Perspectives on Land Use, Residual Value, Transportation Costs and Site Value, and Option Value

Transportation costs and access dominate land use patterns, no matter what kind of transport we use.

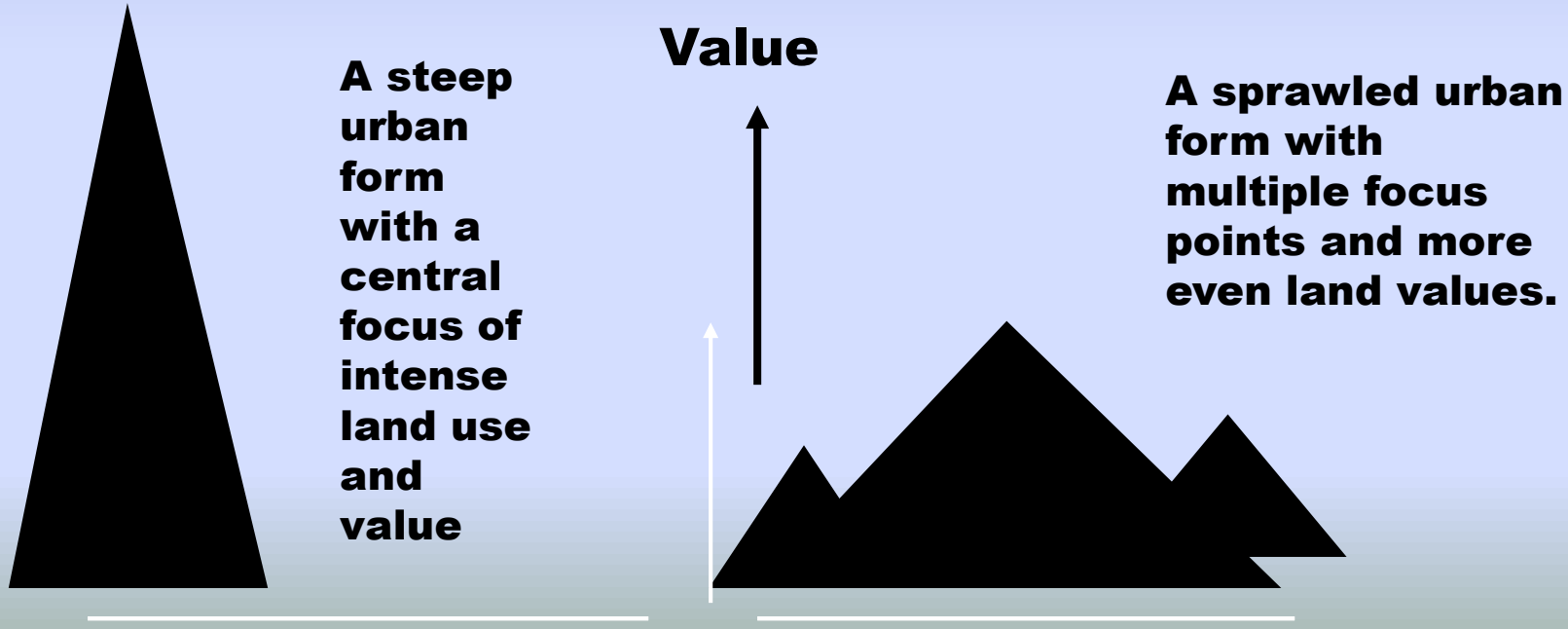
Topics We Will Cover

- How transportation costs and productivity affect land values in a city
- Why and how a freely functional competitive land market will lead to land being used at its “highest and best use”
- The impact of population growth, transport nodes and regulation on land values and density
- Some illustrations of how poor city planning distorts land use patterns.
- The notion of option values in land

Urban Form

Physical spatial characteristics of a city when market driven based on

- **Size**
- **Population density**
- **Density variation in different parts**
- **Patterns of locations of different land use**



Residual Nature of Land Value

- Four basic "factors" of production
- Labor, capital and raw materials are Mobile factors
- Land is not "mobile"
  - Residual Claim: Whatever is left over, after the mobile factors have been paid for, will be available for land in form of rent

- Example:

Clothing Factory

Gross Sales Revenue = $10,000,000

Mobile Factor Costs:

- **Raw materials = $ 4,000,000 including normal profit**
- **Labor cost = $ 5,000,000 including normal profit**
- **Capital costs = $ 900,000 incl. normal profit/ fees**
- **Residual = $ 100,000 (Available to pay rent for land)**

Land gets only the residual, but it also gets all of the residual after mobile factors have been paid for, thus if:

Assume Sales Revenue increased to $11m, and other input costs remained same, then the land could eventually claim $1,100,000 per year, subject to lease renewals and market competition.

The landowner can benefit from this only in the "long-run" as more productive users out bid others for the land by conversion to a "higher and better use", maybe an office or apartments? What happens when there are more productive uses?

What is the value of the land leased to the clothing factory?

- If the current rent is $100,000 and there is a long term fixed lease then the lease will constrain the value. (note this may be inconsistent with property tax assessors view)
- Value based on current use = $100,000/R
- Where R is the long term yield required, say 10% then
- Land is worth $1,000,000 based on the lease.
- But what would you pay for this land?

The Impact on Residential Land Prices when home prices change

- **The value of land is a derivative of home prices.**

	2025	2026
Average Home Sales Price	$500,000	$400,000
Less Cost to Build	$250,000	$250,000
Less 20% Required Profit on Building Costs	$50,000	$50,000
Land Value (Residual)	$200,000	$100,000

- Note a 20% reduction in home price in this example results in a 50% reduction in land value. A 20% increase in home price results in a 50% increase in land value in this simple model.
- What would the value of the land be in 2026 if the average sales price for the same home as above is $600,000? _____?

The Impact on Residential Land Prices One More Time: Here we add other costs.

- The actual relationship between home price and land value will vary from project to project, based on a variety of assumptions.
- Base Case: Results in 12% profit

	Base Case
Home Prices	
Plan 1 (45 units)	305,000
Plan 2 (45 units)	320,000
Plan 3 (45 units)	335,000
Total Revenue	44,258,400
Costs	
Land Value at Sale	6,600,000
Other Costs	32,303,314
Total Costs	38,903,314
Total Profit	5,355,086
Profit	12%

What would you pay for the land if the market rent will be $1,100,000 once the lease expires?

- Depends on when the lease expires
- Depends on the cost to tear down (demolish) the clothing factory or convert to new uses
- Depends on other regulations and entitlement costs that must be “priced” into the formula, but perhaps as much as $10 million?
- So the land may be worth close to $10 million today with $1 million current use value and $9 million as option value based on a higher and better use.

The Impact on Residential Land Prices

- The actual relationship between home price and land value will vary from project to project, based on a variety of assumptions.
- Base Case: Results in 12% profit
- So a 20% reduction in home prices results in 14% loss

	Base Case	20% Price Reduction
Home Prices		
Plan 1 (45 units)	305,000	244,000
Plan 2 (45 units)	320,000	256,000
Plan 3 (45 units)	335,000	268,000
Total Revenue	44,258,400	35,514,720
Costs		
Land Value at Sale	6,600,000	6,600,000
Other Costs	32,303,314	33,906,950
Total Costs	38,903,314	40,506,950
Total Profit	5,355,086	(4,992,230)
Profit	12%	-14%

20% Reduction In Home Prices

The Impact on Residential Land Prices

- The actual relationship between home price and land value will vary from project to project, based on a variety of assumptions.
- Base Case: Results in 12% profit
- 20% reduction in home prices results in -14% loss
- 20% reduction in home prices demands a reduction in land value of 87% to meet original profit requirements

	Base Case	20% Price Reduction	20% Price Reduction
Home Prices			
Plan 1 (45 units)	305,000	244,000	244,000
Plan 2 (45 units)	320,000	256,000	256,000
Plan 3 (45 units)	335,000	268,000	268,000
Total Revenue	44,258,400	35,514,720	35,514,720
Costs			
Land Value at Sale	6,600,000	6,600,000	840,722
Other Costs	32,303,314	33,906,950	30,376,717
Total Costs	38,903,314	40,506,950	31,217,439
Total Profit	5,355,086	(4,992,230)	4,297,281
Profit	12%	-14%	12%

87% Reduction In Land Price

How do seller’s anchor values?

If prices are sticky it takes a while for prices to drop. Some sellers can be stubborn or use non-market based thinking, e.g. “this is what I paid so…”

Any time there are more productive uses we will see option value included in total land value:

- Land value = current use value + option value from the marginal increase in productivity from a higher and better use.

- How do transport costs affect land values?

What are transportation costs?

- Transport costs are function of:
  - Mode (walk, bike, bus, subway)
  - Energy costs for fuel (unless subsidized)
  - Maintenance and Capital Costs
  - Time Costs: Opportunity costs (e.g. lost income or time spent with family and friends or recreation time.

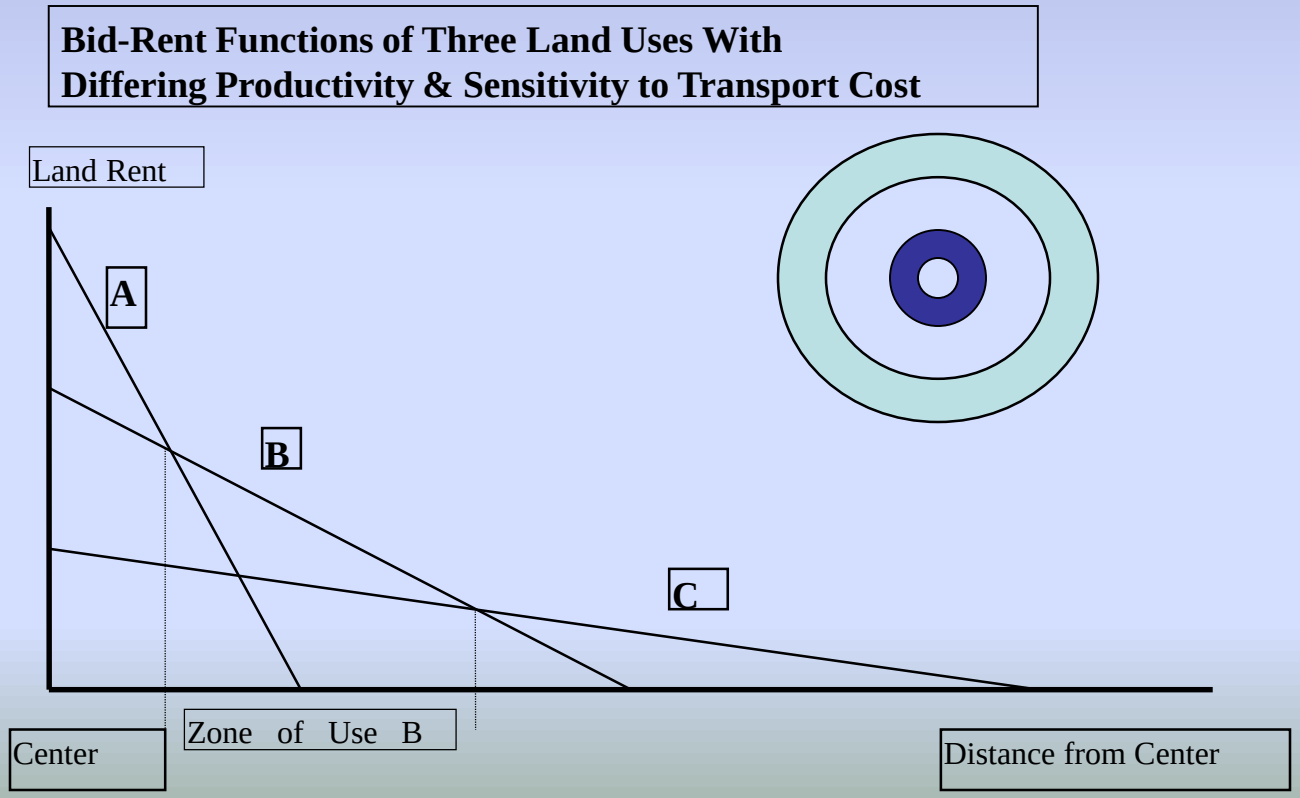
Transportation Costs

- Transport costs are part of “mobile” costs, hence lower transport cost = higher land value

- When the highest and best site user of land wins by bidding for the site the aggregate transportation costs are minimized for the market as whole resulting in the land use values and densities as follows.

