Urban Economics

Lecture 3: Monocentric city model - Extensions

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Outline

- **The model analyzed so far has been very stylized**
- **In this lecture, we will analyze some extensions and modifications to the model**
  1. Intercity predictions
  2. A city with two income groups
  3. Commuting by freeway
  4. Employment outside the CBD
  5. Durable housing
- **This lecture will follow Brueckner's Chapters 2 and 3**

Intercity predictions

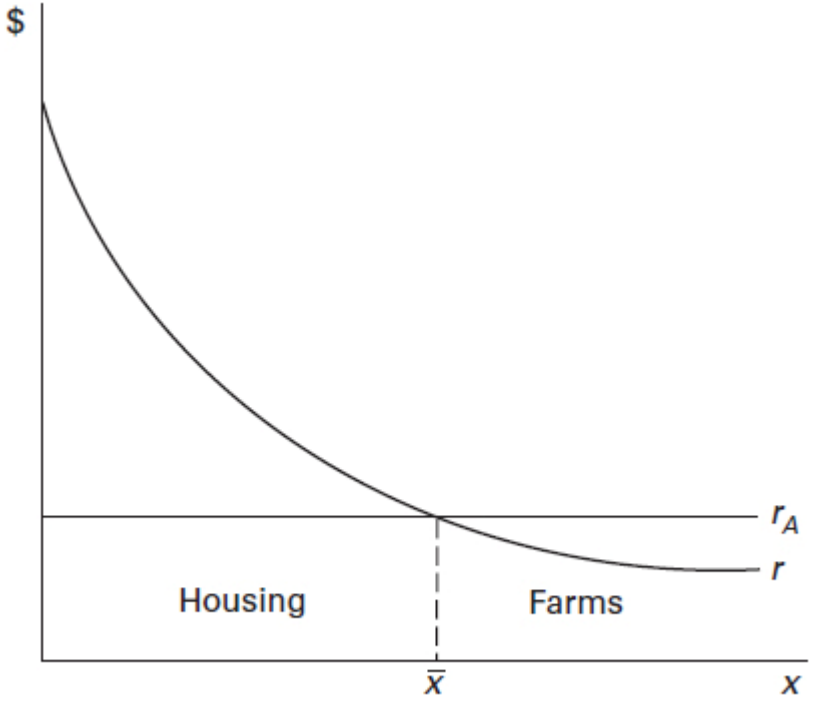
Intercity predictions

- **Even though we are dealing with a closed model, that is, there is no migration from other cities, we can still use the model to make some predictions about intercity differences**
  - E.g. how do cities of different size differ?
- **We will deal with a model with multiple cities later on**
  - In these types of models, we abstract away from the within city structure and analyze the between city differences in wages, housing costs and local amenities
  - There we will rely on another type of spatial equilibrium concept; the spatial equilibrium across cities

Geographic size of the city

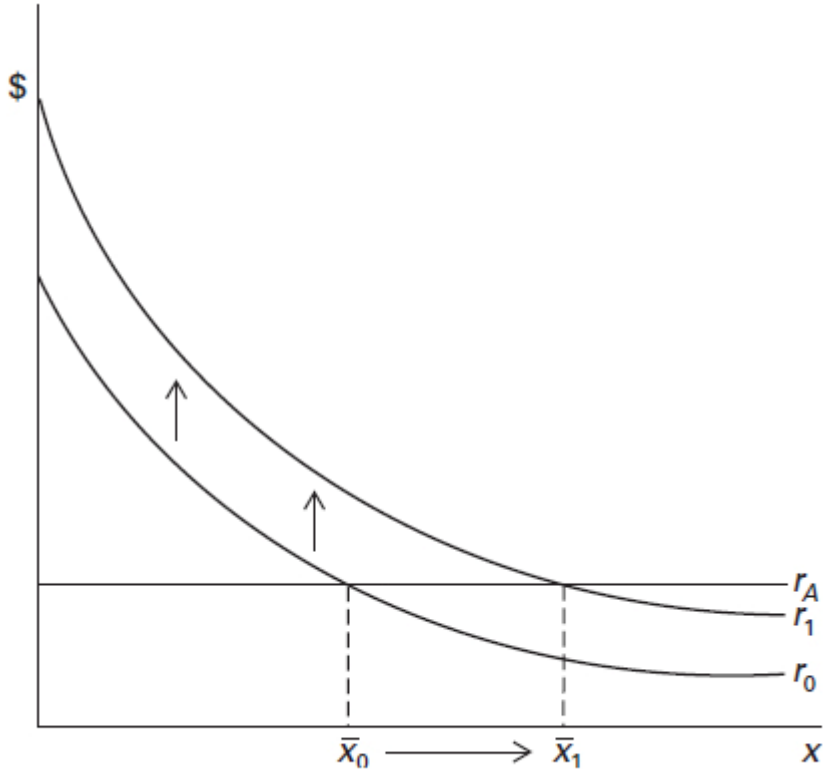
- **Supply-demand equilibrium of the city**
  - The city fits its population so that the supply of housing equals the demand for it
- **The city's land area is a result of competition between housing developers and farmers**
  - Suppose that farmers are willing to pay r_A for a hectare or km² of farmland and that this agricultural rent is constant through space (independent of x)
  - Landowner will rent the land to the highest bidder

