Modeling Real Estate Supply

Webinar 7 of an 8-part TMIP Webinar series on land use forecasting methods.

Paul Waddell, 2011

Land Use Forecasting Webinar Series

1. The Evolving State of the Practice
2. Land Use Theory and Data
3. Scenario Planning and Visioning (I-PLACE3S)
4. Spatial Input-Output Frameworks (PECAS)
5. Dynamic Microsimulation (UrbanSim)
6. Modeling Real Estate Demand
7. Modeling Real Estate Supply
8. Scenario Planning and Visualization

2

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1. Connecting Demand and Supply: Prices

2. Three Approaches to Modeling Real Estate Supply
3. A Behavioral Approach to Real Estate Development

1. Theory of Hedonic Prices
2. The Hedonic Regression Model
3. Empirical Example

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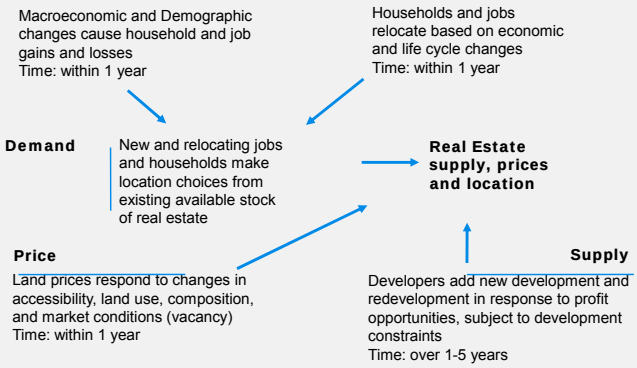
Real Estate Demand, Supply and Prices



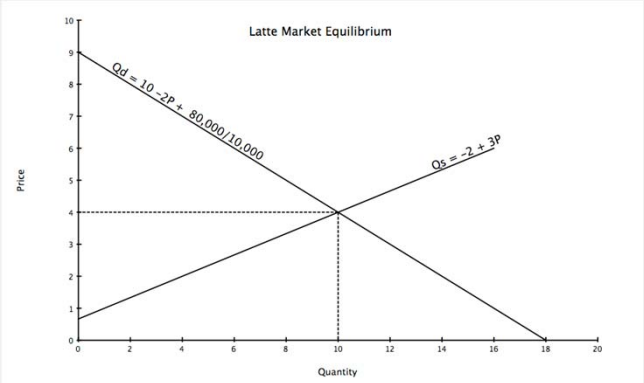
Where do Prices Come From?

- Why is housing in San Francisco so much more expensive than Phoenix?
- How much of a premium is there for homes in good school districts?
- How much does a water view add to the price of a house in the Bay Area?
- How much does a superfund site reduce property values around it?

- These are the kinds of questions that hedonic regression is designed to help answer

Where do Prices Come From?

- Aggregate perspective from micro-economics:
  - Prices are determined at equilibrium: where demand equals supply
  - We usually see the standard demand - supply graph with a unique equilibrium
  - The markets are for homogeneous commodities like corn, wheat, lattes...



Hedonic Price Theory: Key Ideas

- Housing is a composite good - when you buy a house you buy a 'bundle'
- There are no markets for components:
  - bathrooms, garages, kitchens, views
- But people value these components - so need a model of the implicit markets for housing components, looking at the statistical relationship to total price
- In essence, 'unpack' total price into a sum of implicit prices for components

Hedonic Price Theory: The Literature

- Key citations to seminal contributions and more recent synthesis:
  - Zvi Griliches, Hedonic price indices for automobiles: an econometric analysis of quality change. In: Griliches, Editor, Price Indexes and Quality Change, Harvard, Cambridge, Massachusetts (1971).
  - Sherwin Rosen, “Hedonic Prices and Implicit Markets,” Journal of Political Economy, 82(1), 1974: 334-55.
  - Stephen Sheppard, “Hedonic Analysis of Housing Markets,” in Paul Cheshire and Edwin S. Mills, eds., Handbook of Urban and Regional Economics, 3, North Holland, 1999: 1560-1594.
- Hedonic price models have become the ‘standard’ research tool to analyze impacts of (fill in the blank) on housing prices, and for generating price indices
- A Google Scholar search on the keywords ‘hedonic price’ generates 46,900 hits

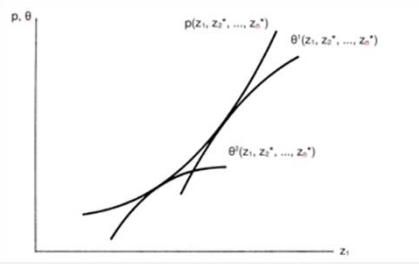
Housing Preferences

- What is the value of a 1920’s tudor architectural style?
- Is it the same for everyone?
- Tastes are idiosyncratic: vary by individual, and we really don’t know where they come from
- Still - if someone likes a feature, they will be more motivated to pay for it (within their budget constraints)

Hedonic Price Theory: Demand and Supply

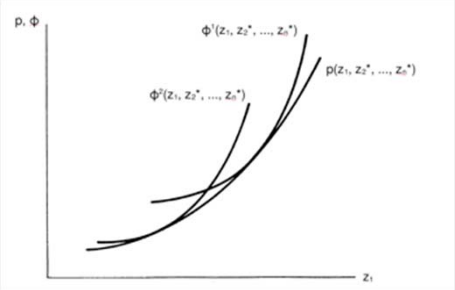
- Individual Demand Curves and the principle of diminishing marginal returns
  - Preferences are expressed by the 'utility' that a consumer derives from a good
  - when you consume more of something, at the margin, it offers less and less utility for more and more consumption.
  - Compare the utility of the 1st slice of pizza when you are hungry, to the 5th slice...
  - The shape of such a marginal utility response to additional consumption would rise rapidly at first, then taper off, and possibly begin to fall after some level
- Producer's Supply Functions and increasing costs of production
  - Utility for producers is profit
  - Profit is the residual of price less the cost of production
  - Cost of production usually has an optimal 'economy of scale', beyond which the costs increase more rapidly per unit of production
  - E.g. imagine trying to scale up production at a coffee shop by hiring more and more baristas to work in the same limited space...
  - Or a housing developer having to go to higher and higher density - up to high-rise.

Hedonic Theory



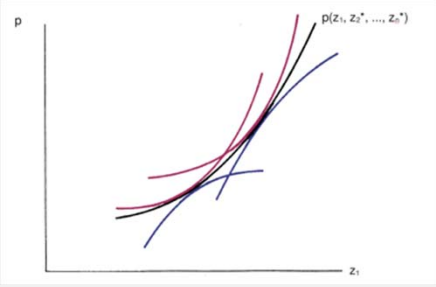
- Individual demand functions tangent to the market (equilibrium) price function - note diminishing marginal willingness to pay

Hedonic Theory



- Individual supply functions, tangent to market price function - note increasing costs

Hedonic Theory



- Hedonic Price Function is the envelope of individual demand and supply functions, meet where:
- buyers marginal willingness to pay = sellers marginal willingness to supply

1. Theory of Hedonic Prices
2. The Hedonic Regression Model
3. Empirical Example

Hedonic Regression Model

$$Y = X\beta + \varepsilon$$

- Y = vector of response variables (n x 1)
- X = matrix of predictor variables (n x p)
- β = vector of model coefficients (p x 1)
- ε = vector of normally-distributed errors (n x 1)

- n = number of cases
- p = number of model parameters

Can use Ordinary Least Squares to calculate the β matrix as:

$$\beta_{est} = (X^T X)^{-1} X^T Y$$

Some Typical Problems

- Finding data and selecting the right variables
- Using discrete / categorical / qualitative data
- Heteroskedasticity
- Nonlinearity
- Outliers
- Collinearity
- Omitted variables bias
- Considerations of supply and demand

Data Sources

- Property tax assessor records of sales transactions
- Real estate broker data (see www.redfin.com or www.zillow.com for examples)
- National housing surveys
- Specialized data sources

Which Variables to Use?