The “Bid-Rent” Curve When the Highest Bidders Win the Site

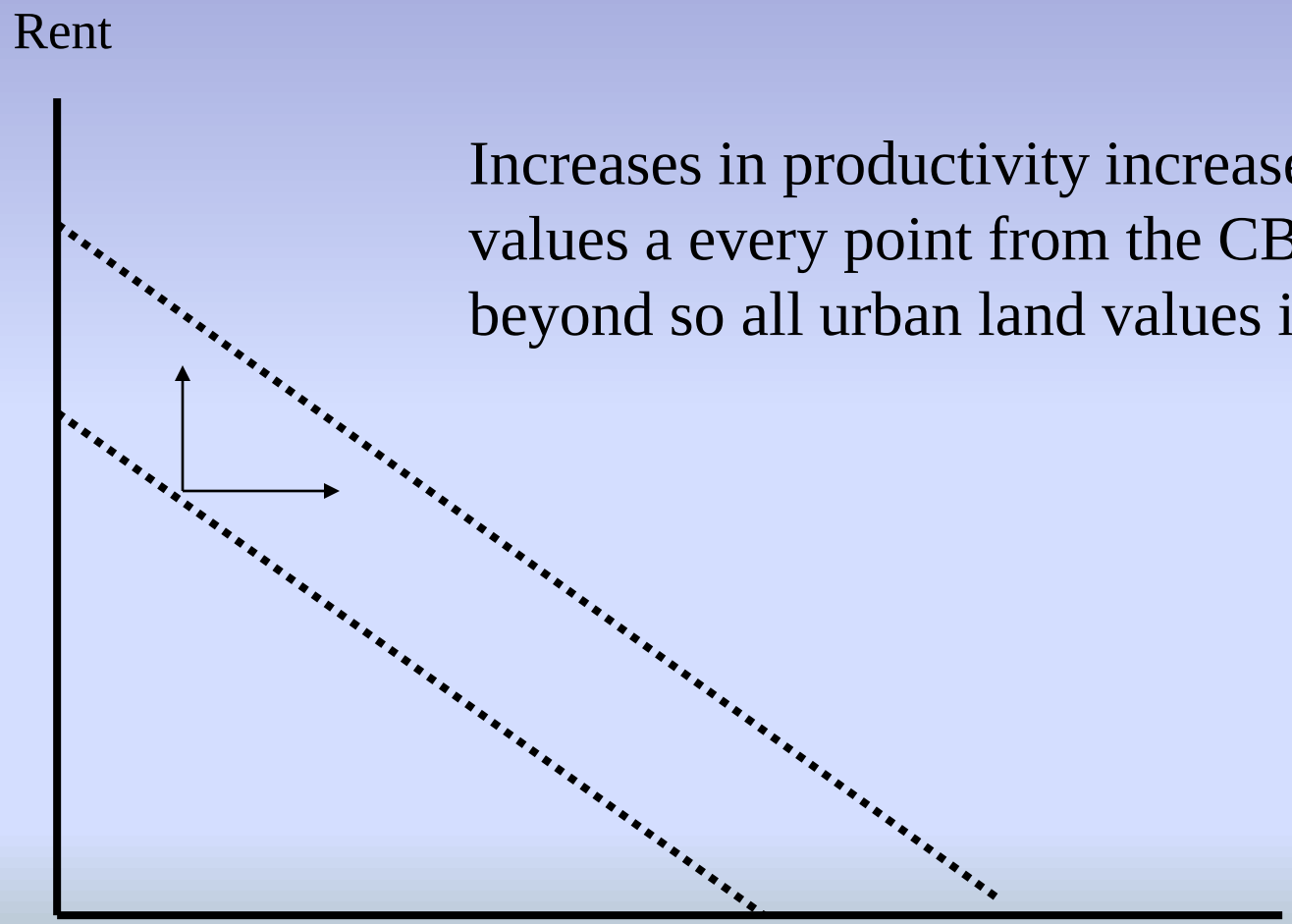
- **The “bid-rent” is the maximum rent that a potential user would be willing to pay for a site or location**
- **Central point concept**
- **The view from above appears as an archery target patterned “monocentric city”**



We can quantify a bid rent curve

- Rent = Productivity(d)–TC(d)
- Productivity might be sales (cost of goods and fixed costs) and it will change with location, d.
- TC = transport costs for the market or clients of this service times d for distance from a central density point of the market.

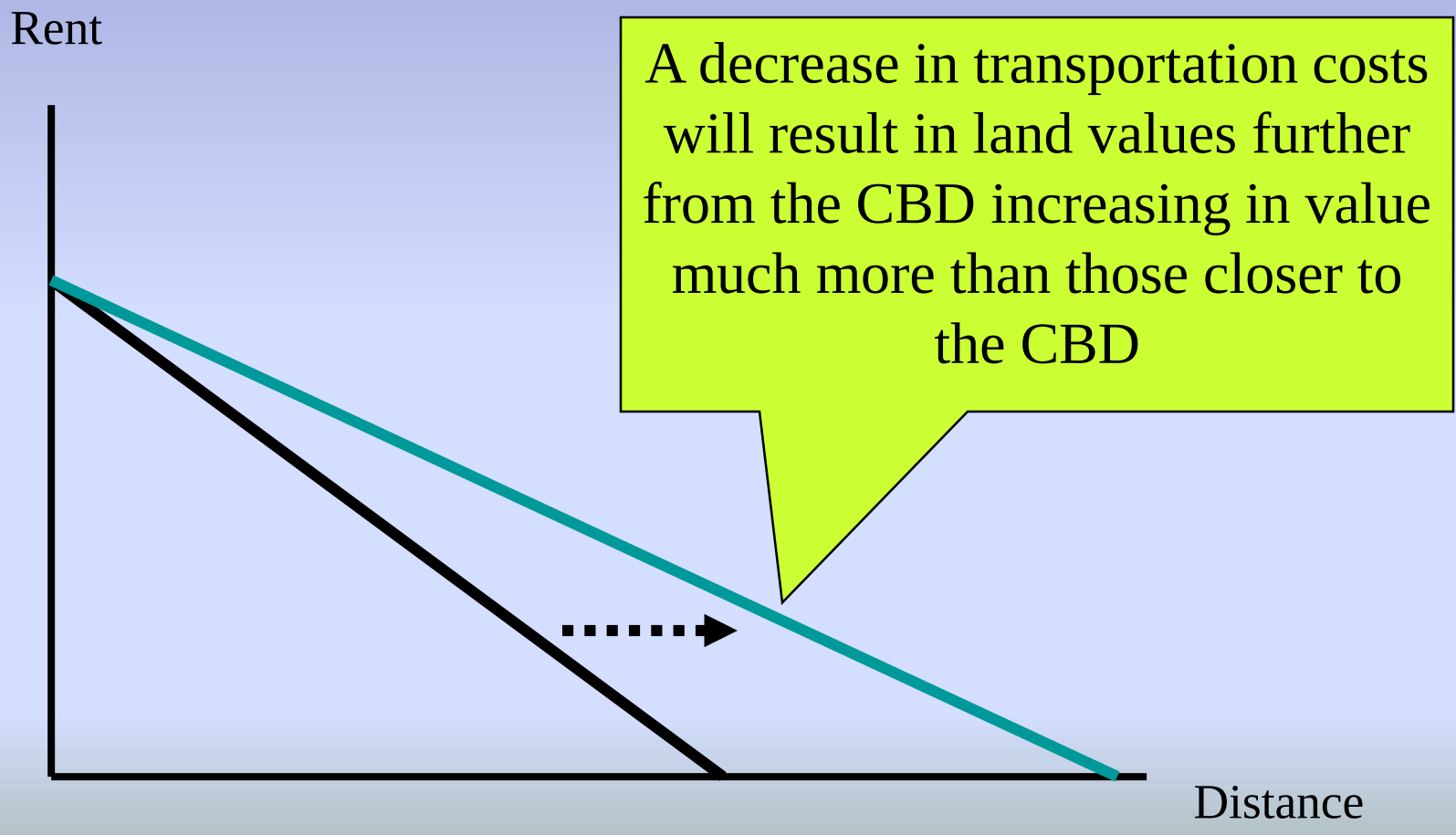
Changes in Productivity Influence Value Across Space Equally



Increases in productivity increase land values a every point from the CBD and beyond so all urban land values increase

