Chapter 4:

Inside the City I:
Some Basic Urban Economics

"Location, location, location…"

- Ch.3 was about the 1st level of *"location"* (city location & city size).
- Ch.4 goes *inside the city*:
  - **The nature of land use spatial patterns within the city: "urban form" ("urban spatial structure").**
  - Important for:
    - **Understanding property values in different neighborhoods**
    - What types of buildings & land uses are feasible in a given location, at a given time.
    - Location value ➔ Land value ➔ LRMC shape ➔ LR rent trend.

Chapter 4 Learning Objectives…

- ***What determines land rents in a city.***
- ***Why and how a freely functioning, competitive land market will lead to land being used at its "highest and best use" (i.e., most productive use).***
- ***What determines how big spatially or how dense a city is.***
- ***What determines the relative land values at different locations wihtin a city, and the relative growth rate of these values at different locations.***
- ***Why different land uses and densities occur at different locations within a city.***

4.1.1 Location & the Residual Nature of Land Value

- Value of land is based on supply (of land) and demand (for land).
- *"Land" = "Space & Location".*

Demand for land

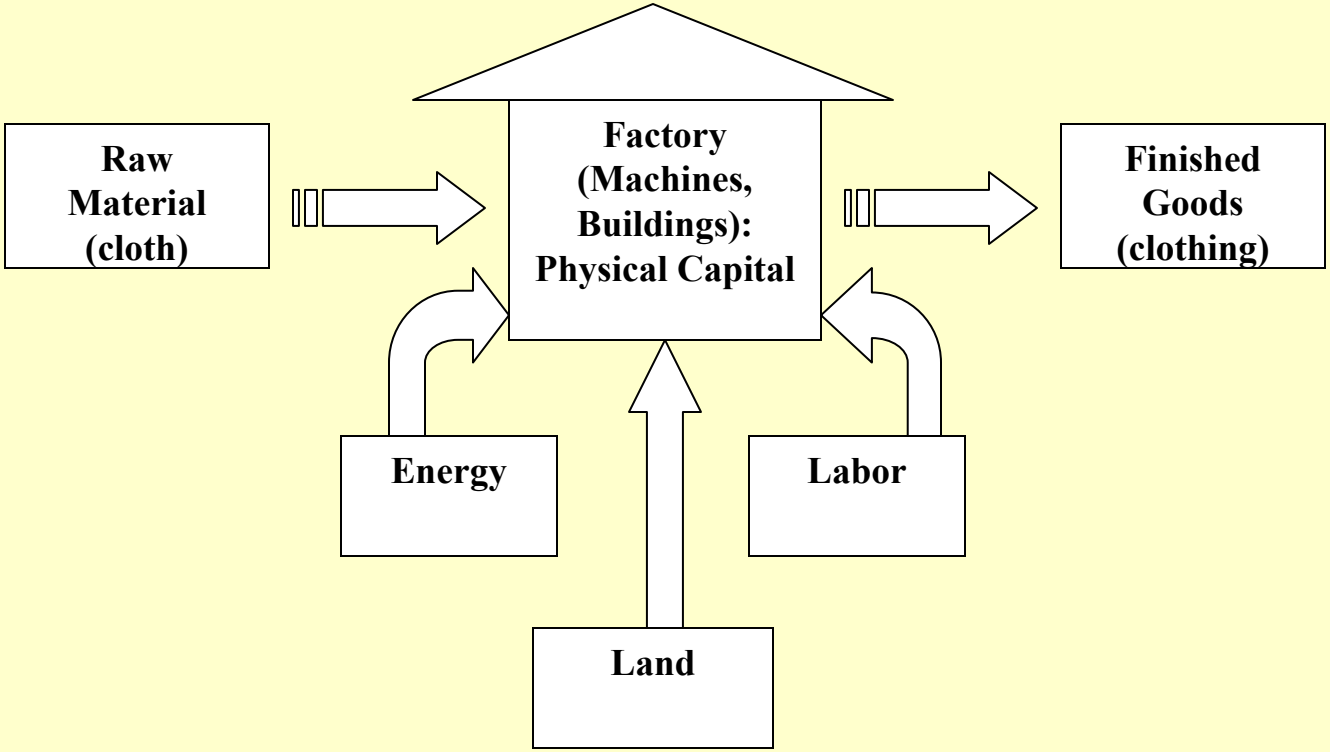
Demand for land is ***derived demand***. Land has value only because it enables production or consumption of goods & services. Land provides space and location for…

- ***Living (residential land use)***
- Industrial production of goods (industrial land use)
- Storage & distribution of goods (warehouse & retail land uses)
- Administration & control (office land use)
- Provision of services (office & retail land uses)
- Recreation & entertainment (retail & park land uses)
- Etc…

Residual Theory of Land Value:

- ***Land value is the difference between the value of what is produced on the site and the cost of producing it there.***

Consider a clothing factory:



Clothing Factory (cont'd):

- **Value of Finished Output:**
  - ***Clothing products*** ***$10,000,000***
- **Cost of Production:**
  - Cost of Goods Sold:
    - Raw material & Energy $ 4,000,000
    - Labor (including mgt) $ 5,000,000
  - Total COGS $ 9,000,000
- **Gross Margin:** $ 1,000,000
- **Cost of Capital:**
  - Machine & Building Rent $ 900,000
- **Residual** (available to pay land rent)**:** $ 100,000

Clothing Factory (cont'd):

Of the 4 factors of production (Labor, Capital, Energy/Raw Materials, & Land), Land is the ***least mobile***, and so it gets only the ***residual***, what is left over after the more mobile factors have been paid their market values.

4.1.2 Competition, Equilibrium, and Highest & Best Use…

Competition in the land market…

- **Demand side of land market:**

  Potential land users compete against each other for sites.