- Some theory will help, but depends on empirical results
- Cautions
  - Easy to over-fit, using kitchen sink approach
  - Easy to go ‘fishing’ for the results you want
  - Collinearity and omitted variable bias

1. Theory of Hedonic Prices
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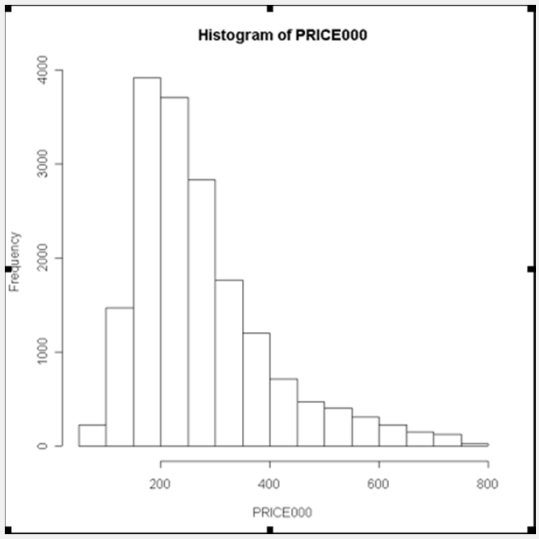
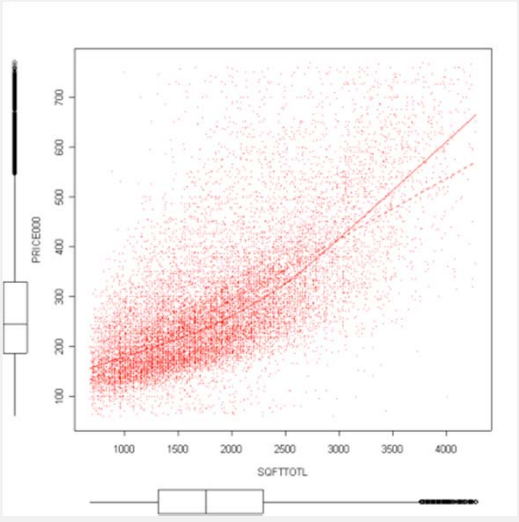
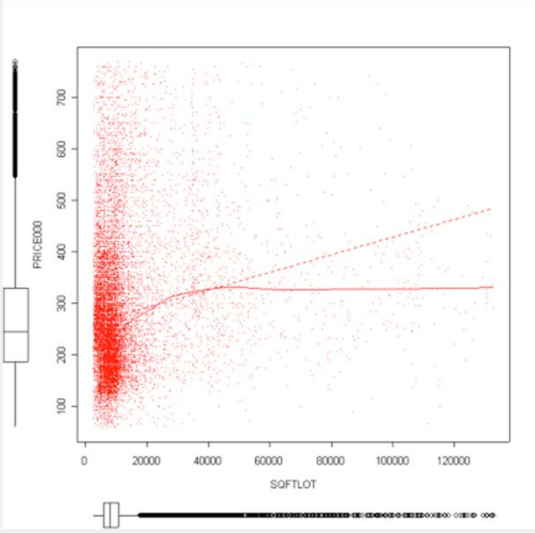
An Empirical View From Seattle: Housing Sales



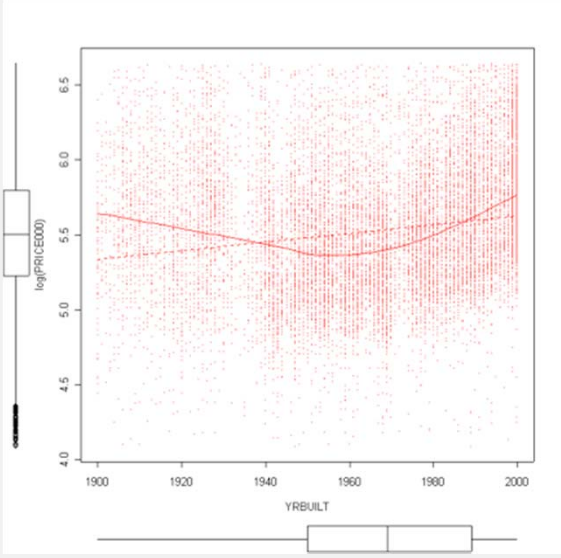
Price vs Sqft



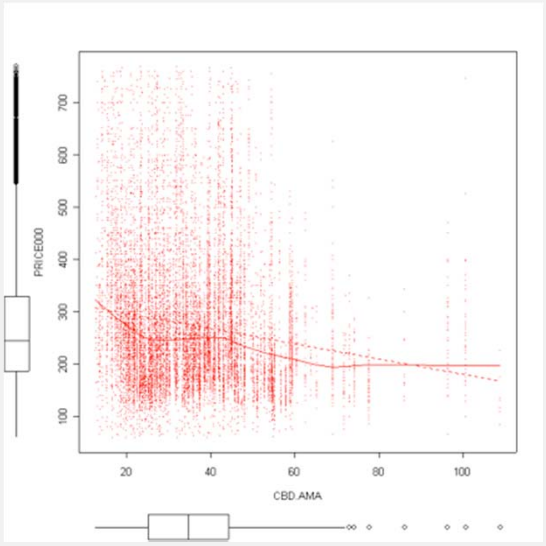
Price vs Sqft Lot



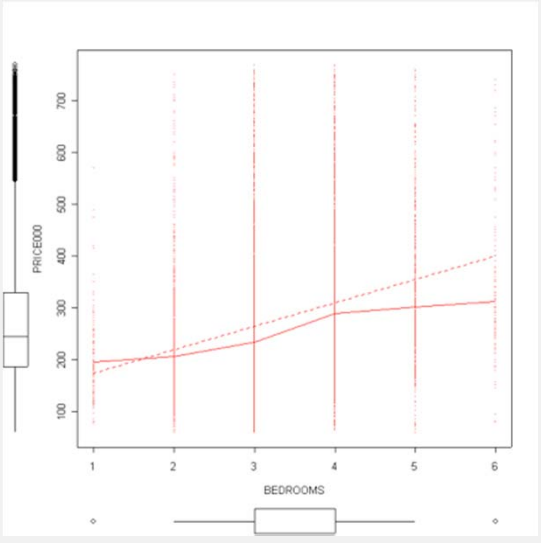
Price vs Year Built



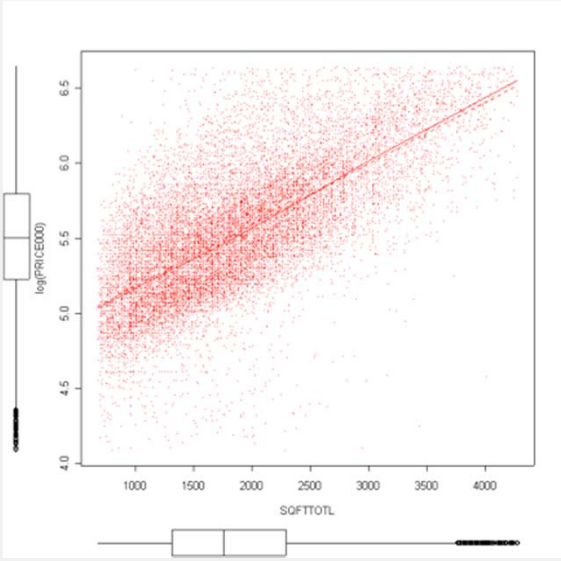
Price vs Travel time to CBD



Price vs Bedrooms



log(Price) vs Sqft



Simple Regression: Price on Sqft of House

```
lm(formula = PRICE000 ~ SQFTTOTL)


Coefficients:
             Estimate Std. Error t value Pr(>|t|)
(Intercept) 5.044e+01  1.952e+00   25.84   <2e-16 ***
SQFTTOTL    1.216e-01  9.825e-04  123.73   <2e-16 ***


Residual standard error: 92.53 on 17556 degrees of freedom
Multiple R-Squared: 0.4658,     Adjusted R-squared: 0.4658
```

Regression 2: add Travel Time to CBD

```
lm(formula = log(PRICE000) ~ SQFTTOTL + CBD.AMA)


Coefficients:
             Estimate Std. Error t value Pr(>|t|)
(Intercept)  5.035e+00  7.750e-03  649.70   <2e-16 ***
SQFTTOTL     4.414e-04  3.137e-06  140.71   <2e-16 ***
CBD.AMA     -9.143e-03  1.635e-04  -55.93   <2e-16 ***

Residual standard error: 0.2849 on 16907 degrees of freedom
Multiple R-Squared: 0.5513,     Adjusted R-squared: 0.5513
```

