Week 3: The Urban Housing Market, Structures and Density.

- Hedonic Regression Analysis.
- Shadow “prices” versus marginal costs.
- Land value maximizing FAR.
- FAR and Urban Redevelopment.
- Land Use competition: Highest Price for Housing – versus – highest use for land

Urban Housing

- Great diversity from historical evolution, changes in technology and tastes.
- Multiple attributes to each house: size, baths, exterior material, style….location
- Consumers value each of these attributes with the normal law of micro-economics: diminishing marginal utility.
- Huge industry has evolved to applying statistical models to understand and predict diverse house prices:
  - Property Tax appraisals.
  - Automatic Valuation Services for lenders, brokers…

Hedonic Regression Analysis

1). Linear:

$$R = \alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \ldots$$

X's are structural, location attributes

2). Log Linear:

$$R = e^{[\alpha + \beta 1X1 + \beta 2X2 + \beta 3X3 + \ldots]}$$

$$\ln(R) = \alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \ldots$$

3). Log Log:

$$R = \alpha X_1^{\beta 1} X_2^{\beta 2} X_3^{\beta 3} \ldots$$

$$\ln(R) = \ln(\alpha) + \beta_1 \ln(X_1) + \beta_2 \ln(X_2) + \ldots$$

Dallas apartment rent Hedonic equation: 1998

Regression Statistics	
Multiple R	0.90518672
R Square	0.819363
Adjusted R Square	0.81899567
Standard Error	0.14378576
Observations	7885

ANOVA

	df	SS	MS	F	ignificance F
Regression	16	737.8460495	46.11538	2230.561	0
Residual	7868	162.6657463	0.020674		
Total	7884	900.5117958			