- **Supply side of land market:**

  Potential sites compete against each other for users (tenants).

Competition, Equilibrium, and Highest & Best Use (cont'd)

- With *"perfect competition"*, the **equilibrium** result will *maximize the total value of all the land* (and this will maximize the value of all production). This is called *"Pareto Optimality"*: Nobody can be made better off without making someone else more worse off.
- The result is each land parcel being used at its ***"Highest & Best Use" (HBU)***. This means each site is used in the way that is most productive for that location.

Example:

- Two Potential Land Uses:
  - ***The previous clothing factory.***
  - A grocery store.
- Two Available Land Sites:
  - ***Site 1 is the previously-described site for the clothing factory.***
  - Site 2 is closer to most residences, but farther from highways.

Exhibit 4-1: Highest & Best Use Example

	Site 1		Site 2	
	Clothing Factory	Grocery Store	Clothing Factory	Grocery Store
Revenues	$10,000,000	$4,600,000	$10,000,000	$5,000,000
Mobile Factor Costs	9,900,000	4,550,000	9,990,000	4,625,000
Residual (Land Rent)	100,000	50,000	10,000	375,000

Example (cont'd)

- Clothing Factory can bid $100,000 land rent for Site 1, only $10,000 for Site 2.
- Grocery Store can bid $375,000 land rent for Site 2, only $50,000 for Site 1.
  - *HBU **for Site 1 is clothing factory.***
  - **HBU** for Site 2 is grocery store.

Example (cont'd)

- In a competitive, freely-functioning land market, Site 1 will end up with the clothing factory, and Site 2 with the grocery store.
- This result will *maximize the net aggregate value* of production:

  ($10,000,000 + $5,000,000) - ($9,900,000 + $4,625,000) = $475,000.

- It will also *maximize the aggregate land value* (land rent):

  $100,000 + $375,000 = $475,000.

4.1.3 Role of Transport Costs: The Bid-Rent Curve…

- Land Rent ← HBU Residual ← Transport Costs
- Transport costs include:
  - ***Cost to move "inputs".***
  - Cost to move "outputs".
  - Trans.Costs directly borne by "seller" on site.
  - Trans.Costs indirectly borne by "buyers" on site.
  - Value of travelers ***time*** (& inconvenience) spent traveling to/from site.
- e.g., Site 1 minimized transport costs for factory, Site 2 minimized transport costs for grocery store (considering customers travel costs).

Equilibrium in a well-functioning land market

➔ *Minimization of aggregate transport costs*

➔ **Maximization of aggregate land value.**

The *"Bid-Rent Curve"* (or Bid-Rent Function)

- "Bid-Rent" = Maximum land rent a potential user would be willing to pay for a given site (location). (Equals residual value.)
- "Bid-Rent Curve" shows how a potential user's bid-rent changes as a function of distance from some ***central point***.
- The "central point" is the point at which transport costs are minimized (bid-rent maximized) for the given use.
- Each potential use has its own bid-rent curve (and central point).

e.g., clothing factory example:

- Central point = highway entrance.
- Site 1 is located at 1 mile distance from highway entrance.
- Site 2 is located at 4 miles distance from highway entrance.

Clothing factory bid-rent function:

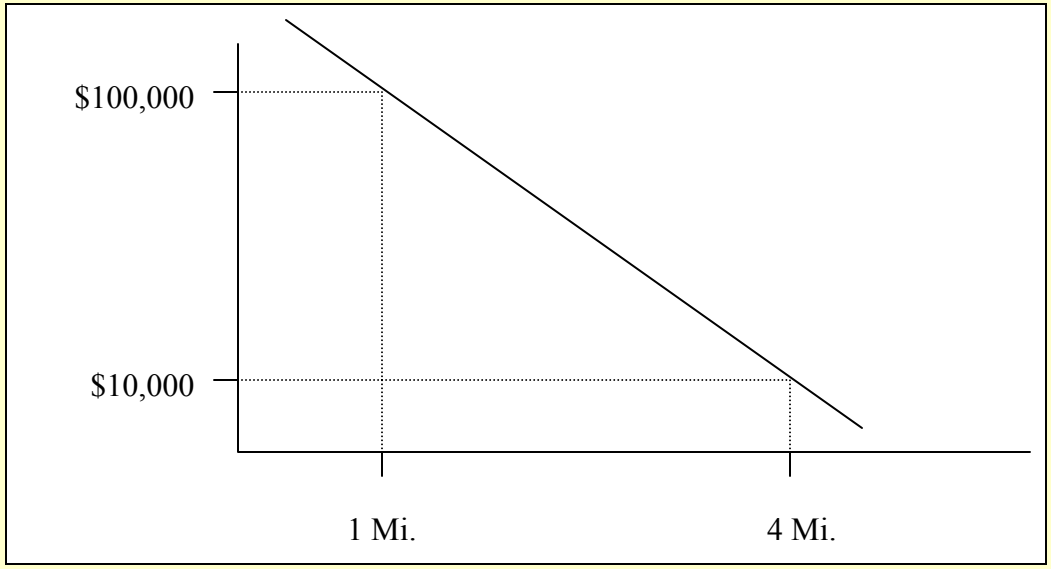
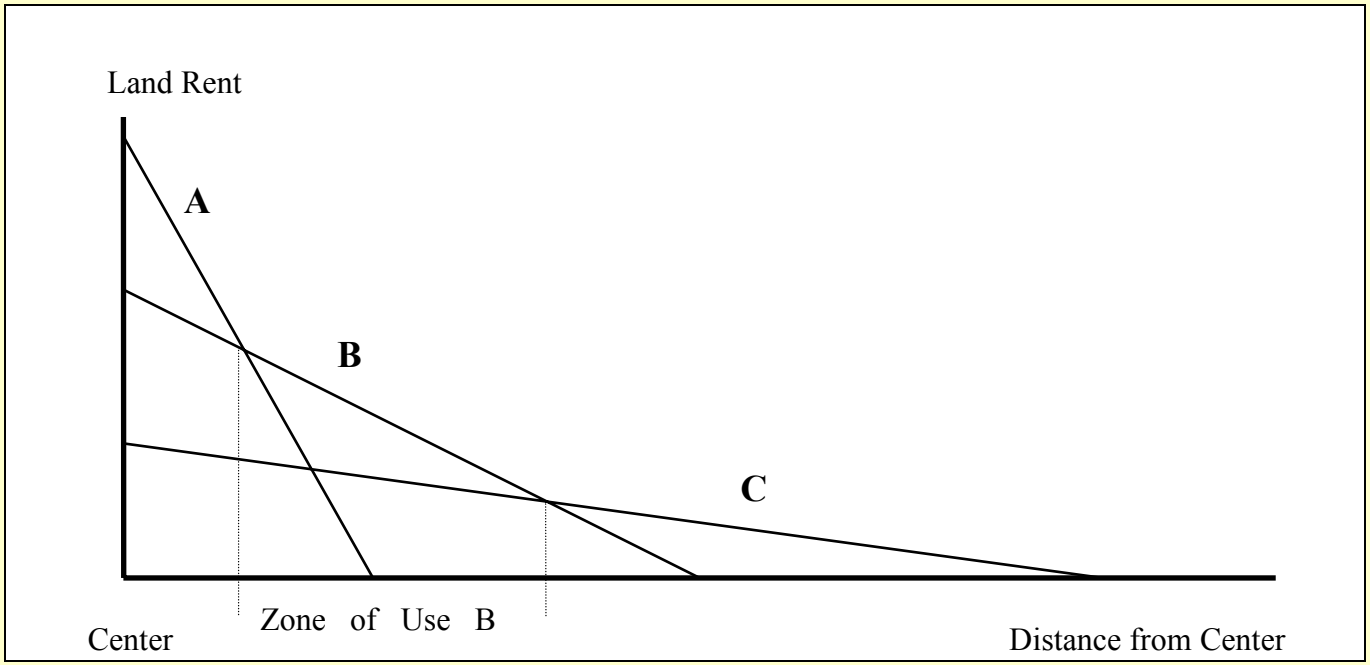


