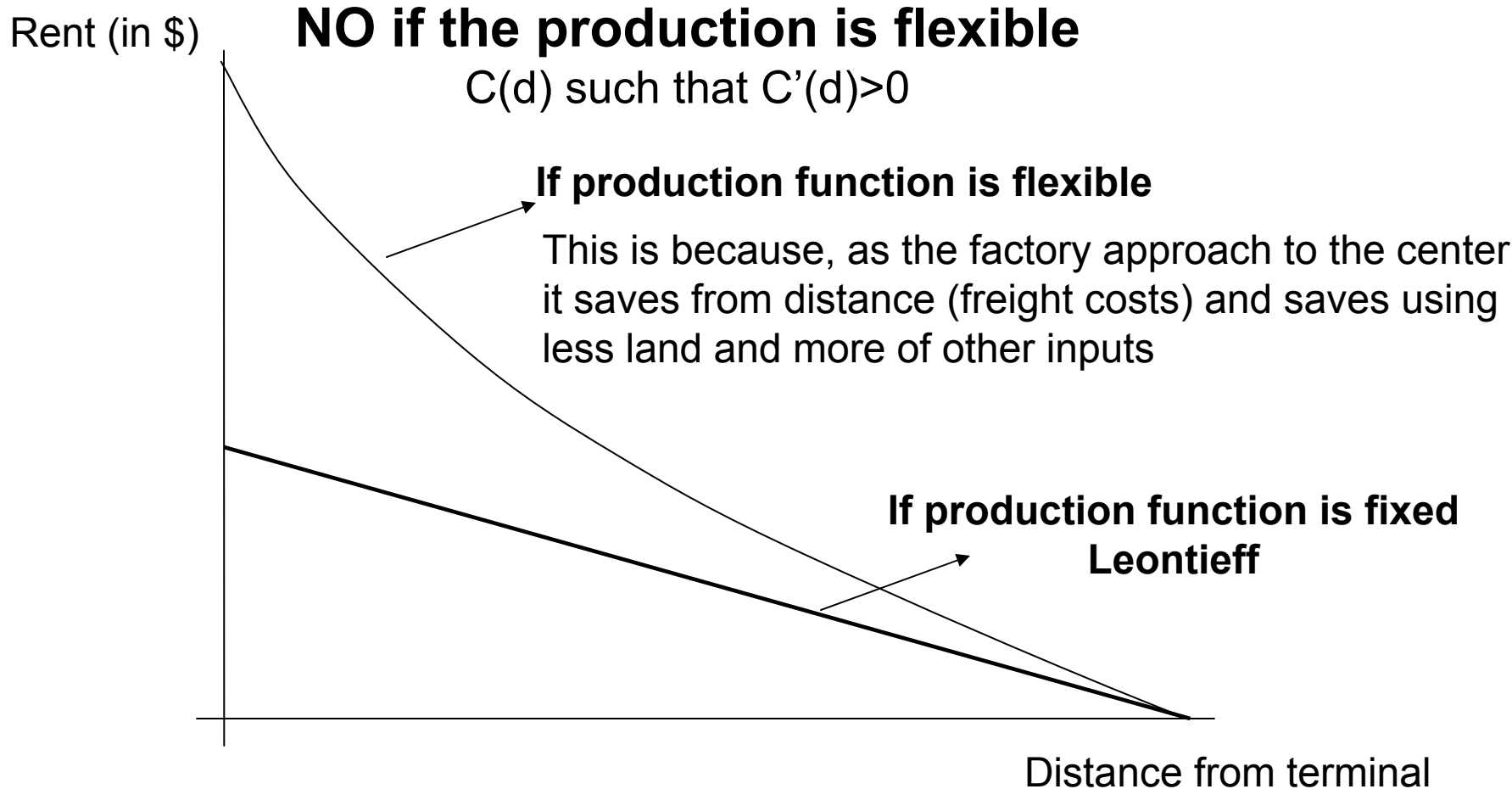
- Rent is determined by the terminal station location.

Manufacturing Bid-Rent Curve



Manufacturing Bid-Rent Curve

Is the Bid-Rent Curve always linear?



Offices Bid-Rent Curve

- Travel costs in the information and consulting sector is subject to agglomeration economies.
- While the manufacturing sector just has to transport the production to the terminal (one way), in the information sector employees have to return to offices (round trip)
- In this case, the central location minimize total travel distance, which increases exponentially as the firm separates from the center.

The median location minimizes total travel distance

Principle of Median Location

- Many input or output locations
- Example: Pizza Delivery
 - Ubiquitous inputs ($tc=0$)
 - Pizza price fixed (2 dollars/pizza, 1 pizza/consumer)
 - Each pizza sold requires one trip from store to buyer's location
 - Many markets (differ in size and location)
 - Delivery cost per pizza = \$2/mile

Principle of Median Location


■ Optimal Location?

	W	X	Y	Z
Distance from W	0	1	2	9
# of consumers	2	8	1	10
Monetary Weight	\$4	\$16	\$2	\$20

- Median Location has $\frac{1}{2}$ of the monetary weight to the left and $\frac{1}{2}$ to the right. MB of moving to the left or right (decrease in transport costs) is lower than the MC (increase in transport costs).

Principle of Median Location

■ Optimal Location?



