Housing Market(s) of San Diego

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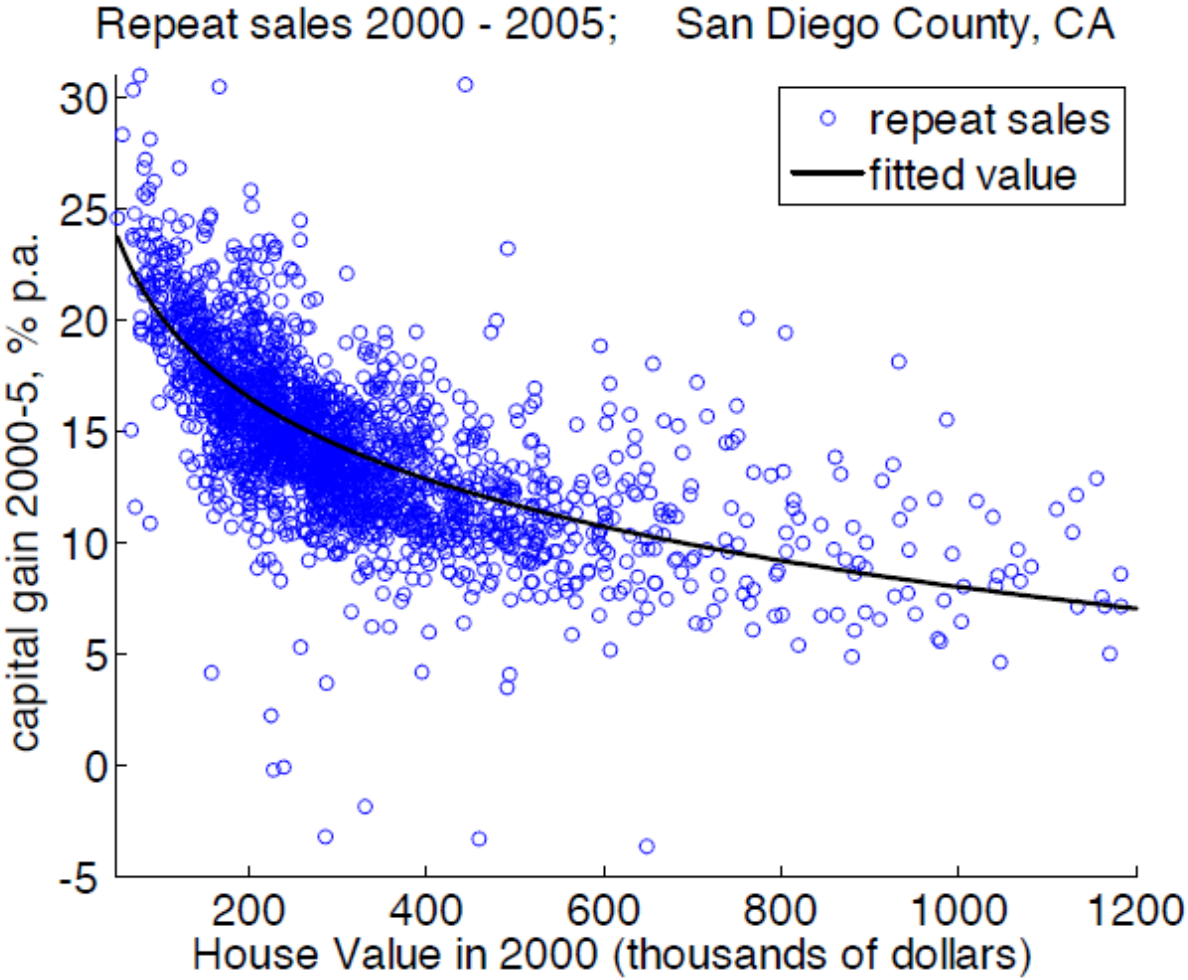
Motivations

During the 2000-2005 housing boom, there were large differences in capital gains across houses within San Diego county.



Research Questions

How to understand the cross section of capital gains during the boom?