Determination of the city's edge



- Urban land rents for housing r slope downwards (and are convex)
- At some distance $\bar{x}$, urban and agricultural land rents are equal
- Beyond this point farmers can outbid landlords for the land
- Housing is built inside the intersection of the rent curves and land outside the intersection is in agricultural use
- This determines the city's edge

Increase in population size

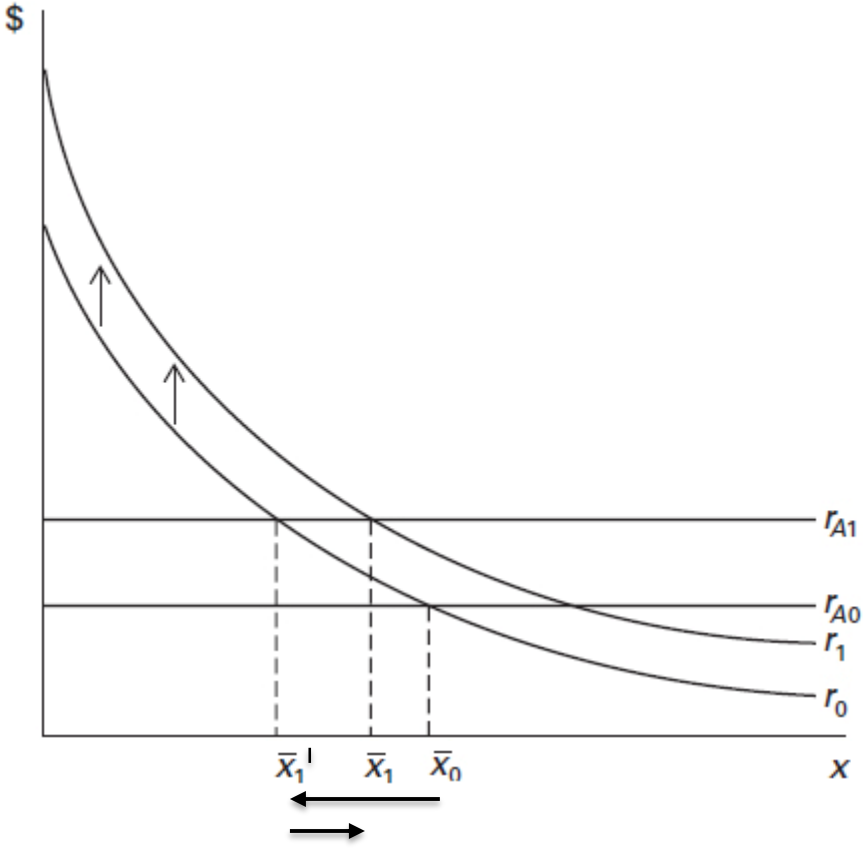


- **Leads to excess demand for housing:**
  - Higher housing prices *p* everywhere in the city so that people economize on dwelling size *q*
  - Housing price increase makes building more profitable and developers compete for land driving up land rent *r* at all locations
  - Higher cost of land leads to taller buildings as developers substitute capital for land
  - City edge expands as developers are able to outbid farmers farther away from the CBD
  - With taller buildings and smaller dwellings, population density *D* increases at all locations
  - Population density has increased and city's land area has expanded so that the new city can fit the larger population