	W	X	Y	Z
Distance from W	0	1	2	9
# of consumers	2	8	1	10
Monetary Weight	\$4	\$16	\$2	\$20

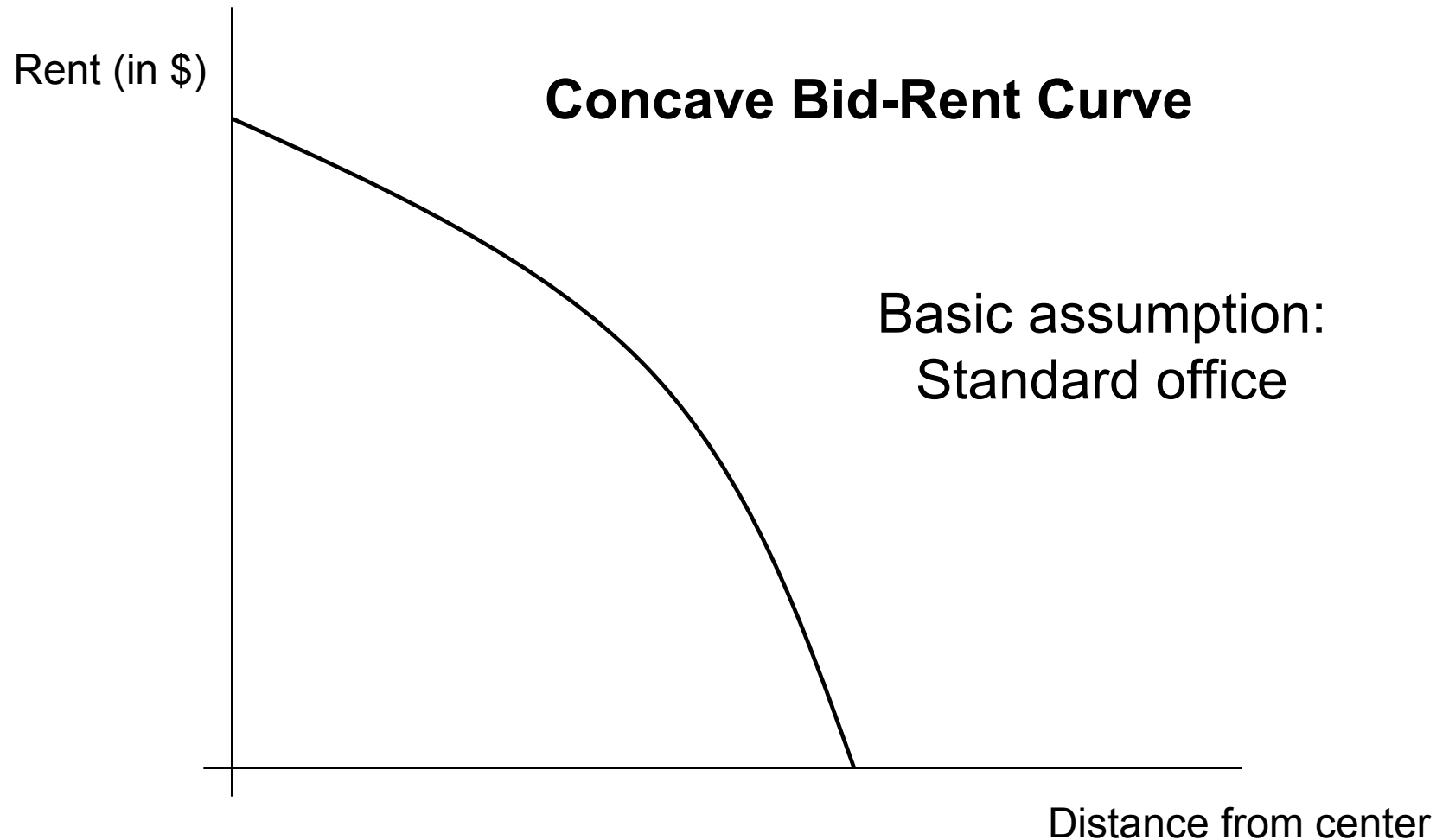
■ Why not move from Y? to X?

□ Total TC at X: $\$4 \times 1 + \$16 \times 0 + \$2 \times 1 + \$20 \times 8 = \$168$

□ Total TC at Y: $\$4 \times 2 + \$16 \times 1 + \$2 \times 0 + \$20 \times 7 = \$164$

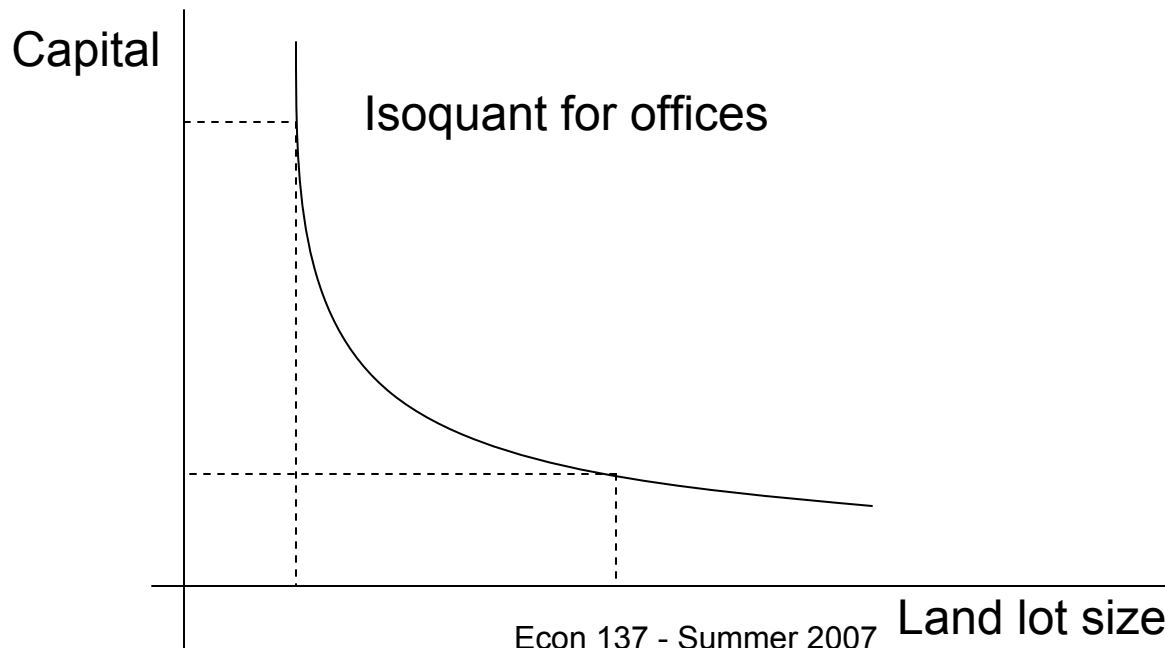
■ What if 4 new consumers move to W?