CBD or Central Business District

Changes in Transportation Costs Influence Value More as Distance Increases



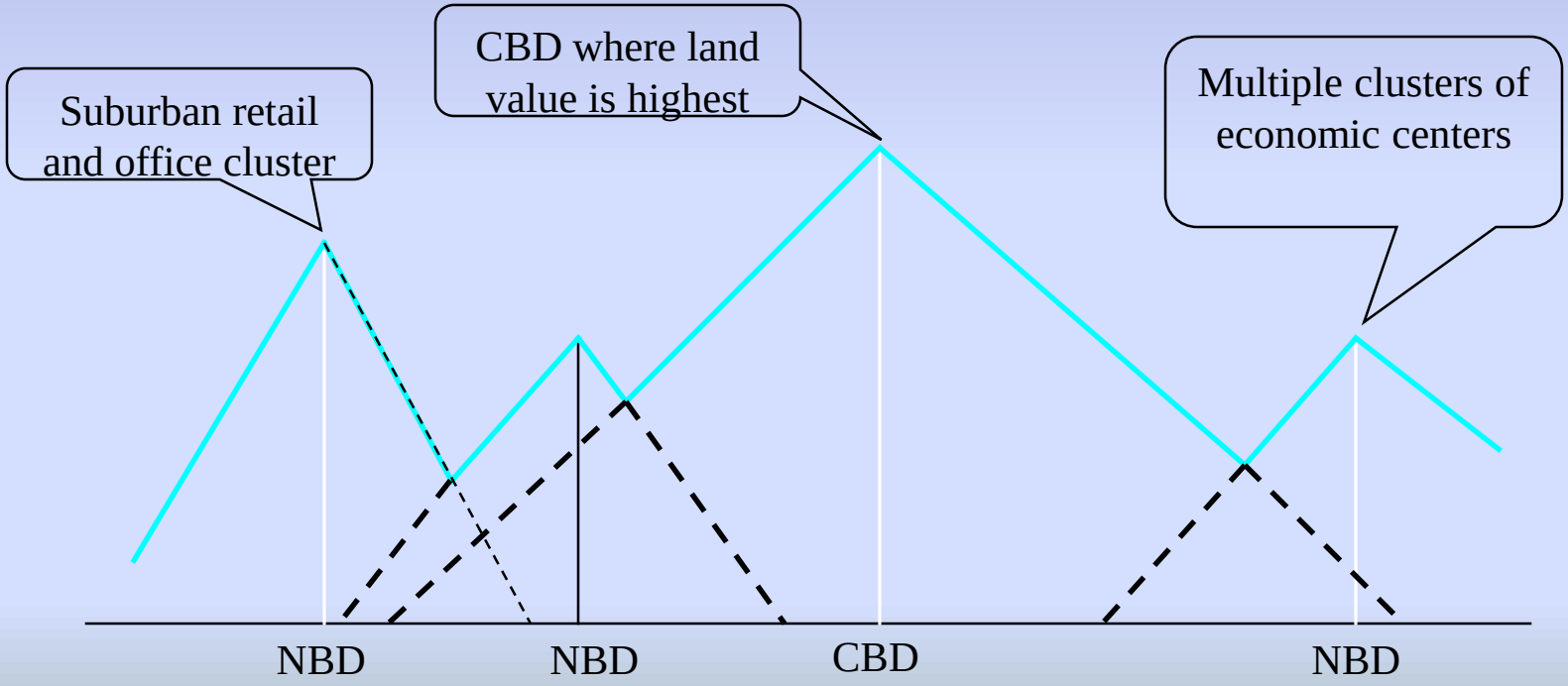
What would the land value pattern look like if transportation costs were zero or ignored by the market or planners?

City Center

Suburbs

What about many city centers? Polycentric or Multiple Nuclei Cities

- **Real world cities are not purely monocentric, they have other major activity areas besides the CBD.**
- **Large cities are sprinkled with neighborhood business districts (NBDs) that serve needs of local communities**



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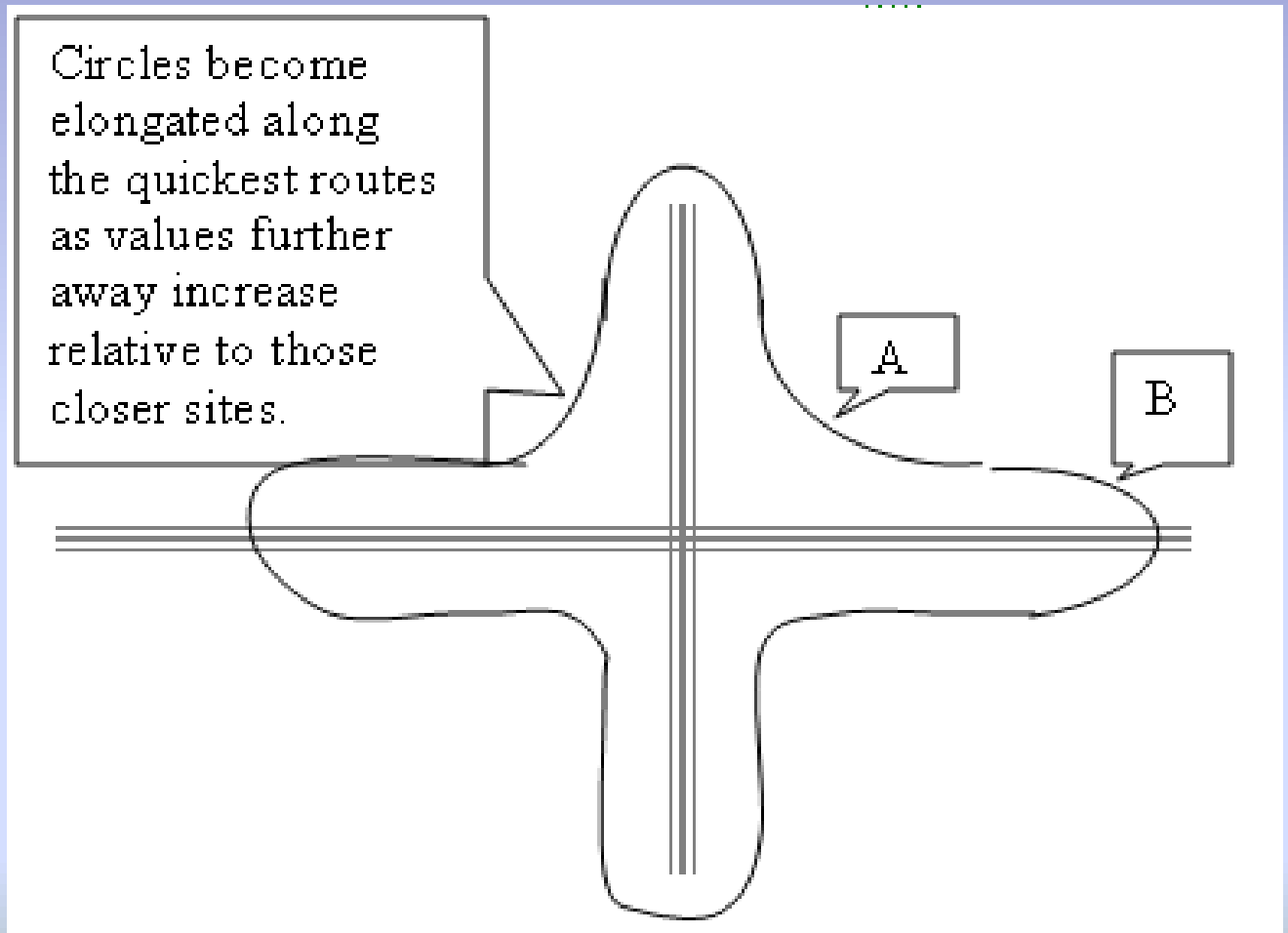
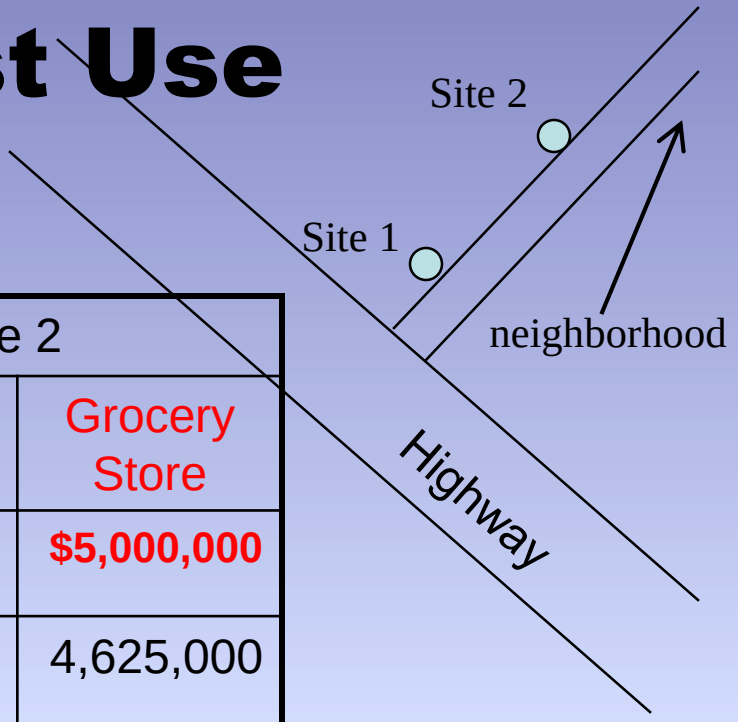
Impact of Highways or Metros on Land Values



Competition, Equilibrium & Highest and Best Use

- Land parcels with similar characteristics compete
- Competitive markets move towards "equilibrium"
  - Reflected in the case of land through interaction between landowners and tenants over price
- Equilibrium in land market must result in land parcels being used at their "highest and best use" in the long run
- Example

Highest & Best Use



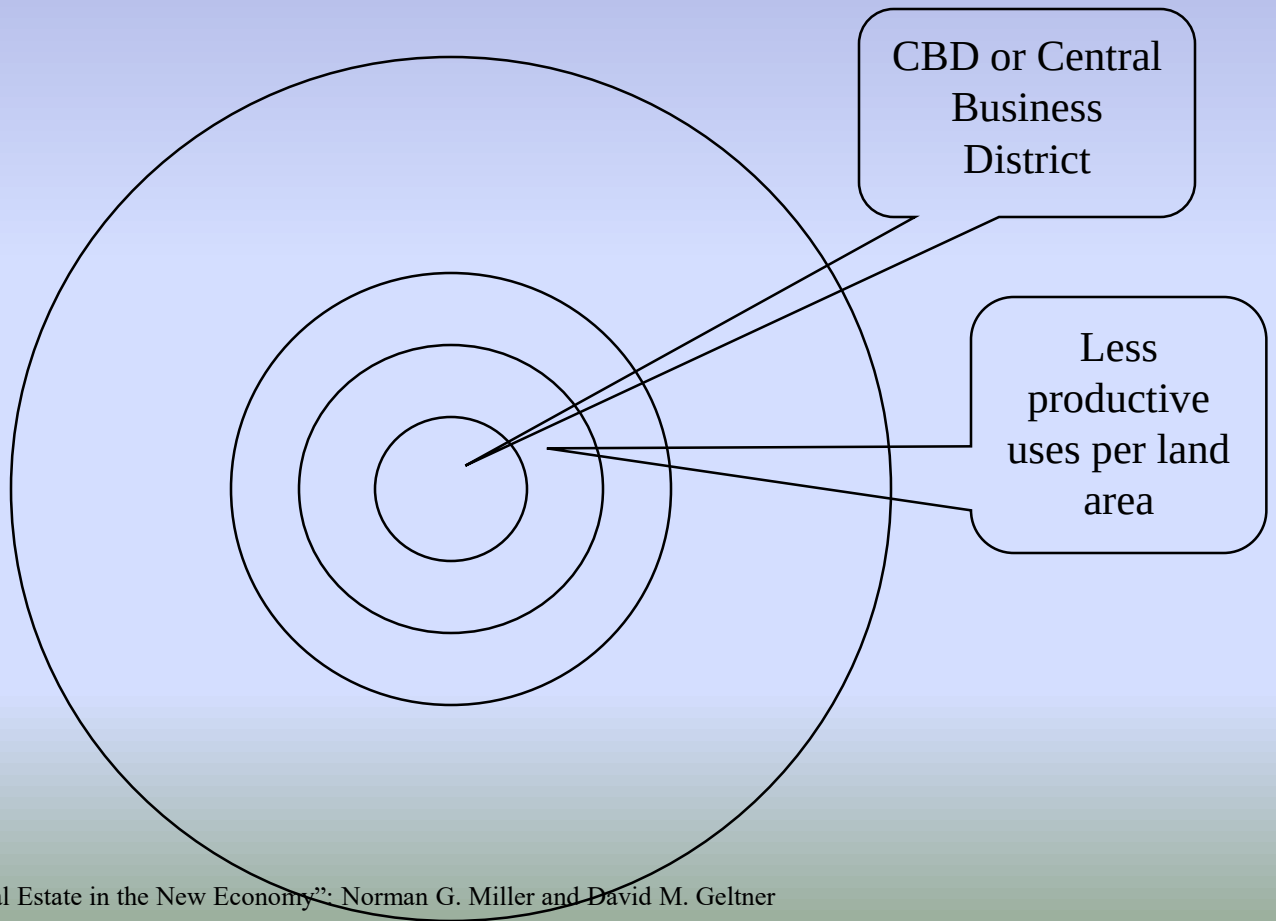
	Site 1		Site 2	
	Clothing Factory	Grocery Store	Clothing Factory	Grocery Store
Revenues	$10,000,000	**$4,600,000**	$10,000,000	**$5,000,000**
Mobile Factor Costs	9,900,000	4,550,000	9,9**90,000**	4,625,000
Residual (Land Rent)	**100,000**	50,000	10,000	**375,000**

