Real Estate

Urban Economics: Week 9

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Housing

- Residential real estate is a huge market
  - The course will not cover commercial real estate
- Housing is by far most household's main asset
  - Leveraged purchases through the mortgage market
- Macroeconomic relevance
  - Determinant of intra-national mobility
  - Potential for large wealth effects
- Asset-pricing perspective
  - OTC financial asset
  - Differentiated durable consumption goods
- At the heart of the Great Recession

The Demand for Housing

- Three distinct but related questions

1. Where do you want to live?
   - Spatial equilibrium
   - Within cities: Alonso-Muth-Mills
   - Across cities: Rosen-Roback
   - Hedonic pricing of amenities and local public goods
2. Do you want to own or to rent?
   - Ownership-rental equilibrium
3. How much housing do you want?
   - Structure and space
   - The least studied among these questions

Housing Hedonics

- Goods are valued for their utility-bearing attributes
- Hedonic prices are the implicit prices of those attributes
- They are revealed from the observed prices of differentiated products and the attributes associated with each of them
- Hedonic analysis starts from regressing prices on attributes
  - Doing it rigorously is not as simple as that
- Houses within a metropolitan area are a perfect object of analysis
  - The metropolitan area is a single labor market, so wages do not vary
- What is the structural interpretation of the hedonic coefficients?
- Rosen (1974) highlights the problem of a two-sided market

The Consumer's Problem

- House price is a function $p(\mathbf{z})$ of utility-bearing attributes $z_1, ..., z_n$
- Consumer utility is $U(x, \mathbf{z})$ where x is non-housing consumption
- The consumer buys one house and has budget $y = x + p(\mathbf{z})$
  - y denotes exogenous income
  - x denotes consumption of non-housing goods
- Equilibrium utility u defines the bid function $\theta(\mathbf{z}; u, y)$ such that

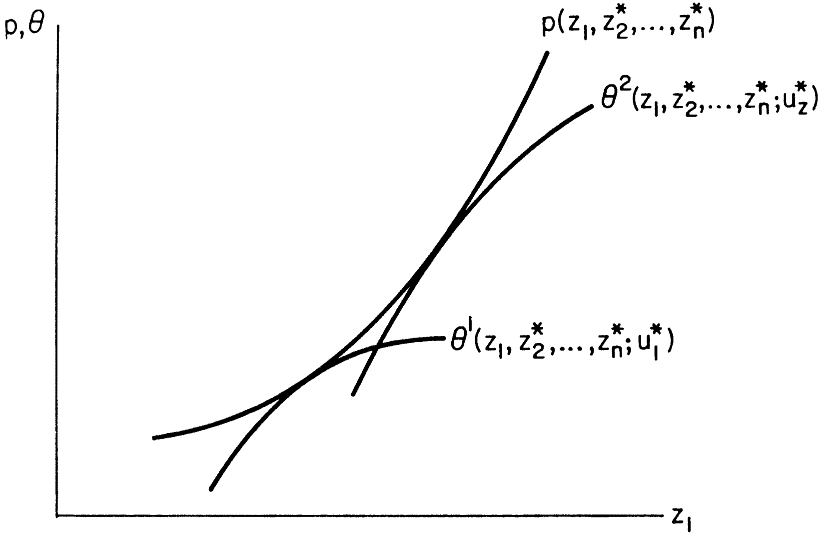
$$U(y - \theta, \mathbf{z}) = u$$

- The first derivatives of the bid function are

$$\frac{\partial \theta}{\partial z_i} = \frac{\partial U / \partial z_i}{\partial U / \partial x} > 0, \ \frac{\partial \theta}{\partial u} = -\frac{1}{\partial U / \partial x} < 0 \text{ and } \frac{\partial \theta}{\partial y} = 1$$

- If U is strictly concave, θ is concave in $\mathbf{z}$

Consumption Decision



The Producer's Problem

- Each firm produces a specific bundle of attributes $\mathbf{z}$
- Production costs are $C(M, \mathbf{z})$ where M denotes quantity
- The firm is a price taker and maximizes profits

$$\pi = Mp(\mathbf{z}) - C(M, \mathbf{z})$$

- The optimal choice of M and $\mathbf{z}$ satisfies

$$\frac{\partial p}{\partial z_i}(\mathbf{z}) = \frac{1}{M}\frac{\partial C}{\partial z_i}(\mathbf{z}) \text{ and } p(\mathbf{z}) = \frac{\partial C}{\partial M}(M, \mathbf{z})$$

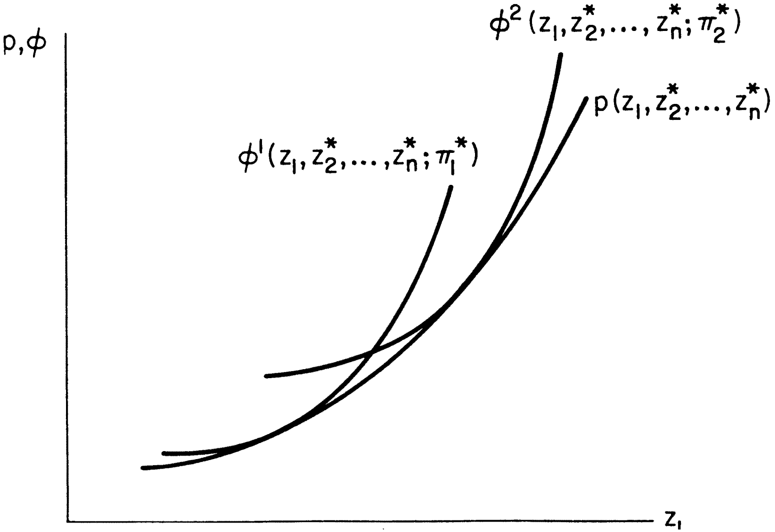
- Equilibrium profits π define the offer function $\phi(\mathbf{z}; \pi)$ such that

$$\pi = M\phi - C(M, \mathbf{z}) \text{ and } \phi = \frac{\partial C}{\partial M}(M, \mathbf{z})$$

- The first derivatives of the offer function are

$$\frac{\partial \phi}{\partial z_i} = \frac{1}{M}\frac{\partial C}{\partial z_i} > 0, \; \frac{\partial \phi}{\partial \pi} = \frac{1}{M} > 0$$