Regression 3: add Sqft of Lot

```
lm(formula = log(PRICE000) ~ SQFTTOTL + CBD.AMA + SQFTLOT)


Coefficients:
              Estimate Std. Error t value Pr(>|t|)
(Intercept)  5.050e+00  7.731e-03  653.28   <2e-16 ***
SQFTTOTL     4.299e-04  3.180e-06  135.19   <2e-16 ***
CBD.AMA     -9.969e-03  1.689e-04  -59.03   <2e-16 ***
SQFTLOT      3.100e-06  1.786e-07   17.36   <2e-16 ***

Residual standard error: 0.2824 on 16906 degrees of freedom
Multiple R-Squared: 0.5592,     Adjusted R-squared: 0.5591
```

Regression 4: add Bedrooms

```
lm(formula = log(PRICE000) ~ SQFTTOTL + CBD.AMA + SQFTLOT +
BEDROOMS)


Coefficients:
              Estimate Std. Error t value Pr(>|t|)
(Intercept)  5.151e+00  9.901e-03  520.25   <2e-16 ***
SQFTTOTL     4.655e-04  3.857e-06  120.69   <2e-16 ***
CBD.AMA     -9.835e-03  1.678e-04  -58.60   <2e-16 ***
SQFTLOT      2.882e-06  1.778e-07   16.21   <2e-16 ***
BEDROOMS    -5.186e-02  3.225e-03  -16.08   <2e-16 ***

Residual standard error: 0.2803 on 16905 degrees of freedom
Multiple R-Squared: 0.5658,     Adjusted R-squared: 0.5657
```

Reminder: interpret variables with respect to all other variables in the model

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2. **Three Approaches to Modeling Real Estate Supply**
3. A Behavioral Approach to Real Estate Development

Real Estate Development

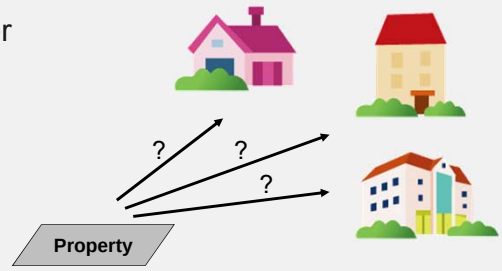
- "Why Don't we Know More About Housing Supply" (Dipasquale, 1999):
  - Diverse agents and complicated decision making process: Land owners, builders, investors
  - Poor data availability
- Development takes place over long time periods
- Supply commitments may badly miss changes in the market
  - Boom and bust cycle
  - Path dependence
- Real estate development influenced by myriad local, state and federal regulations, taxes, fees, permitting and review processes
- … and by NIMBYism

Models of Real Estate Development

- Real Estate Transition Model
  - Site looking for a use; highest and best use
- Project Location Choice Model
  - Use looking for a site; Site selection problem
- Project Proposal Sampling Model
  - proposals competing on profitability

Real Estate Transition Model

- State transition model
  - Perspective of a land owner
  - Land/site looking for use
  - Emphasizes local and neighboring attributes



- Generally uses gridcell or parcel as unit of analysis

- Applications: CUF (Landis and Zhang, 1998); ILUTE (Miller et al., 2004); UrbanSim (Waddell et al., 2000, 2002); Land cover change models, e.g. SLEUTH

Real Estate Transition Model

- Decision makers: Land / Land Owners
- States/alternatives: Land use types, Development types
- Model Framework:
  - Discrete Choice Model
  - Cellular Automata
- Development Constraints: filtering choices included in alternative set

Real Estate Transition Model

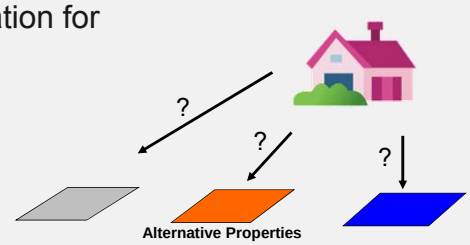
- Waddell and Ulfarsson, 2003. Dynamic Simulation of Real Estate Development and Land Prices within an Integrated Land Use and Transportation Model System
  - Decision makers: developable gridcells
  - Alternatives: no build + 24 development types
  - Model stratified by current development type: vacant land
  - Land use regulation on a gridcell limits its alternatives
  - Quantity of development determined by development templates - distributions of development quantity by transition pair
- This approach was later used by PECAS

Limitation of Transition Model

- Bottom-up approach; emphasizes local context, but de-emphasizes larger context
- Requires alternative-specific constants for each transition type, which make the model rigid, and insensitive to changes in policy or conditions (e.g. urban growth boundary)
- Fails to reflect competition among sites for a given project (the developers problem)

Project Location Choice Model

- Modeling location choice of real estate projects
  - Perspective of a property developer
  - Project searching for a site
  - Emphasizes optimal location for individual project



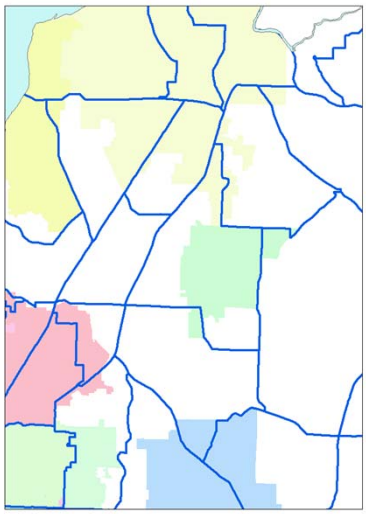
- Applications: UrbanSim; ILUTE; Haider and Miller, 2004

Project Location Choice Model

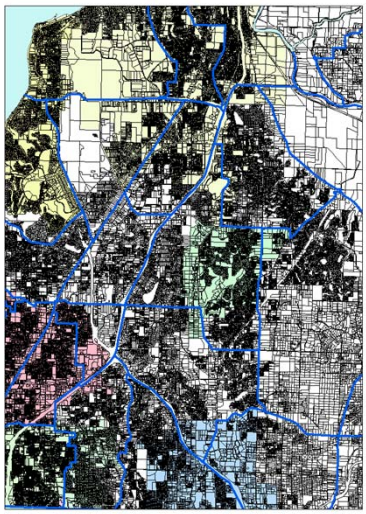
- Decision makers: Development Projects
- Size attributes: residential units or/and building sqft
- Alternatives: sites with varying degrees of aggregation
  - Zones
  - Neighbourhoods
  - Gridcells
  - Parcels
- Development Constraints: limiting locations to be included in alternative set

Designing and Development Model: Choice of Geography

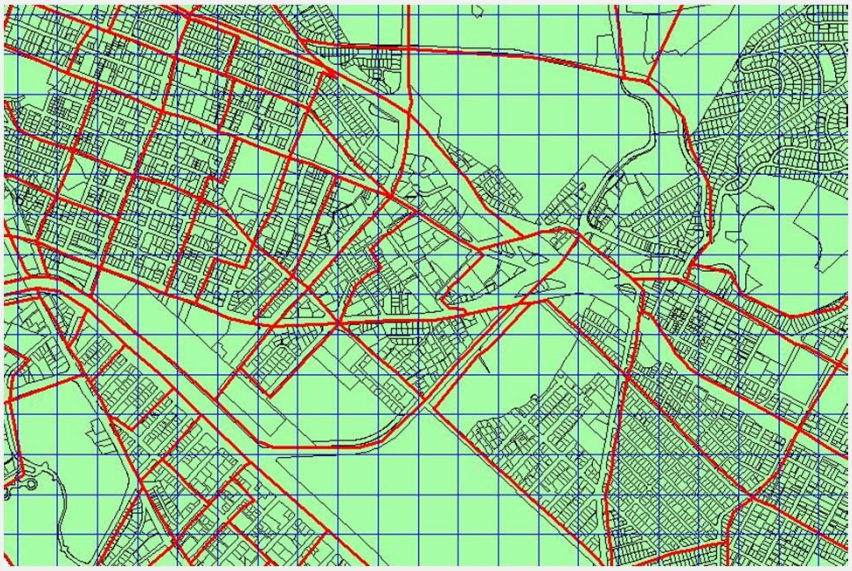
DRAM / EMPAL: Forecast Zones



Individual Parcels



Choice of Geography: Traffic Zones, Gridcells, Parcels



Building Location Choice Model (BLCM) of San Francisco Project

- Decision makers: project developer = building
  - Constructed from development_event_history for estimation
  - Sample new buildings from development_event_history in simulation
- Size attributes: residential units or/and building sqft
- Alternatives: parcels (sampling of alternatives)
- Development Constraints: size attribute of a building < remaining capacity of parcels
- Model stratified by building type