Offices Bid-Rent Curve

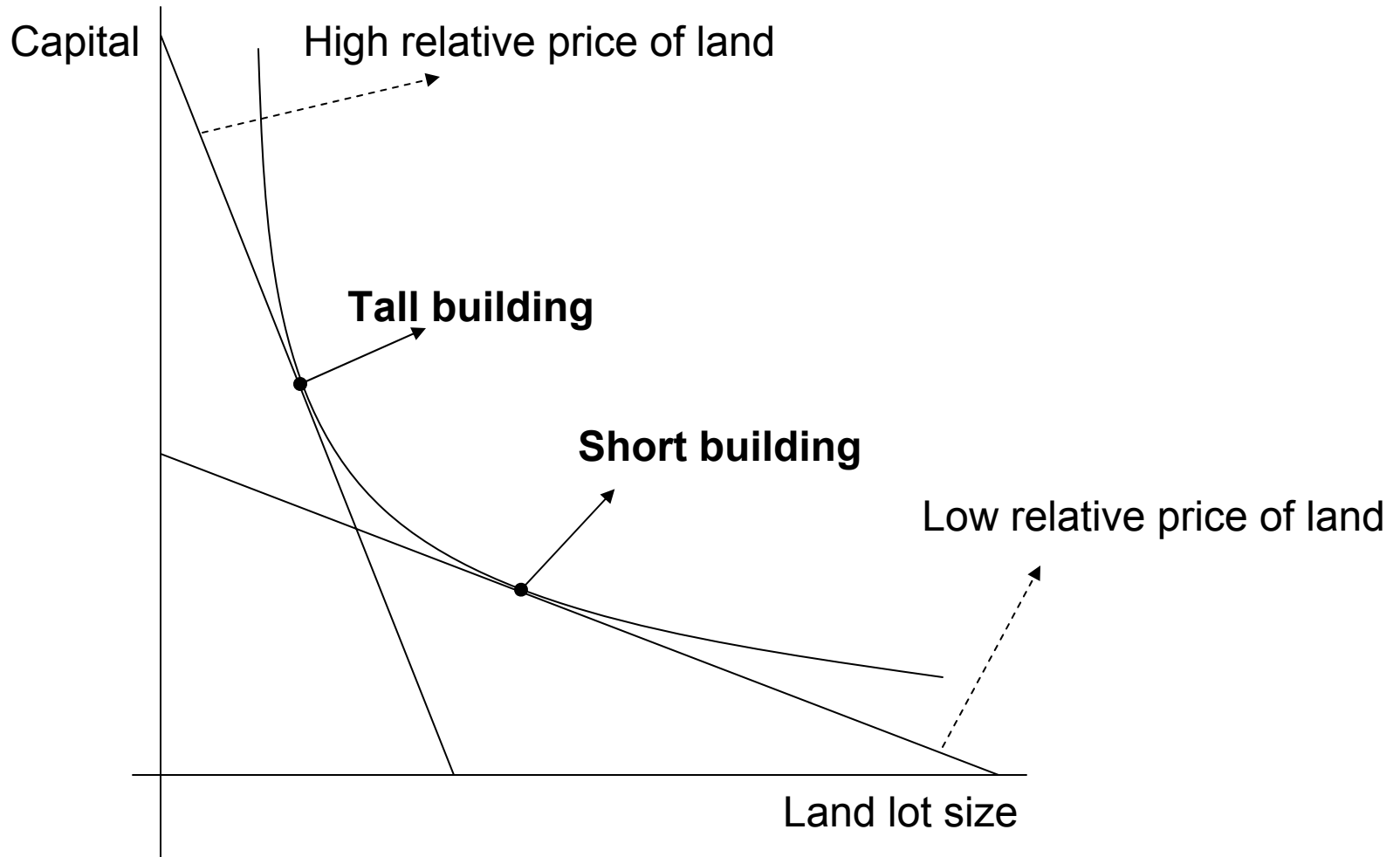


Offices Bid-Rent Curve

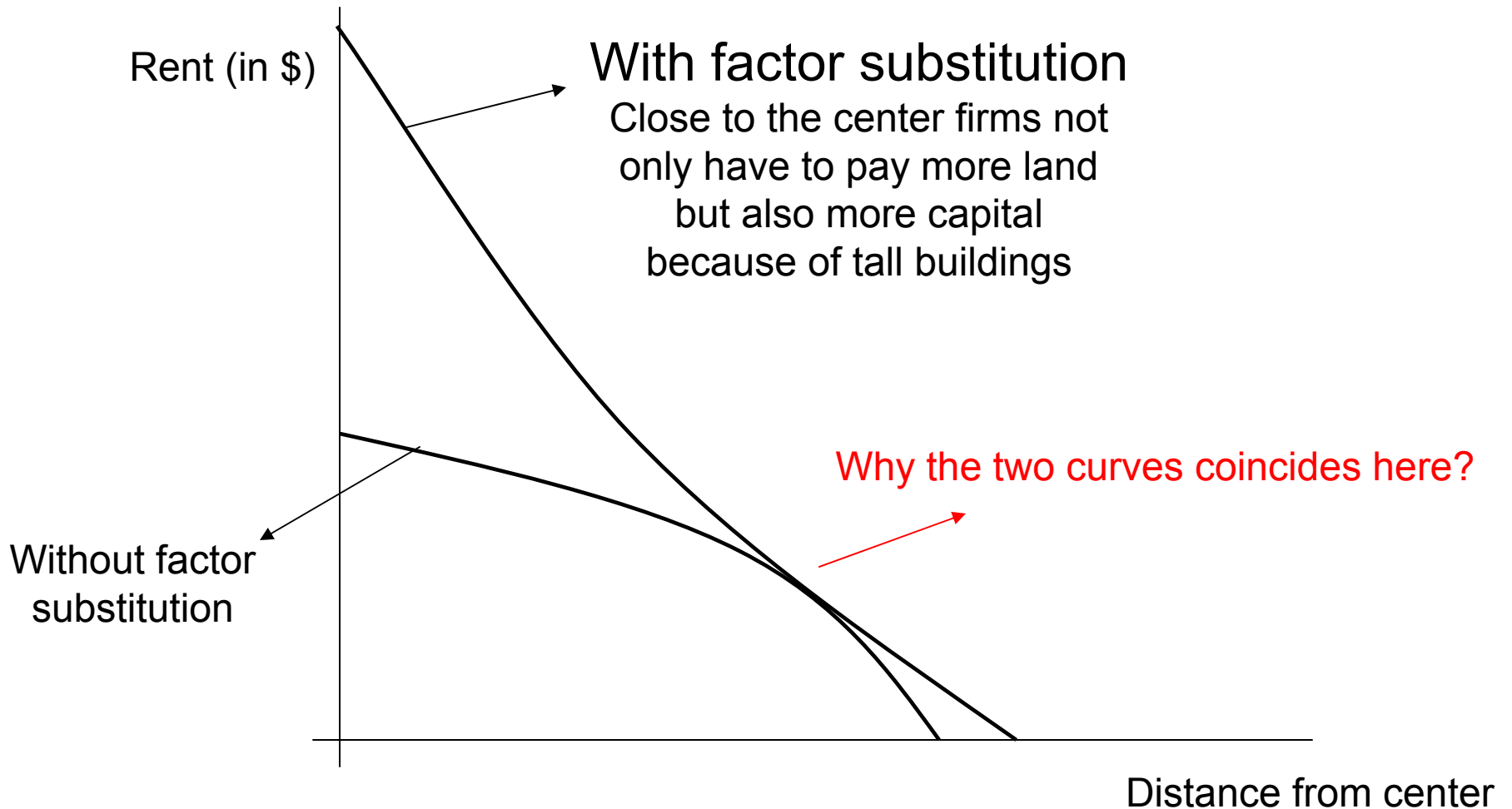
- The firm may decide whether to locate the office at:
 - A tall building (less expensive in land and more expensive in capital).
 - A short building (more expensive in land and less expensive in capital).



