

# Lecture 10: Modelo Hedónico

## Urban Economics

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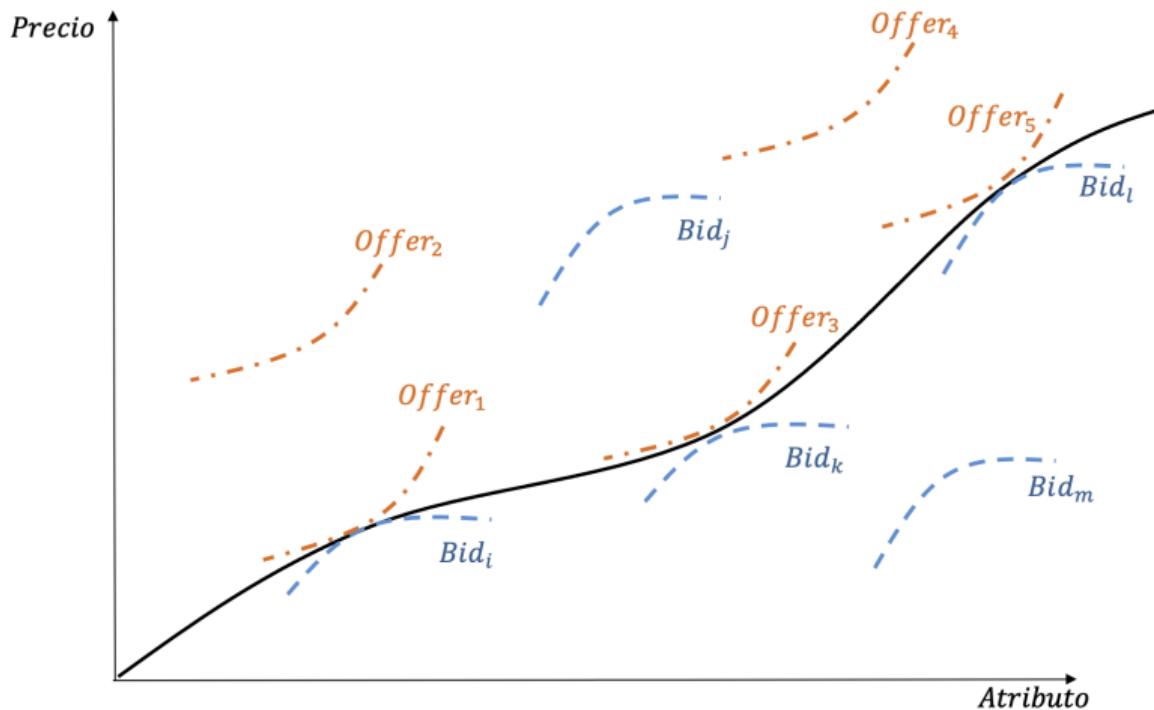
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# Rosen's Hedonic Model

- ▶ Goods are valued for their utility-bearing attributes
- ▶ Heterogeneous or differentiated goods are products whose characteristics vary in such a way that there are distinct product varieties even though the product is sold in one market (e.g. houses, cars, computers, etc).
- ▶ The variation in product variety gives rise to variations in product prices within each market.
- ▶ The hedonic method relies on market transactions for these differentiated goods to determine the implied value or implicit price of characteristics.

# Market Equilibrium



# Market Equilibrium

- ▶ The market hedonic function  $p(z)$  is a joint envelope
  - ▶ Upper envelope of consumer's bid functions
  - ▶ Lower envelope of producer's offer functions
- ▶ Quantities demanded and supplied at each  $z$  depend on all of  $p(z)$