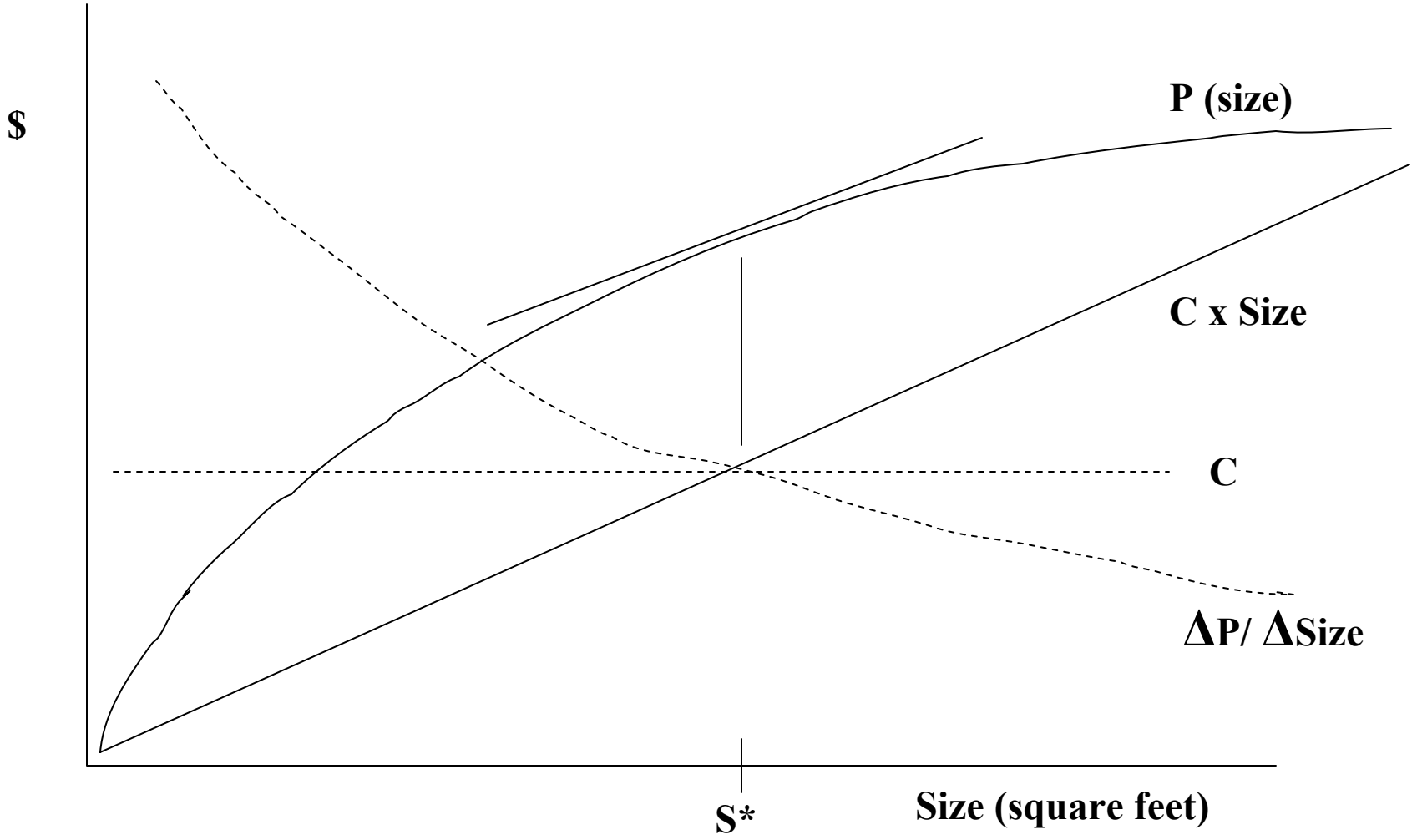
	Coefficients	Standard Error	t Stat	P-value	Lower 95%	pper 95%	ower 95.0
Intercept	-0.57141659	0.176232118	-3.24241	0.00119	-0.9168784	-0.22595	-0.91688
#BED	-0.00076159	0.004946816	-0.15395	0.877649	-0.0104587	0.008935	-0.01046
#BATH	0.04799528	0.005624626	8.533063	1.69E-17	0.0369695	0.059021	0.03697
LnSQFT	0.6432852	0.012443205	51.69771	0	0.6188932	0.667677	0.618893
1/FAR	0.09504048	0.005839225	16.27621	1.31E-58	0.083594	0.106487	0.083594
LnAGE	-0.08762126	0.00195439	-44.8331	0	-0.0914524	-0.08379	-0.09145
LnPARK	0.09666656	0.00533756	18.11063	7.46E-72	0.0862035	0.10713	0.086204
#POOL	-0.03185748	0.001586528	-20.08	1.67E-87	-0.0349675	-0.02875	-0.03497
RCA	0.00732288	0.000715092	10.24048	1.86E-24	0.0059211	0.008725	0.005921
SEC	0.01631909	0.002140012	7.625699	2.71E-14	0.0121241	0.020514	0.012124
WD	0.00775154	0.002556777	3.031761	0.002439	0.0027396	0.012764	0.00274
APP	0.02115624	0.001660838	12.73829	8.35E-37	0.0179006	0.024412	0.017901
FP	0.0181616	0.004472787	4.060466	4.94E-05	0.0093937	0.026929	0.009394
DEN	0.02276466	0.006928009	3.285888	0.001021	0.0091839	0.036345	0.009184
INT	0.00872255	0.001784347	4.88837	1.04E-06	0.0052248	0.01222	0.005225
LnHome$	0.17170179	0.005361375	32.0257	1.2E-211	0.1611921	0.182212	0.161192
LnSAT	0.01175916	0.019835531	0.592833	0.55331	-0.0271238	0.050642	-0.02712

LOG/LOG; verify White Settlement, Rockwall and Ft. Worth HOME$; all observations;

Optimizing House Configuration

- Builders and developers compare the incremental value of additional house features against their incremental cost.
- Profit maximizing house: where the cost of an additional square foot, bath, fireplace falls to the marginal cost of construction.
- But what about land, lot size, density or FAR?
  - FAR: floor area ratio (ratio of floor to land area).
  - Density: units per acre.
  - Density x unit floor area = FAR
  - % of lot “open” = 1-(FAR/stories) (stories>FAR)