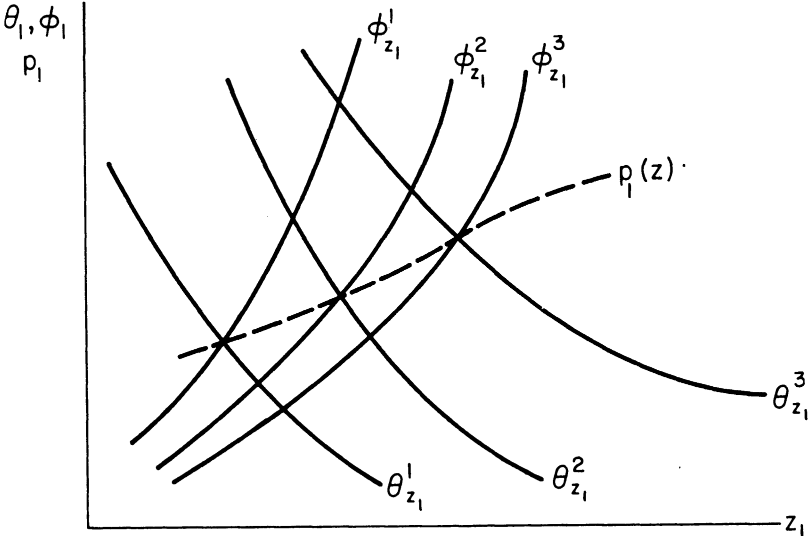
Production Decision



Market Equilibrium

- Consumers have different income and tastes parametrized by α
  - The population is described by the joint distribution function $F(y, \alpha)$
- Producers have different technologies parametrized by β
  - The population is described by the distribution function $G(\beta)$
- The market hedonic function $p(\mathbf{z})$ is a joint envelope
  1. Upper envelope of consumers' bid functions
  2. Lower envelope of producers' offer functions
- Quantities demanded and supplied at each $\mathbf{z}$ depend on all of $p(\mathbf{z})$
- The characterization of a two-sided equilibrium is problematic

Two-Sided Equilibrium



One-Sided Equilibrium

- If one side of the market is homogeneous, it determines market prices
  1. If firms are identical, $p(\mathbf{z})$ coincides with their offer function
  2. If consumers are identical, $p(\mathbf{z})$ coincides with their bid function
- If the market is perfectly competitive, $p(\mathbf{z})$ is determined by supply
  - Free entry implies $\pi = 0$
  - All firms operate at minimum average cost $c(\mathbf{z}) = \min_M \left\{ \frac{1}{M} C(M, \mathbf{z}) \right\}$
  - The market price equals minimum production cost: $p(\mathbf{z}) = c(\mathbf{z})$
  - Quantity adjusts through firm entry, not firm size
- Perfect competition with heterogeneous β if no type is scarce
  - Otherwise the scarce efficient types earn profits and demand matters

How Not to Identify the Model

- Standard simultaneity problem in two-sided markets
- Rosen (1974) proposed a two-step empirical strategy

1. Estimate hedonic prices $p(\mathbf{z})$ with the best fitting functional form
2. Take partial derivatives of the estimate $\hat{p}(\mathbf{z})$ at the sample values and estimate the simultaneous demand and supply equations

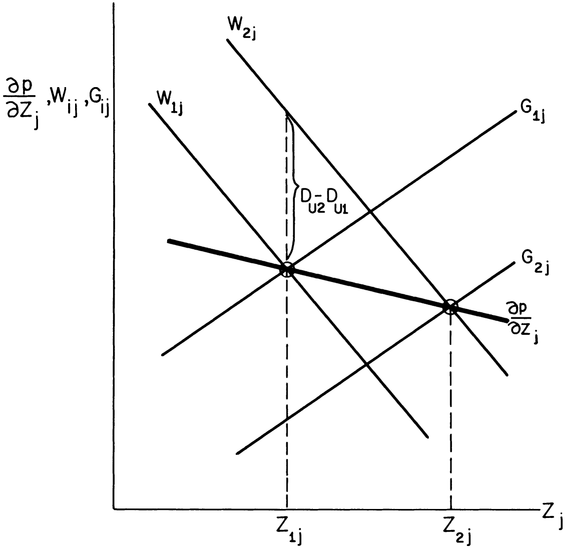
$$\begin{aligned} \frac{\partial p}{\partial z_i}(\mathbf{z}) &= F_i\left(\mathbf{z}, \mathbf{x}^d, y - p(\mathbf{z})\right) \\ \frac{\partial p}{\partial z_i}(\mathbf{z}) &= G_i\left(\mathbf{z}, \mathbf{x}^s, p(\mathbf{z})\right) \end{aligned}$$

- This procedure is incorrect and unusable (Bartik 1987, Epple 1987)
  - The true problem is not simply demand-supply interaction

Identification Problem

1. If $p(\mathbf{z})$ is non-linear, marginal hedonic prices $\partial p / \partial z_i$ depend on $\mathbf{z}$
   - Consumer preferences determine both quantities $\mathbf{z}$ and hedonic prices
   - The demand equation can never be estimated consistently by OLS
   - The problem arises whether supply is endogenous or exogenous
   - If supply is endogenous it suffers from the same problem
2. Observable prices $p(\mathbf{z})$ depend on consumer characteristics $\mathbf{x}^d$
   - The hedonic regression can be estimated consistently by OLS only if its error term is uncorrelated with the error term of the demand equation
3. Consumer tastes also determine the supplier each consumer buys from
   - E.g., the homeowner's taste is correlated with the architect's ability
   - Supplier characteristics cannot be used as instruments
   - The typical exclusion restrictions for estimating demand systems fail

Unobserved Consumer Tastes and Supplier Characteristics



Identifying and Estimating Hedonic Models

- Bartik (1987): exogenous shifts in the consumer's budget constraint
  - Exogenous income changes if you can find them (field experiments)
- Many markets with common preference and technology parameters
  - Variation across cities or over time
  - Identification of demand if unobserved tastes are stable across markets
  - Identification of supply if unobserved productivity is stable
  - Epple (1987): exclusion restrictions for the linear-quadratic model
- Ekeland, Heckman, and Nesheim (2004): nonparametric identification
  - The linear-quadratic model is underidentified but arbitrary
  - Generic nonlinearities allow identification in a single market
  - Cutting-edge econometrics (Heckman, Matzkin and Nesheim 2010)
- Urban economists have mostly shied away from structural estimation
  - Stop at the first-stage hedonic regression
  - Focus on omitted-variable bias

Air Quality and House Prices

- U.S. air pollution greatly decreased in the '80s as regulation tightened
- Did housing values increase more where pollution decreased more?
  - Cross-section and fixed-effects estimates are weak and unreliable
- Chay and Greenstone (2005) instrument by initial compliance
  - Nonattainment counties faced more stringent regulation Figure
  - Nonattainment predicts declining pollution and increasing house prices
  - Nonattainment in '75-76 is largely uncorrelated with observables Table
  - IV estimates are highly significant and robust OLS 2SLS
  - Quite robust to regression discontinuity at the attainment threshold
- Random coefficients model to account for non-random sorting
  - Evidence of taste-based sorting, but small estimated impact
- No control for changes in housing supply, nor in other amenities
  - Arguably population and housing take more than 5 years to react
  - Beware that house prices are forward looking