Increase in population size

- **The larger city occupies more land than the smaller**
- **At a given distance to CBD,**
  - The larger city has taller buildings
  - Smaller dwellings
  - Higher housing price per square meter
  - Higher land rent per km^2
  - Higher population density
- **These predictions match many of the observed differences between large and small cities in the real world**

Increase in agricultural rent



- This might happen because yields increase, or the prices of agricultural products increase
- As land rent increases, farming takes over some of the residential land at the edge of the city
- With fewer dwelling, the city cannot fit its population anymore
- The adjustment process is exactly as in the case of population increase just discussed

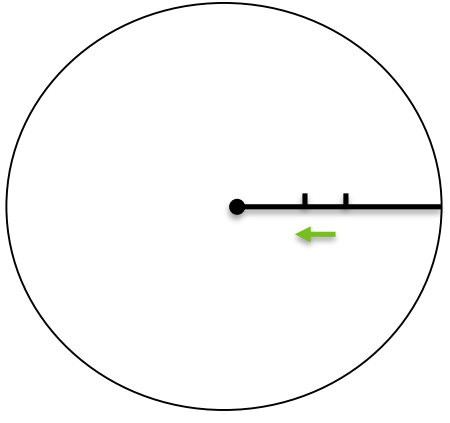
Increase in commuting cost

- **The consumer compares the marginal benefit (*MB*) and the marginal cost (*MC*) of moving, say, one kilometer closer to the CBD, $x_0 \Rightarrow x_1$, $x_1 < x_0$**
  - In equilibrium, for each consumer the marginal benefit from moving is equal to the marginal cost

Lower commuting cost

$$MB = -t(x_1 - x_0) = (p_1 - p_0)q = MC$$

Higher housing cost

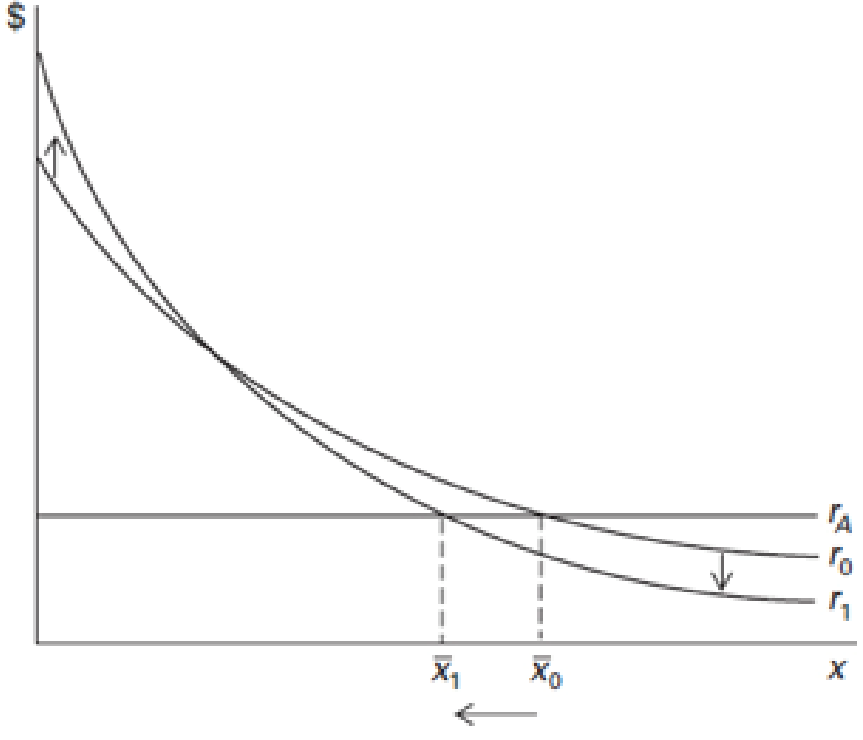


  - When t decreases, this no longer holds

Increase in commuting cost

- **Increase in commuting time means that the housing price differences between central-city and suburban locations are no longer enough to equate utility**
  - Suburban commuters can increase their utility by moving closer to the CBD (at the prevailing house prices)
- **This increased demand pushes housing prices up near the CBD, while the lower demand in suburbs lowers prices there**
  - Housing prices will adjust until a new equilibrium is reached
  - The housing price curve rotates in a clockwise direction