# Empirics

- ▶ Rosen (1974) proposed a two-step empirical strategy
  - 1 Estimate hedonic prices  $p(z)$  with the best fitting functional form
  - 2 Take partial derivatives of the estimate  $\hat{p}(z)$  at the sample values and estimate the simultaneous demand and supply equations

$$\frac{\partial p}{\partial z_i} = F_i(z, x^d, y - p(z)) \quad (1)$$

$$\frac{\partial p}{\partial z_i} = G_i(z, x^s, p(z)) \quad (2)$$

- ▶ Full of problems

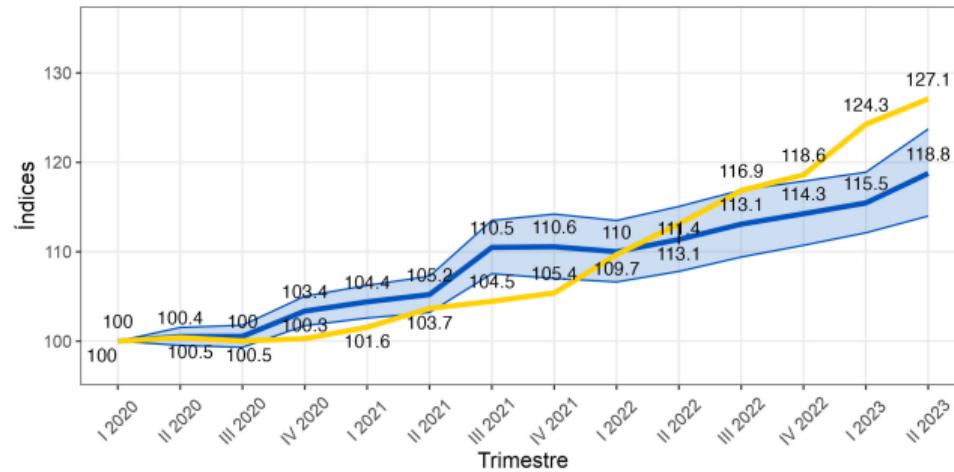
# Hedonic Price Function

$$P_i = \beta_0 + \sum_{j=1}^h \beta_j H_{ij} + \sum_{k=1}^n \beta_k N_{ik} + u_i \quad (3)$$

- ▶  $P$  the sales price of a house;
- ▶  $H$  represents structural and property characteristics of the house (e.g. square footage of the living area, lot size, etc)
- ▶  $N$  represents location characteristics, (e.g. quality of schools, distance to CBD, parks, etc.)

# House Price Indices

- The most common approaches for constructing house price indices are hedonic price functions and the repeat sales estimator



# House Price Indices

- ▶ Both estimators
  - ▶ Focus on changes over time in mean prices.
  - ▶ Are designed to measure the expected sale price of a home after controlling for features of the structure and location.
- ▶ Hedonic price functions control directly for structural and locational characteristics by including them as explanatory variables in the estimated regression.
- ▶ The repeat sales approach controls for these variables more indirectly by restricting the analysis to properties that sold at least twice during the sample period.

# Hedonic price functions

$$\log(P)_{it} = \sum_{t=1}^T \delta_t D_{it} + \sum_{j=1}^h \beta_j H_{ij} + \sum_{k=1}^n \beta_k N_{ik} + u_{it} \quad (4)$$

- ▶  $\log(P)_{it}$  represents the natural logarithm of the sale price of house  $i$  at time  $t$  ( $t = 1, \dots, T$ ),
- ▶  $D_{it}$  is a variable indicating the house  $i$  sold at time  $t$ ,
- ▶  $H$  represents structural and property characteristics of the house (e.g. square footage of the living area, lot size, etc)
- ▶  $N$  represents location characteristics, (e.g. quality of schools, distance to CBD, parks, etc. )

# Hedonic price functions

## ► Advantages

- Produces a quality-adjusted index by including controls for observable characteristics of the house and location
- Leverages large sample sizes available for home sales over time.

