Urban Economics

Land Rent and Land Use Patterns

PART II
To assess the variation of housing prices within a city, we focus on commuting as the key determinant for residential location decisions.

Model assumptions:

- The cost of commuting is strictly monetary ($ per mile). Time cost will be ignored.
- One member of the household commutes to the employment area (CBD or manufacturing center).
- Noncommuting travel is insignificant.
- Same public services and taxes at all locations
- Same amenities at all locations.

Employment area is the focal point for commuting residents
First, we assume no consumer substitution. Every household occupies 1,000 square feet regardless of the price of housing.

Every household:

- has $800 to spend on housing and commuting
- spends $50 per mile per month on commuting

The price of housing is defined as the price per square foot of housing per month. A rent of $600 means a housing price of $0.60 ($600/1000 sq.f).
Land Rent
Linear Housing-Price Curve

FIGURE 6–6 The Housing-Price Curve Without Consumer Substitution

The price of housing decreases as the distance to the employment area increases, offsetting commuting costs and ensuring locational equilibrium for households. In the absence of consumer substitution, the housing-price curve is linear.

Source: O'Sullivan (2009)
Housing prices will adjust to ensure locational indifference among residents, or

\[ \Delta P \times h = \Delta x \times t = 0 \]

The change in housing cost equals the negative of the change in commuting cost:

\[ \Delta P \times h = -\Delta x \times t \]

To get the slope of the function, we divide by \( \Delta x \) and \( t \)

\[ \frac{\Delta P}{\Delta x} = -\frac{t}{h} = -\frac{50}{1,000} = -0.05 \]

see points e and d in figure 6-6
Real households obey the law of demand, consuming fewer square feet, when the prices increase. Why?

- As the price for housing rises (with proximity to the CBD), the opportunity cost of housing rise.
  - Residents lose more income for other consumption
  - Residents consume less square feet to spend more on consumption of other goods
Land Rent
Convex Housing-Price Curve

FIGURE 6-7  Consumer Substitution and the Price of Housing

Consumer substitution generates a convex rather than a linear housing-price curve. As the price rises, consumers substitute other goods for housing, so housing consumption (square feet of space) decreases, increasing the absolute value of the slope.

Source:
O'Sullivan (2009)
Consumer substitution increases the bid-rent curve for households, allowing them to bid more for land close to the CBD.

- The slope gets steeper

\[ \frac{\Delta P}{\Delta x} = - \frac{t}{h(x)} \]

\[ = - \frac{50}{500} = \$0.10 \]

- Housing consumption at \( x=5 \) is now 500 sqf, which increases the slope from -0.05 to -0.10
We use the **housing-price** curve to derive the **residential bid-rent** curve:

How much are **developers** willing to bid at different locations within the city (zero economic profit assumption)?

- Each firm builds houses of Q sqf on one hectare of land with $K worth of capital.
- The erected building can be divided into q units with Q/q sqf of living space each.
- E.g. a building with 5,000 sqf can be divided into 10 units with 50 sqf each.
Since the housing-price curves are convex, so are the bid-rent curves for firms (even without factor substitution).

The land bid rent of housing producers equals total revenue minus nonland cost. The bid-rent curve is negatively sloped and convex, reflecting the negatively sloped and convex housing-price curve. At $x = 11$, total revenue = total nonland cost, so the bid rent is zero.

Source: O'Sullivan (2009)
Extending the model: Factor substitution

As we approach the center, housing firms will build taller buildings and will occupy smaller lots to economize on land.

- The savings increase the willingness to pay for central locations
- The bid-rent curve becomes even more convex
- Population density increases stronger around employment centers

The intensity is determined by two forces:

**Consumer substitution**: Households substitute land and occupy less space in the center.

**Factor substitution**: Housing firms also respond to higher land prices by using less land per unit of housing.
Relaxing the assumptions leads to more realistic settings:

1. **Time cost**: Commuting creates opportunity cost, since it comes at the expense of work or leisure time. The higher the opportunity cost of travel, the steeper the housing price curve and the bid-rent curve.

2. **Households**: We find constantly increasing proportions of two-earner households, which leads to two commuters and stronger effects on travel behavior.
   - A common workplace doubles the cost and increases the housing-price slope.
   - Different workplaces cause ambiguous effects
Relaxing the assumptions leads to more realistic settings:

3. **Noncommuting travel**: If the destinations are concentrated, there are stronger effects on the prices around shopping, entertainment, and other opportunities.

4. **Public services and taxes**: Differences in public services such as schools, taxes or infrastructure cause local peaks at the level of certain neighborhoods or central stations outside the traditional CBD.

5. **Amenities**: Differences in amenities such as attractive architecture, air quality or scenic views affect location decisions of residents and affect housing-price and bid-rent curves.
Different land users have generate different bid-rent curves. This allows us to model a city’s equilibrium land-use pattern.

We assume three types of land-use:
- office firms
- manufacturers
- residents

We assume the following features of local infrastructure:
- manufacturers use trucks to move goods
  - main highway leads through the city center and a beltway leads around it.
- office firms exchange information in the CBD
- residents work in firms and offices and travel by car to their workplaces.
Land Use Patterns

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**FIGURE 6–9** Panel A: Bid Rent of the Office Sector
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FIGURE 6–9 Panel B: Bid Rent of the Manufacturing Sector
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FIGURE 6-9 Panel C: Maximum Bid Rent of Employers
**Land Use Patterns**

*Introduction*

**FIGURE 6–10** Bid Rents and Land Use Patterns

The equilibrium land-use pattern is determined by the bid-rent curves of firms and residents. The CBD is the area over which office firms outbid other users (from $x = 0$ to $x_1$). The area between $x_1$ and $x_2$ is occupied by residents who work in the CBD. Manufacturing workers live in the areas between $x_2$ and $x_3$ and $x_5$ and $x_6$. Manufacturers occupy the area between $x_3$ and $x_5$. 