Trends in Particulate Concentration by County

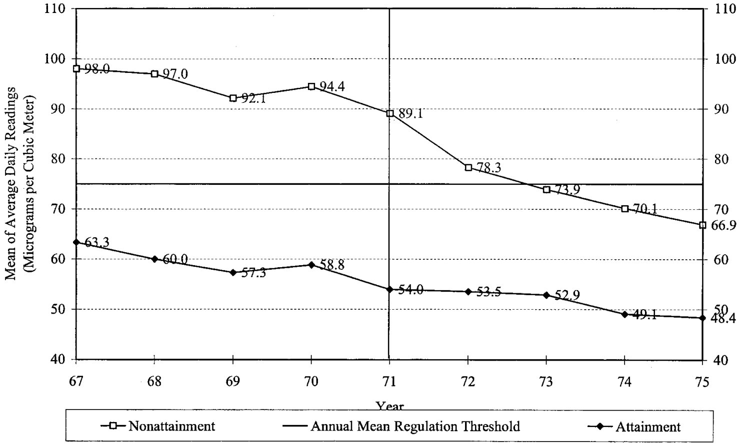


FIG. 2.—1967–75 trends in TSPs concentrations, by 1972 attainment status. The data points are derived from the 228 counties that were continuously monitored in this period. The 116 attainment counties had a 1970 population of approximately 25.8 million people, whereas about 63.4 million people lived in the 112 nonattainment counties in the same year. Each data point is the unweighted mean across all counties in the relevant regulatory category.

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Nonattainment and Changes in Air Quality

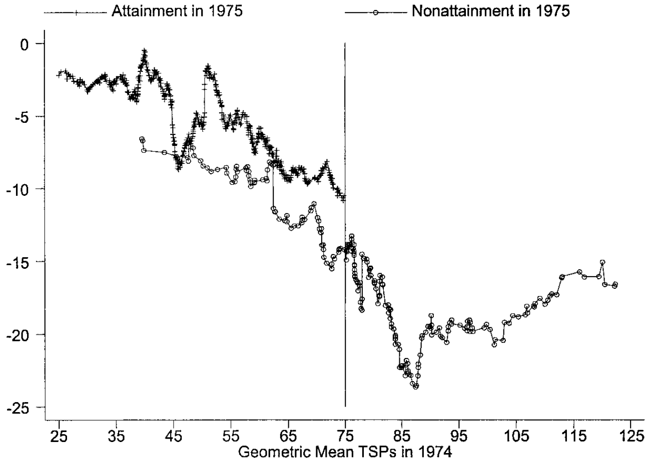

FIG. 4.—1970–80 change in mean TSPs by 1975 nonattainment status and the geometric mean of TSPs in 1974.

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Nonattainment and Changes in House Prices

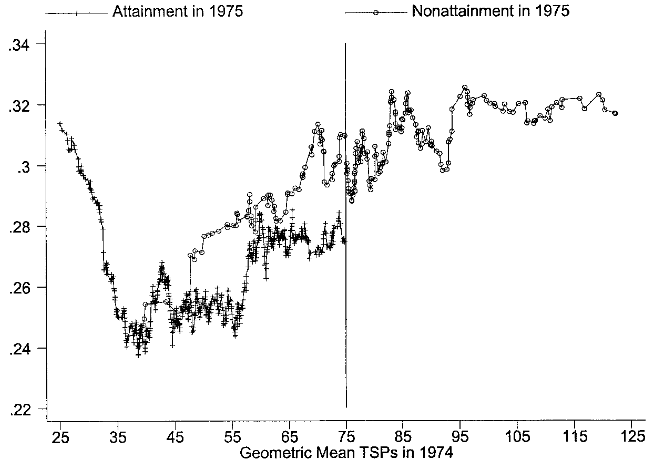

FIG. 5.—1970–80 change in log housing values by 1975 nonattainment status and the geometric mean of TSPs in 1974.

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Differences in Sample Means between Groups of Counties, Defined by TSPs Levels, Changes, or Nonattainment Status

	Cross Section 1970 (1)	First Difference 1980−1970 (2)	TSPs Nonattainment: In 1970, 1971, or 1972 (3)	TSPs Nonattainment: In 1975 or 1976 (4)	TSPs Nonattainment: In 1975 Regression Discontinuity Sample (5)	TSPs Nonattainment: In 1975 Bad Day Sample (6)
Total counties (nonattainment)	988	988	988	988	475	419
			(380)	(280)	(123)	(67)
Housing value	1,092	−3,237**	−517	2,609**	2,007	2,503
	(918)	(713)	(726)	(806)	(1,193)	(1,585)
Mean TSPs	39.2**	−30.9**	−19.6**	−10.0**	−12.3**	−4.8
	(1.2)	(1.0)	(1.4)	(1.8)	(2.4)	(2.9)
Economic condition variables:						
Income per capita (1982–84 dollars)	377.7**	−159.9**	−81.6*	48.6	47.2	−37.2
	(94.7)	(40.7)	(41.2)	(46.4)	(65.1)	(94.1)
Total population (% change)	142,016**	−.058**	−.046**	−.001	.005	.015
	(24,279)	(.013)	(.013)	(.017)	(.028)	(.030)
Unemployment rate (×100)	−.144	.519**	.200	.043	.305	−.032
	(.120)	(.129)	(.132)	(.152)	(.215)	(.274)
% employment in manufacturing (×10)	.098	−.119**	−.081**	−.005	−.057	−.066
	(.083)	(.026)	(.026)	(.028)	(.042)	(.051)
Demographic and socioeconomic variables:						
Population density	602.3**	−66.9**	−100.5**	−18.0	1.0	42.6
	(192.6)	(24.8)	(31.4)	(24.9)	(48.0)	(49.7)
% urban (×10)	1.413**	−.051	−.087	−.009	−.021	.124
	(.168)	(.051)	(.048)	(.053)	(.062)	(.088)
% poverty (×10)	−.118**	.107**	.154**	.139**	.029	.173**
	(.046)	(.024)	(.024)	(.024)	(.040)	(.034)
% white (×10)	.119	−.072**	−.224**	−.195**	−.086	−.124
	(.083)	(.031)	(.032)	(.036)	(.054)	(.066)
Housing stock variables:						
% of houses built in last 10 years		−.034**	−.025**	−.006	−.006	.007
		(.007)	(.007)	(.008)	(.012)	(.016)
% owner-occupied (×10)	−.127*	.081*	.127**	.082*	.046	−.109
	(.055)	(.036)	(.033)	(.037)	(.044)	(.064)
% houses no plumbing (×1,000)	−.005**	−.055**	−.073**	−.075**	.013	−.077**
	(.001)	(.017)	(.018)	(.018)	(.031)	(.019)
Tax and expenditure variables:						
Per capita government revenue	23.8	77.3*	60.2	44.6	10.2	101.9
	(24.7)	(34.2)	(42.6)	(30.2)	(49.0)	(68.6)
Per capita property taxes	8.5	26.0**	7.2	−1.1	−1.7	14.6
	(11.7)	(9.6)	(10.3)	(9.4)	(12.9)	(19.2)
% of spending on education	−.030**	−.006	−.009	.012	.009	−.020
	(.008)	(.006)	(.006)	(.007)	(.009)	(.012)