# Hedonic price functions

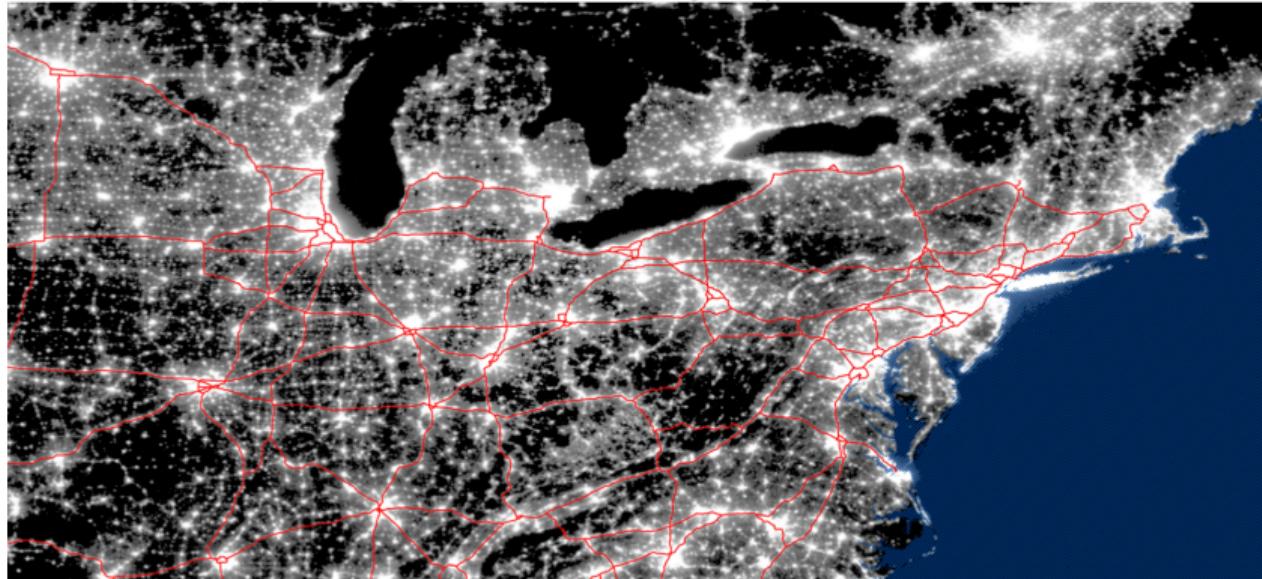
## Problems

- ▶ Market definition

# Hedonic price functions

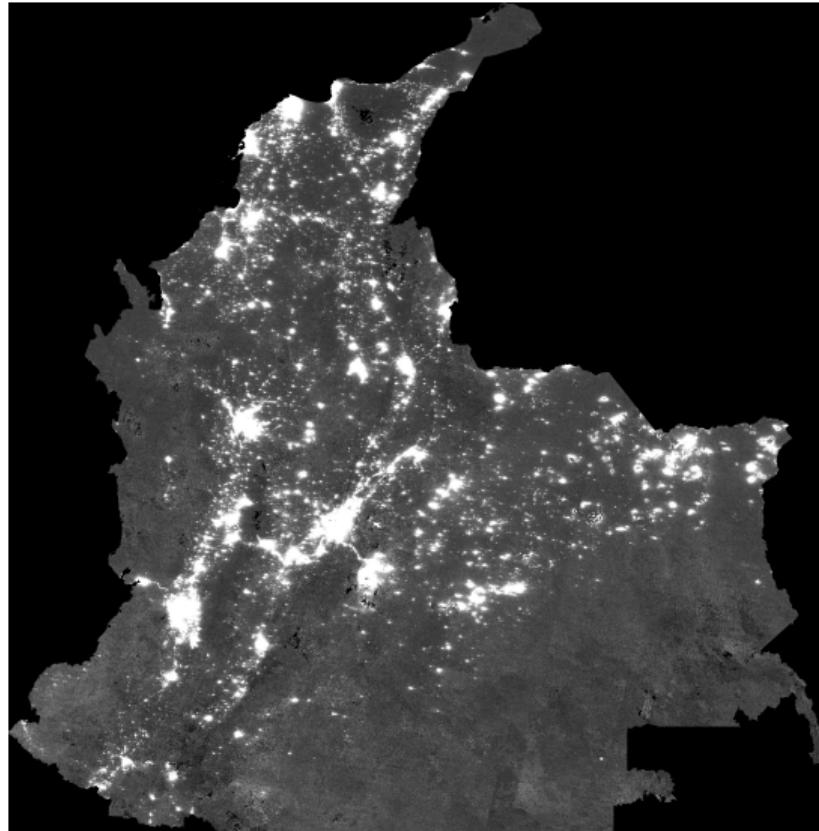
## Problems

Figure 1: Lights at night and Interstate Highways in the Northeast US, 2007.