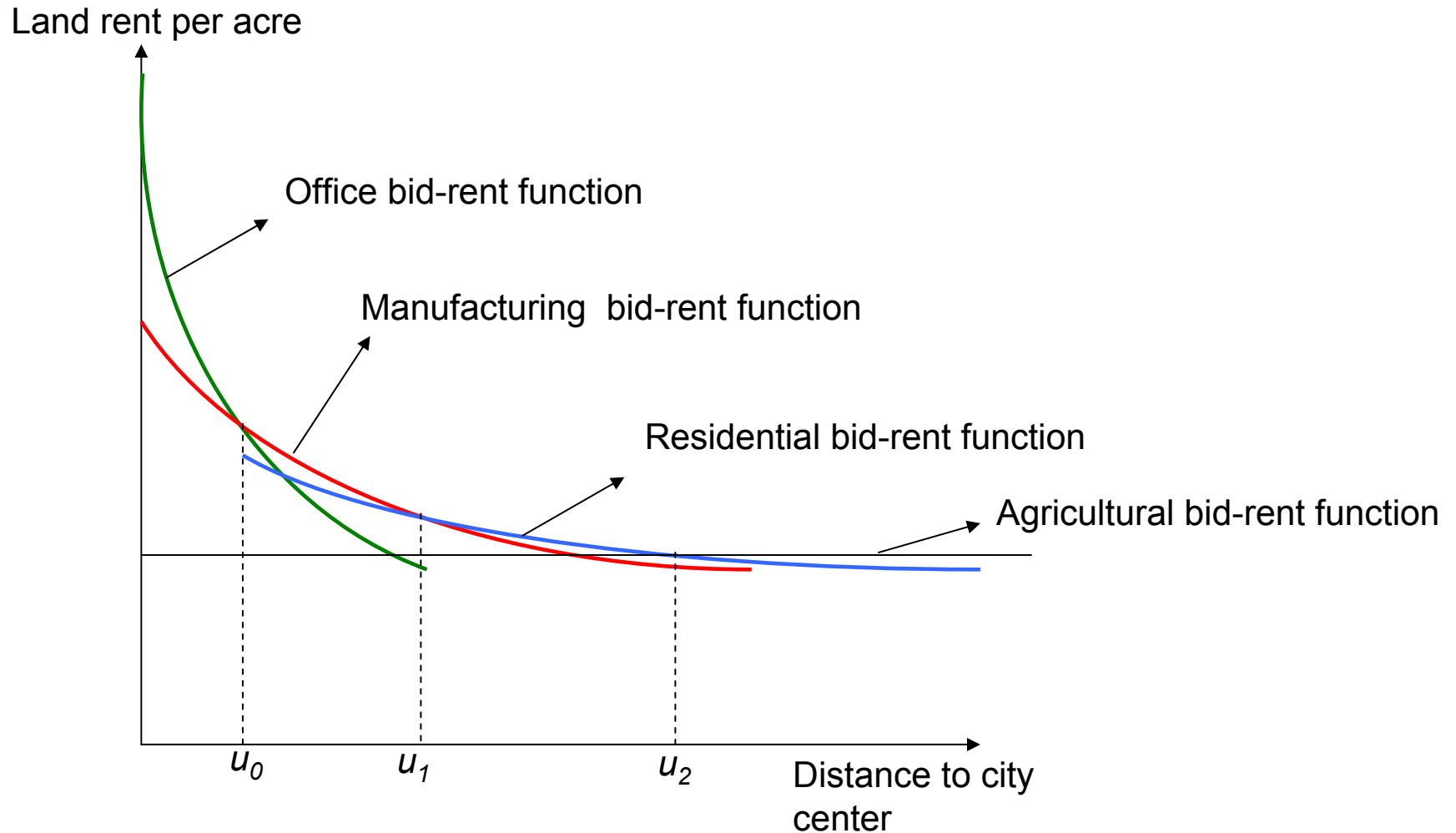
Offices Bid-Rent Curve



Offices Bid-Rent Curve



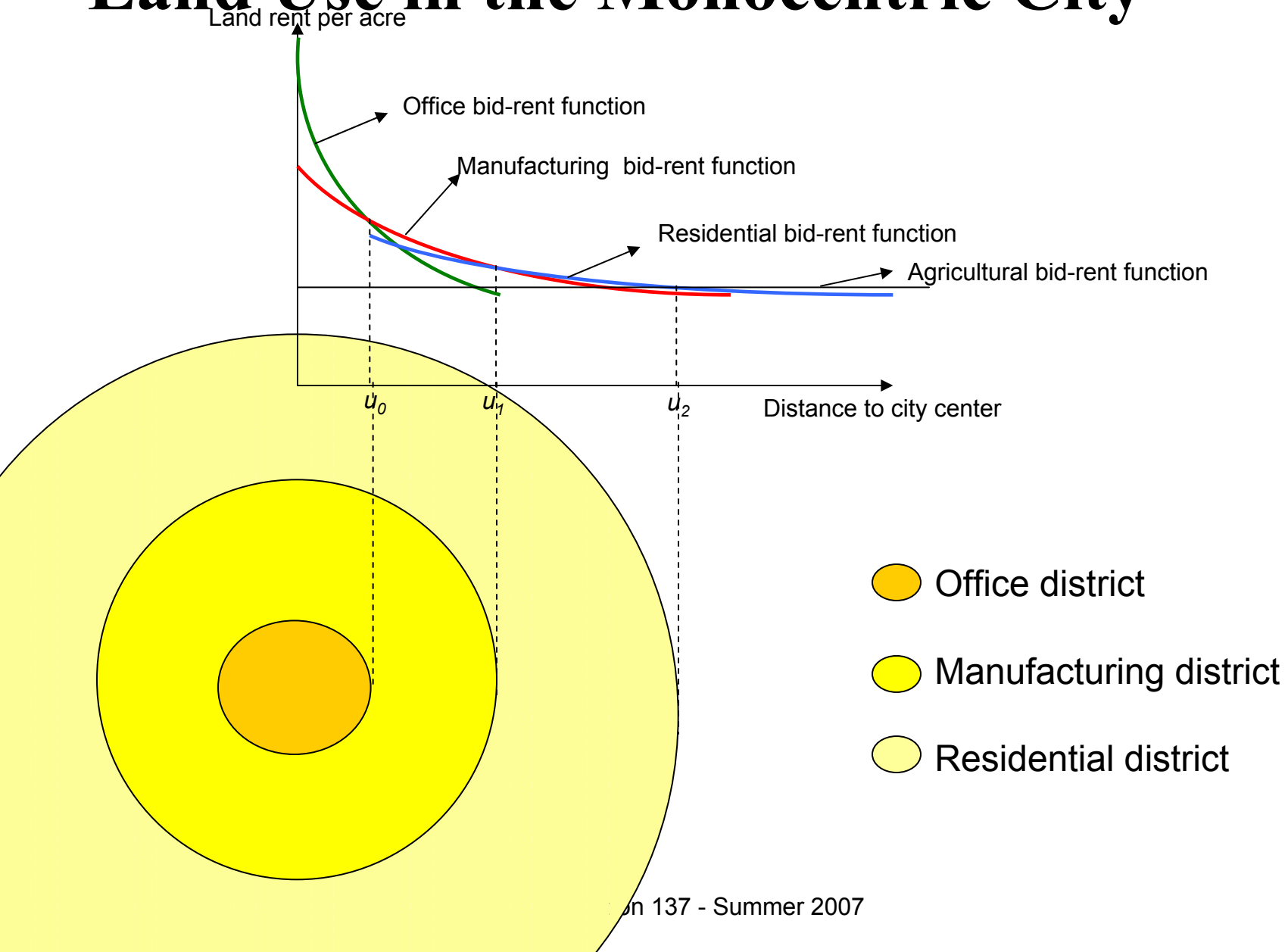
Land Use in the Monocentric City



Why these slopes?

- Steeper bid rents curves keep the center (more willingness to pay)
- Slopes are determined by transport costs.
- Office steeper because use people (workers walk)
- Manufacturing use horses and wagoneers (trucks)
- Resident commute of streetcars (buses or metro), which represent the lowest cost among the possibilities.