Building Location Choice Model (BLCM)

- Submodel: 6 (hotel)
- Convergence achieved.
- Akaike's Information Criterion (AIC): 97.967980998
- Bayesian Information Criterion (BIC): 105.450518805
- Number of Iterations: 12
- **********
- Log-likelihood is: -43.983990499
- Null Log-likelihood is: -112.239513595
- Likelihood ratio index: 0.608123831882
- Adj. likelihood ratio index: 0.563576240398
- Number of observations: 33
- Suggested |t-value| > 1.86989506697
- Convergence statistic is: 0.000964771270526
- ----------

Example Estimation Result from Multinomial Logit Model

Coeff_names	estimate	std err	t-values
ln_hholds_per_acre_in_zone	-0.335668	0.098788	-3.39787
ln_land_area	-2.7479	0.368748	-7.45199
ln_price	0.255571	0.118766	2.15188
lrt_travel_time_weighted_access_by_population	0.00351013	0.00159295	2.20354
lrt_travel_time_weighted_access_to_employment	-0.00086614	0.000432838	-2.00107

- **********

Limitation of Project Location Choice Model

- Difficult to capture spatial clustering of developments
- Composition of development project has to be determined exogenously
- Does not represent competition within a site across project types (the landowners problem); weak in respecting capacity constraints (dePalma, Picard, and Waddell, 2007)
- Possible violation of I.I.D assumption of Multinomial Logit

Project Proposal Sampling Model

- From the perspective of financial agents, reconciling the perspectives of landowners and developers
- A proposal combines a site with a development template
- Approximates feasible proposals competing for financing

Development Constraints

Zoning

- Medium Density SF Residential
- Min Units 4.5, Max Units 8.7
- 2.5 acres / 107,000 SQFT size

Other possible factors:

- Urban Growth Boundary
- Physical and environmental constraints: slope, wetland, flood plain

Development Templates: Alternative Approaches

- Standards based: standard housing type (Hooper and Nicol, 1999);
- Empirical classification (Song and Knaap, 2007):
  - Cluster analysis on recent historical development
  - Identification factors: lot size, density (units per acre / far), floor space
- Place Types used in visioning: ULI Reality Check, Criterion Paint the Town

Development Templates

Table 2: Residential templates

ID	Template Type	Characteristics	Property type	Lot size range (min)	Lot size range (max)	Units per acre	Sample size
1	Subdivision	10- to 20-acre lots	SFH	37.00	150.00	0.08	14
3	Subdivision	3.3- to 10-acre lots	SFH	20.00	58.00	0.20	64
5	Subdivision	1.3- to 3.3-acre lots	SFH	12.00	35.00	0.46	86
7	Subdivision	0.67- to 1.3-acre lots	SFH	6.50	23.00	1.12	261
9	Subdivision	0.40- to 0.67-acre lots	SFH	4.00	14.00	2.05	325
11	Subdivision	0.25- to 0.40-acre lots	SFH	3.00	12.00	3.13	436
13	Subdivision	0.20- to 0.25-acre lots	SFH	2.50	10.00	4.45	715
15	Subdivision	0.15- to 0.20-acre lots	SFH	2.00	8.00	5.96	964
17	Subdivision	0.10- to 0.15-acre lots	SFH	2.00	6.50	8.41	585
19	Subdivision	0.050- to -0.10-acre lots	SFH	1.00	3.50	13.42	185
21	Single property	0.050- to 0.12-acre lots	SFH	0.05	0.12	10.61	11115
23	Single property	0.12- to 0.20-acre lots	SFH	0.12	0.20	6.20	21359
25	Single property	0.20- to 0.28-acre lots	SFH	0.20	0.28	4.37	16329
27	Single property	0.28- to 0.40-acre lots	SFH	0.28	0.40	3.07	11216
29	Single property	0.40- to 0.60-acre lots	SFH	0.40	0.60	2.09	8194
31	Single property	0.60- to 0.90-acre lots	SFH	0.60	0.90	1.37	5466
33	Single property	0.90- to 1.3-acre lots	SFH	0.90	1.30	0.92	8009
35	Single property	1.3- to 1.8-acre lots	SFH	1.30	1.80	0.64	3407
37	Single property	1.8- to 2.8-acre lots	SFH	1.80	2.80	0.42	6316
39	Single property	2.8- to 4.0-acre lots	SFH	2.80	4.00	0.30	1917
41	Single property	4.0- to 5.8-acre lots	SFH	4.00	5.80	0.20	7653
43	Single property	5.8- to 8.0-acre lots	SFH	5.80	8.00	0.15	1310
45	Single property	8.0- to 12-acre lots	SFH	8.00	12.00	0.10	1231
47	Single property	12- to 18-acre lots	SFH	12.00	18.00	0.07	294
49	Single property	18- to 50-acre lots	SFH	18.00	50.00	0.04	439
51	Single property	townhouse extra large lots	Condo	0.67	61.18	2.38	35
53	Single property	townhouse large lots	Condo	0.38	23.89	4.35	143
55	Single property	townhouse medium lots	Condo	0.26	21.98	6.60	151
57	Single property	townhouse small lots	Condo	0.19	26.64	9.34	173
59	Single property	low-rise large units	Condo	0.14	20.61	12.79	181
61	Single property	low-rise medium units	Condo	0.11	13.64	17.06	161
63	Single property	low-rise small units	Condo	0.09	11.01	22.02	110
65	Single property	med-rise large units	Condo	0.07	3.58	27.95	103
67	Single property	med-rise medium units	Condo	0.06	4.55	37.68	104
69	Single property	med-rise small units	Condo	0.06	1.22	54.51	108
71	Single property	high-rise large units	Condo	0.11	2.72	102.20	43
73	Single property	high-rise small units	Condo	0.25	0.72	206.30	8

Choose Among Project Proposals

- Probabilistic Profit Maximization:
  - $U_i = \text{profitability} + \varepsilon_i$
  - ε_i = random error term
  - If assumed to Independently Identically Gumbel Distributed, proposals are sampled with weight of exp(profitability), a multinomial logit probability distribution

Profitability

- Return on Investment (ROI)
  = (revenue – total cost) / total cost
- Revenue = Net Present Value (simplified as expected sale price):
  - Assume proposals are built on their site
  - Apply Hedonic regression model to predict property values of proposed projects

Expected Sale Price

- Coefficients for Hedonic regression (SFH)

Variable	Coefficient	t-statistics
Intercept	2.192	84.501
Whether property is close to water	0.224	189.915
Age of property	-0.0020	-79.046
Is property built before 1940	0.092	59.059
ln building sqft	0.822	884.283
ln lot sqft	0.145	301.501
Is of premium building quality	0.0648	73.997
ln average income in TAZ	0.298	170.826
ln employment density in TAZ	0.027	44.209
ln population density in TAZ	0.0384	52.506
Trip weighted average travel time	-0.005	-27.0403
ln generalized cost traveling to CBD	-0.159	-63.715
School district specific fixed effect (56 in total, not showing due to limit of space)		significant
Number of Observation: 785088		
Adjusted R-squared: 0.765		

Expected Sale Price

- Coefficients for Hedonic regression (MFA)

Variable	Coefficient	t-statistics
Intercept	-1.06466	-10.154
Whether property is close to water	0.114781	13.4462
Age of property	0.00293166	26.1313
ln building sqft	1.62904	1078.05
ln number of units in building	-0.0724484	-23.5851
Is of premium building quality		
ln average income in TAZ	0.136954	14.7372
ln generalized cost traveling to CBD	-0.0632105	-5.72444
Large area specific fixed effect (18 in total, not showing due to limit of space)	-	-
Number of Observation: 27135		
Adjusted R-squared: 0.491		

Expected Sale Price

- Coefficients for Hedonic regression (Condo)