Note.—See the note to table 1. The entries in each column are the differences in the means of the variables across two sets of counties and the standard errors of the differences (in parentheses), which allow for heteroskedasticity. Col. 1 presents the mean difference in the 1970 values of the covariates between counties with 1970 TSPs concentrations greater and less than the median 1970 county-level TSPs concentration, respectively. Col. 2 reports the analogous calculations for 1970–80 changes in TSPs; i.e., the entries are the mean difference in the change in the covariates between counties with a change in TSPs that is less than and greater than the median change in TSPs. The entries in cols. 3 and 4 are the mean difference of the 1970–80 change in the covariates between 1971–72 and 1975–76 nonattainment and attainment counties, respectively. The entries in cols. 5 and 6 compare 1970–80 changes for 1975 nonattainment and attainment counties; the samples are restricted to the regression discontinuity and bad day test samples as described in the text. See the text for more details.

* Significant at the 5 percent level.

** Significant at the 1 percent level.

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Reduced-Form Relations

ESTIMATES OF THE IMPACT OF MID-DECADE TSPS NONATTAINMENT ON 1970–80 CHANGES IN TSPS POLLUTION AND LOG HOUSING VALUES

	(1)	(2)	(3)	(4)
	A. Mean TSPs Changes			
TSPs nonattainment in 1975 or 1976	−9.96	−10.41	−9.57	−9.40
	(1.78)	(1.90)	(1.94)	(2.02)
F-statistic TSPs	31.3	29.9	24.4	21.5
nonattainment*	(1)	(1)	(1)	(1)
R^2	.04	.10	.19	.20
	B. Log Housing Changes			
TSPs nonattainment in 1975 or 1976	.036	.022	.026	.019
	(.012)	(.009)	(.008)	(.008)
F-statistic TSPs	8.5	6.2	9.3	6.4
nonattainment*	(1)	(1)	(1)	(1)
R^2	.01	.56	.66	.73
County Data Book covariates	no	yes	yes	yes
Flexible form of county covariates	no	no	yes	yes
Region fixed effects	no	no	no	yes
Sample size	988	983	983	983

NOTE.—See the notes to previous tables. In panel A the dependent variable is the difference between the 1977–80 and 1969–72 averages of mean TSPs concentrations. The mean is -7.82 $\mu g/m^3$. In panel B the dependent variable is the difference between 1980 and 1970 log housing values, and its mean is 0.27. Standard errors (in parentheses) are estimated using the Eicker-White formula to correct for heteroskedasticity.

* Numbers in parentheses in rows with *F*-statistics are numerator degrees of freedom.

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Instrumental Variables Estimates

INSTRUMENTAL VARIABLES ESTIMATES OF THE EFFECT OF 1970–80 CHANGES IN TSPS POLLUTION ON CHANGES IN LOG HOUSING VALUES

	(1)	(2)	(3)	(4)
	A. TSPs Nonattainment in 1975 or 1976			
Mean TSPs (1/100)	−.362	−.213	−.266	−.202
	(.152)	(.096)	(.104)	(.090)
Sample size	988	983	983	983
	B. TSPs Nonattainment in 1975			
Mean TSPs (1/100)	−.350	−.204	−.228	−.129
	(.150)	(.099)	(.102)	(.084)
Sample size	975	968	968	968
	C. TSPs Nonattainment in 1970, 1971, or 1972			
Mean TSPs (1/100)	.072	−.032	−.050	−.073
	(.058)	(.042)	(.041)	(.035)
Sample size	988	983	983	983
County Data Book covariates	no	yes	yes	yes
Flexible form of county covariates	no	no	yes	yes
Region fixed effects	no	no	no	yes

NOTE.—See the notes to previous tables. The coefficients are estimated using 2SLS. The first row of panels A–C indicates which instrument is used. From panels A to C, the instruments are an indicator equal to one if the county was nonattainment for TSPs in either 1975 or 1976, an indicator equal to one if the county was nonattainment for TSPs in 1975, and an indicator that equals one if the county was nonattainment for TSPs in either 1970, 1971, or 1972, respectively. Standard errors (in parentheses) are estimated using the Eicker-White formula to correct for heteroskedasticity.

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User Costs of Housing

- Annual flow costs of housing
    1. Constant depreciation δ
    2. Maintenance and repair expenditures in proportion κ to value
    3. Property tax at rate μ
    4. Mortgage interest payments at an interest rate i
        - A single interest rate: i is also the opportunity cost of funds
        - Then the loan-to-value ratio does not matter
- Tax considerations
    - Marginal income tax rate θ
    - Deductibility of mortgage interest and property taxes (in the U.S.)
- Poterba's (1984) contingent focus is on fiscal drag
    - Nominal income from financial assets is taxed
    - Nominal mortgage interest payments are deductible
    - Housing generates largely untaxed real income

Asset Market Equilibrium

- Total stock H of homogeneous "unit structures"
  - Real asset price Q
  - Flow value of rental services $R(H)$
- No uncertainty
- Fundamental asset pricing equation with inflation π

$$[\delta + \kappa + (1 - \theta)(\mu + i)]\, Q = R + \dot{Q} + \pi Q$$

- Define the real user cost of housing

$$\nu \equiv \delta + \kappa + (1 - \theta)(\mu + i) - \pi$$

- Then the no-arbitrage equation has the familiar form

$$\nu Q = R + \dot{Q}$$

Net Present Value

- Define the service value of housing

$$S \equiv R - [\delta + \kappa + (1 - \theta)\,\mu]$$

- Then the no-arbitrage equation has the form

$$[(1 - \theta)\, i - \pi]\, Q = S + \dot{Q}$$

  - The real after-tax interest rate falls with inflation

- Transversality conditions
  1. The service value grows at less than the discount rate
  2. There is no bubble in house prices