Concern of Clothing Factory: Low shipping costs
Concern of Grocery Story : Customer convenience

Factory must locate at Site 1 and Store at Site 2

Considering Population Changes and Land Use Regulation or Constraints

- **Consider a simple monocentric city**



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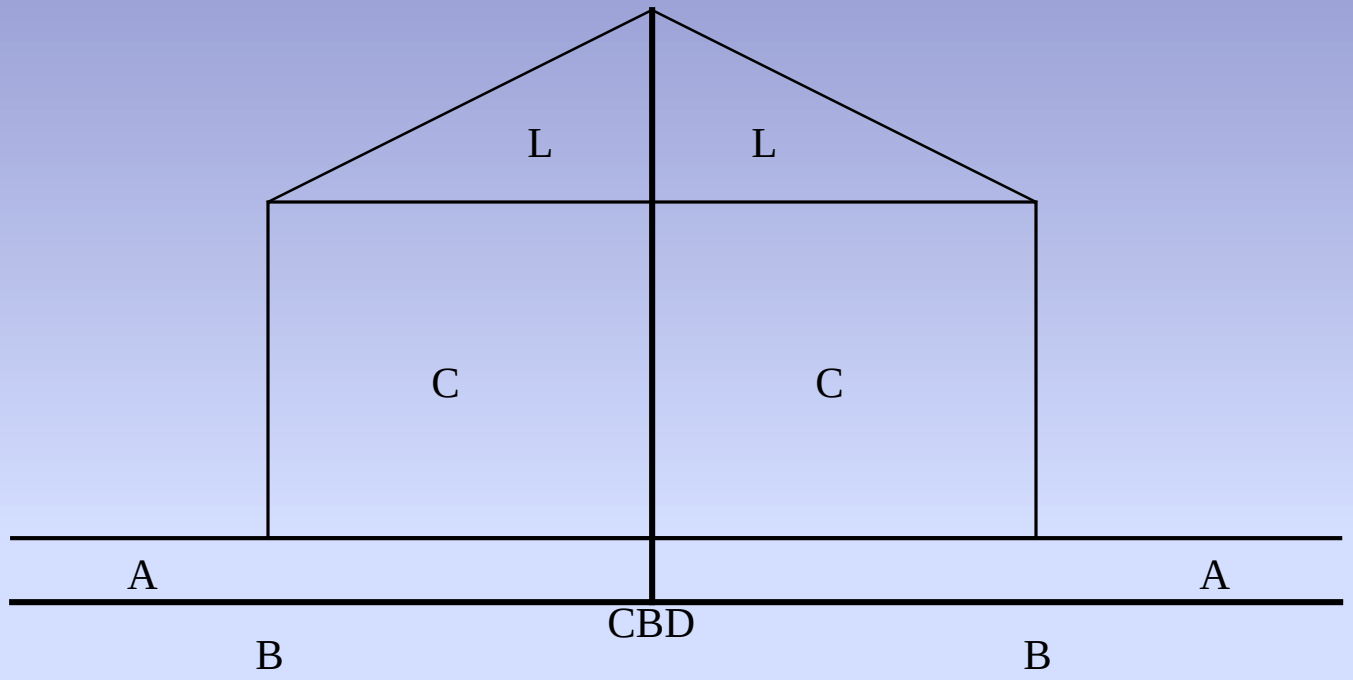
Land Use Patterns: Classical Monocentric City Model

- A simplified model to capture the essence of modern cities:
  - ♦ There is only one “central point” in the whole city, which applies to all potential land uses of the land
  - ♦ There is only one type of land use in the city, i.e. housing
  - ♦ Transportation cost is a function of distance of the use (say a home) from the central point

Annual rent for housing in the Classical Monocentric City

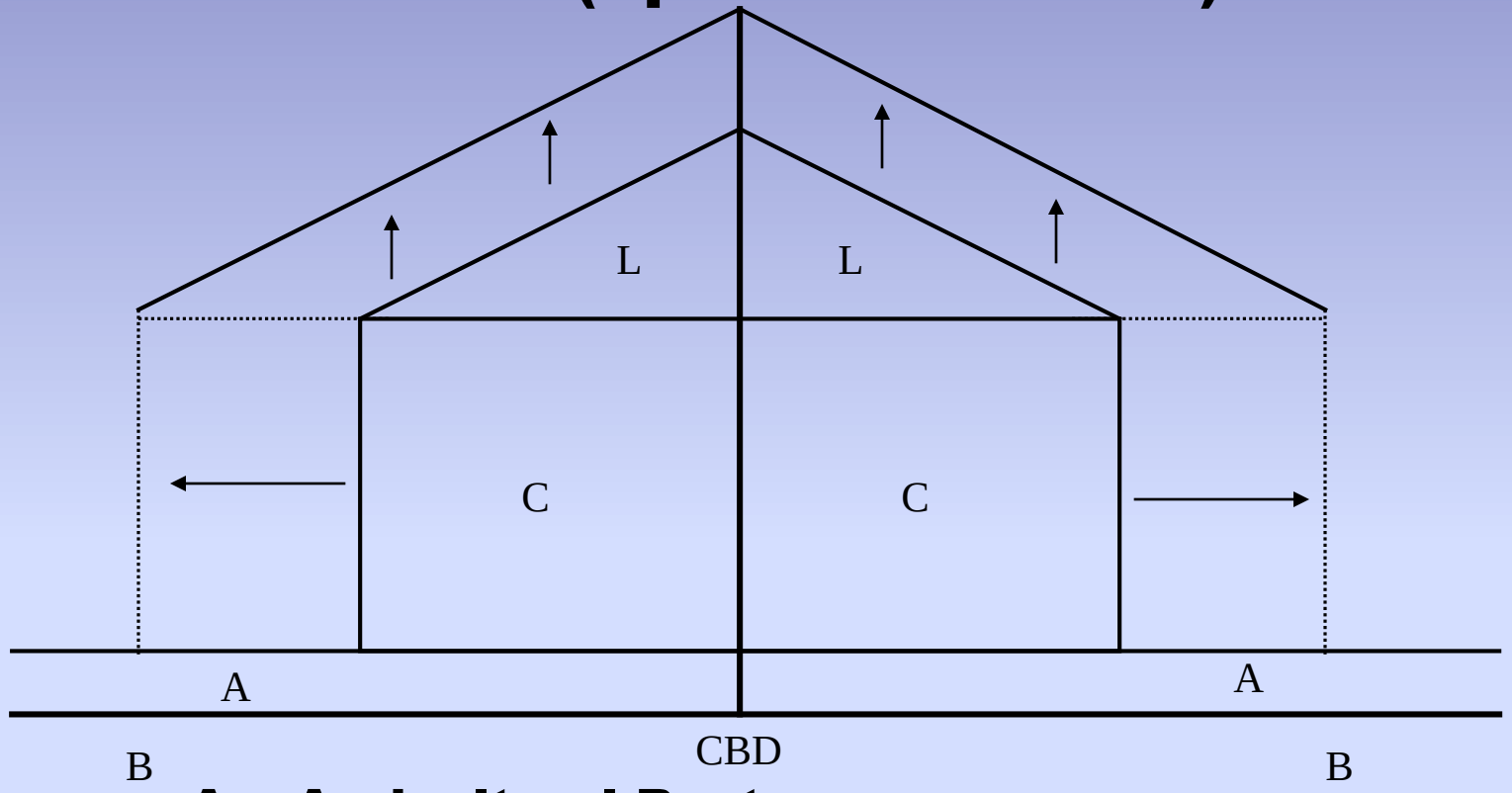
- At edge of city rent:
  - At boundary between urban and agricultural land use, rent would include the agricultural use residual or bid-rent for the land
- As we move towards central point:
  - The residents at more central locations will not have to pay as much in commuting costs, so they will be able to pay more rent
  - “The housing rent must rise as we approach the center at exactly the rate that the cumulative transportation costs fall”
- Rent Gradient:
  - The transportation cost per mile per person times the number of people per acre or sq kilometer

A Cross-Section of Land Rents



A = Agricultural Rent
C = Construction Rent
L = Location Rent
CBD = Central Business District
B = Urban Boundary

Effect of Population Growth with Density and Transportation Cost Constant but with More Land (Sprawl Permitted)



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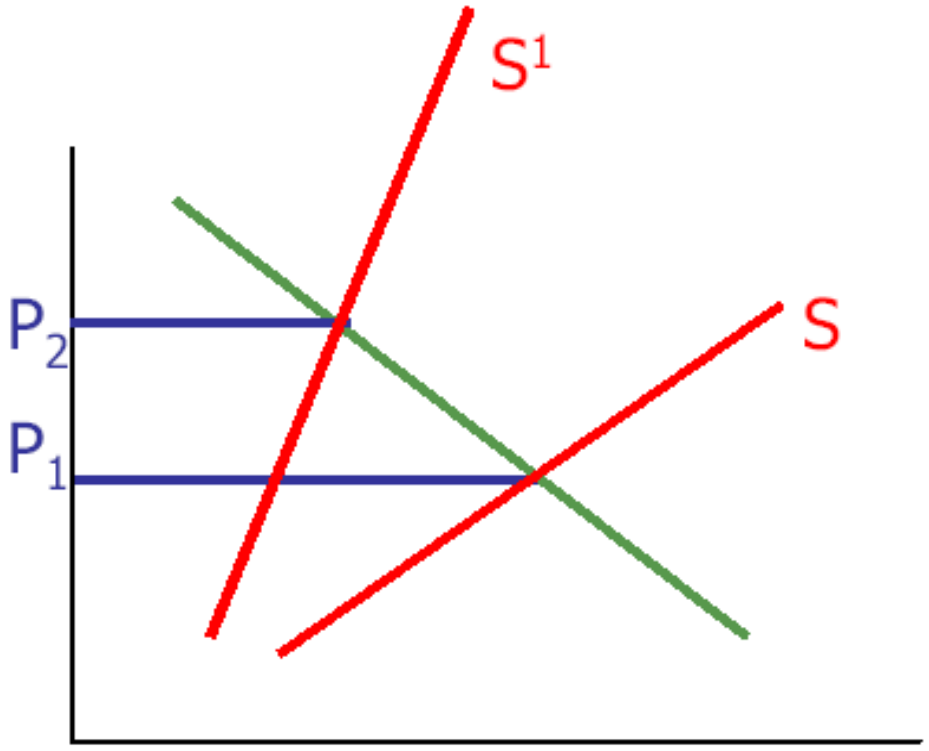
Land use regulations and available land can make supply curves steep meaning it is really hard to add new supply.