Variable	Coefficient	t-statistics
Intercept	0.304637	1.367
Whether property is close to water	0.263	15.742
Age of property	-0.0018	-5.061
ln building sqft	1.510	186.327
ln number of units in building	0.0310501	8.00414
ln average income in TAZ	0.0936	5.902
ln population density in TAZ	0.0563	8.883
ln employment accessible within 30 minutes transit and walk	0.0304223	6.2217
ln generalized cost traveling to CBD	-0.0940894	-6.19377
Is zone in core suburban cities	-0.146351	-9.68671
Is zone in smaller suburban cities	-0.18573	-11.0005
Is zone in rural areas	0.140946	3.70511
Number of Observation: 5463		
Adjusted R-squared: 0.879		

Costs

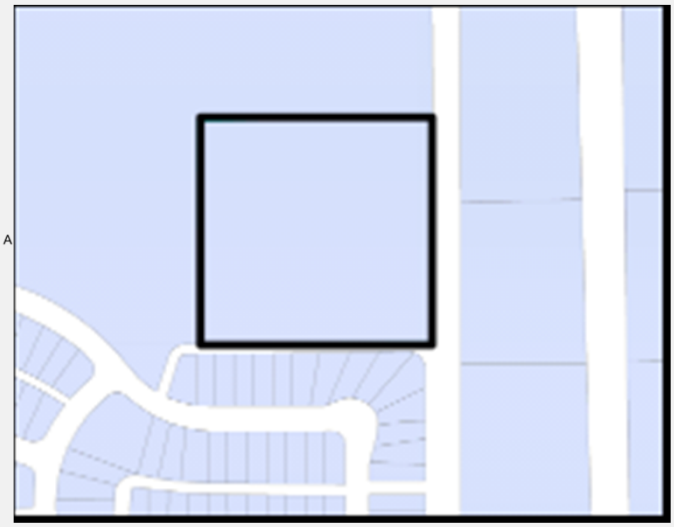
- Acquisition cost: land cost (new development); land cost + cost for existing structure (redevelopment)
- Demolition cost (redevelopment)
- Construction cost
- Other costs/subsidies: impact fees, development incentives

Developer Model Step 1: Select Parcel for Evaluation

BEFORE DEVELOPMENT

parcel
- .parcel_id = 9551
- .zone_id = 35
- .ownership_type_id = 5
- .land_use_type_id = 26
- .city_id = 3
- .county_id = 4
- .plan_type_id = 6
- .mpa_id = 1
- .census_block_id = 532
- .raz_id = 23
- .parcel_sqft = 43560
- .unit_price = 1.76
- .assessor_parcel_id = 13708011 A
- .tax_exempt_flag = 0
- .is_in_floodplain = 0
- .is_on_steep_slope = 0
- .is_in_fault_zone = 0
- .is_in_archaeological_area = 0

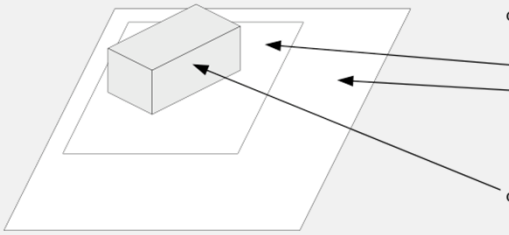
building
- .building_id = -1
- .building_type_id = -1
- .parcel_id = 9551
- .building_quality_type_id = -1
- .land_area = 0
- .non_residential_sqft = 0
- .residential_units = 0
- .sqft_per_unit = 0
- .year_built = -1
- .zone_id = 35



Step 2: Based on Plan Type, Evaluate Development Constraints

development_constraints
- .development_constraint_id = 46
- .generic_land_use_type_id = 3
- .plan_type_id = 6
- .ownership_type_id = 5
- .priority = 1
- .city_id = 3
- .county_id = 4
- .constraint_type = units_per_acre
- .minimum = 15
- .maximum = 50
- .is_in_floodplain = -1
- .is_on_steep_slope = -1
- .is_in_fault_zone = -1
- .is_in_archaeological_area = -1

Step 3: Constraints Identify Allowed Development Templates



development _templates
.development _template_id = 1
.percent _open = 0
.min_land = 16000
.max_land = 52000
.density_type = units_per_acre
.density = 40
.land_use_type_id = 3

development _template_component
.development _template_component_id = 1
.building_type_id = 4
.percent _of_building_sqft = 100
.construction_cost_per_unit = 250000
.sqft_per_unit = 1200
.velocity_function_id = 5

Development templates can be defined in a number of different ways, including using the known development projects as the basis, or general plans, or a statistical analysis of recent developments. PSRC project is using the latter approach.

Step 4: Select Development Proposals to Build

AFTER DEVELOPMENT
UPDATED FIELDS
parcel
.
.
.
.land_use_type_id = 3
.
.
.
.
.
.
.
.unit_price = 251916 .62
.
.
.
.
.
.

building
.building_id = 4587
.building_type_id = 4
.
.building_quality_type_id = 3
.land_area = 43560
.
.residential_units = 40
.sqft_per_unit = 1200
.year_built = 2001
.

A hedonic price model predicts the price of a post-development proposal on the parcel, and subtracts the predicted cost of site acquisition, and other costs such as site preparation, demolition of existing buildings, extension of infrastructure, financing, and other costs that can be incorporated. This is used to generate an estimate of the Return on Investment (ROI) for each proposal.

Proposals are selected using a probability that is proportional to their expected ROI.

When projects are accepted, they result in Development Projects with status set to 'Active'. These projects are then added by the Building Construction Model.

Put them all together…

Vacant Parcel

Medium Density SF Residential
Min units/acre: 4.5
Max units/acre: 8.7
2.5 Acres
107,000 SQFT

Template #1

Land Use……..SF Resid
Units Per Acre…….. …6
Total Units……14
Min Parcel size…….87,000 SQFT
Max Parcel size….350,000 SQFT
NPV: .....……$4,400,000
Costs: .....……$3,960,000
ROI: .....……11%

Template #2

Land Use……...SF Resid
Units Per Acre……8.5
Total Units……20
Min Parcel size…….87,000 SQFT
Max Parcel size…..283,000 SQFT
NPV: ...……...$5,360,000
Costs: .....……$4,700,000
ROI: ...……..14%

Advantages of Proposal Sampling Model

- Advances the realism of Real Estate Development Model with parcel geography
- Reconciles landowner and developer perspectives
- Provides a market-based approach that enables:
  - Assessing policies from a market-based perspective
  - Evaluating market-based polices: Impact Fees, Tax Abatement

Limitation of Proposal Sampling Model

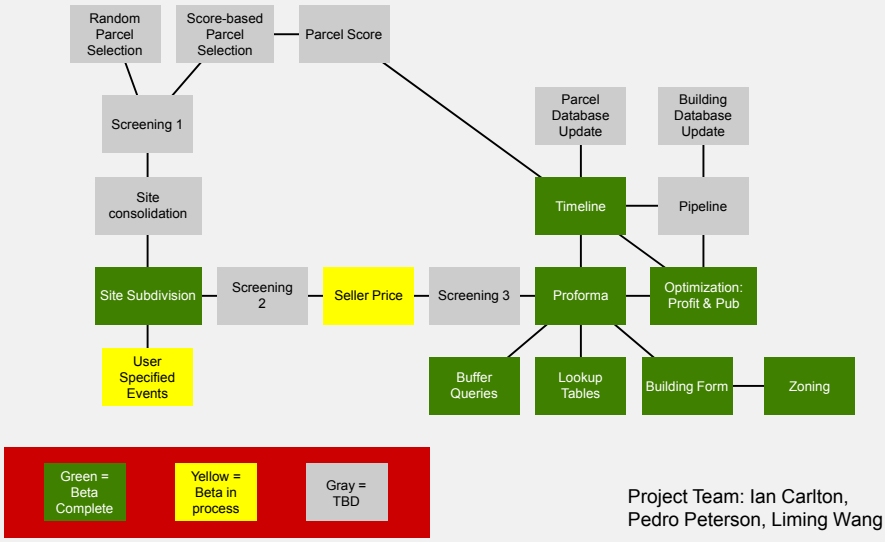
- Data intensive; parcel-level data, land use regulation, costs data difficult to obtain
- Model parameter estimation dependent on hedonic regression; other parameters (e.g. costs) are fixed inputs
- Significantly simplifies developer behavior
- Leaves out time costs and other factors