Increase in commuting cost



- Housing price changes increase developer profits near the CBD and decreases profits in the suburbs
- This leads to stronger competition for land near the CBD and weaker competition for suburban land
- The land rent curve rotates in a clockwise direction as depicted in the figure
- Due to this rotation, the city edge moves closer to the CBD
- Additionally, higher land rents near the CBD lead to taller buildings there

Population heterogeneity

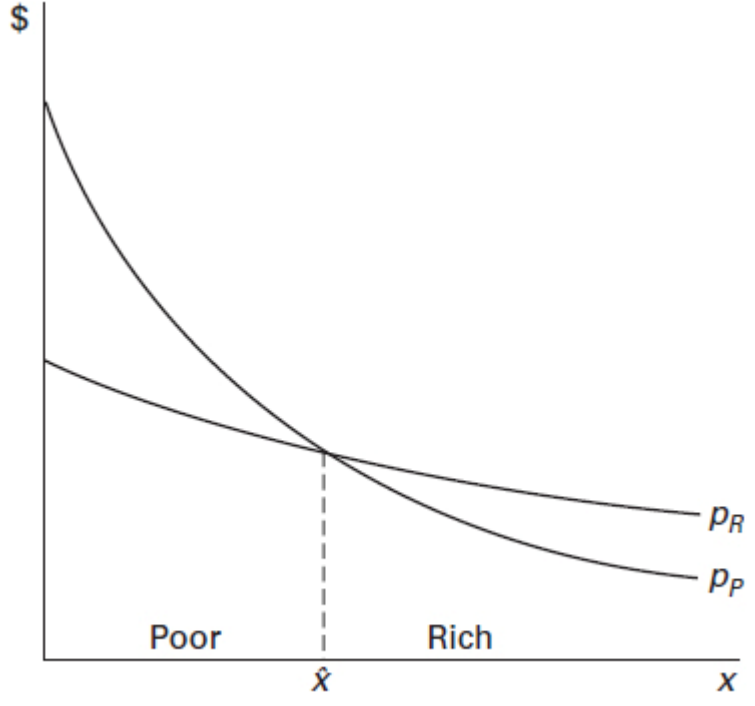
City with two income groups

- **Suppose that instead of all having the same income, some households in the city are rich (y_R) and some are poor (y_P),**
  - So that $y_P < y_R$
- **Assume that the commuting cost is still the same monetary cost as before and the same for both groups**
- **What does the model predict about the residential location of these two groups?**

Two housing price curves

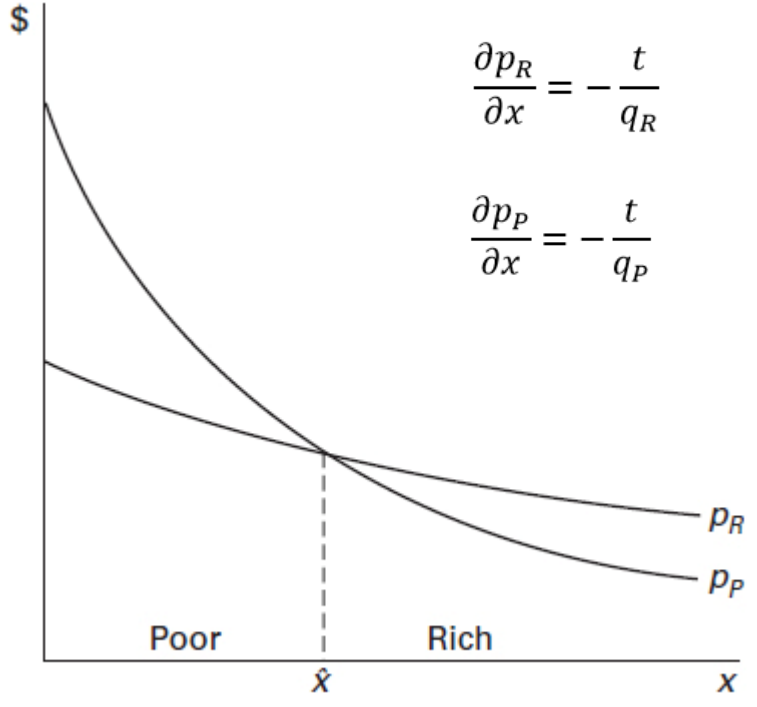
- **With two income groups, there are going to be two housing-price curves (p_R and p_P)**
- **This result follows again from the locational/spatial equilibrium condition**
  - Paying housing prices per square meter along the p_R curve, rich households will be locationally indifferent reaching the same welfare level everywhere
  - The same applies to poor households and housing price curve p_P