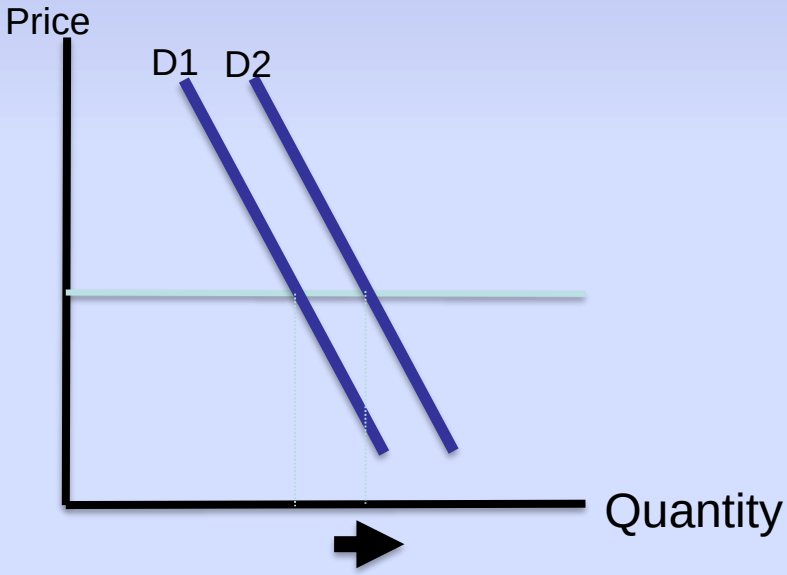
By changing the Responsiveness of Housing Markets…

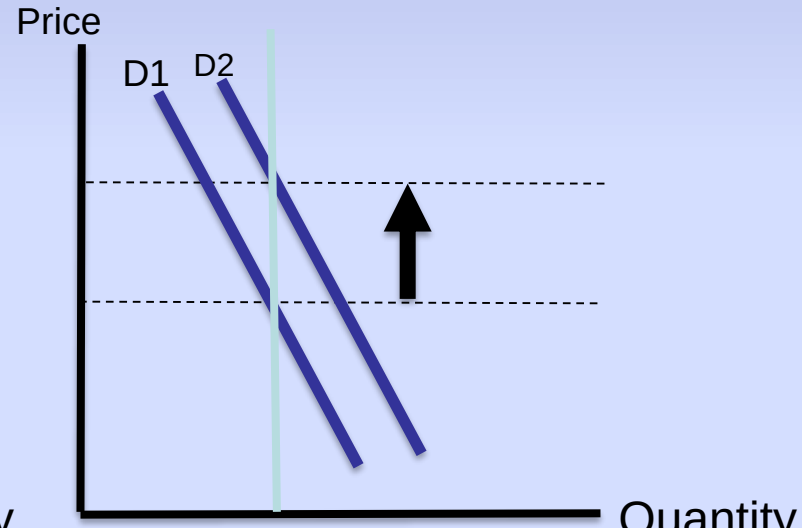


A less elastic supply of housing – such as S^1 - can result in much higher house prices

The Key Factor in Housing Affordability: Elasticity of Supply

Markets with low elasticity will see prices rise the most with increases in demand. Compare the inelastic market on the right to the elastic one on the left with a change in demand.





Percent of Undevelopable Land Using 50 Kilometer radius and based on only water and slope attributes.

Source: Sumner La Croix, University of Hawaii, Aug 4, 2015

City	Percent Undevelopable
Honolulu	92%
Miami, FL	77%
San Francisco	73%
San Diego	63%
New York City	40%
Portland	38%
Denver	17%
Fresno	13%
Saint Louis	11%

Man made regulations constrain supply, for example:

- Endangered Species Act
- Wetland Protection
- County zoning
- Restrictive development plans
- Coastal zone management and oversight: California Coastal Commission (increases land prices by restricting supply)
- Prop A type vote required by local citizens
- Historic or archaeological preservation requirements
- Water and sewer restrictions

Severity of Land Use Restrictions Based on Regulations (Wharton Index Created by Albert Saiz) 0 = Average Regulation

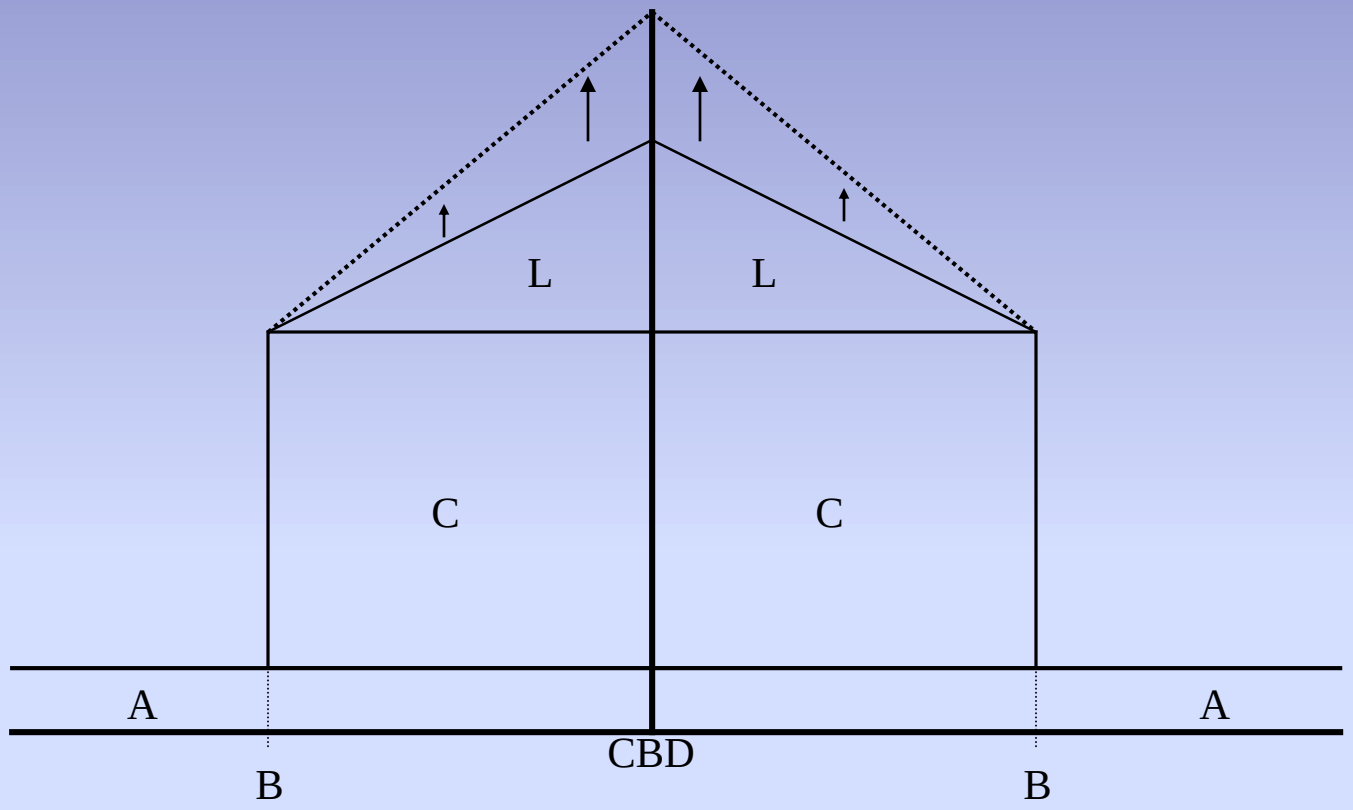
City	Index
Honolulu	2.50
Providence, RI	1.79
Philadelphia	1.03
Phoenix	.70
San Diego	.48 (inland only)
Portland	.29
Houston	-.19
Saint Louis	-.72

Does not account for coastal regulations

The more limited is supply the more volatile prices and the greater development risks

- **Growth management, infrastructure limits & environmental standards are constraining the amount of land available for development**
  - Urban growth boundaries
  - Linking development approvals to availability of infrastructure (roads, parks, schools, utility services, etc.)
  - Fees or taxes to help offset the increased impacts of new development
  - Limits on the amount and/or pace of new construction
  - Design review requirements
  - Affordable housing requirements
  - Environmental protection regulations (wetlands, habitat protection, open space)
  - NIMBYs

Effect of Population Growth with Area Constant (No sprawl permitted)



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Economic Results

Principle 1:

"Other things equal, larger cities will have higher average rents"

This makes housing and everything else more expensive, i.e

Which of the following cities are the most densely populated? Or have more regulation limiting available land?