Paul Waddell, 2011

1. Connecting Demand and Supply: Prices
2. Three Approaches to Modeling Real Estate Supply
3. **A Behavioral Approach to Real Estate Development**

Paul Waddell, 2011

Current Effort Focusing on Modeling Real Estate Development



Project Team: Ian Carlton, Pedro Peterson, Liming Wang

Development Types Evaluated in Model

Paul Waddell, 2011

- **Single-Family Builder**
- **Single-Family One-off**
- **Multi-Family**
- **Condo**
- **Office**
- **Manufacturing Industrial**
- **Warehouse Industrial**
- **Neighborhood-retail**
- **Auto-oriented Retail**
- **Big-Box Retail**
- **MXD-MultiFam**
- **MXD-Condo**
- **MXD-Office**

Development Types Evaluated in Model

Paul Waddell, 2011

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- **MXD-Condo**
- **MXD-Office**

Suburban – Large Lot

Suburban – Small Lot

Modern Urban

Development Types Evaluated in Model

Paul Waddell, 2011

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Development Types Evaluated in Model

Paul Waddell, 2011

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Development Types Evaluated in Model

Paul Waddell, 2011

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- MXD-Office






Paul Waddell, 2011

Developer behaviors are distinct

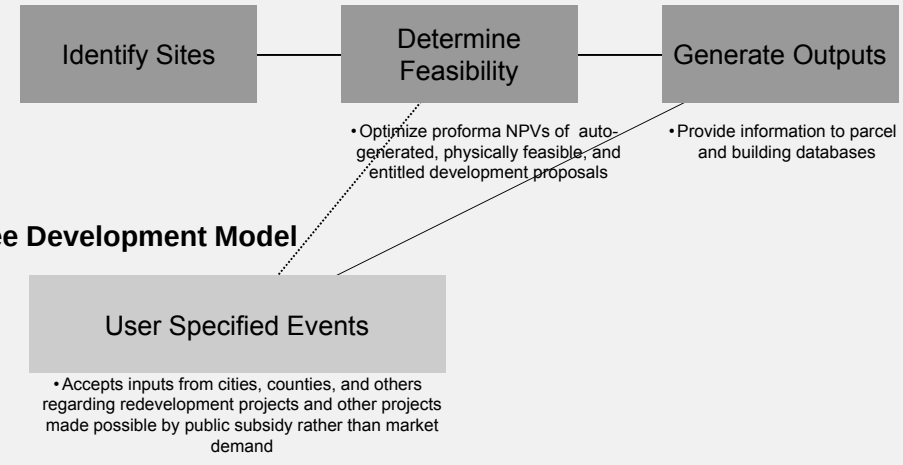
Type of Development Opportunity	Predetermined Aspects of Deal	Associated Developer Behavior
Build to Suit	Land, tenant	Fee developer*
Government sponsored	Land, entitlements	Fee developer
Listed land	N/A	Spec developer*
Hot market	N/A	Spec developer

(*) Note: Firms involved with fee-based developments may also act as speculative developers and vice versa, but behavior varies depending on the type of activity in which they are engaged

Paul Waddell, 2011

Developer Model

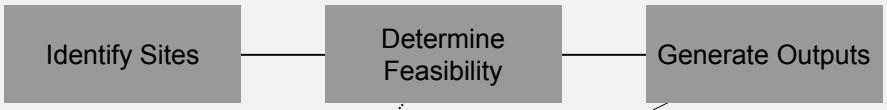
Spec Development Model



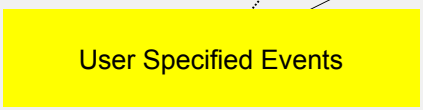
Paul Waddell, 2011

Developer Model

Spec Development Model



Fee Development Model



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Major fee developments underway in the Bay Area

- Hunters Point Shipyard/Candlestick Point
- Concord Naval Weapons Station
  - Up to 10,000 housing units
- Treasure Island
  - 8,000 housing units
  - 550,000 SF of commercial space
  - 500 hotel rooms
- Oyster Point (South San Francisco)
  - 2.2 million SF of office/biotech R&D space

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Hunters Point Shipyard & Candlestick Point

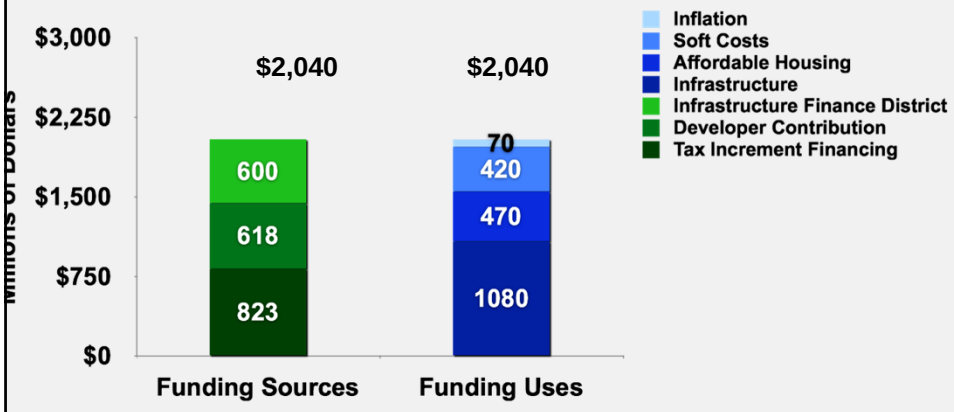
Paul Waddell, 2011

Hunters Point Shipyard & Candlestick Point

- Master developed by Lennar Urban
- Three phases over 20 years
  - Hunters Pt Phase I (under construction) - 75 acres
  - Hunters Pt Phase II (entitled) - 425 acres
  - Candlestick Point - 270 acres

Paul Waddell, 2011

Hunters Point Shipyard & Candlestick Point project funding



Paul Waddell, 2011

Parcelization and land use

Paul Waddell, 2011

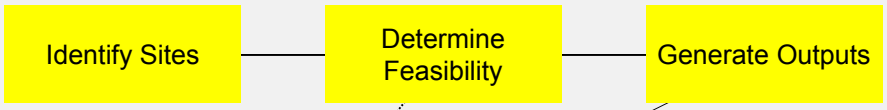
Development planned for Hunters Point Shipyard & Candlestick Point

THE SHIPYARD & CANDLESTICK POINT PHASE II SUMMARY STATISTICS									
	Residen-tial	Commercial (sq. ft.)							Open Space (acres)
Parcel	Units	Neighbor-hood Retail	Regional Retail	Artist's Studio	Office / R&D	Hotel	Arena	TOTAL Commercial	TOTAL Open Space
HUNTERS POINT SHIPYARD									
HP Village Center	110	20,000	0	200,000	0	0	0	245,000	
Hunters Point	2,300	25,000	0	0	0	0	0	25,000	
R&D / Office	90	80,000	0	55,000	2,000,000	0	0	2,110,000	
Stadium	0	0	0	0	0	0	0	0	
Subtotal	**2,500**	**125,000**	**0**	**255,000**	**2,000,000**	**0**	**0**	**2,380,000**	**241.5**
CANDLESTICK POINT									
Alice Griffith	1,000	0	0	0	0	0	0	0	
CP North	4,125	70,000	0	0	0	0	0	70,000	
Jamestown	350	0	0	0	0	0	0	0	
CP Center	375	0	635,000	0	150,000	150,000	75,000	1,010,000	
CP South	1,650	55,000	0	0	0	0	0	55,000	
Subtotal	**7,500**	**125,000**	**635,000**	**0**	**150,000**	**150,000**	**75,000**	**1,135,000**	**97.6**
TOTAL AREA	**10,000**	**250,000**	**635,000**	**255,000**	**2,150,000**	**150,000**	**75,000**	**3,515,000**	**339.1**