Optimizing House price (P) minus construction cost (C) as a function of square feet



Optimizing FAR

1). $P = \alpha - \beta F$

α = all housing and location factors besides FAR

F = FAR

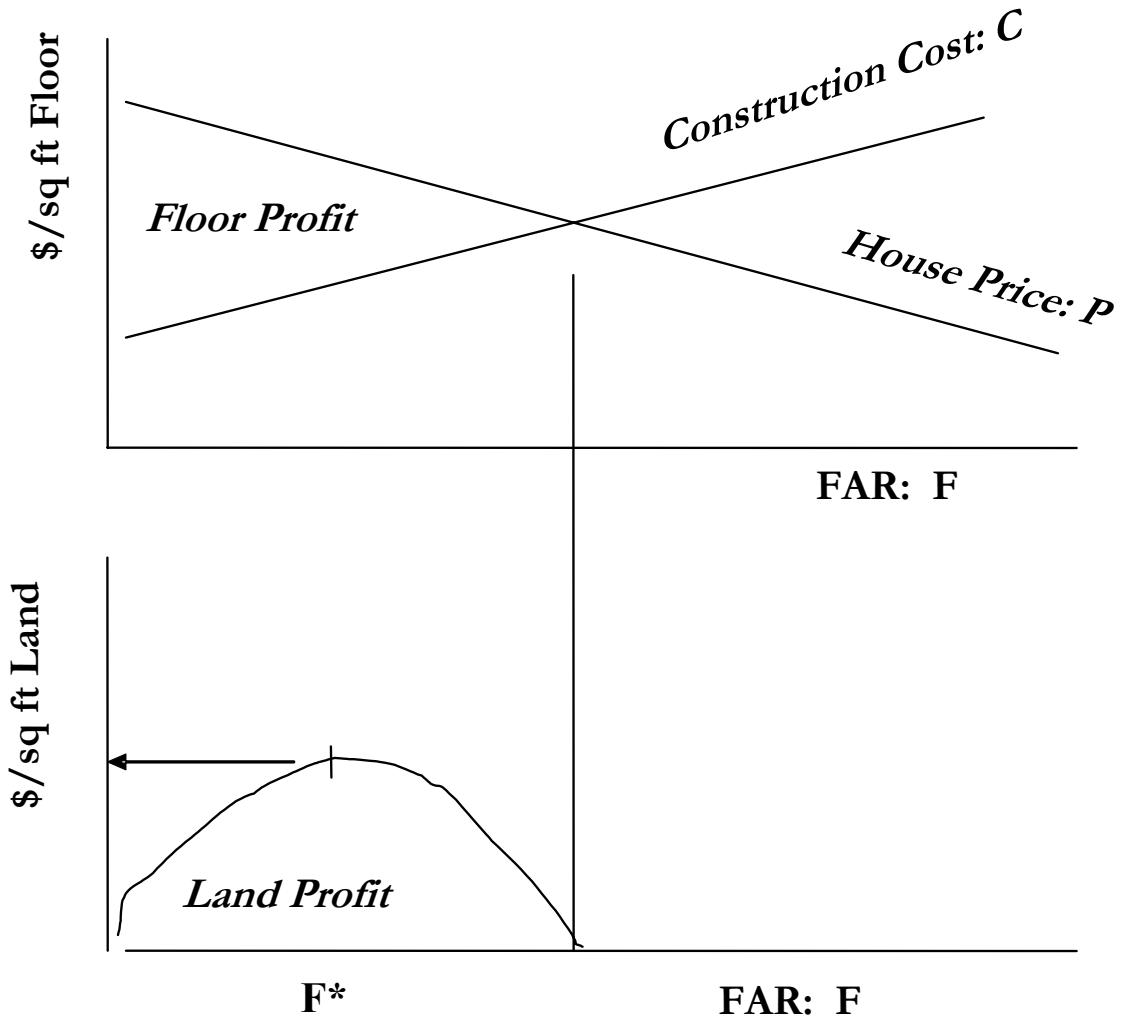
β = marginal impact of FAR on price per square foot.