Land Use in the Monocentric City



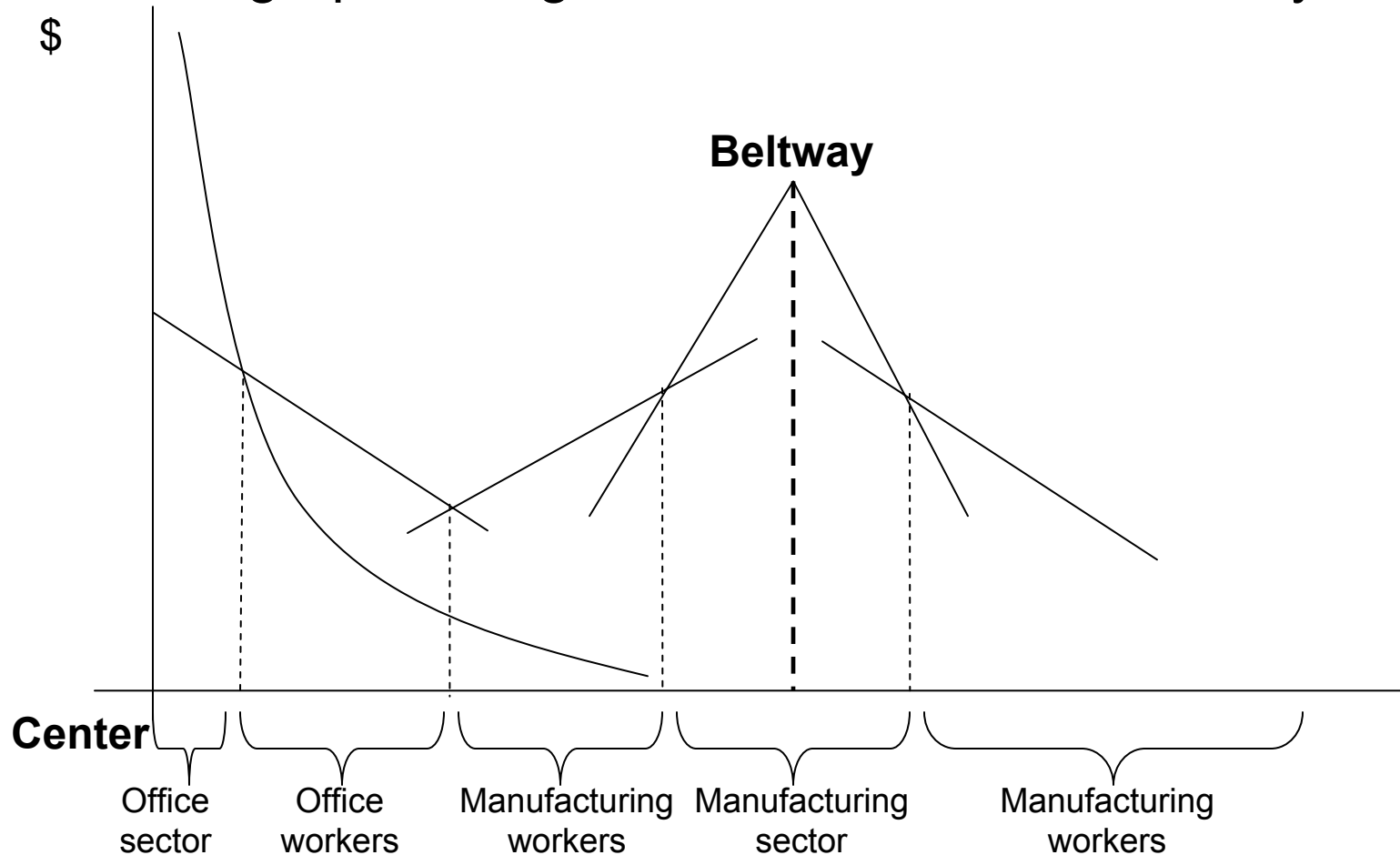


Relaxing assumptions

- Time cost of commuting
- Non commuting travel
- Two earner households
- Spatial Variation in other locational attributes
- Income differentials
- Zoning

Relaxing assumptions

- How the graph changes if we introduced a beltway?