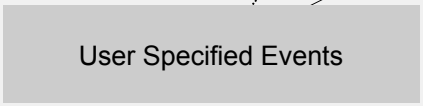
Paul Waddell, 2011

Developer Model

Spec Development Model

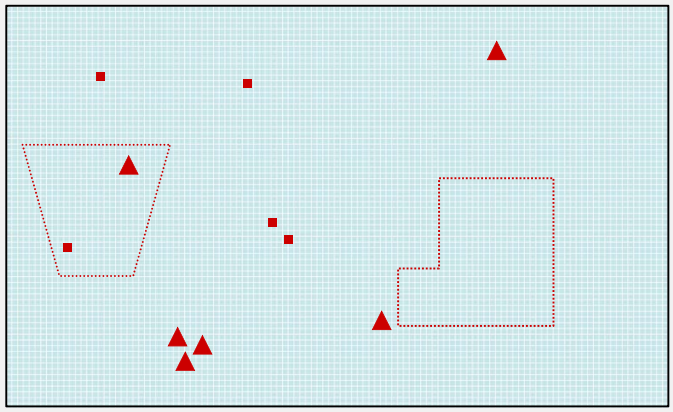


Fee Development Model



Paul Waddell, 2011

Spec development occurs when developers find land…



▲ Underutilized property ▪ Listed property ◌ Hot market

Paul Waddell, 2011

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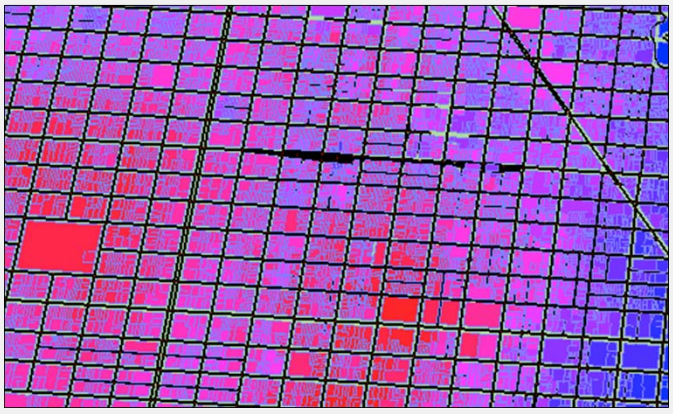
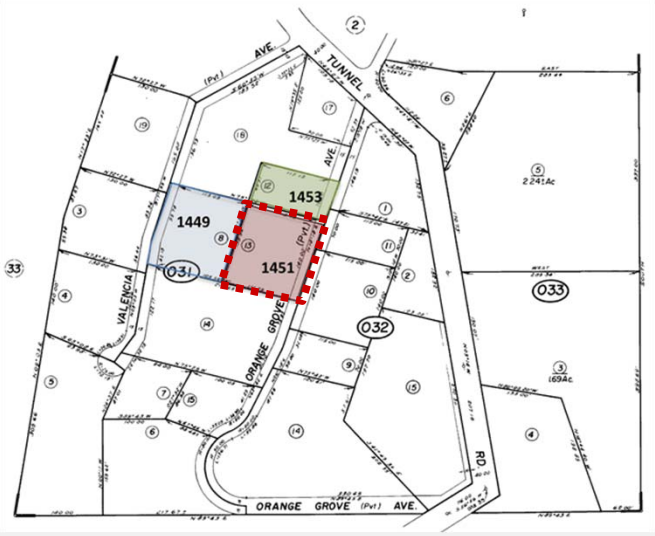


Paul Waddell, 2011

…and consolidate a site for development…



Paul Waddell, 2011

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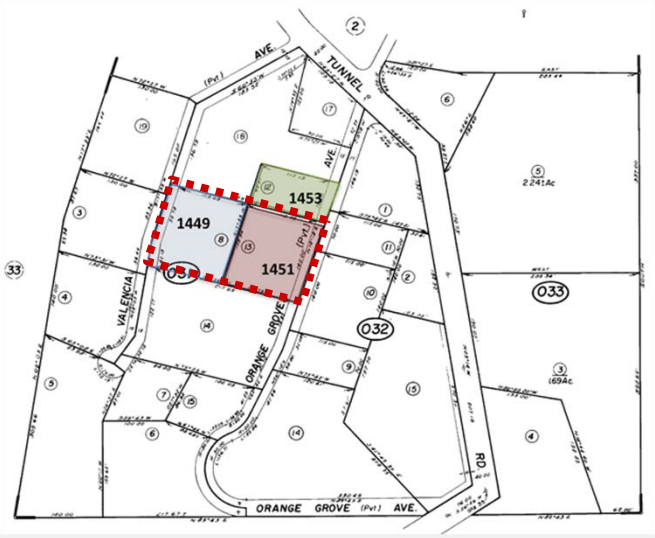

Paul Waddell, 2011

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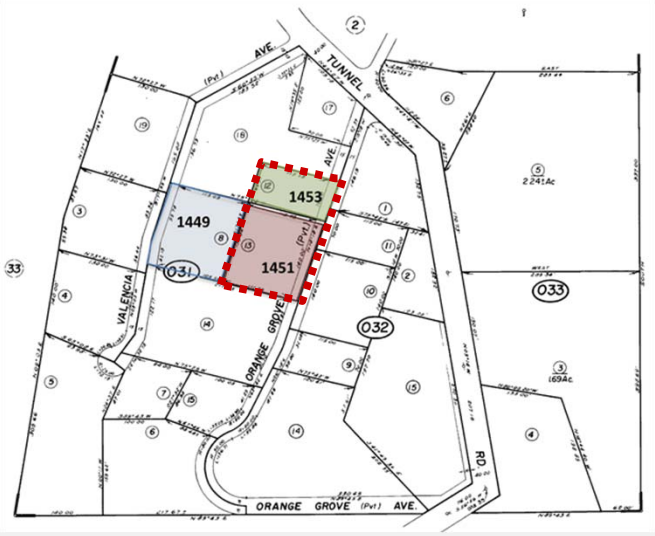

Paul Waddell, 2011

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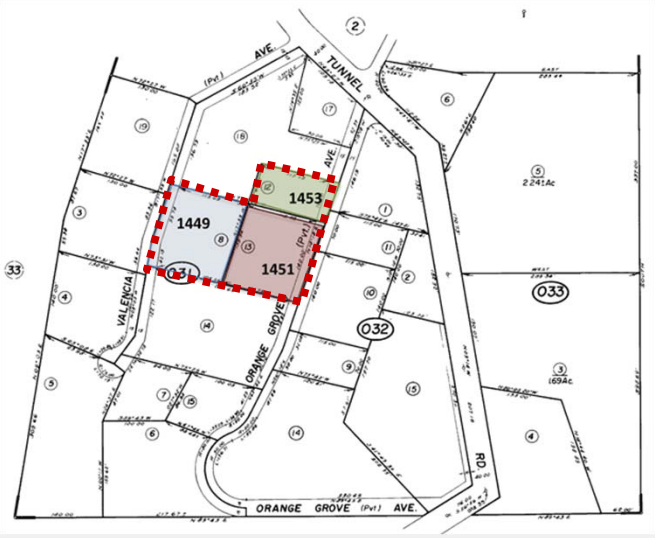


Paul Waddell, 2011

…where market demand is adequate…

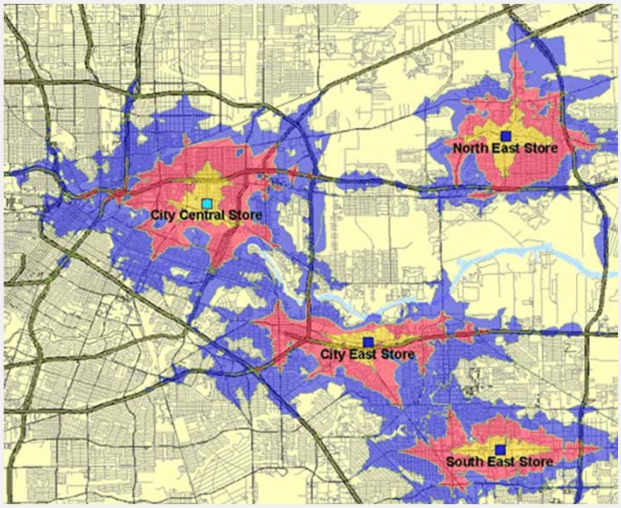
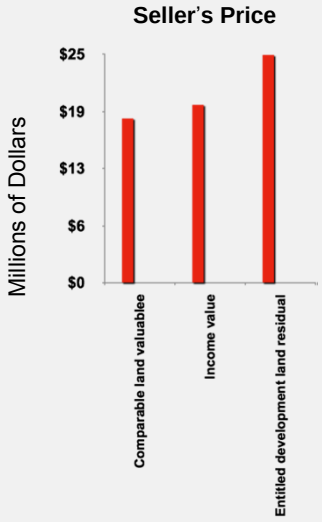