- Which houses are in the market (house quality)
- What kind of people choose to move (age, income, wealth)
- Availability of cheap credit

Relax credit constraints $\Rightarrow$ Poor households benefit more $\Rightarrow$ Prices of the low end houses rise more

What They Do

An assignment model with a continuum of houses and heterogeneous agents:

- **Movers' demand** for housing quality derived from a life-cycle problem with credit market frictions
- **Equilibrium house prices** adjust to assign houses differ by quality to households differ by age, income and wealth
- Quantify the model with micro data on San Diego county during 2000s boom

- **Use 2000 price distribution as quality index**
- Completely segmented markets by quality
- **No supply side of housing: only have realized distribution of houses transacted**

Contributions

New Evidence on Cross Section of Capital Gains and Trading Volume by Quality

- Contribute to the study of house trading volume (Stein 1995)
- Comparing house price dynamics across price segments within a metro area (Poterba 1991, Case and Mayer 1996, Case and Shiller 2005, Guerrieri, Hartley and Hurst 2013)

Richer Model

- An assignment model with a continuum of houses and a multidimensional distribution of mover characteristics (Caplin and Leahy 2010, Stein 1995, Ortalo-Magne and Rady 2006, Rios-Rull and Sanchez-Marcos 2008)

Contributions

Jointly Consider Credit Constraints and Changes in House Quality

- Credit matters for prices (Lamont and Stein 1999, Mian and Sufi 2009, Mian and Sufi 2010)
- Quality matters for prices (Poterba 1991, Bayer, Ferreira and McMillan 2007, Guerrieri, Hartley and Hurst 2013)

Outline

Data

House prices and market volume:

- All deeds written in San Diego county 1997-2008 (Trulia.com)
- Drop all data except for single-family dwellings

Mover characteristics:

- 2000 Census: count of all housing units; 5% survey sample of households (25,000) containing household income, age of the head, housing tenure. age of dwelling, whether moved in recently
- For owner-occupied dwellings: house value and mortgage payment
- 2005 American Community Survey (ACS): 6,500 representative households

Price as Quality Index

If there is a one-dimensional quality index that household care about, then house quality at any point in time is reflected one-for-one in the house price $\Rightarrow$ Use 2000 house price as quality index

Assume quality of any single house doesn't change over given period $\Rightarrow$ Houses with same (2000) quality should appreciate the same amount over the same period

This implies we could get 2005 quality distribution from 2000 quality/price distribution

Price Change by Quality

$$\log p^i_{t+1} - \log p^i_t = a_t + b_t \log p^i_t + \varepsilon^i_{t+1}$$

Fit 70,315 repeated sales during 1997-2008 at the dwelling level to the second equation below (GMM)

$$\log p^i_{t+k} - \log p^i_t = a_{t,t+k} + b_{t,t+k} \log p^i_t + \varepsilon^i_{t,t+k}$$

TABLE 1: ESTIMATED COEFFICIENTS FROM REPEAT SALES MODEL FOR SAN DIEGO

Year	1999	2000	2001	2002	2003	2004	2005	2006	2007
a_t	0.76	1.29	1.41	1.30	0.87	0.60	−0.56	−1.09	−3.18
	(0.04)	(0.04)	(0.04)	(0.04)	(0.05)	(0.06)	(0.07)	(0.10)	(0.12)
b_t	−0.05	−0.093	−0.10	−0.09	−0.05	−0.04	0.04	0.07	0.22
	(0.003)	(0.003)	(0.003)	(0.003)	(0.004)	(0.004)	(0.01)	(0.01)	(0.01)
σ^i_t	8.8	8.3	8.6	8.2	8.0	8.4	9.7	11.4	13.8

Imply 2005 Quality Distribution

- $a_{0,5} = 4.75$, $b_{0,5} = -.322$
- Predicted log price for 2005:

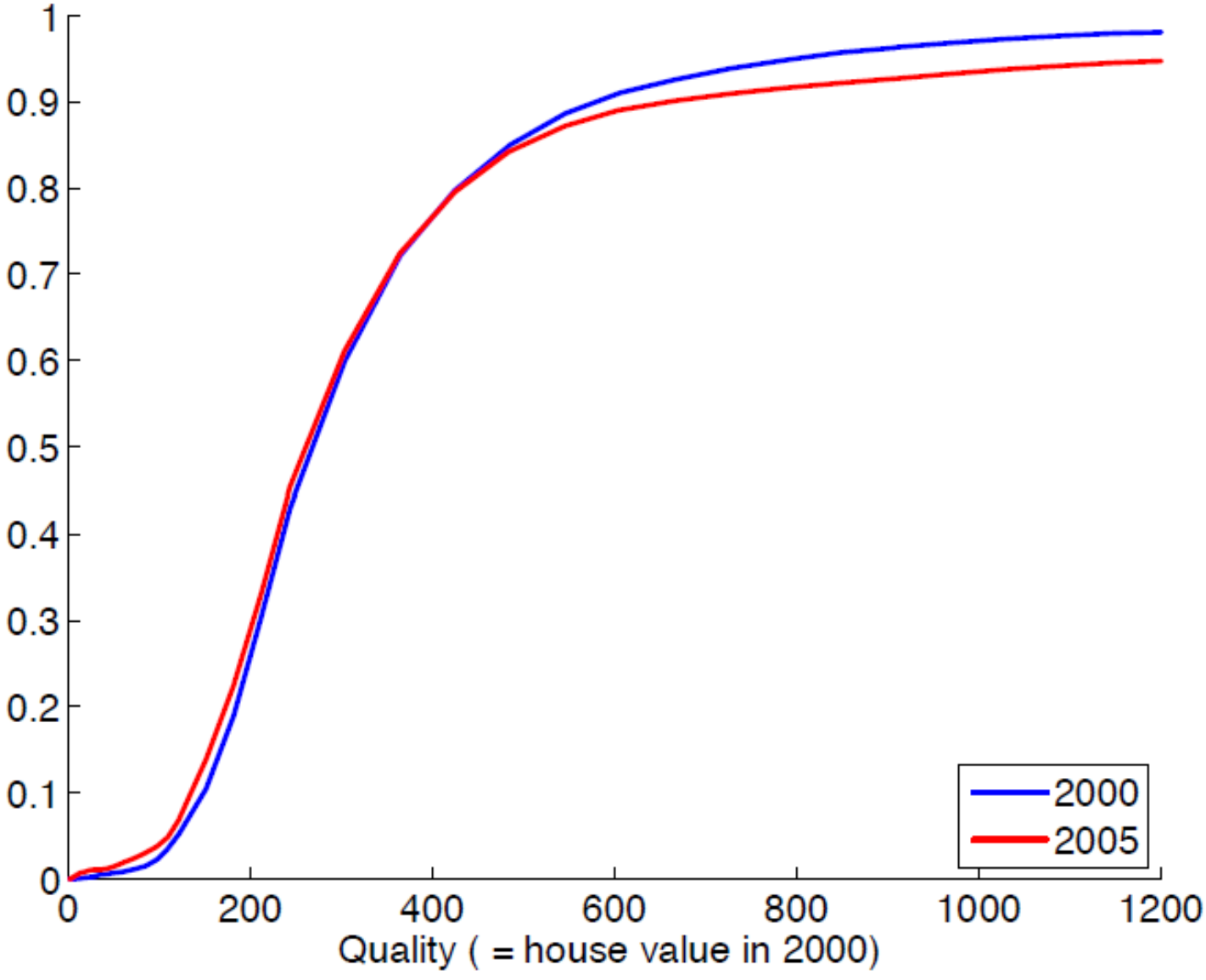
$$\log \widehat{p}_5 = a_{0,5} + (1 + b_{0,5}) \log p_0$$