Exhibit 4-2: Bid-Rent Functions of Three Land Uses With Differing Productivity & Sensitivity to Transport Cost (and *same central point*).



Use A: Most productive use, Most sensitive to transport costs.

Use C: Least productive use, Least sensitive to transport costs.

Each use prevails where its bid-rent curve is highest.

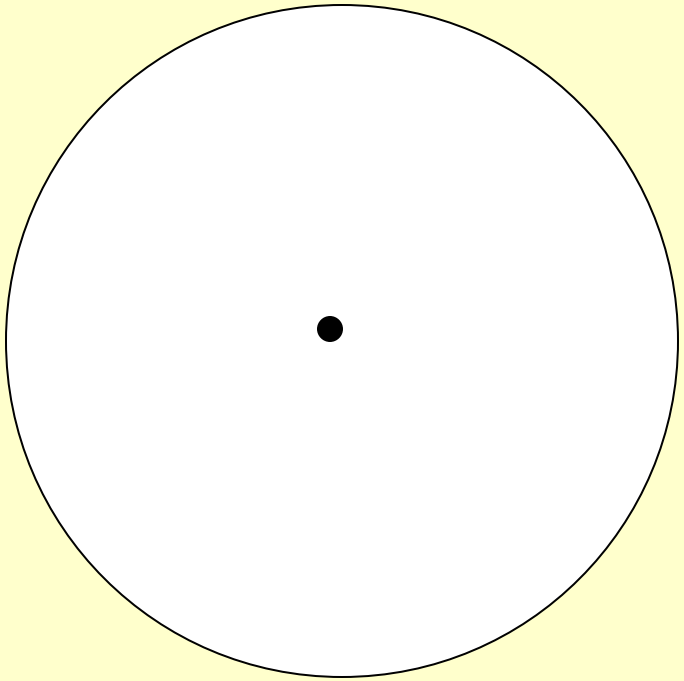
4.2 Classic Monocentric City Model

Combines previous principles of land use and value to represent determinants of "*urban form"* (city size & shape).

A very simple city:

- ***One central point (everyone must commute to it)***
- One land use (housing)
- “Featureless Plain” (same in all directions)

Result: City is a perfect circle:



"Circlopolis"

Simplicity in the model enables it to reveal key *insights* about the determination of urban form, the physical spatial characteristics of cities…

Circlopolis…

- All households must commute to the central point (CBD) every day to earn the income they need to pay for housing, transportation, and all other consumption goods that make them healthy and happy citizens of Circlopolis.
- Transportation costs are proportional to the distance the good citizens must travel.
- Circlopolis has *constant density* at any given time within the city.

Circlopolis has:

- ***Population = 1,000,000.***
- Density = 2 persons/acre = 1280 hab/Mi^2

What is the physical size (area in Mi^2) of Circlopolis?…

- ***Area = 1,000,000 / 1280 = 781 Mi^2***

What is the physical extent (radius in Mi) of Circlopolis?…

- ***Radius = SQRT(A/pi) = SQRT(781/3.14) = 16 Mi.***

What is the annual property rent at the edge of the city (16 mi from the CBD)?…

Circlopolis…

- Property rent at edge of city (16 mi from CBD)…
- Suppose you're a housing developer building houses for rent at the edge of Circlopolis. What rent will you charge?…

Circlopolis…

– *First:* ***You have to rent the land from the farmers who own it. In effect, to convert land from farming to urban (residential) use, you first have to pay the farmers the amount of net profit (residual) the land could otherwise earn for the farmer in agricultural use each year. This is the agricultural (or non-urban use) opportunity value of the land. For Circlopolis this is*** *$500/Yr/Acre*.