- The real price is the present value of service flows

$$Q(t) = \int_t^{\infty} S(z)\, e^{[(1-\theta)i-\pi](t-z)}\, dz$$

Housing Market Equilibrium

- The housing stock evolves according to the accounting identity

$$\dot{H} = I - \delta H$$

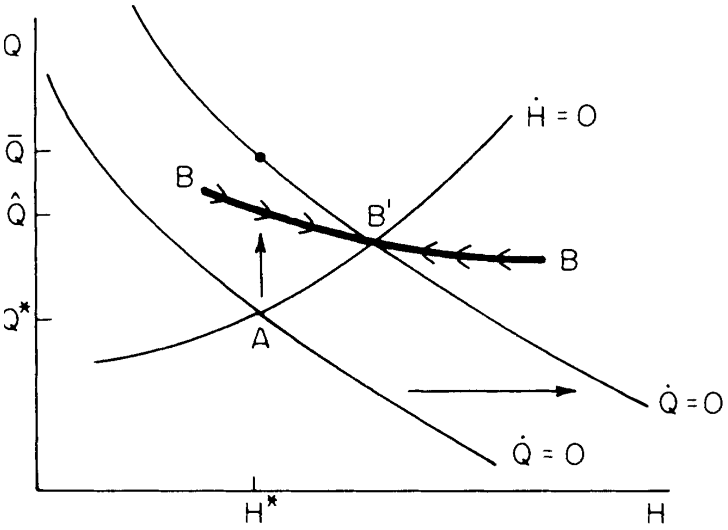
- Gross investment is sensitive to price: $I = \psi(Q)$ with $\psi' > 0$
  - The role of land is disregarded
- Dynamic system for quantity and price

$$\begin{cases} \dot{Q} = \nu Q - R(H) \\ \dot{H} = \psi(Q) - \delta H \end{cases}$$

- Steady state

$$\begin{cases} R(H^*) = \nu \psi^{-1}(\delta H^*) \\ \psi(Q^*) = \delta R^{-1}(\nu Q^*) \end{cases}$$

Effects of a Reduction in Homeowners' User Cost



Unexpected Inflation Shock Simulations

	Change in inflation rate			
	0–0.02	0–0.05	0–0.08	0.03–0.09
$\theta = 0.25$ case				
Static expectations price change	8.3	23.8	44.4	35.3
Perfect foresight price change	5.1	13.6	23.4	18.7
Steady-state price change	2.7	7.4	13.1	10.6
Steady-state capital change	5.5	15.3	27.8	22.3
$\theta = 0.35$ case				
Static expectations price change	13.0	40.2	84.8	71.2
Perfect foresight price change	7.7	21.3	38.7	32.3
Steady-state price change	4.2	12.0	22.8	19.7
Steady-state capital change	8.5	25.2	50.5	43.1

All reported changes are percentage movements from initial equilibrium. Assumed exogenous parameter values are $\delta = 0.015$, $\mu = 0.02$, $\kappa = 0.02$, $\delta^* = 0.04$, real rate of interest $r = 0.02$. Further information is reported in the Appendix.

Owner Occupants vs. Landlords

- An occupant is indifferent between owning and renting if

$$\left[\delta + \kappa + (1 - \theta)(\mu + i) - \pi\right] Q \equiv \nu Q = R + \dot{Q}$$

or in net present value terms

$$Q(t) = \int_t^{\infty} R(z)\, e^{\nu(t-z)} dz$$

- An investor is willing to buy a house and rent it if

$$\left(\tilde{\delta} + \tilde{\kappa} + \mu + i - \pi\right) Q \equiv \tilde{\nu} Q = R + \dot{Q}$$

  - Depreciation $\tilde{\delta}$ and maintenance costs $\tilde{\kappa}$ may be different for a landlord
  - Taxes on profits, including capital gains and deducting expenses
  - The investor's tax rate is irrelevant for his no-arbitrage condition

Omitted Maintenance Costs

- If depreciation and maintenance are independent of ownership

$$\tilde{\nu} - \nu = \theta\left(\mu + i\right)$$

- The differential tax treatment alone would lead to owner-occupancy
  - In the NPV formula, investors have a higher discount rate
- For reasonable calibrations, the difference is substantial
  - Himmelberg, Mayer, and Sinai (2005): $\delta + \kappa = 2.5\%$, $\theta = 25\%$, $\mu = 1.5\%$, $i = 5.5\%$ and a constant growth rate of rents $\dot{R}/R = 3.8\%$
  - Owner-occupiers justify a price-to-rent ratio of 25
  - Landlords justify a price-to-rent ratio of 17.5, i.e. 30% less
- Indifference if landlords face lower depreciation and maintenance costs

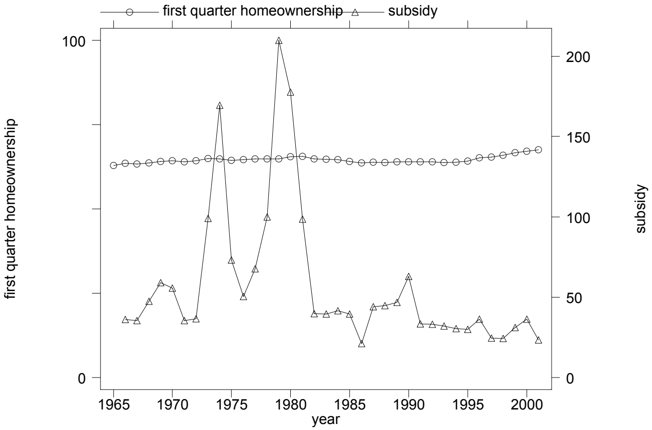
$$\delta + \kappa - \tilde{\delta} - \tilde{\kappa} = \theta\left(\mu + i\right)$$

  - In the calibration $\tilde{\delta} + \tilde{\kappa} = 0.75\%$, i.e., 70% less

Homeownership and the Mortgage Interest Deduction

- The U.S. homeownership rate has been very steady around 65%
  - Since the 1950s it has remained in a fixed band from 63 to 68%
  - By comparison: Germany $\sim$ 45%, Spain $\sim$ 85%
- The tax benefit of the mortgage interest deduction fluctuates Figure
- The deduction benefits only higher-income taxpayers
  - Standard deduction of $5,800 per spouse or itemized deductions Figure
  - Itemizers are inframarginal owner-occupiers Table
- Effects of the mortgage interest deduction
  1. Reduce the progressiveness of the income tax
  2. Incentivize wealthier Americans to buy a more expensive house
  3. Incentivize wealthier American to leverage more their house purchase
- No effective incentive to homeownership (Glaeser and Shapiro 2003)

Homeownership and Inflation in the U.S.



Notes: Subsidy series shows the effect of federal taxes on the price of owner-occupied housing, based on the twelve-month CPI inflation rate prior to the first quarter of each year. Data from www.freelunch.com. See Section III for a discussion of the calculation of the subsidy. Homeownership rate is estimated rate for first quarter of each year. Data from www.census.gov.

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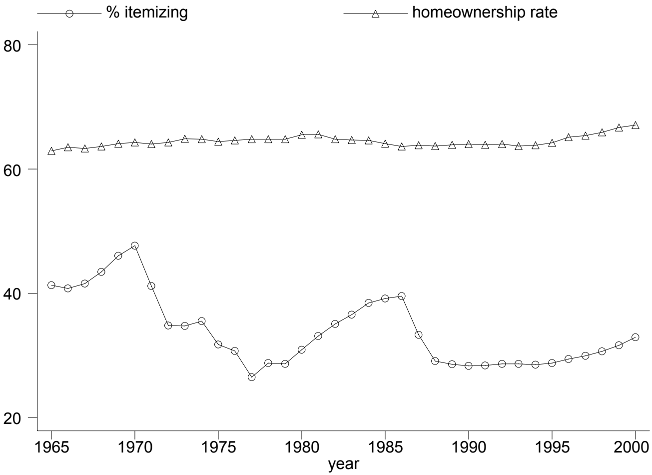
Trends in Itemization of U.S. Income-Tax Deductions



Notes: Series is percent of all federal tax returns itemizing deductions. Data from www.irs.gov.