image source: MappingAnalytics.com

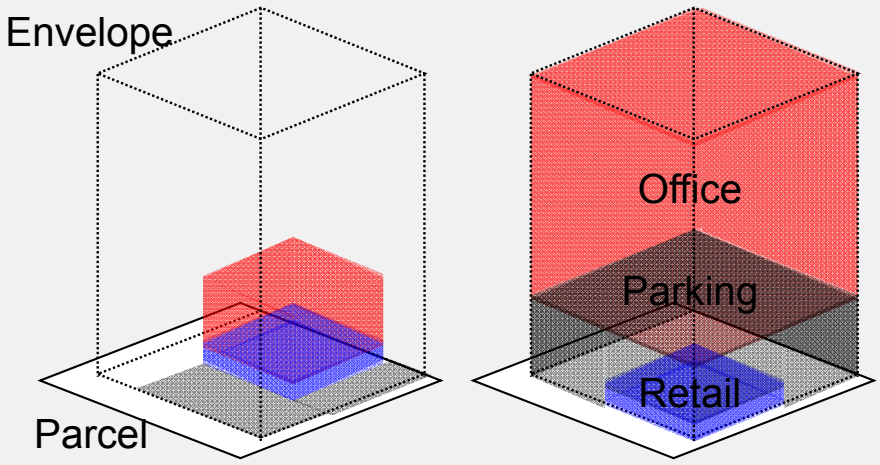
Paul Waddell, 2011

…and where landowners are willing to sell at a price…



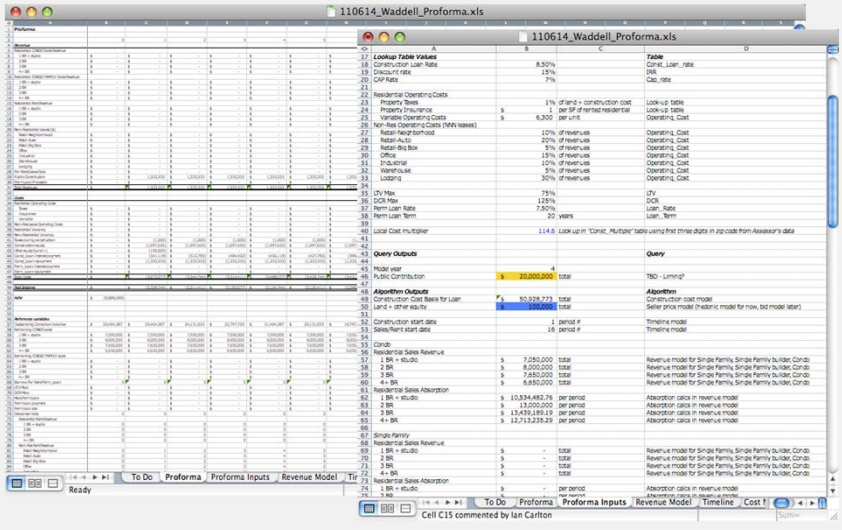
Paul Waddell, 2011

…and a structure can be feasibly and legally built…



Paul Waddell, 2011

…that leads to a profitable proforma evaluation…



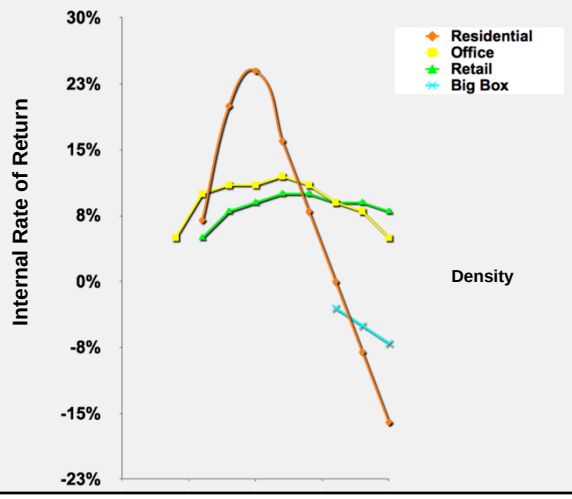
Paul Waddell, 2011

…that leads to a profitable proforma evaluation…

- Economic inputs
  - Inflation rate
- Demand model data
  - Price per sq ft in buffer area
  - Absorption rate in buffer area
- Policy inputs
  - Zoning (use and bulk)
  - Property taxes
  - Inclusionary zoning and linkage fees
  - Local permit fees
  - Local impact fees
- Operating cost inputs
  - Operating cost per sq ft by bldg type
  - Property insurance
- Finance inputs
  - Loan to cost & value
  - Debt coverage ratios
  - Loan rates & terms
  - Seasoning requirements
  - Cap rates
- Construction inputs
  - Construction cost per sq ft by building type
  - Demolition cost per sq ft by building type
  - Cost per sq ft of road
  - Infrastructure costs
  - Open space costs
  - Geographic multiples
  - Permit timeframe
  - Construction timeframe

Paul Waddell, 2011

…that leads to a profitable proforma evaluation…



Paul Waddell, 2011

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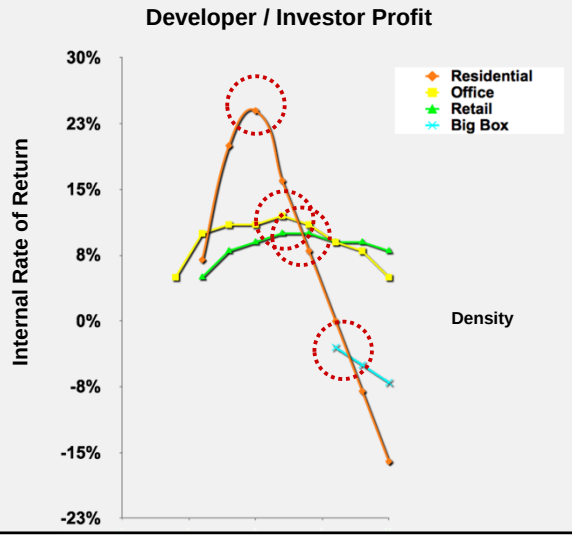

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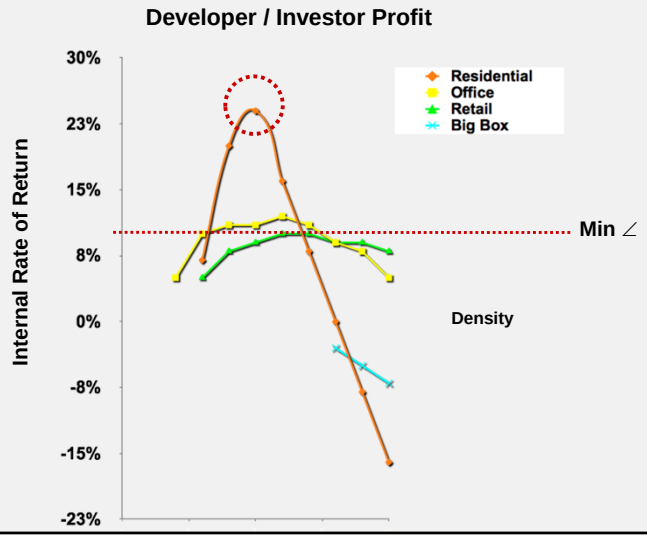
…which is more lucrative than alternative investment options.



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Contributions of the Behavioral Developer Model

- Incorporates of local regulatory and market conditions (Bay Area)
- User-interface allows inclusion of “fee developments” into endogenously generated market conditions
- Calculates profitability based on NPV / IRR
- Uses parcel geometry to calculate land values and development potential

Further Development

- Behavioral Developer model being implemented as part of Plan Bay Area process being used by Metropolitan Transportation Council (MTC) and the Association of Bay Area Governments (ABAG)
- Demand side of the model application is based on UrbanSim household and firm location choice models
- Model is being integrated with MTC activity-based travel model
- Further refinements to make:
  - Improving input data on costs, existing development, development plans, zoning
  - Improving methods to assess uncertainty in inputs
  - Refining the integration with parcel geometry calculations for subdivision and consolidation of parcels

Questions and Discussion

Presenters:

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Department of City and Regional Planning
University of California Berkeley