Circlopolis…

- *Second:* ***You have to finance the construction cost of building houses on the land. Suppose it costs $50,000 to build each house*** **(including necessary profit for the developer),** ***and you can take out a mortgage to cover this cost. The mortgage has monthly payments of $416.67, or $5,000/Yr/House. You can build*** *two houses per acre*. ***So the rent required*** **per acre** ***to cover the housing construction (& development) cost is*** *$10,000/Yr/Acre*. ***This is called the*** **construction cost rent.**

Circlopolis…

Thus, you must charge a rent of at least $5,250 per house, or a rent per acre of at least **$10,500/Yr/Acre**, in order to break even. So **property rent** at the edge of Circlopolis must be *at least $10,500/Yr/Acre*.

Circlopolis…

Suppose you tried to charge a higher rent than that?…

[Hint: the $50,000 housing construction cost already includes sufficient profit for housing developers.]

Circlopolis…

- Housing rent at locations *inside* the city (closer than 16 mi to the CBD)…
- Houses inside the city, closer to the center, will be able to command a higher rent in equilibrium than those at the edge of the city (other things being equal).

Why?…

- The closer a house is to the city center, the less the residents will have to spend on transportation costs, and therefore the more money they will have left over to pay for housing and other consumption.

- Suppose they used some of this transport cost savings to buy other consumption goods besides housing.
- Then the people living closer to the center would be better off than the people living farther from the center (because they would have the same housing, plus more other things).

- This would cause demand for more centrally-located houses to be greater than the demand for more peripheral houses. The price of centrally-located houses would get bid up, and the price of peripheral houses would fall. This would happen until all people living in any location (central or peripheral) are equally satisfied, in other words, until everybody has the same amount of housing and the same amount of other consumption goods. This will occur only when ***housing rent increases at exactly the rate that transportation costs fall, as you move closer to the center of the city*****.**

Basic Equilibrium Land Rent Condition:

- *The sum of annual housing rent + annual commuting cost must be the same for all residents, no matter where they live in Circlopolis.*

Therefore:

- The ***slope*** of the bid-rent curve for housing in Circlopolis ***equals the transportation cost per mile per acre***. This slope is called the ***"rent gradient"***. It tells you how much land rents decline per mile of additional distance from the city center, in equilibrium.
- ***The land rent gradient equals the transportation cost per mile per person times the number of people per acre.***

In Circlopolis:

- ***Transport costs = $250/Yr/person (round-trip commuting costs).***
- One person lives in each house (*a city of loners!*).
- Density is 2 houses (2 inhabitants) per acre (1280/Mi^2).

What is Circlopolis' land rent gradient (in $/acre)?…

Land Rent Gradient =

(2 hab/acre)*($250/Mi) = $500/acre/Mi.

What will be the annual rent for a house located 1 Mi. in from the urban boundary?…

House Rent @ 15 Mi = Rent at edge (16 mi) + $250 = $5,500/Yr.

What will be the property rent ($/acre) 1 mi in from the edge?…

Property Rent @ 15 Mi = $10,500 + Gradient*(Dist from edge) = $10,500 + $500*1 mi = $11,000/Yr/Acre.

What will be the property rent in the center of the city?…

Property Rent @ Ctr = $10,500 +
($500/Mi)(16 Mi) = $18,500/Yr/Acre.

The concept of ***Location Rent***…

- The property rent in the center of Circlopolis is **$18,500/Yr/Acre**. This consists of *three components*:
  - Non-urban use opportunity cost rent:
    - $ 500/Yr/Acre
  - Construction cost rent:
    - $10,000/Yr/Acre
  - Location Rent:
    - $ 8,000/Yr/Acre
- Total Property Rent Center: $18,500/Yr/Acre

Non-urban opportunity cost & construction cost rent is the same everywhere in the city.

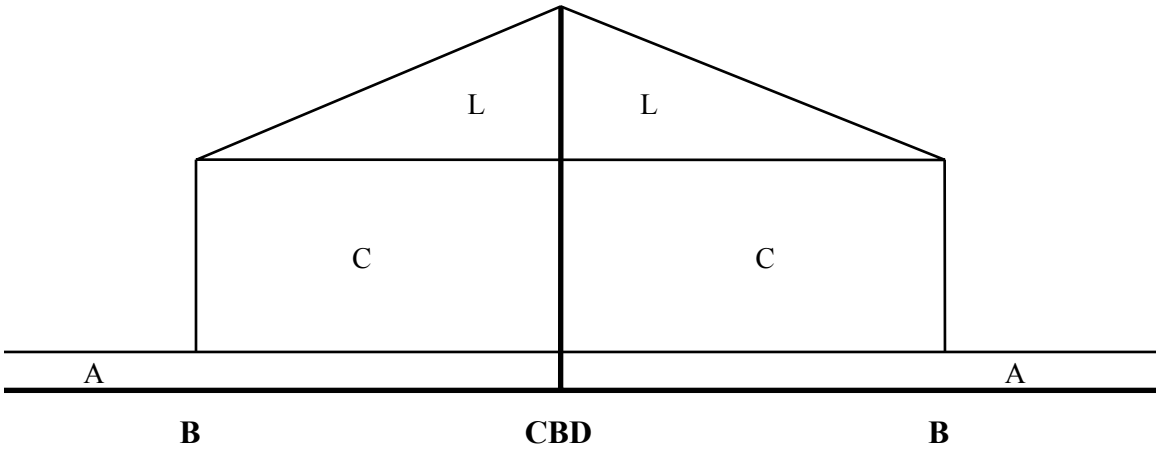
Location rent is a function of where the land is located:

- *Location Rent = (Rent Gradient)(Dist from Edge)*
- *Everyone in Circlopolis pays $9,250/Yr for the **sum** of housing cost plus commuting cost. (Otherwise, what?…)*

(The city's land rents are not in long-run equilibrium.)