Itemization, Income, and Homeownership

Decile	Percent of itemizers	Percent of itemized income	Percent itemizing Renters	Percent itemizing Homeowners	Percent itemizing Total	Percent owning residence
1	0.28	0.18	0.36	11.59	3.39	28.76
2	0.69	0.43	0.41	7.85	3.61	42.83
3	1.68	1.03	3.22	14.15	7.71	49.67
4	2.71	1.71	5.05	17.86	12.47	55.47
5	4.21	2.77	7.92	24.48	18.79	64.03
6	6.70	4.07	6.09	34.79	24.14	67.70
7	11.28	7.16	11.30	43.01	33.65	71.55
8	16.71	11.73	14.70	52.77	46.24	83.55
9	24.20	19.64	19.23	70.66	63.89	87.58
10	31.54	51.28	48.22	78.12	75.16	92.61
TOTAL	100	100	5.77	42.65	28.51	64.44

Notes: Data are from authors' calculations based on the Survey of Consumer Finances, 1998. Decile is by household income. Survey weights used in constructing means and deciles.

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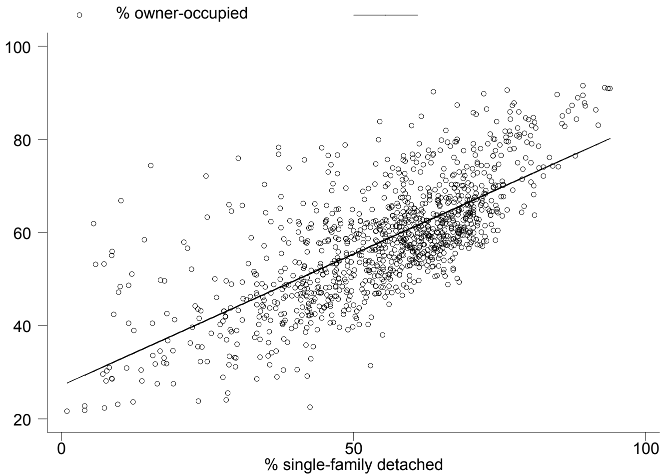
Arbitrage Approaches to Housing

- Spatial equilibrium is an imprecise no-arbitrage condition
  - No absolute prediction about nationwide price trends
  - Qualitative more than quantitative predictions about prices
    - What's the objectively correct price of sunshine?
- Asset pricing offers the allure of tighter predictions
  - No arbitrage between ownership and rental
  - No arbitrage from timing house purchases
  - No arbitrage between investing in real estate or any other asset
- Empirically, the precision of the financial predictions evaporates
  - The asset-pricing approach is theoretically unimpeachable
  - The relevant variables are largely unmeasured if not unmeasurable

Owner-Occupied Houses and Rental Flats

- In the U.S., rental and owner-occupied homes are very distinct goods
- The type of structure is almost perfectly correlated with tenure mode
  - The vast majority of owner-occupied homes are single-family dwellings
  - Rental units are overwhelmingly part of denser multi-family buildings
- Standard agency explanation: one building, one owner
  - Moral hazard: houses are better maintained by an owner-occupier
  - Collective action: apartment buildings are better managed by a landlord
- Legal origins
  - The French civil code recognizes condominium ownership since 1804
  - Common law recognized ownership of land and vertical structures only
  - Condominium was introduced by statutes in the U.S. since 1960
  - "Commonhold" was introduced by statute in England in 2004

Homeownership and Structure



Notes: Graph shows percent of housing owner-occupied and percent of housing that is single-family detached in 1990 for places containing 25,000 people or more. Data from the City and County Data Book, 1994.

Comparing Ownership and Rental in the U.S.

	Owner-occupied housing	Renter-occupied housing
Single-family detached unit type (percent)	64.3	17.7
Located in central cities (percent)	30.5	45.7
Rating their neighborhoods as excellent[a] (percent)	45.6	34.2
Median household income in 2005	$53,953	$24,651
Married households with minor children (percent)	27.6	15.4

NOTES: Data are from the 2005 *American Housing Survey* unless otherwise noted.

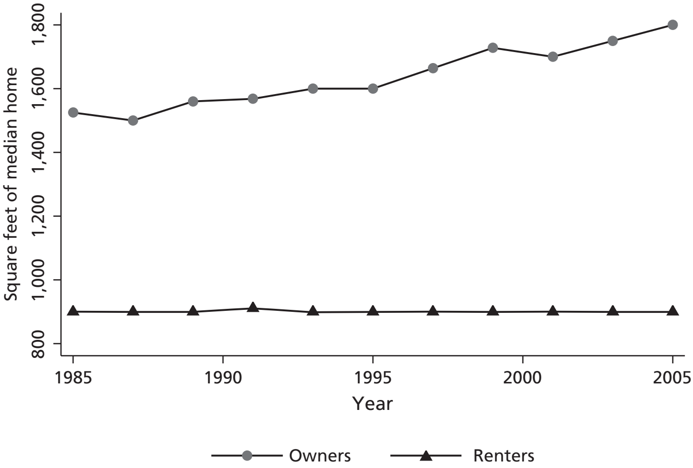
[a] We label a neighborhood as excellent if the survey respondents gave it a rating of 9 or 10 on a 1–10 scale.

Differences between Owner-Occupancy and Tenancy

- Owner-occupied units are typically larger than rental units ▸ Figure
  - Size per capita also differs: 65 m^2 vs. 40 m^2
- Owner-occupied units and rental units are in different locations
  - Rental units are closer to the urban core (AMM density gradient)
  - Rental units are more likely to be in less attractive neighborhoods
- Owner-occupants are also systematically different from tenants
  - They are substantially richer
  - They are older and have larger families (i.e., married with children)
  - Their income is much more volatile
    - ★ This may explain why rents are more stable than house prices ▸ Table
- One interpretation: vertical market segmentation
  - Rental units are downmarket, owner-occupied units upmarket

Bottom line: U.S. home prices and rents do not refer to close substitutes

Housing Unit Size by Tenure



SOURCE: U.S. Census Bureau (1985–2005).