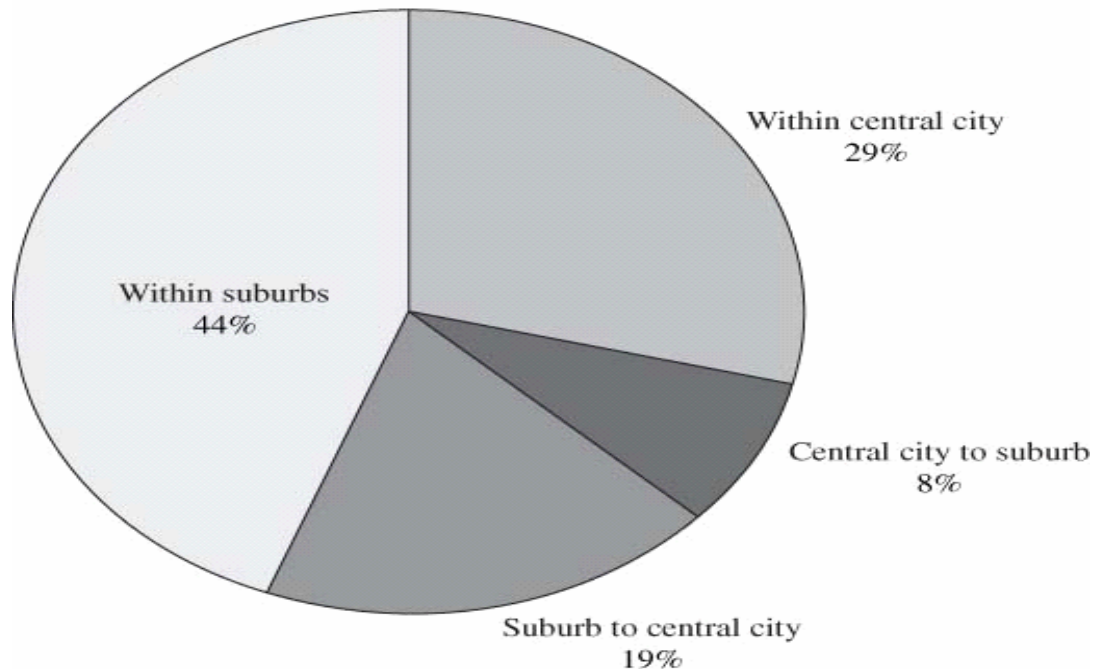
Summary Ch. 6 O'Sullivan

- In the monocentric city, manufacturers export their output in horse-drawn wagons to a central export node; office workers travel by foot from offices to a central market area to exchange information; commuters and shoppers travel to a hub-and-spoke streetcar system.
- The bid-rent curves are negatively sloped because of transportation cost, and convex because of factor substitution (and also consumer substitution in the case of housing).
- The office sector has higher transportation cost per mile, so its bid-rent function is relatively steep and office firms occupy the city central area.
- Employment is concentrated in the CBD because the cost of commuting from the suburbs to the CBD (via streetcars) is low relative to the cost of moving output from the suburbs to the city center.
- The urban land and labor markets are connected because labor demand is determined by the territory and density of the business sector, and labor supply is determined by the territory and density of the residential sector.

Cities are changing

- Employers are more dispersed on the metropolitan area.
 - In the US, CBD concentrates 20% of total employment in MA
 - In the US, CBD concentrates 40% of total offices in MA
 - Population (20% in 3 miles around CBD) and commuting

FIGURE 7-5 Metropolitan Commuting Patterns, 2000



Source: U.S. Census, Journey To Work.

General characteristics of centers and subcenters in US

- Numerous in both new and old large MAs
- Jobs dispersed rather than concentrated.
- Subcenters highly specialized
- However, centers still important.
- Density decreases as distance from center increases.
- Centers still more developed in face2face type of activities.