Land Rents in Circlopolis…

Exhibit 4-3: A Cross-Section of Land Rents in Circlopolis and Agricolia . . .



A = Agricultural Rent = $500/ac
C = Construction Rent = $10000/ac
L = Location Rent = from $0 to $8000/ac
CBD = Circlopolis Central Business District
B = Circlopolis Urban Boudnary (16 mi radius)

What is the property rent (per acre) four miles from the urban boundary, 12 miles from the CBD?…

$500 + $10000 + (4 mi)*($500/mi) = $12500

(or $12500 / 2 = $6250 / person)

What are the transportation commuting costs for residents at this distance from the center?…

$250/mi/person * 12 mi = $3000

What is the sum of these two costs, per person?…

$6250 hsg + $3000 trans = $9250 total

What if the people had a "French culture" ("Circleville"): They don't want to spend that much on housing and commuting?…

[Hint: What do you know about the density of French vs. American cities?…]

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[Hint: What do you know about the density of French vs. American cities?…]

- Suppose 3 inhab/acre
- $4000/mo houses (smaller)

	U.S.	France
Periph	16mi, $10500	
Ctr	$500/mi, $18500	

What if the people had a "French culture" ("Circleville"): They don't want to spend that much on housing and commuting?…

[Hint: What do you know about the density of French vs. American cities?…]

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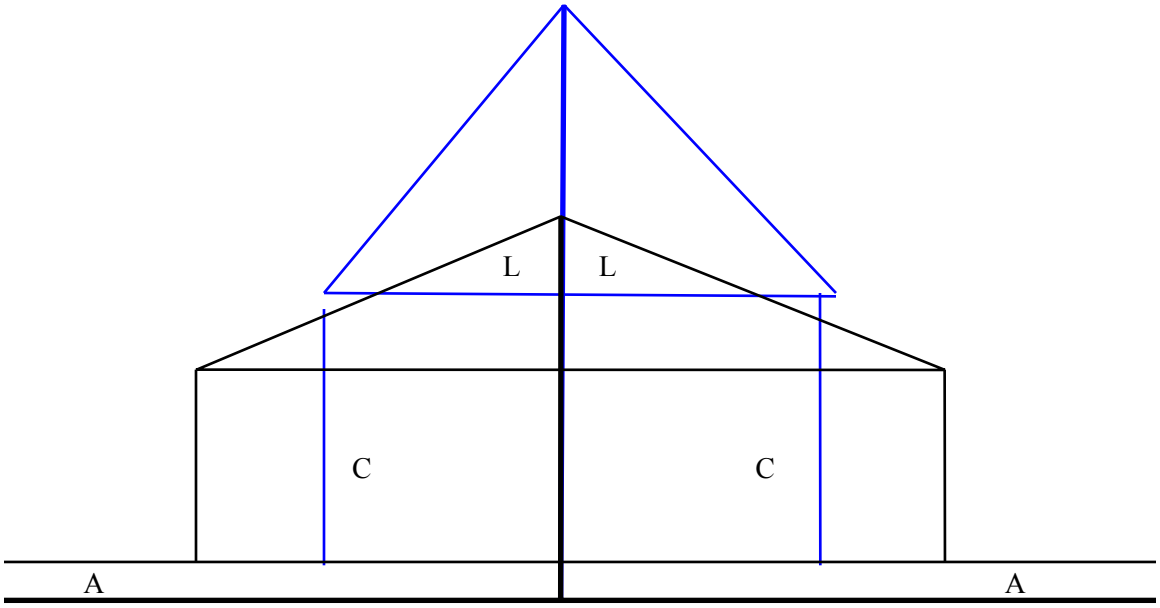


CBD

4.2.2 Using the simple monocentric city model…

The monocentric city model greatly simplifies the complexities of real world cities. This simplification enables the model to reveal some basic insights about urban form. E.g., relationships between:

Variables relevant to real estate opportunities:

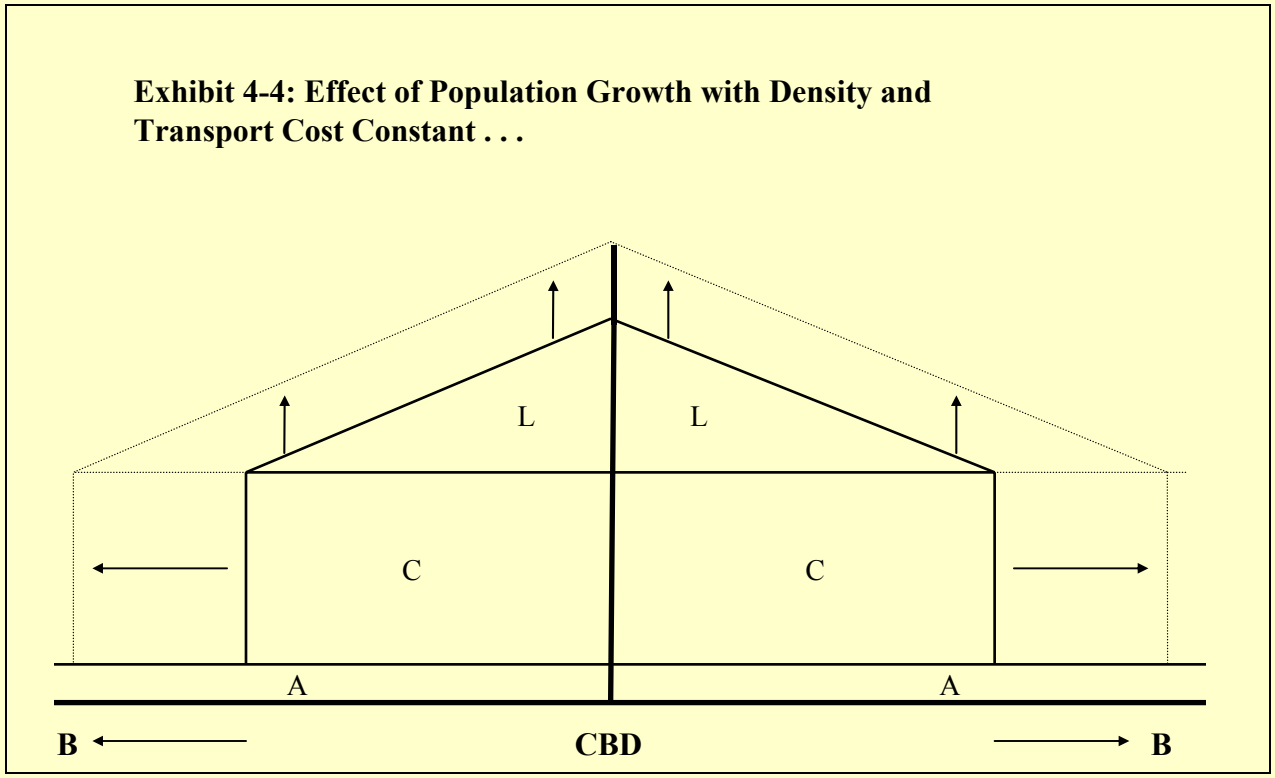
- *City size*
- *Pattern of location value within the city*
- *Trend in real rents over time for a given location*

And economic causal forces:

- *Population change*
- *Income change*
- *Transport cost change (infra-structure, technology)*

1. The pure effect of Population Growth with Constant Density…

(holding all else constant, including per capita income, & transport costs per mile.)



The pure effect of Population Growth with Constant Density…

- ***Rent at periphery ($10,500/Yr/Acre) must be same as before (for same reasons)***
- ***Gradient ($500/Acre/Mi) must be same as before (for same reasons).***
- ***Hence…***

Principle 1:
"Other things equal, larger cities will have higher average rents."
e.g., housing costs in NYC, LA, Chi, SF,…

Note: We have assumed constant income per capita.

Is difference in per capita income the only (or the necessary) reason for housing prices to be higher in NYC, LA, Chi, SF than in Cincinnati?…

1999 prices for a typical (same) house: 2200 SF, 4BR/2B, 2-car Garage…

City	Price	Index
Houston, TX	$115,000	50
Pittsburgh, PA	$163,000	70
Dallas, TX	$180,000	78
Atlanta, GA	$200,000	87
Cleveland, OH	$201,000	87
Cincinnati	$231,000	100
Chicago, IL (Schaumburg)	$300,000	130
New York, NY (Westchstr)	$353,000	153
Chicago, IL (Lincoln Pk)	$409,000	177
Boston, MA	**$421,000**	**182**
Los Angeles, CA (Hollywd)	$530,000	229
San Francisco, CA (city)	$720,000	311
New York, NY (Manhattan)	$1,144,000	495
Source: Caldwell-Banker		

New York is 10-times Houston…
Boston is almost 3-times Pittsburgh:

"Location, location, location…"

1999 prices for a typical (same) house:

New York is <u>10-times</u> Houston…

Boston is almost <u>3-times</u> Pittsburgh:

"Location, location, location…"

So, what is the direct or fundamental cause of the higher land rents (& higher housing costs) due to population increase in Circlopolis?…

- ***Is it an increase in per capita income?…***

- ***Is it the increase in population per se?…***

The direct or fundamental cause of the higher land rents

It's actually the increase in the radius. (The rent at the edge is fixed by the agricultural opportunity cost of the land and the construction cost of the houses. The gradient is fixed by the density and the per capita transport costs per mile. The location rent equals the gradient times the distance from the edge of the city.)

Holding population & density constant, the radius is inversely related to the fraction of the 360^{o} arc the city can use for residential development.)

What causes cities to not be able to use an entire 360^{o} arc for growth?…

Coastlines, Water bodies, Mountains, Political constraints,…

(e.g., NYC, LA, Chi, SF, …, Cinci/Nky?…)

An important implication of Principle 1. . .

Suppose per capita incomes were the same in large & small cities.

Then inhabitants of large cities would be worse off than inhabitants of small cities (same income, but less $ left over after paying housing & commuting costs).

Over time (in an integrated system of cities), people would migrate from larger to smaller cities.

Therefore, in long-run equilibrium across cities (i.e., in the system of cities), average per capita incomes must by higher in larger cities.

➔ *Continued*

Inhabitants of larger cities must be more productive (on average) than those of smaller cities. (Larger cities must attract and retain the most productive people.)

In fact, in the US, the largest cities do have higher per capita incomes.

Thus, although higher per capita income is not the only or proximate cause of higher housing costs in larger cities, higher incomes are a long-run result of higher housing costs in larger cities. (And they may also be part of the cause.)

Suppose Circlopolis' population increases by 10%, holding density constant.

Then Area must increase by 10%.

Thus, the radius must increase by approximately 5%:

$$r = \sqrt{A/\pi} \quad \rightarrow \quad \sqrt{1.10} - 1 = 1.049 - 1 = 4.9\%$$

New urban boundary is at 16.8 Mi instead of 16 Mi.

Location rent increases by $400/Yr/Acre at all points on and inside the previous 16-mile radius. ($400 = ($500/Mi)(0.8 Mi).)