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Comparing House Price and Rental Growth

	Average annual rent growth (percent)	Average annual price growth (percent)
44 markets	0.51	1.88
San Francisco	1.96	3.93
Boston	2.06	4.37
Los Angeles	1.29	3.62
Atlanta	0.22	1.06
Chicago	0.83	2.20
Phoenix	−0.20	2.19

NOTES: Rent data are from REIS, Inc. Home price appreciation rates are computed from the Office of Federal Housing Enterprise Oversight price index. All data are in real terms.

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Risk Aversion and the Timing of Transactions

- Individuals are often tenants before becoming owner-occupants
- The timing of the purchase decision should be optimized
  - Individuals can exploit any short-run predictability of house prices
- Not quite a one-period no-arbitrage condition, due to risk aversion
  - A diversified investor is risk neutral for a small purchase of one stock
  - A house instead is a large, undiversified, typically leveraged investment
- Glaeser and Gyourko (2009) find no benefit of delaying purchase
  - Prices are significantly predictable with one year's advance
  - The predictive power is not worth the risk due to volatility
  - In most cases the predicted price movement is an increase
  - There is some value to delaying sales, but few owners become tenants

The Benefits of Short-Term Predictability

Percentile	Distribution of one-year price changes[a] $(P_{i,t+1} - P_{i,t})$	Distribution of net gains from delaying purchase[b] $-\overline{H(t+1)-H(t)} - \frac{2Var(\varepsilon)}{100,000 + 2\overline{H(t+1)-H(t)}}$	Distribution of net gains from delaying sale[c] $\overline{H(t+1)-H(t)} - \frac{2Var(\varepsilon)}{500,000 - 2\overline{H(t+1)-H(t)}}$
10th	−\$2,698	−\$15,352	−\$2,864
25th	−\$612	−\$8,089	−\$775
50th	\$2,361	−\$3,199	\$2,144
75th	\$6,163	\$112	\$5,609
90th	\$10,802	\$2,179	\$9,739

NOTES: [a] The underlying specification estimated regresses the one-year, forward-looking change in home prices on a series of observables as follows: $P_{i,t+1} - P_{i,t} = \alpha + \beta^* P_{i,t} + \gamma^*7\text{yrRealRate}_t + \delta^*\text{RealGDP}_t + \eta^*\text{MSA}_i + \varepsilon_{i,t}$, where $P_{i,t}$ reflects house price in metropolitan area i in year t, 10yrRealRate is the real interest rate on seven-year Treasuries (calculated as in Himmelberg, Mayer, and Sinai, 2005), RealGDP is real gross domestic product from the Economic Report of the President, MSA_i is a vector of metropolitan area dummies, and ε is the standard error term.

[b] Net gain from delaying purchase for one year for a renter household with \$50,000 in nonhousing wealth and a relative risk aversion coefficient equal to 2. See the discussion in the text for more detail.

[c] Net gain from delaying sale for one year for an owner household with \$250,000 in wealth and a relative risk aversion coefficient equal to 2. See the discussion the text for more detail.

Owner-Occupied Housing as a Hedge

- A house is a rather risky asset to invest in
  - High price volatility and low diversification, if any
- But owning your house hedges the risk of rent fluctuations
  - Everyone needs a house to live in
- Homeownership locks in future housing consumption and its price
  - Reduces volatility of the owner-occupant's price index
  - Hinders readjustment of housing consumption: quantity and location
- The trade-off favors ownership over rental when
  1. The household's expected length of stay in their house is longer
  2. House prices are more positively correlated across markets
     - ★ "Markets" can be cities, neighborhoods, sizes and types of homes ...

Volatility and the Ownership-Rental Trade-Off

- Sinai and Souleles (2005) provide evidence of the hedging motive
  - The idea had been around for a long time, but they wrote the paper
- Imputed household horizon by age, occupation and marital status
  - Probability of staying equal to the fraction of stayers in the group

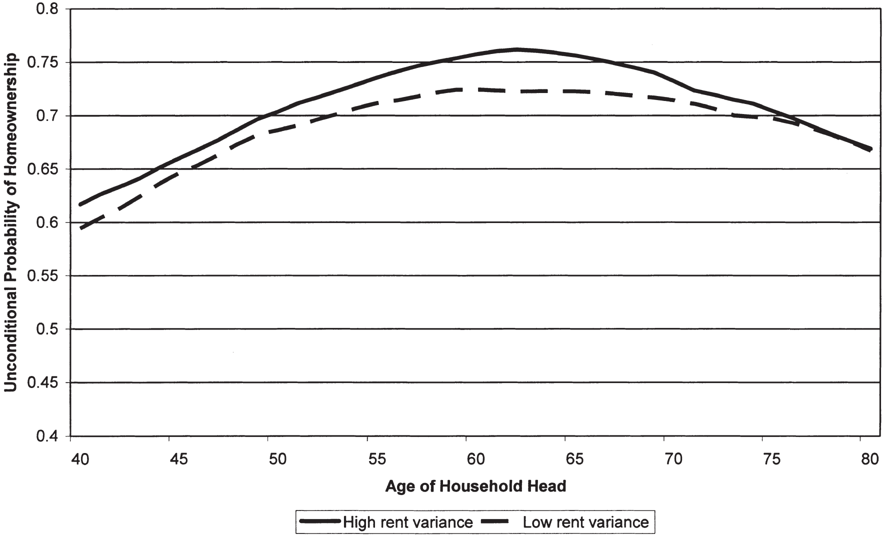
1. Homeownership rates: significant interaction effects
   - Household with longer horizons respond more to rent volatility
   - Rent volatility matters more in cities with high rent-to-income ratios
2. House price-to-rent ratios: significant level effect
   - The ratio increases with variance of rents
   - The ratio increases with the level of expected rents

THE EFFECT OF NET RENT RISK ON THE PROBABILITY OF HOMEOWNERSHIP

	(1)	(2)	(3)	(4)	(5)
Dependent variable: one if household is a homeowner, zero otherwise					
β_1: σ_r [σ_r = Standard deviation of real rent]	0.028 (0.024)	0.008 (0.022)			
β_2: N [N = Probability of staying, $P(STAYS)$]	0.036 (0.011)	0.015 (0.013)	0.020 (0.011)		0.018 (0.012)
β_3: $\sigma_r \times N$ [$N = P(STAYS)$]		0.042 (0.014)	0.029 (0.011)		0.018 (0.013)
β_2: N [N = Age if over 60]				−0.0006 (0.0007)	
β_3: $\sigma_r \times N$ [N = Age if over 60]				−0.0029 (0.0014)	
β_4: r/Y [= Market Rent/ Household Income]					−0.018 (0.016)
β_5: $r/Y \times N$ [$N = P(STAYS)$]					0.017 (0.019)
β_6: $\sigma_r \times r/Y$					−0.021 (0.020)
β_7: $\sigma_r \times r/Y \times N$ [$N = P(STAYS)$]					0.054 (0.025)
MSA controls	Yes	Yes	No	No	No
MSA × year dummies	No	No	Yes	Yes	Yes
Household controls	Yes	Yes	Yes	Yes	Yes
Number of observations:	40,274	40,274	40,274	9,699	39,468
Pseudo R^2	0.2352	0.2355	0.2498	0.1989	0.2566