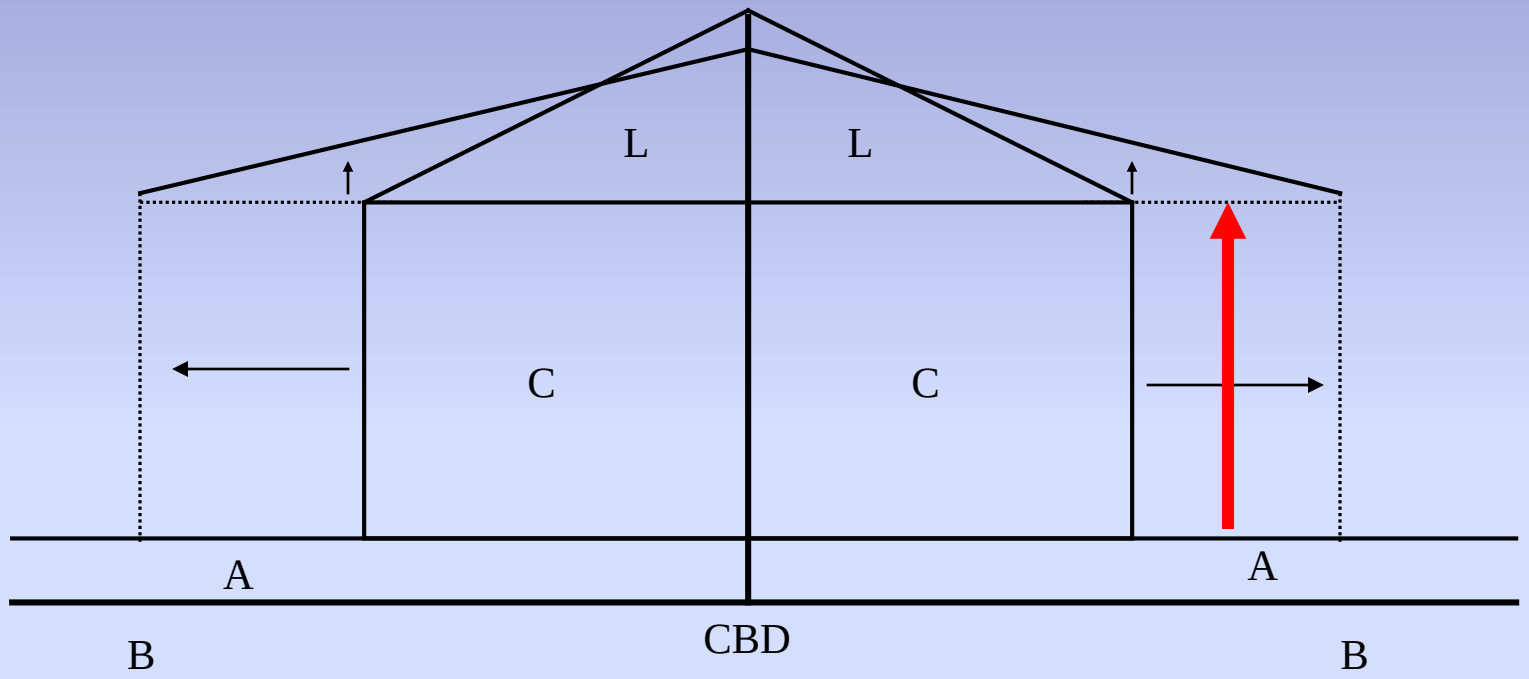
	House Price-to-Income Ratio
China	14.8
Poland	10.8
Russia	7.4
Korea	9.3
France	4.3
Japan	11.6
South Africa	1.7
India	7.7
Brazil	2.3

Source: Housing Indicators

Principle 2

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

Effect of Transportation Cost Reduction Savings Applied to Greater Consumption of Land (sprawl Effect)



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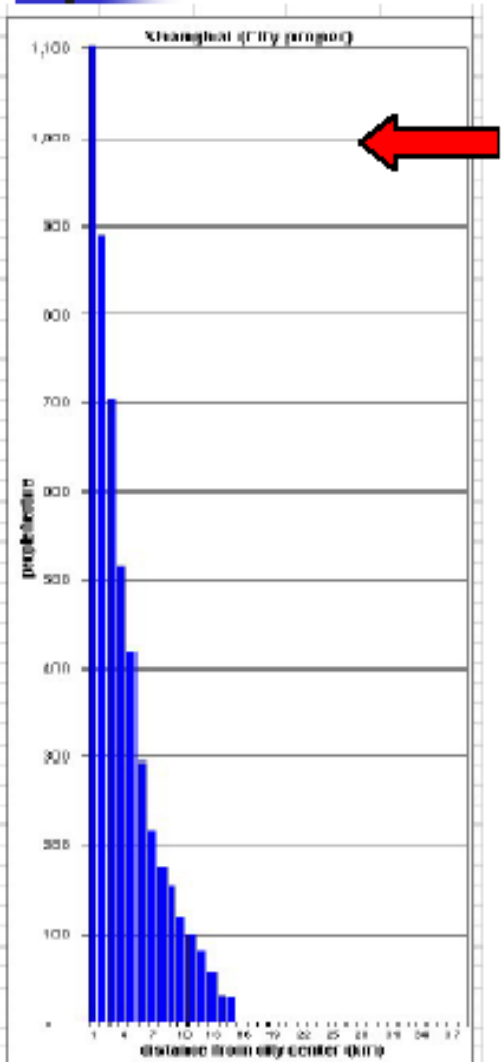
Back to transport costs

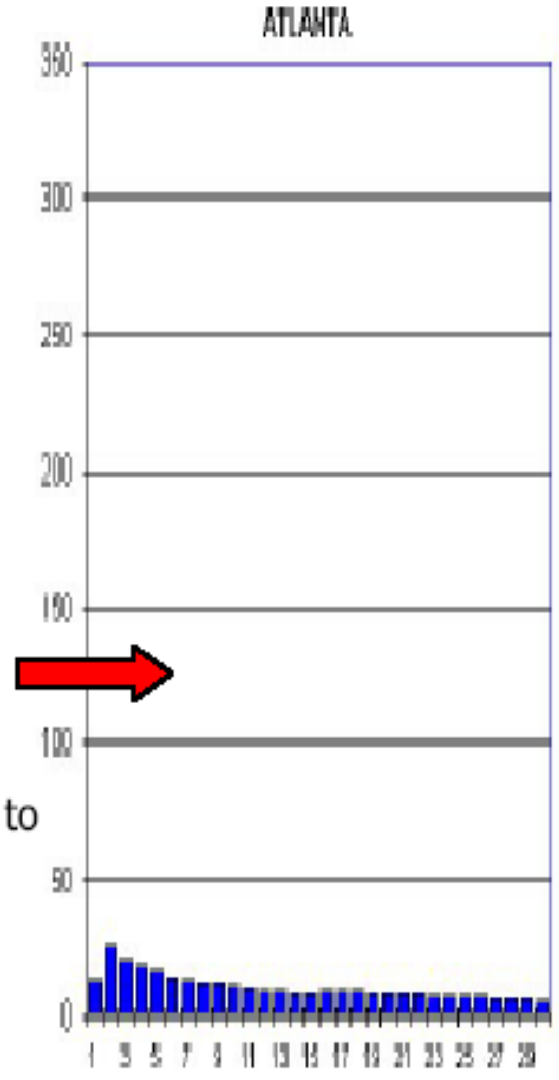
- Recall our transport costs are a function of mode and time.
- Consider the bicycle – how large will the city spread?
- What if we add cars?
- What if we add metros?

The Bicycle vs The Car City: Shanghai and Atlanta

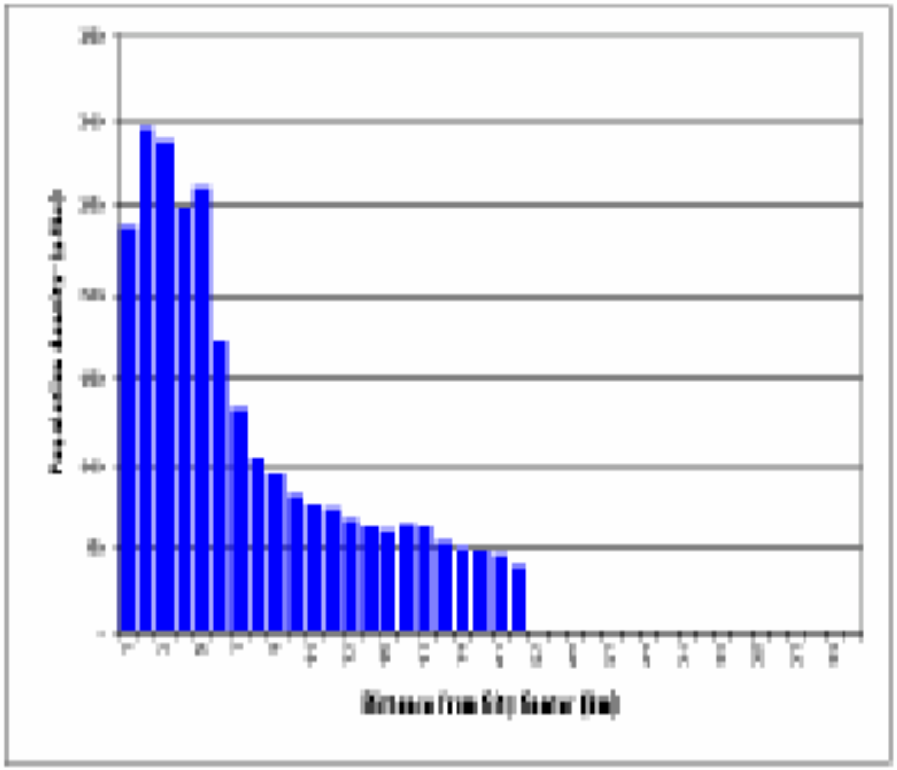


- Extremely high-density center = compact city
- Steep Density Gradient
- The Gradient's steepness is driven in part by reliance on bicycles

- Very low-density center = spread out city
- Shallow Density Gradient
- So it seems that, as opposed to Shanghai, Atlanta is heavily reliant on highways and cars.

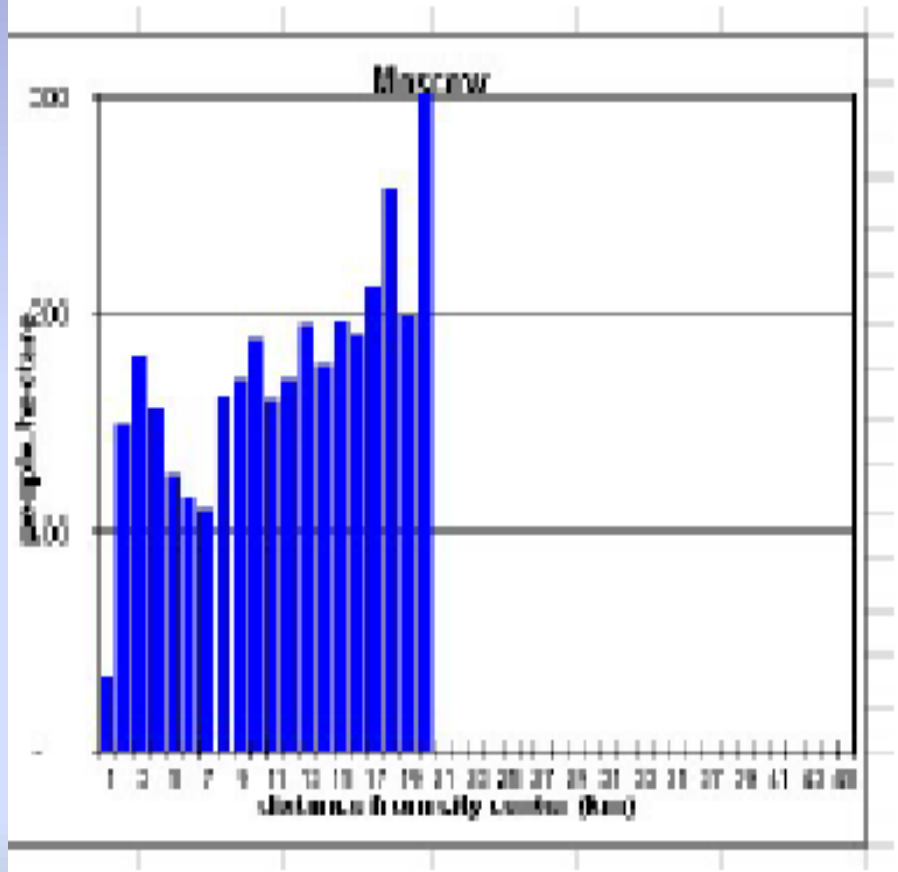


Paris



- Ceremonial central city, with lots of green space,
- Yet the gradient is still clearly negative
- In some places the market works.