This is a 3.8% increase at the old periphery:

$10,900 / $10,500 - 1 = 3.8%.

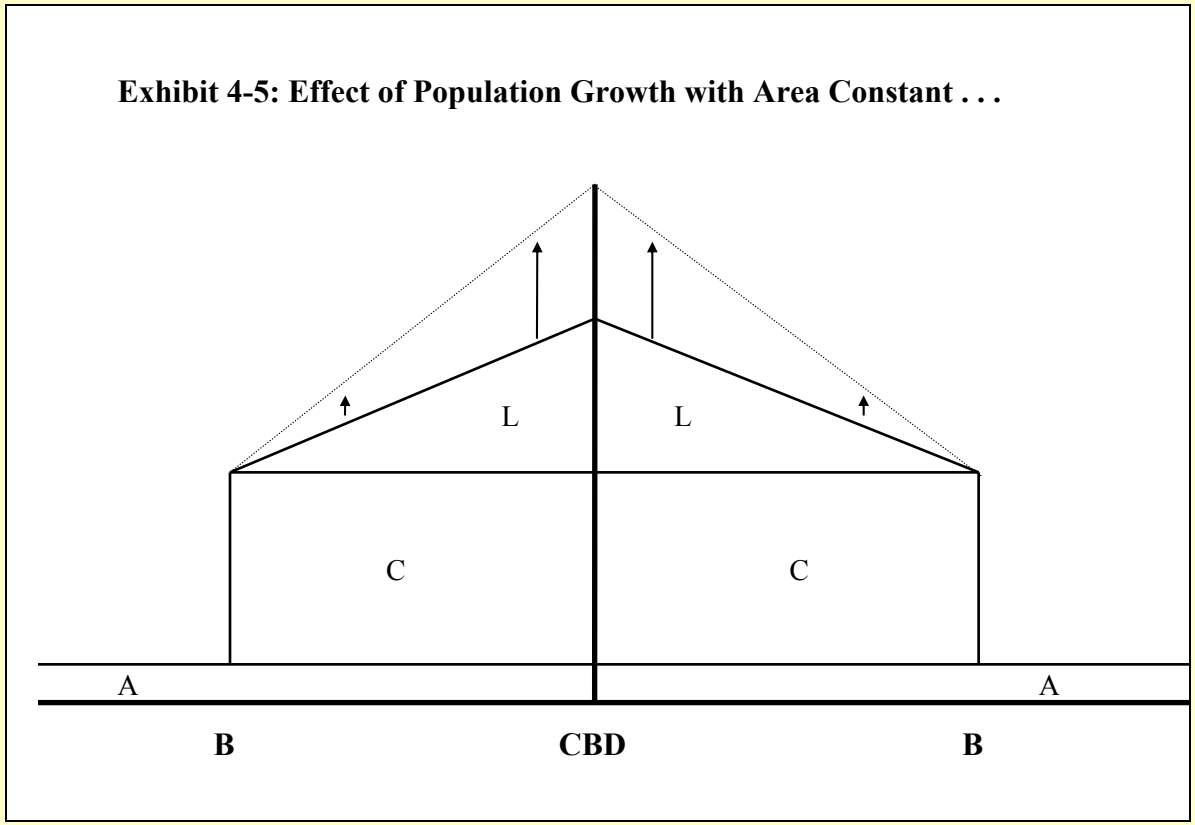
But only a 2.2% increase in the center of the city:

$18,900 / $18,500 - 1 = 2.2%.

Land rents grow faster in peripheral locations, near expanding boundary.

2. The Pure Effect of Population Growth with Constant Area…

(holding all else constant, including per capita income, & transport costs per mile.)



Density must increase.

➔ *Transport cost per acre increases.*

➔ *Land Rent Gradient increases.*

Land rent at boundary remains the same (for same reasons).

➔ *Land rent increases everywhere, but proportionately more in center.*

Principle 2:

"If a city grows by increasing area rather than density, property rent growth will be relatively greater closer to the periphery, but if a city grows by increasing density instead of area, property rent growth will be relatively greater the closer to the center of the city.“

What would cause pop growth without commensurate area growth?…

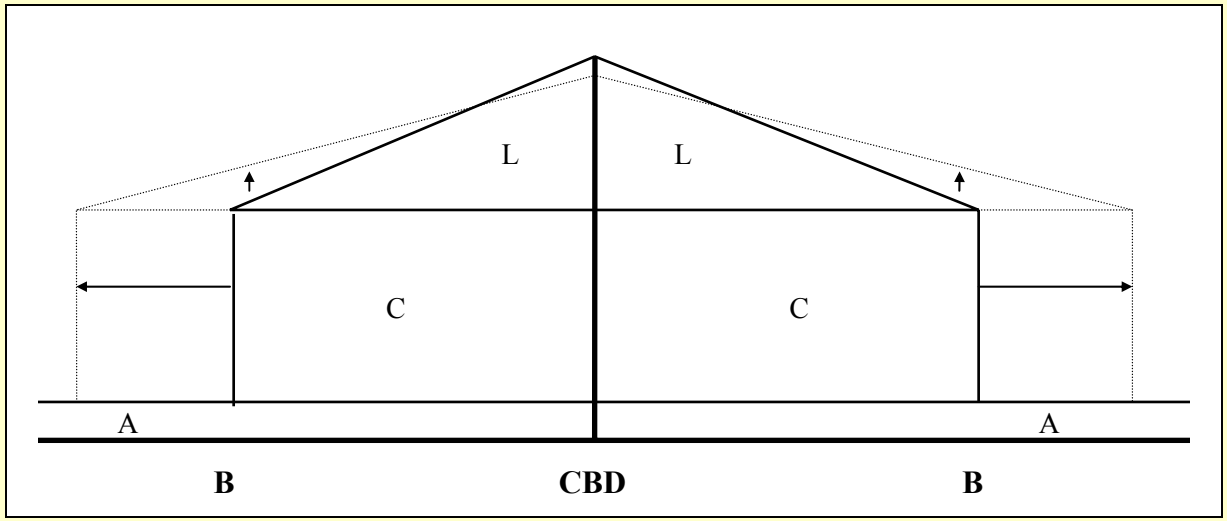
3. The Pure Effect of Transport Cost Reduction…