2). $C = \mu + \tau F$

μ = "baseline" cost of "stick" SFU construction

τ = marginal impact of FAR on cost per square foot

If each unit of floor are is unprofitable then so is land – regardless of FAR. As FAR approaches zero, land profit is zero no matter how profitable floor area.



3). $p = F\,[\,P - C] = F[\alpha - \mu] - F^2[\beta + \tau]$

4). $\partial p/\partial F = [\alpha - \mu] - 2F[\beta + \tau] = 0$, or

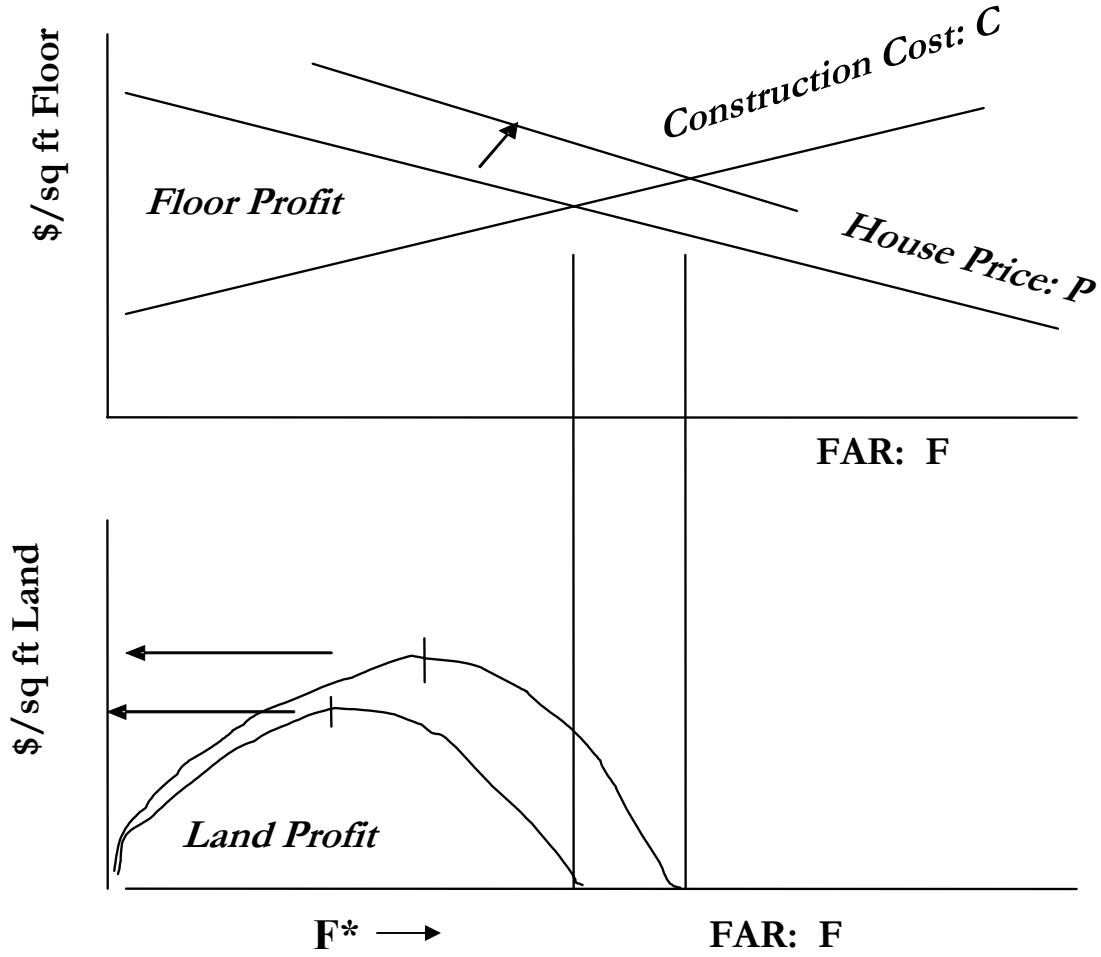
$F^* = [\alpha - \mu] / 2[\beta + \tau]$, and

$p^* = [\alpha - \mu]^2 / 4[\beta + \tau]$

5). How do prices and FAR vary by:

- Location
- Other factors that shift the parameters

At "better" locations, the price of housing at any FAR is higher. This yields a substitution of capital for land and the optimal FAR rises.