In this way, a one-to-one mapping between 2005 price and quality (i.e. 2000 price) is constructed, which could be used to induce 2005 house quality distribution:

$$G_t(p_0) = \Phi_t(a_{0,5} + (1 + b_{0,5}) \log p_0)$$

where Φ_t is calculated directly from 2005 ACS data

Quality Distribution: 2000, 2005



Mover Characteristics

TABLE 2: CHARACTERISTICS OF SAN DIEGO MOVERS AND STAYERS

	Year 2000		Year 2005	
	Movers	Stayers	Movers	Stayers
Fraction of households				
aged $\leq$ 35 years	0.34	0.13	0.46	0.14
aged $>$ 35 years	0.66	0.87	0.54	0.86
Median Income (in thousands)				
aged $\leq$ 35 years	74.1	74.8	77.5	86.7
aged $>$ 35 years	82.3	74.4	88.7	78.5
Median Wealth (in thousands)				
aged $\leq$ 35 years	145.0	161.2	222.3	257.0
aged $>$ 35 years	361.4	402.2	603.3	724.7

Model Setup: Preferences

- Households live for at most T periods and die at random: D_t
- D_t independent over time but has an age-dependent probability.
- Preference defined over housing service streams s, numeraire consumption goods c, amount of consumption w left as bequest in the period of death

Conditional on period τ, utility for an age a_τ agent is

$$E_\tau \left[\sum_{t=\tau}^{\tau+T-a_\tau} \beta^t \left[(1 - D_t) \; u(c_t, s_t(h_t)) + (D_t - D_{t-1}) \; v^b(w_t) \right] \right]$$

Model Setup: Assets –Houses and Bonds

Houses:

- Differ by quality $h \in [0, 1]$ that trade at price $p_t(h)$
- **No renting**, only owning house could generate housing service
- A house with quality h_t produces a period t service flow $s_t(h_t)$

Bonds:

- Between period t and $t+1$, agent either lend at rate R_t, or borrow at rate $R_t + \rho_t$, with $\rho_t > 0$
- Denote net borrowing as b_t, the **borrowing constraint** is

$$b_t \leq (1 - \delta_t) p_t(h_t).$$

where δ_t downpayment requirement on a house.

Model Setup: Market Frictions and Exogenous Shocks

Houses:

- Transaction cost ν proportional to the value of the house
- Maintenance cost ψ every period

In addition, there is a moving shock $m_t \in \{0, 1\}$, $m = 1$ means they must sell their current house

Households receive stochastic income every period

$$y_t = f\left(a_t\right) y_t^p y_t^{tr}$$

where $f(a_t)$ is a deterministic age profile, y_t^p is a permanent stochastic component, and y_t^{tr} is a transitory component

Model Setup: Household's Problem

$$E_\tau \left[\sum_{t=\tau}^{\tau+T-a_\tau} \beta^t \left[(1 - D_t) \; u(c_t, s_t(h_t)) + (D_t - D_{t-1}) \; v^b(w_t) \right] \right]$$

s.t.

$$c_t + (1+\psi) p_t(h_t) = w_t + 1_{[h_t = h_{t-1} \& m_t = 0]} \nu p_t(h_{t-1}) + b_t$$

$$w_t = (1-\tau) y_t + p_t(h_{t-1})(1-\nu) - (1-\tau)(R_{t-1} + \rho_{t-1} 1_{\{b_{t-1}>0\}}) b_{t-1}$$

$$b_t \leq (1-\delta_t) p_t(h_t)$$

$$y_t = f(a_t) \, y_t^p \, y_t^{tr}$$

Model Setup: Equilibrium

- Given age, current house price, income (current and future), expected future house prices, interest rate, spread, moving shock, agent max utility $\Rightarrow h_t^*(p_t; a_t, y_t^p, w_t)$
- Aggregate housing demand using joint distribution of (a_t, y_t^p, w_t)

Equilibrium is given by

$$\Pr\left(h_t^*\left(p_t; a_t, y_t^p, w_t\right) \leq h\right) \leq G_t\left(h\right)$$

where the RHS is quality distribution in time t

Calibration: All Inputs

1. Preferences and Technology

   (Parameters fixed throughout all experiments.)