Two housing price curves



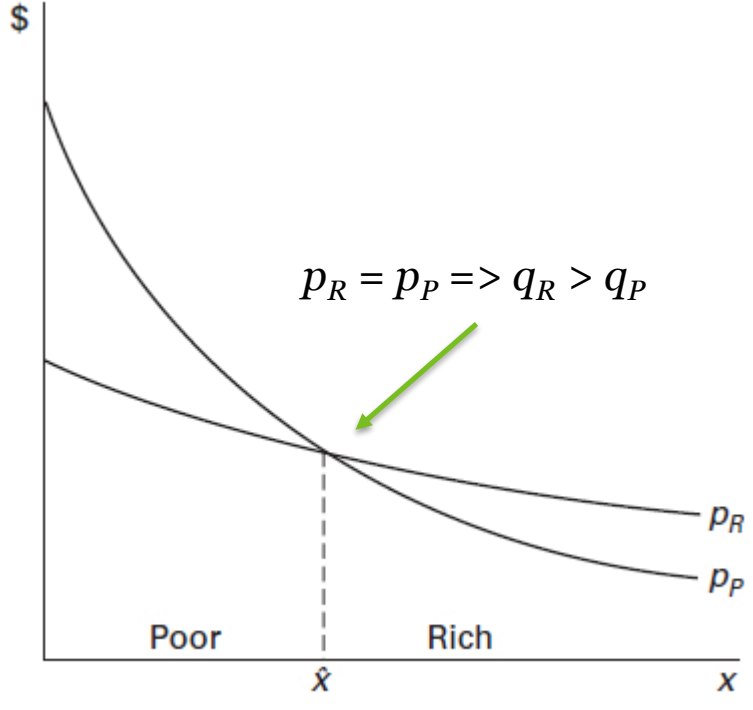
- Examples of these curves are depicted in the figure
- For the members of an income group to live in a particular location, they must be the highest-bidder at that location
- If the curves are as in the figure, poor households are the highest-bidder inside the intersection point $\hat{x}$ of p_R and p_P
- In this example, the poor live near the CBD, while the rich live in the suburbs

Two housing price curves



- With the assumptions that we have, this outcome is, in fact, the only possible one
- This is because the slope of the price curve is $-t/q$ with different housing consumption for the groups (q_P and q_R)
- One would expect that rich people consume more housing space ($q_R > q_P$), but this is true for sure only when the groups face the same price per square meter!

Two housing price curves



- This happens when the curves intersect
- At this point, the p_R curve must be flatter than the p_P curve, so that the price-curve diagram must look like this
- Thus, the model predicts that under these assumptions the poor live in the central-city and the rich in the suburbs
- The prices that we would actually observe are always the highest curve in each location

Opportunity cost of time

- **This result, however, depends on the absence of time cost related to commuting**
- **If there are time costs, the predictions concerning the location of different income groups become ambiguous**
- **One way of showing this is to assume (unrealistically) that leisure time is fixed and commuting time is away from working time**
  - Thus, a longer commute would lower the workers income because of monetary commuting cost as before *and* because of diminishing income from work

Opportunity cost of time

- **If an extra km of commuting reduces work time by some fraction δ of an hour, one extra km reduces income by δw**
  - Instead of just t, the new commuting cost would be $m = \delta w + t$
- **Given that wages/income differ, the groups will face different commuting costs: $m_P = \delta w_P + t$ and $m_R = \delta w_R + t$**
- **Thus, the slopes of the of the housing price curves change so that t is replaced with m_P or m_R:**
- $\frac{\partial p_P}{\partial x} = -\frac{m_P}{q_P}$ **and** $\frac{\partial p_R}{\partial x} = -\frac{m_R}{q_R}$
- **But since $q_R > q_p$ and $m_R > m_p$, it is unclear which slope is flatter**