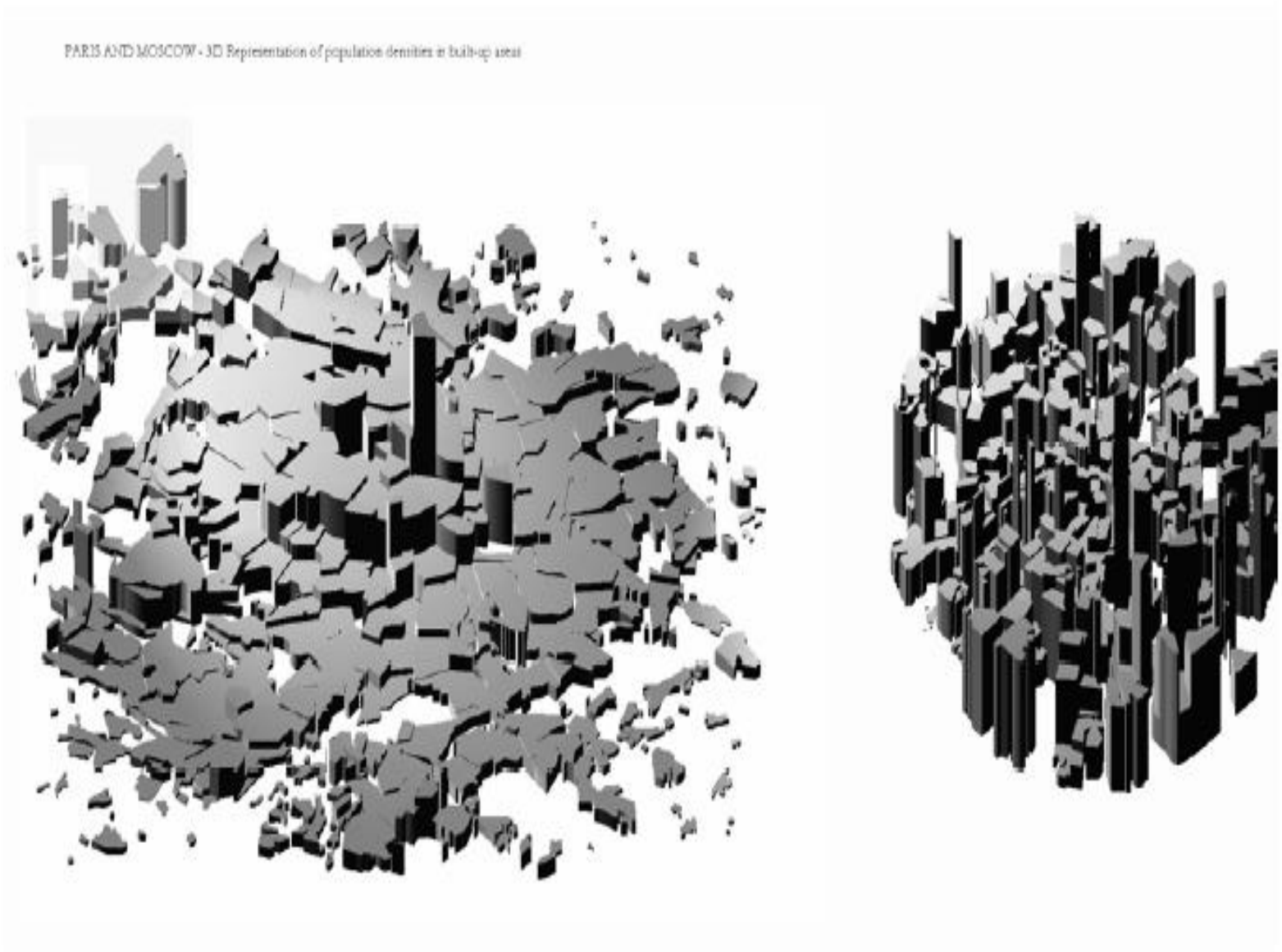
Moscow: Stalin's Camel Shaped City



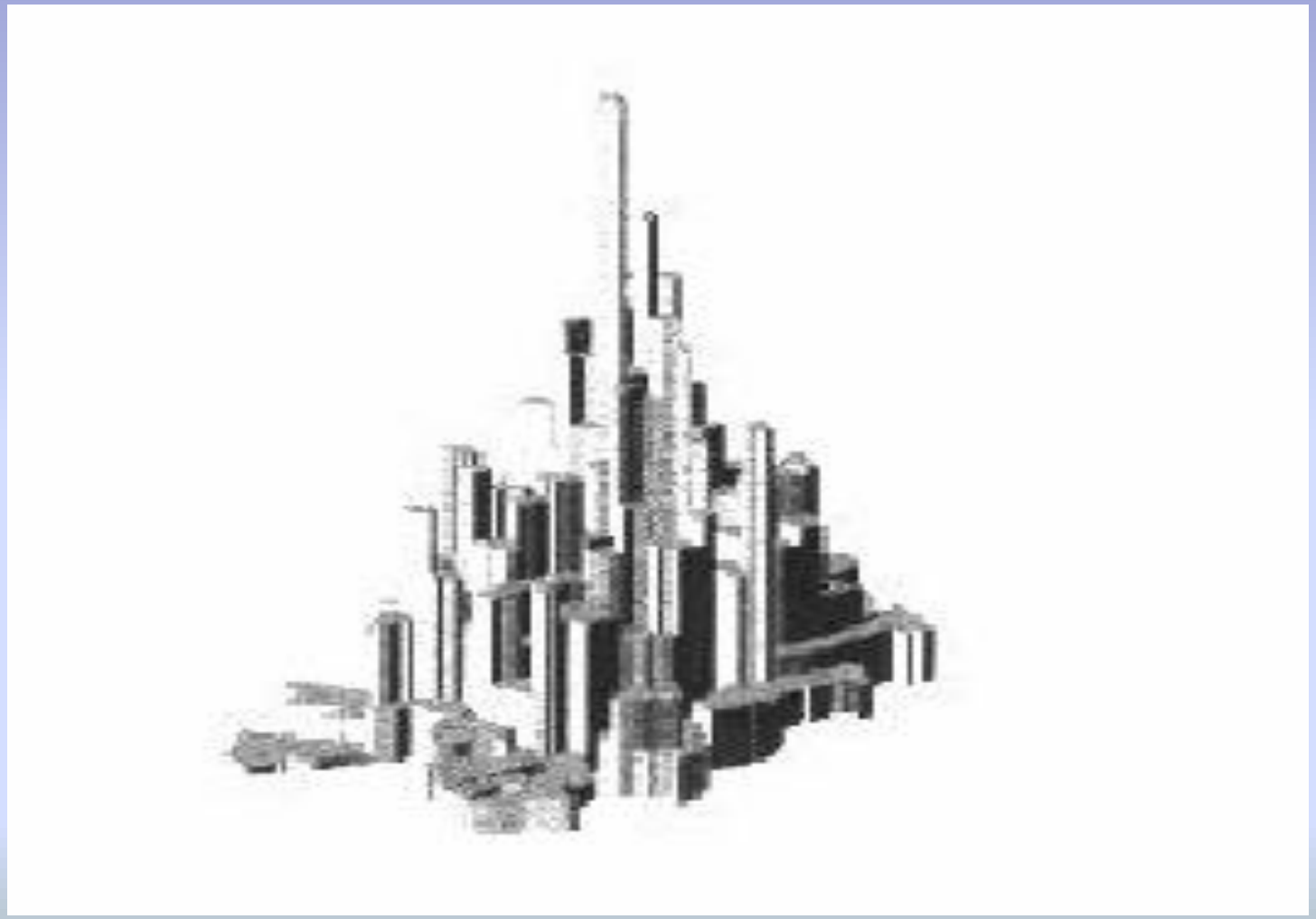
Back in 1998 it looked like this but it is changing.

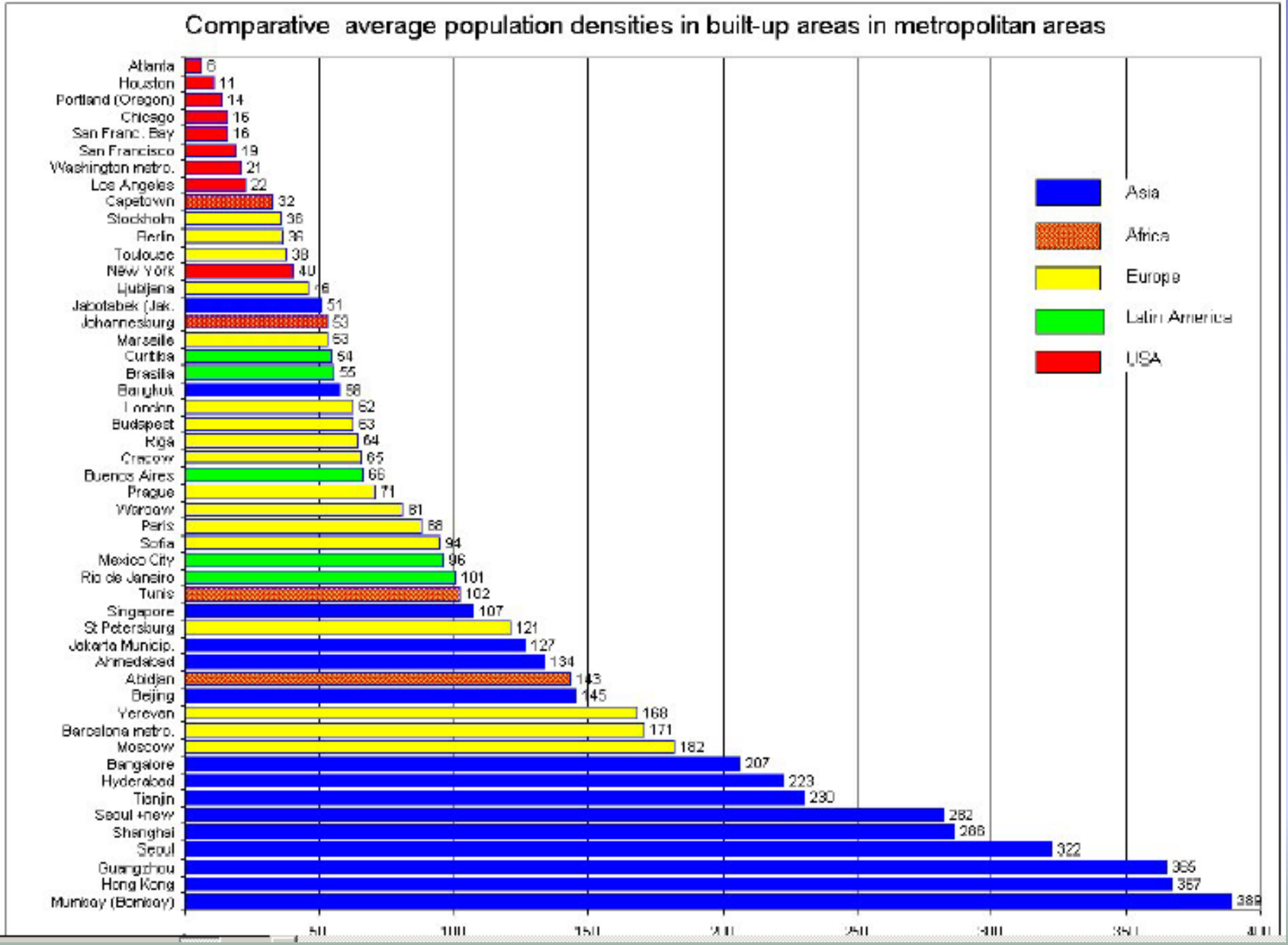
- Marxist Ideology: 3 concentric circles
  1. Industrial Center
  2. 4-5 story apartment buildings
  3. High-rise apartments
- Positive Density Gradient
- Large dispersal Distance