- Median workplace of the largest 100 metropolitan areas are about 7miles from city center

Urban density

- Varies a lot across countries and cities in the US
- Density gradient: Rate at which population decreases with distance
$$dg = \frac{\Delta \text{density}}{\text{density}} / \text{distance}$$
- For example, 0.1 means the density decreases by 10% per mile from center.
- In average the density gradient in the US goes from 0.05 to 0.15

Urban density

Average Density Gradient 4 Metropolitan Areas

Year	Avg Gradient
1880	1.22
1890	1.06
1900	0.96
1910	0.80
1920	0.69
1930	0.63
1940	0.59
1948	0.50
1954	0.40
1958	0.35
1963	0.31

Baltimore, Milwaukee, Philadelphia, and Rochester. Source, Mills (1972)

Subcenters in Los Angeles

- Conventional view of Los Angeles: “Endless urban sprawl, with employment and population dispersed throughout”
- In fact, highly complex space economy characterized by a system of specialized centers, dispersed but yet strongly influenced by the pull of LA central area.
- Up to WWII, metropolitan growth confined to LA county.
- By 1965 suburbs well extended into Orange County to the south and San Fernando Valley to the north.
- By 1980 suburbs well extended to Riverside and San Bernardino to the east and Ventura County to the western edge.

Subcenters in Los Angeles

■ Definition:

- Density at least 25 workers / hectare
- Total employment at least 10,000 workers

■ 32 in 1980 (average 45 workers / hectare), including Downtown LA, Riverside, Ventura and San Bernardino

■ 23 % of total metropolitan employment

■ 4 largest centers form an arc from Santa Monica through downtown LA (Wilshire corridor, a giant center 19 miles long)

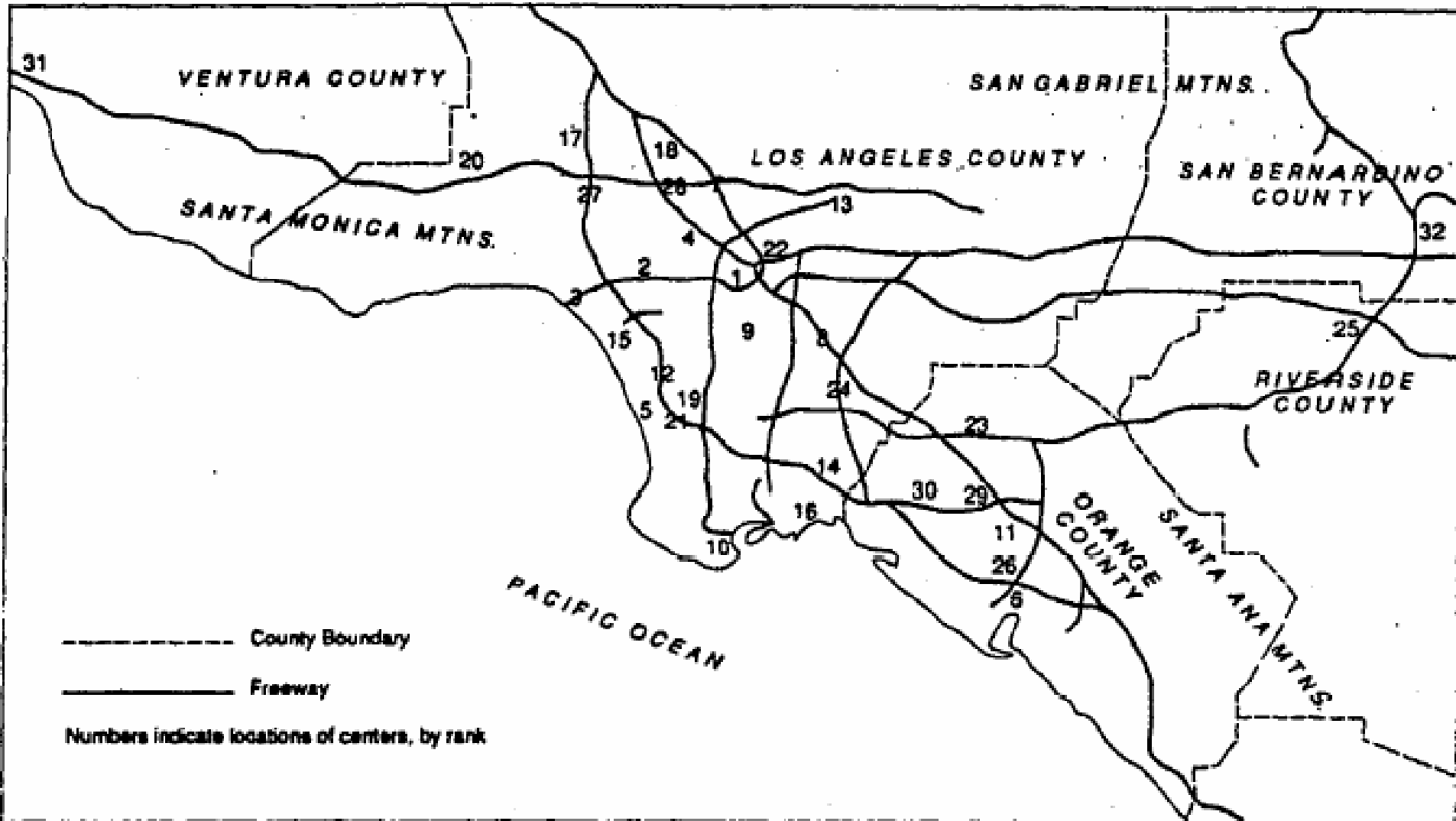
■ Downtown LA comprises ½ percent of region's land area but contains 10% of workers and 31% jobs within centers.