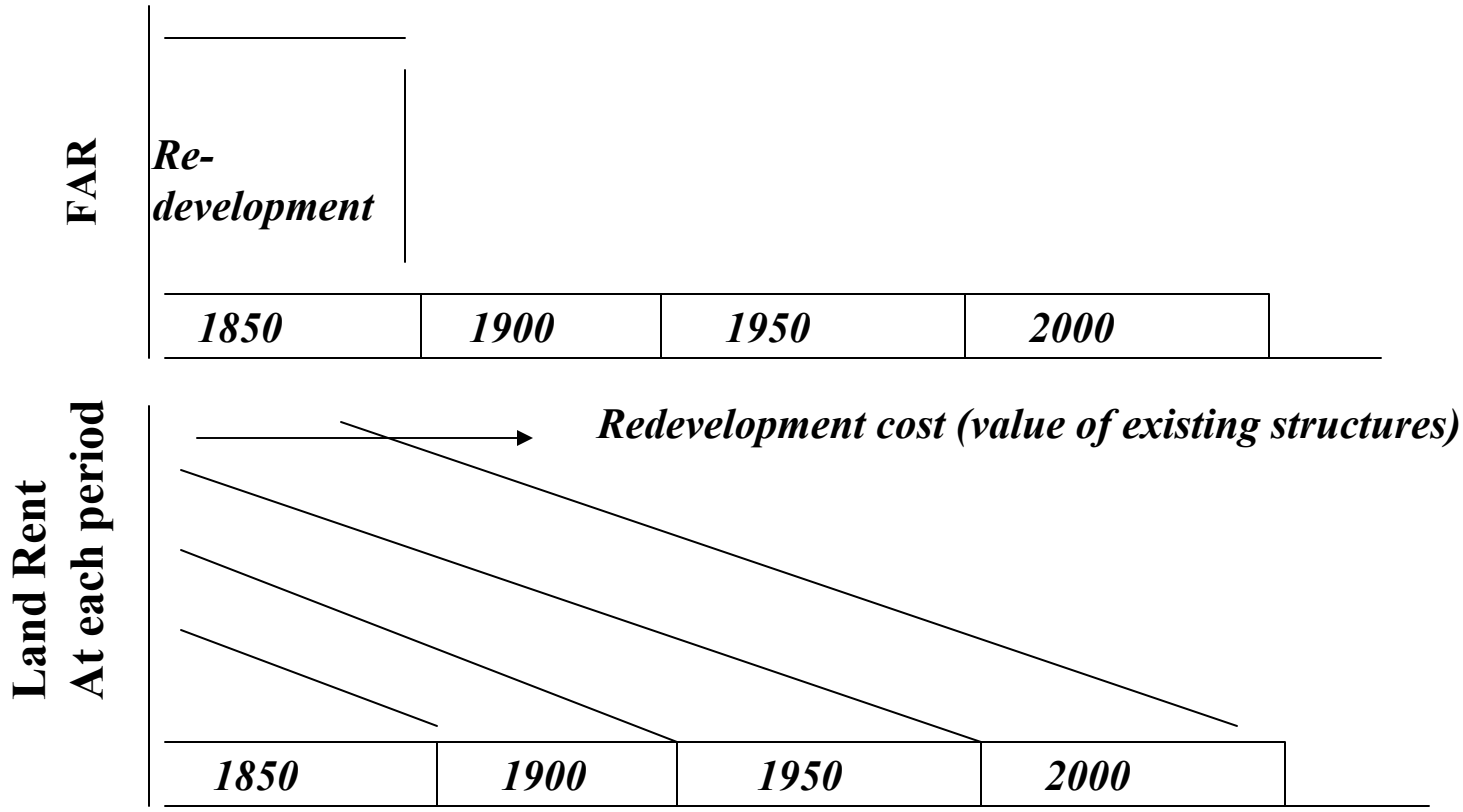
Boston Back Bay Condominium Example

- From 1984 regression: R = 222 – 1.48F, for new 2-bed, 2-bath with parking on Beacon hill. (178-1.48F for end of Commonwealth Ave.
- Construction costs: C = 100+2F
- F* = 17.5, p* = 46million (per acre)
- At F of 4.0, 2-bed, 2-bath existing land has value of 10.6 million (1/4 as much!)

How does land use "evolve"?

- **City Development evolves from the center outward – on vacant land at the edge.**
- **At each time period, there is a "shadow" value for interior land that is already built upon.**
- **When does that "shadow" value exceed the entire value of the existing structures?**
- **Fires, disasters create vacant land – shaping development**
- **Gentrification? [Helms]**

The spatial Pattern of Economic Redevelopment



Economic Redevelopment

6). The sunk cost of existing structures generates a barrier to the smooth adjustment of FAR.

7). Rarely do we see incremental FAR increases. Rather old uses are destroyed and replace with new.

8). Existing "older" structures:

$P_0 = \alpha_0 - \beta F_0$

δ = demolition cost per square foot

F_0 = FAR of existing use

$p_0 = F_0 [\alpha_0 - \beta F_0]$:land acquisition cost

9). $p^* - p_0 > \delta F_0$ implies

$F^*(\alpha - \beta F^*) - F_0(\alpha_0 - \beta F_0) > \delta F_0 + F^*(\mu + \tau F^*)$

"increase in value of land and capital" > "demolition plus development cost"

Most likely if $\alpha > \alpha_0$ (existing capital deteriorated)

$F^* > F_0$ (new use much more dense)

See: [Rosenthal and Helsley].

Boston Back Bay Condominium Example (continued)

- Assume that historic properties have 75% of the structure value versus new. Hence the value of 1 acre of 4-story brownstones is:

  4 x [166.5-1.48x4] x 43560 = 27m

- Thus even with significant demolition costs the current historic stock might be ready for "market demolition".
- Ocean Front in LA? Mid Ring Tokyo?
- The lower existing FAR – the less the opportunity cost of redevelopment.

Land competition between groups

10). $P_i = \alpha - k_i d - \beta_i F$

d = distance from desirable location

F = FAR

i = 1,2 (different household types)

$k_1 > k_2$, $\beta_1 > \beta_2$

i.e. 1's value location more and mind FAR more (value lot size more).

11). $\partial P_i / \partial d = - k_i$ hence P_1 steeper than P_2 (previous lecture on location of groups)