Opportunity cost of time

- **Thus, when there are time costs present, the model does not offer a clear prediction about the relative location of different income groups**
- **The ambiguity arises from two opposing forces:**
  - The desire to rent their large dwellings at a low price per square meter pulls the rich toward the suburbs
  - And the desire to limit their high time cost of commuting pulls them toward the center
  - Depending on the relative strengths of these forces, either location is possible for the rich (and the poor)

Other explanations – transportation mode

- **In US cities, richer people tend to live farther away from CBD in large houses (of course there are exceptions)**
- **One explanation for this pattern is related to transport modes**
  - The hypothesis is that the poor cannot afford cars, and thus, need to locate in central parts of the city where population density is high enough for public transit
  - That is, poor households need to live in central cities in order to have mobility
- **However, this pattern is not universal**

Other explanations – age of the housing stock

- **Another hypothesis is that high-income households prefer newer and higher quality housing**
- **Newest housing stock is often in the suburbs or far from the CBD, and thus, these locations attract the rich**
- **If old buildings in the city center are replaced with new ones, this pattern might change**
  - This type of development is often referred to as "gentrification"
  - Rich households displace the poor in these areas

Other explanations – urban amenities

- **Some European cities (e.g. Paris) have the opposite pattern to the US, so that high-income households tend live in the city center**
- **One hypothesis is that in these cities central locations have high urban amenities**
  - Historical monuments, architecture, natural amenities
- **If the rich value living next to these more than the poor, we may observe a pattern where the rich live in city center and poor farther away**
- **But these aspects are missing form the simple model!**

Recap – heterogeneous population

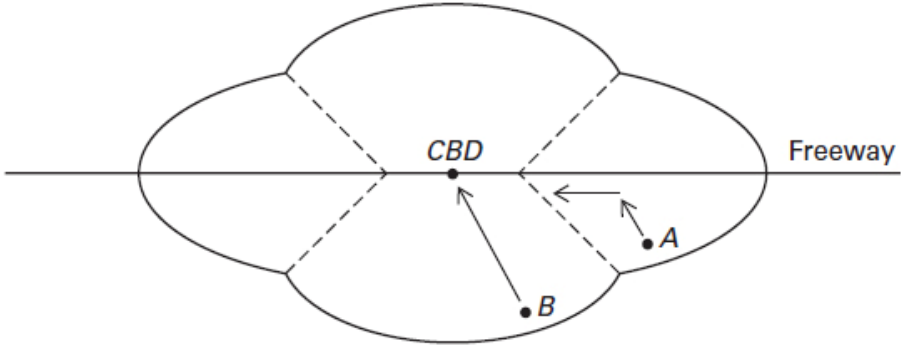
- **The simple monocentric city model is less successful in predicting the residential patterns of different income groups than it is in predicting price, density and building height patterns**
  - The model is missing some important components in this respect
- **At the same time, the model does predict segregation by income groups, which is a prevalent feature in many cities**
- **We will talk about issues related to segregation during the latter part of course**

Other extensions

Commuting by freeway

- **Suppose that there is a single freeway passing through the city**
- **The freeway is faster than the smaller city streets**
  - Since the freeway is faster, commuters living close to the freeway will use the city streets to get to the freeway and use it for the rest of the way
  - Those who live far from the freeway, will use the smaller and slower city streets
- **What implications does this have for the main predictions of the model?**

Commuting by freeway



- For example, locations A and B may have the same commuting cost even though location A is farther away from the CBD
- Then the rent per square meter p would be the same in these locations as is land rent r
- Land rent falls more slowly along the freeway catchment area than outside of it
- Land rent takes longer to fall to the agricultural rent level => the edge of the city expands