Paris Vs. Moscow Land Values (1998)



Shanghai (1998)

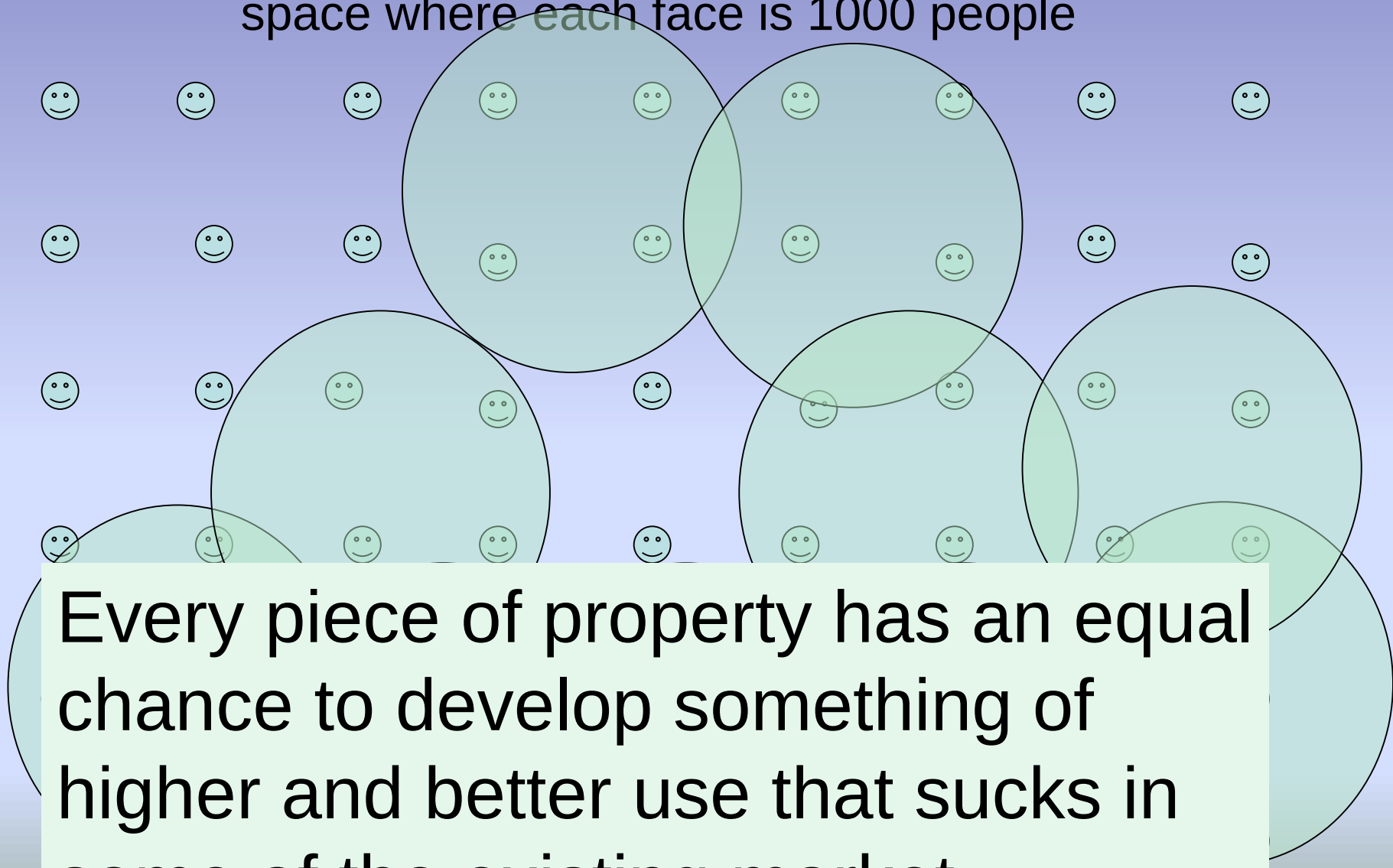



Comparative average population densities in built-up areas in metropolitan areas
Atlanta 6
Houston 11
Portland (Oregon) 14
Chicago 16
San Franc. Bay 16
San Francisco 19
Washington metro. 21
Los Angeles 22
Capetown 32
Stockholm 36
Berlin 36
Toulouse 39
New York 40
Ljubljana 46
Jabotabek (Jak. 51
Johannesburg 53
Marseille 53
Curitiba 54
Brasilia 55
Bangkok 58
London 62
Budapest 63
Riga 64
Cracow 65
Buenos Aires 66
Prague 71
Warsaw 81
Paris 88
Sofia 94
Mexico City 96
Rio de Janeiro 101
Tunis 102
Singapore 107
St Petersburg 121
Jakarta Municip. 127
Ahmedabad 134
Abidjan 143
Beijing 145
Yerevan 168
Barcelona metro. 171
Moscow 182
Bangalore 207
Hyderabad 223
Tianjin 230
Seoul +new 282
Shanghai 286
Seoul 322
Guangzhou 365
Hong Kong 367
Mumbay (Bombay) 389
50
100
150
200
250
300
350
400
Asia
Africa
Europe
Latin America
USA

In a city under transformation what about land option value?

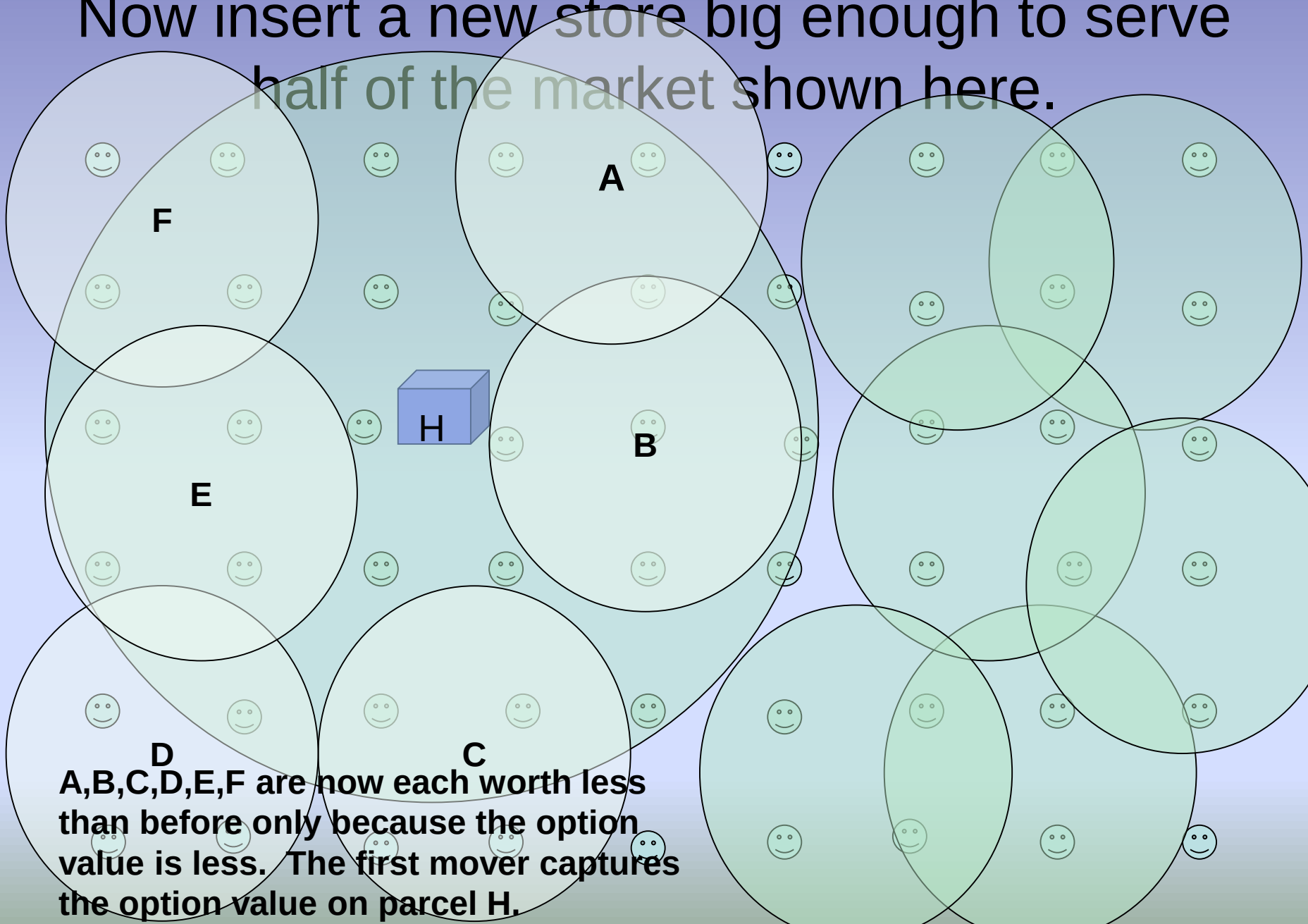
- Recall every piece of land had a value equal to
  - The current use value plus
  - The option value for uses that are more productive
  - If a site is at highest and best use the option value is zero
  - But if a site is underutilized the option value can be high
  - Note the effect of one development on another

Imagine a market of potential shoppers distributed over space where each face is 1000 people



Every piece of property has an equal chance to develop something of higher and better use that sucks in some of the existing market.

Now insert a new store big enough to serve half of the market shown here.



A,B,C,D,E,F are now each worth less than before only because the option value is less. The first mover captures the option value on parcel H.

When a city has non-market land use densities and then moves to a market driven economy there will be opportunities.

- **Where will they be most often?**
  - Nearer the center and the fringe
  - Converting to higher and better uses
  - Near new transport nodes (access points)

End