   (a) Felicity u, bequest function v, discount factor β

   (b) conditional distributions of death and moving shocks

   (c) conditional distribution of income

   (d) maintenance costs ψ, transaction costs ν

   (e) service flow function (relative to trend)

2. Distributions of house qualities and mover characteristics

3. Credit market conditions

   (a) current and expected future values for the interest rate R and the spread ρ

   (b) current and expected future values for the downpayment constraint δ

4. House price expectations

Calibration: Utility, Income, Housing Service, Price Expectations

$$u(c,s) = \frac{\left[c^{1-\rho}\, s^{\rho}\right]^{1-\gamma}}{1-\gamma}$$

Permanent income shock and housing service:

$$y_t^p = y_{t-1}^p \exp\left(\mu + \eta_t\right)$$

$$s_{t+1}(h) = \exp\left(\mu\right) s_t(h).$$

Price expectations:

$$p_{t+1}\left(h\right) = p_t\left(h\right) \exp\left(\mu + u_{t+1}\left(h\right)\right)$$

Initial price function $p_0(h)$ and service function $s_0(h)$ are parameterized as shape-preserving cubic splines (to be estimated)

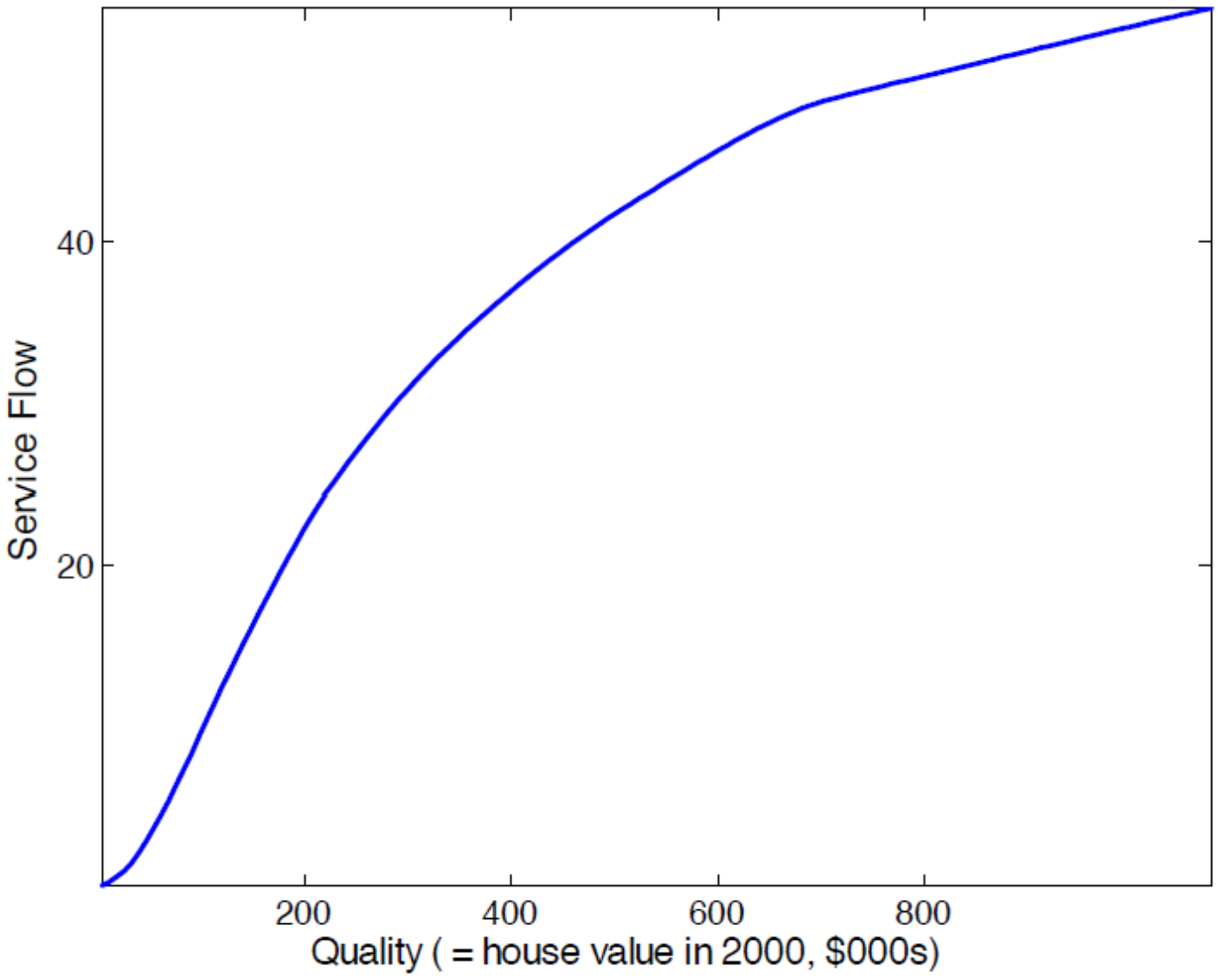
Estimate Price and House Service Flow

Using the "calibrated" model, the initial price function $p_0(h)$ and service function $s_0(h)$ could be estimated using housing market clearing condition

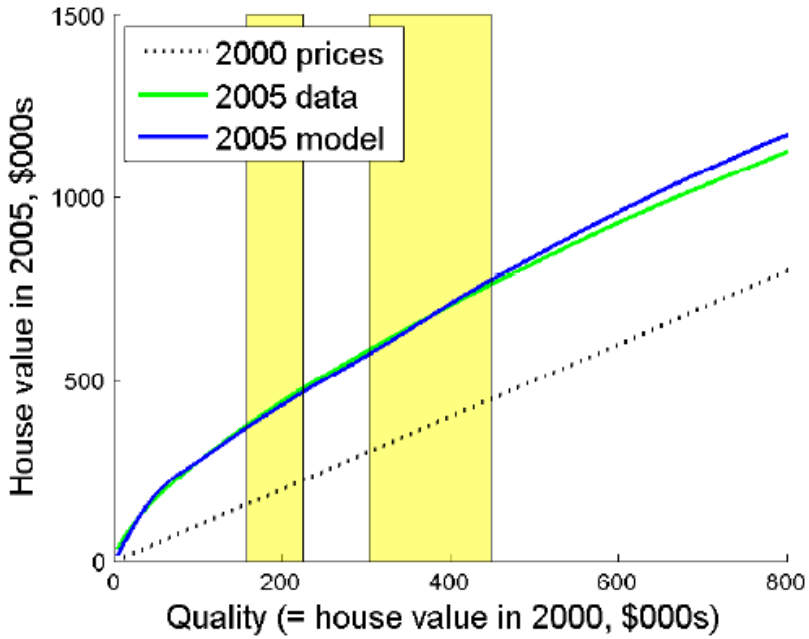
The estimation method is minimize the distance between empirical CDF of demand for house quality (implied by the consumer's problem) and calculated CDF of quality distribution for transacted houses