Commuting by freeway

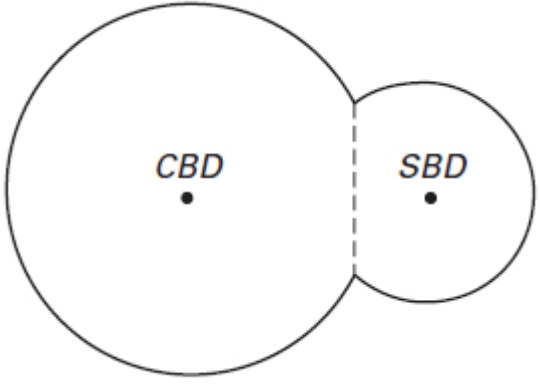
- **The freeway causes the city to sprawl and take up more space**
- **Otherwise, the model's predictions are unaffected**
  - Housing price p, land rent r, building heights and population density D all decrease as distance to CBD grows
  - Their rates of declines are less along the freeway catchment area
  - Dwelling size increases with distance, but again the rate is different along the freeway

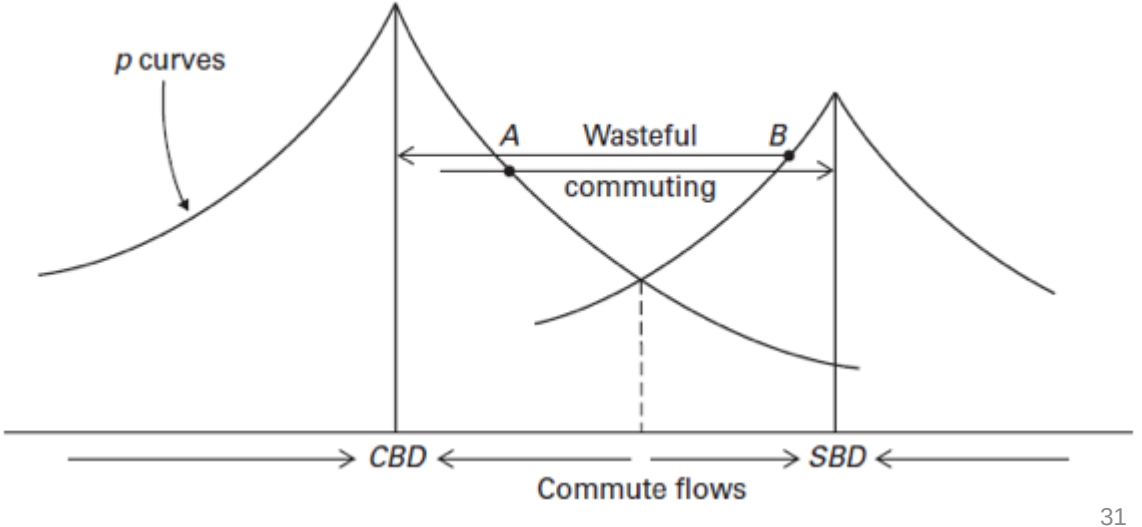
Employment outside CBD

- **In real-world cities, all employment is not concentrated to the CBD**
- **Often employment is high in the center, but additional jobs may be widely dispersed throughout the city or some may be in secondary employment centers**
- **How do these different employment patterns affect the predictions of the model?**

Employment subcenters

- **The existence of another employment center would, in effect, generate another city joined to the original city**





Durable housing

- **Buildings usually last for decades and we often observe old buildings standing next to newer ones**
- **This may invalidate the predictions of the model as the newer buildings may be taller than older ones**
- **Thus, the spatial pattern of building height will depend on both location and construction date**
  - For buildings constructed at a given date, those farther from the CBD will be shorter
  - For buildings constructed at a given location, those constructed later can be either taller or shorter

Durable housing

- **CBD is built first and has the oldest housing stock**
- **The city then expands by adding blocks farther away from the CBD**
- **If improvement in construction technology leads to newer buildings being taller, we could observe taller buildings farther away from the CBD than near the CBD**
  - But this depends on the durability of buildings and what happens to the cost of adding extra floors to buildings
- **See Brueckner for an illustration**

Recap

- **The simple monocentric city model can be used to compare different types of cities**
- **It does not give as unambiguous predictions about segregation patterns, but does predict segregation**
  - Segregation patterns depend on the nature of commuting cost, neighborhood and housing quality, and transportation mode
- **Other extensions, such as secondary employment centers, freeways and durable housing, modify some of the predictions in interesting ways**