# Hedonic price functions

## Problems



# Hedonic price functions

## Problems

- ▶ Market definition
- ▶ The model's conceptual logic implies that the market should be chosen to satisfy the **"law of one price function"**
- ▶ That is, when a house can be fully defined by a unique bundle of physical characteristics and location-specific amenities, then equivalent bundles sell for the same price throughout that market.
- ▶ A common approach is to define the market as a single metropolitan area over a few years (e.g. Pope 2008b, Abbott and Klaiber 2013).

# Hedonic price functions

## Problems

### ► Functional form

- Need to specify a functional form and the possibility that omitted variables may affect the results. (Functional form misspecification can also be viewed as a form of omitted variables.)
  - Theoretical and simulation evidence suggest that the hedonic price function should be assumed to be nonlinear (Ekeland, Heckman, and Nesheim, 2004).
  - Kuminoff, Parmeter, and Pope (2010) found that flexible Box-Cox models continue to outperform linear models

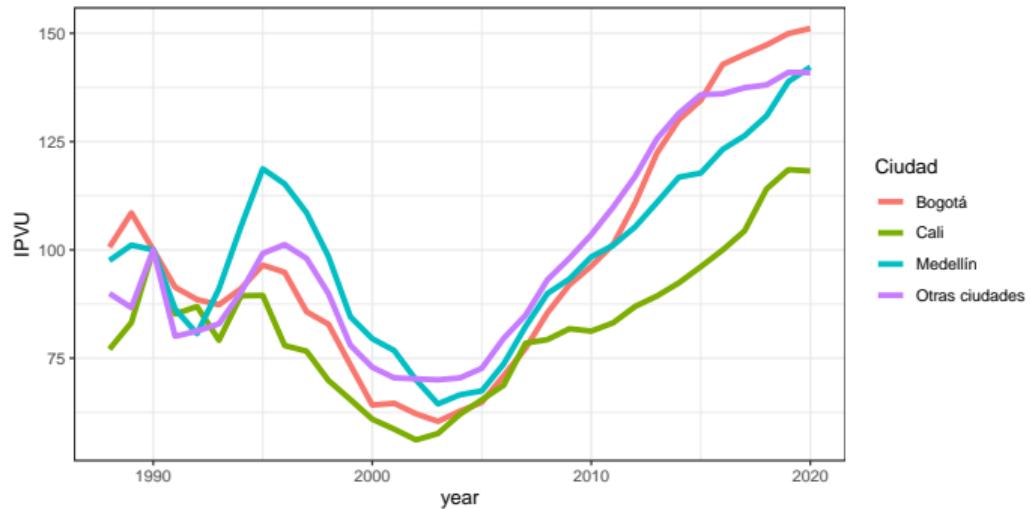
# Hedonic price functions

- ▶ Sample selection

- ▶ A key question in price indices is whether  $D_{it}$  are correlated with  $u_{it}$ 
  - ▶ If the sample of sales in a time period tends to be composed of unusually high- or low-quality homes— i.e., homes with high or low average values for X—then the effect of the missing variables will be to bias the estimated value of  $\delta_t$  upward or downward.

# Repeat sales estimator

- Repeat sales approach attempts to control for the effects of missing variables by restricting the analysis to the set of homes that sold at least twice during the sample period (Bailey, Muth and Nourse 1963, Case and Shiller 1987, 1989).



## Repeat sales estimator

- ▶ The Indice de Precios de la Vivienda Usada (IPVU) estimated by BanRep uses the repeat sales approach proposed by Case and Shiller (1989)
- ▶ Built in 3 stages using properties sold at least twice
- ▶ Case and Shiller (1989) model the price behavior as

$$\ln(P_{it}) = \beta_t + H_{it} + N_{it} \quad (5)$$

- ▶  $\beta_t$  is the log of the citywide level of housing prices at time  $t$
- ▶  $H_{it}$  is a gaussian random walk (where  $\Delta H_{it}$  has zero mean and variance  $\sigma_h^2$ ) and uncorrelated with  $C_t$ . Represents the deviation of a particular house from the market price
- ▶  $N_{it} \sim_{iid} N(0, C)$  are idiosyncratic differences