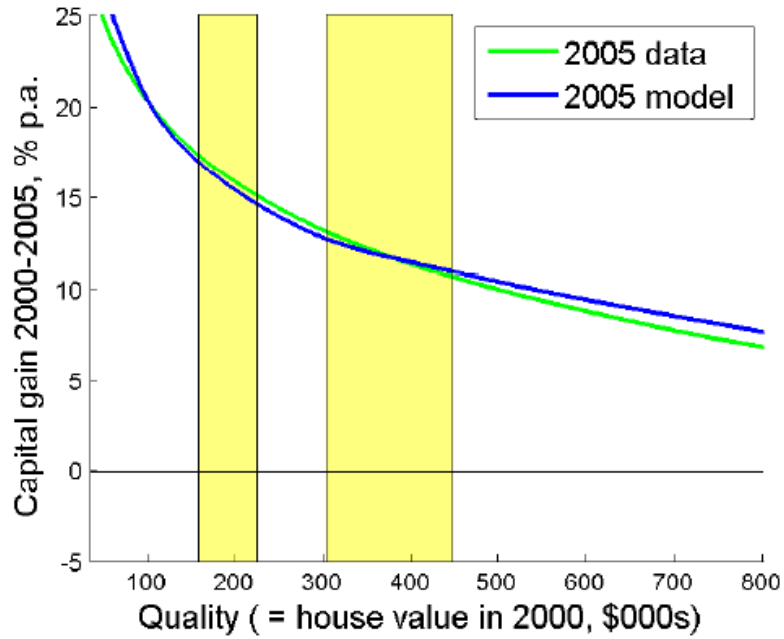
This exercise is repeated for 2000 and 2005 with different set of parameter values. The estimated price distribution is then compared with the one from data