(Per person-mile, holding all else constant, including population, & income per capita.)

e.g., From improvements in transport infrastructure & technology. This includes:

- Increased comfort while traveling (e.g., air conditioning, sound-systems)
- Increased productivity while traveling (e.g., cell-phones, computers in cars)
- Increased ability to transmit information electronically (e.g., the internet)

Exhibit 4-6: Effect of Transport Cost Reduction Savings Applied to Greater Purchase of Land . .



Effect of Transport Cost Reduction Savings Applied to Greater Purchase of Land

Usually (at least in the U.S.), people use some of their increased consumption purchasing power (which results from transport cost reduction) to consume more urban land (reduce density).

This results in an increase in land rents near the periphery, and a decrease in land rents near the center of the city.

Relation of Central Land Rent to Density & Transport Cost…

Location Rent @ Center = (Rent Gradient)(Radius)

Rent Gradient = (Transport Cost Per Capita)(Density)

Radius = $\sqrt{Area / \pi} = \sqrt{Population /(Density\ \pi)}$

Therefore:

Location Rent @ Center = TD $\sqrt{P/(D\pi)} = \sqrt{P/\pi}\,T\sqrt{D}$

Where: ***T = Transport Cost Per Capita Per Year***

D = Density (Pop/Mi^2)

P = Population of the city

Relation of Central Land Rent to Density & Transport Cost…

Thus, in the absence of a population increase, a reduction in density leads to a reduction in the central location rent, as does a reduction in transport costs. Both of these two effects together magnify the reduction in central location rent.

In general, transport cost reductions reduce the value of centrality of location within the city.

Principle 3:

"Declining transport costs (per person, per mile or per year) holding population & income constant, will always reduce the absolute value of land rent in the center of the city, and always increase the relative value of land rent near the periphery of the metro area; the effect on the absolute land rent near the periphery is generally ambiguous, depending on changes in density."

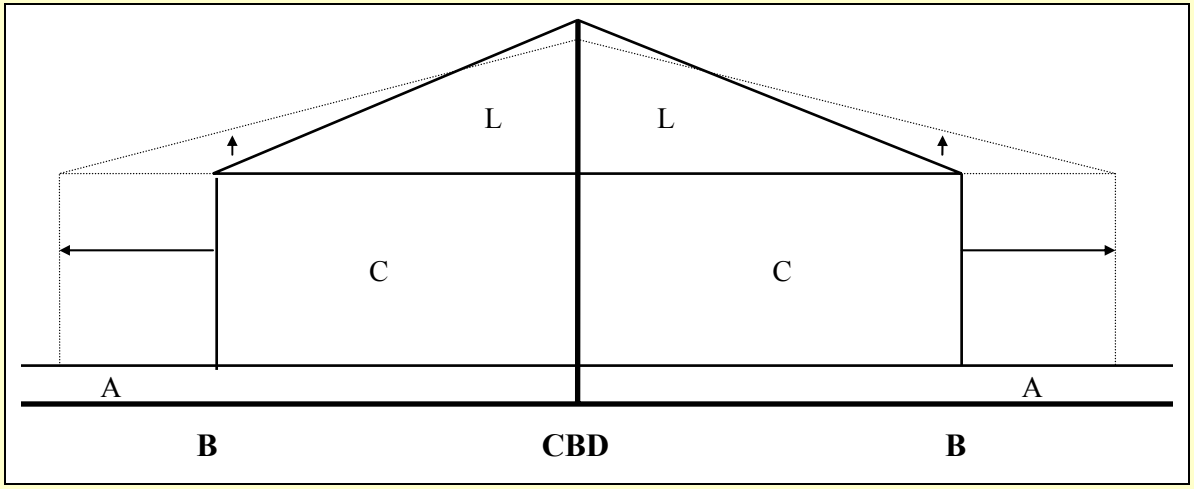
4. The Effect of Growth in Per Capita Income…

(Holding population constant.)

Income growth typically has two effects on urban form:

- *People choose to spend some of their extra income consuming more urban land (larger houses, larger yards, more houses per capita, more parks & golf courses), thereby decreasing density: ➔ Reduction in rent gradient.*
- *People have higher value of time, thereby increasing transport cost: ➔ Increase in rent gradient.*

Effect on land rent in the city is ambiguous, but in most U.S. cities tends to be like the effect of transport cost reduction:



Principle 4:

"Increasing real income per capita (holding population constant), will tend to decrease rent gradients, with a possible result of absolute reductions in land rent at the center of the city, though a secondary transport cost increase effect of higher incomes may mitigate this result or even reverse it, especially if the spatial expansion of the city is constrained.“

Chapter 4 Summary:

Will commercial property rents grow over time in a growing city?…

Will single-family home land values grow over time in a city that is not growing in population?…

Do you see how simplifying the world (e.g., through the "monocentric city model") can bring practical insights?…

Chapter 4 Learning Objectives…

- *What determines land rents in a city.*
- *Why and how a freely functioning, competitive land market will lead to land being used at its "highest and best use" (i.e., most productive use).*
- *What determines how big spatially or how dense a city is.*
- *What determines the relative land values at different locations within a city, and the relative growth rate of these values at different locations.*
- *Why different land uses and densities occur at different locations within a city.*