■ Commutes to jobs within the center are longer than outside the center.

Subcenters in Los Angeles

Rank	Location*	Employment (1000's)	Employment density (no./acre)	Area (1000s) acres)	Employment- population ratio	Distance from CBD (miles)
1	Downtown LA	469.0	36.0	13.0 ^c	1.47	0.1
2	LA West	176.2	25.5	6.9 ^c	1.37	15.8
3	Santa Monica	65.1	16.9	3.8 ^c	1.11	16.7
4	Hollywood	64.2	21.4	3.0 ^c	0.73	7.3
5	LA Airport	59.1	16.7	3.5 ^b	4.32	18.8
6	Orange Co. Arpt. (OR)	47.7	16.1	3.0	1589.87	40.7
7	Glendale	43.0	15.5	2.8 ^c	1.07	12.3
8	Commerce	41.9	17.0	2.5 ^b	4.05	9.8
9	Vernon/Hunting. Park	39.2	33.2	1.2 ^b	2.42	4.9
10	San Pedro	37.6	15.7	2.4 ^b	2.74	23.3
11	Santa Ana (OR)	37.5	17.3	2.2 ^b	1.51	32.9
12	Inglewood	36.5	14.6	2.5 ^c	1.24	14.7
13	Pasadena	35.9	25.3	1.4 ^b	1.73	12.1
14	Long Beach Airport	33.2	15.5	2.1	3684.78	23.3
15	Marina Del Rey	31.7	11.4	2.8 ^c	1.28	14.0

Subcenters in Los Angeles



Subcenters in Los Angeles

■ 5 types

- **Mixed industrial** (near a transport node, e.g. airport, port, marina). (LAX, Orange County Airport, Inglewood, Marina del Rey, etc.)
- **Mixed service** (typically an independent center in the past) (Downtown LA, Santa Monica, Glendale, Santa Ana, Pasadena, Long Beach, Riverside, Ventura, San Bernardino, etc.)
- **Specialized manufacturing** (Long Beach Airport, Burbank Airport, Hawthorne, Lawndale, etc.)
- **Service oriented** (West LA, East LA, Anaheim, etc.)
- **Specialized entertainment** (Hollywood and Burbank)

The rise of monocentric cities.

- Improve in transportation technology
- Rule of thumb: “Radius of a city is the distance that can be traveled in one hour”
- Hub and spoke public transit system in the 19th century.
- Short CBDs
 - Before elevators, price of high floors were cheaper because they were rented at a discount that offset the costs of climbing four or five floors of stairs.

The decline of monocentric cities.

- Decentralization of manufacturing
 - Intercity tucks. Trade off of moving away from center is between higher freight costs and lower wage.
 - Since freight costs decrease, it's better to move out from centers.
 - From factories close to ports, railroads and city centers to factories close to highways, beltways and airports
- Decentralization of offices
 - Advance of communications (a reduction in the need for face2face activities)

The decline of monocentric cities.

- Decentralization of population
 - Evidence: Reduction in density gradients
 - Rising income and change in consumption bundles (not clear)
 - Decrease in commuting costs
 - “Jobs follow workers to suburbs and workers follow jobs to suburbs”
 - Others: Old housing at the center, high taxes, crime, low quality education, etc.

Summary Ch. 7 O'Sullivan

- The median job location is seven miles from the city center and the median residential location is eight miles.
- Cities in the US are much less dense than cities in the rest of the world.
- The key factors in the rise of large monocentric city were innovations in intraurban transportation that decreased the cost of commuting and innovations in construction that decreased the cost of tall buildings.
- The key factors in the decentralization of jobs and people were increases in income and the development of the truck, the automobile and the highway system.
- Between 1950 and 1990, the amount of urban land increased more than twice as fast as the urban population.



Questions for Lecture Notes III

- Is there a land use pattern?
- What is it like?
- What determines the price of land?
- What determines the pattern in the use of land?

Practice Exercises - Lecture Notes III

■ O'Sullivan

- Chapter 6: Exercises 2, 3, 4 and 5.
- Chapter 7: All exercises.