Results: Service Flow Concave in Quality

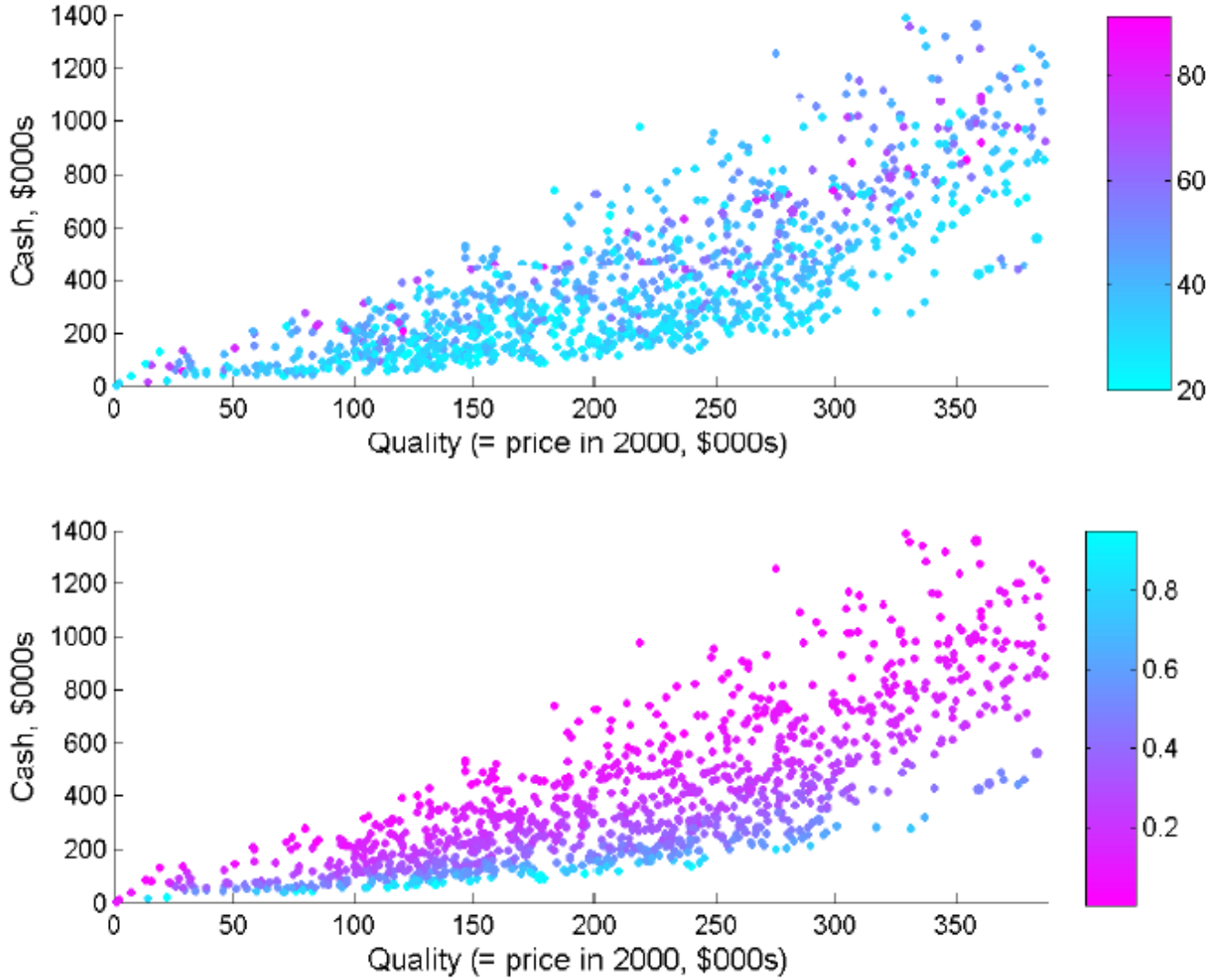


Results: Changes in House Price: 2000-2005





Results: Equilibrium Assignment



Results: Equilibrium Assignment II

TABLE 3: ASSIGNMENT OF HOUSE QUALITIES IN DATA AND MODEL

	Data				Model			
House quality bins	I	II	III	IV	I	II	III	IV
PANEL A: YEAR 2000								
Median Income (in thousands)								
aged $\leq$ 35 years	48.5	68.7	88.1	128.5	38.3	67.6	100.3	206.3
	(1.8)	(2.5)	(4.0)	(7.1)				
aged $>$ 35 years	44.0	63.4	90.3	152.3	33.4	67.4	95.9	182.2
	(2.2)	(2.3)	(4.5)	(8.5)				
Median Cash (wealth plus income, in thousands)								
aged $\leq$ 35 years	112.0	169.7	284.6	646.8	93.2	158.5	361.9	1,551.4
	(5.4)	(7.8)	(15.3)	(39.7)				
aged $>$ 35 years	172.3	284.8	496.4	1,141.8	122.9	241.1	547.1	1,721.0
	(9.2)	(15.4)	(27.6)	(71.5)				
Percentiles of the Cash Distribution (in thousands)								
bottom 10%	60.2	94.9	146.0	310.9	59.6	114.5	221.0	763.0
top 10%	471.1	721.8	1,443.9	3,941.9	205.6	362.5	1,007.1	4,378.9

Results: Equilibrium Assignment III

PANEL B: YEAR 2005

Median Income (in thousands)								
aged $\leq$ 35 years	61.3	73.6	101.9	132.5	51.0	82.0	115.7	137.4
	(4.0)	(3.5)	(8.1)	(7.1)				
aged $>$ 35 years	45.9	78.5	91.7	144.7	35.7	76.4	96.8	244.6
	(4.3)	(4.9)	(5.7)	(12.5)				
Median Cash (wealth plus income, in thousands)								
aged $\leq$ 35 years	203.4	258.5	421.3	735.2	136.7	238.6	526.0	1,689.8
	(18.0)	(22.5)	(43.8)	(76.4)				
aged $>$ 35 years	251.6	459.7	712.2	1,645.6	196.3	360.6	749.3	2,601.8
	(29.5)	(45.2)	(70.9)	(187.7)				
Percentiles of the Cash Distribution (in thousands)								
bottom 10%	79.1	125.3	180.4	391.3	67.0	146.5	314.9	1,093.0
top 10%	714.4	1,099.0	1,733.7	5,582.6	324.8	553.8	1,244.4	6,262.4

Results: Equilibrium Assignment IIII

TABLE 4: HOUSING WEALTH RELATIVE TO CASH (WEALTH PLUS INCOME)

	Age			
	below 35	35-50 years	50-65 years	above 65
Panel A: Year 2000				
Data	0.632	0.459	0.369	0.317
Model	0.613	0.435	0.385	0.403
Panel B: Year 2005				
Data	0.968	0.677	0.317	0.387
Model	0.959	0.627	0.423	0.522

Results: Cross Section of Capital Gains