11). $p_i = \max_F: F[\alpha - k_i d - \beta_i F - (\mu + \tau F)]$

$$F_i^* = [\alpha - k_i d - \mu] / 2[\beta_i + \tau] ,$$

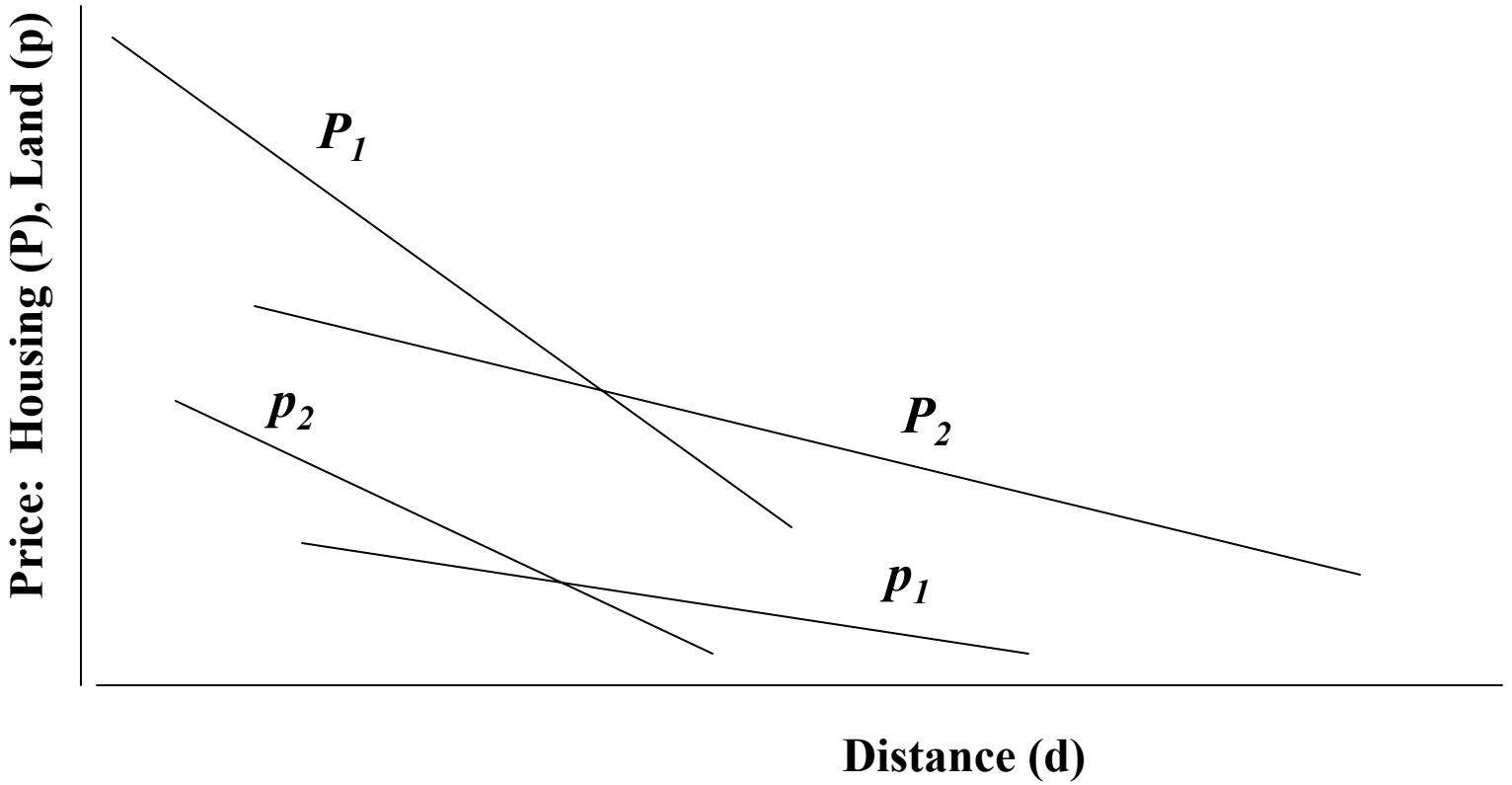
$$p_i^* = [\alpha - k_i d - \mu] F_i^* / 2$$

since $\beta_1 > \beta_2$, $F_1^* < F_2^*$

12). $\partial p^*_i / \partial d = - k_i F_i^*$

Even though P_1 is steeper than P_2 it could be the case that p^*_1 is less steep than p^*_2

Group 1 is willing to pay the most for houses (P) near the center, but group 2 is willing to pay the most for central land (p) - it is the most profitable group to develop central land for.



Examples of location and land bidding between groups

- Miami Waterfront has high rise condos populated by elderly who are never on the beach. Those on the beach (younger families) live inland!
- Why would wealthy families live in the center of Paris or Rome, but at the edge of Boston or Atlanta (with a few exceptions)?

NY Land Residuals: Highest Use?

Location	Office				Condo			
	F	*P*	*C*	*p*	*F*	*P*	*C*	*p*
Downtown	20	220	250	(-)	6	524	350	1050
Midtown	20	376	250	2500	20	594	350	4800
Conn	4	225	150	300	2	350	200	300
NNJ	4	180	150	120	2	242	200	84

Sales data from the Internet, Costs from RS Means.