This table reports marginal effects from probit regressions of equation (7), with standard errors in parentheses, estimated using household-level data covering 44 MSAs in 1990 and 1999. All specifications include year dummies. MSA controls include median real rent, median real house price, real rent growth, and real house price growth. Household controls include log household income and dummies for the head's occupation, race, education, marital status, and age. In columns (1)–(3) and (5), MSAs are deemed to have high rent variance if σ_r is above the median household's value of 2.8 percent. In column (4), the cutoff is the seventy-fifth percentile household's value of 4.1 percent. The probability of staying is high if the household is above the median probability of 88 percent. All dollar values are in real (1990) dollars, deflated by the CPI less shelter. In columns (1) and (2) the standard errors are adjusted for correlation within MSA/year. Column (5) excludes the outliers with the 1 percent highest and lowest values of MSA average rent to household income.

Homeownership by Age and Rent Variance



The effect of Net Rent Risk on the Price-to-Rent Ratio

	(1)	(2)	(3)
	Dependent variable: Price-to-rent ratio		
α_1: Standard deviation of real rent (σ_r)	34.52 (11.88)	11.04 (5.55)	10.10 (3.81)
ψ: Real rent growth	68.99 (14.68)	16.73 (4.67)	18.14 (5.23)
Controls for MSA fixed effects?	No	MSA dummies	First differences
Number of observations	396	396	352
R^2	0.0486	0.9471	0.1609
A one s.d. increase in σ_r leads to a . . . increase in the price-to-rent ratio	0.62 (0.21)	0.20 (0.10)	0.18 (0.07)
A one s.d. increase in σ_r leads to a . . . percent increase in house prices, holding rent constant	3.9	1.3	1.1

Estimation is by OLS, following equation (8). Standard errors are in parentheses. Number of observations equals 44 MSAs per year over the 1990–1998 time period. All specifications include year dummies. σ_r and rent growth rates are computed based on the previous (rolling) nine years. A one standard deviation increase in σ_r is 0.018 (from a mean of 0.031). The average price-to-rent ratio is 15.72.

The Boston Condominium Market

Genesove and Mayer (1997, 2001) had a wonderful sample of Boston flats

1. Weekly records of almost all flats listed for sale, 1990 to 1992
2. Property characteristics and assessed tax valuation by the city
3. Sale prices and mortgage amounts for all transactions, 1982 to 1992

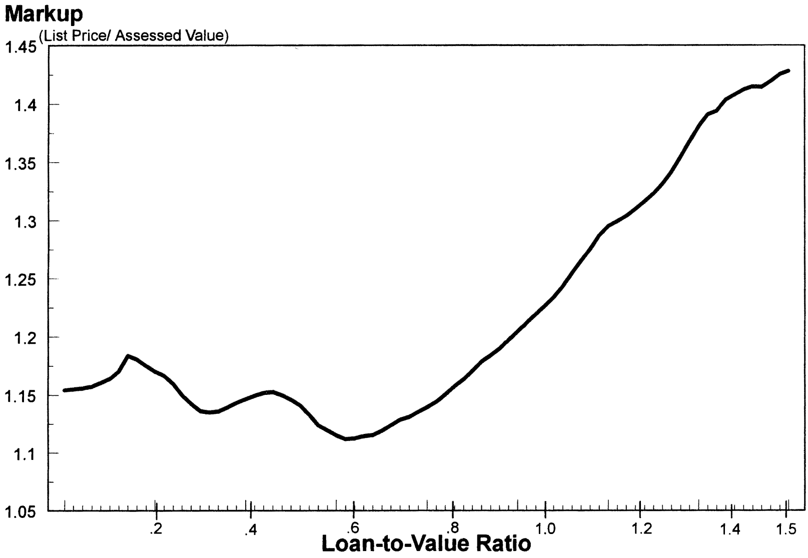
- The data allow them to establish facts that others had not uncovered
    - Two articles in top journals, more than 750 citations in total
- It is unclear if there is anything more to do on this topic
    - Nice examples of a particular kind of work
    - Quite relevant to the current market environment, especially in Spain

Home Equity and Seller Behavior: Rational Explanation

- Owners try really hard to cover their mortgage loans when they sell
  - Occupants need positive equity for a new mortgage downpayment
  - Investors do not want to default (option value of unrealized losses)
- Owners with a loan-to-value ratio above 80%
  1. Set a higher asking price ▸ Figure
  2. Have higher expected time on the market ▸ Table
  3. Receive a higher price if they sell ▸ Table
     - ★ But they are less likely to sell
- Falling prices lead to rising inventory and falling transactions

▸ Psychology

Loan-to-Value Ratio and Asking Price



Loan-to-Value Ratio and Time on the Market

TABLE 3—DURATION EQUATIONS—DURATION VARIABLE IS THE LOG OF THE NUMBER OF WEEKS THE PROPERTY IS LISTED ON THE MARKET BEFORE EXITING (STANDARD ERRORS)

Variable	(1) OLS	(2) Normal	(3) Extreme value	(4) Buckley-James
Loan/value	0.09	0.22	0.16	0.22
	(0.05)	(0.10)	(0.08)	(0.10)
$(\text{VALUE})^{-1}$	29	128	152	121
(000s)	(11)	(24)	(24)	(28)
Years since last sale	0.03	0.09	0.08	0.09
	(0.01)	(0.02)	(0.02)	(0.02)
1991 entry	−0.19	−0.60	−0.59	−0.59
	(0.05)	(0.10)	(0.09)	(0.10)
1992 entry	−0.67	−0.77	−0.84	−0.77
	(0.06)	(0.11)	(0.10)	(0.11)
Standard error of regression	0.962	1.44	1.495	1.036
χ^2 (17 degrees of freedom)	189.0	131.8	152.6	112.0

Notes: Value is obtained from the Boston assessor's office for the year of entry into LINK. All equations contain additional control variables for property attributes. Number of observations = 2,381.

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Loan-to-Value Ratio and Prices

TABLE 7—REGRESSIONS USING LOG OF SALE PRICE AND (ORIGINAL) ASKING PRICE (STANDARD ERRORS)

Variable	(1) Sale price	(2) Sale price	(3) Sale price	(4) Asking price	(5) Sale price − Asking price
Loan/value (LTV)	0.08	0.03	0.0004	0.06	−0.035
	(0.02)	(0.03)	(0.06)	(0.03)	(0.019)
(LTV − 0.8)(LTV > 0.8)		0.19	0.23	0.13	0.06
		(0.10)	(0.20)	(0.09)	(0.05)
No mortgage			−0.028		
			(0.043)		
Years occupied	0.003	0.003	0.002	−0.001	0.005
	(0.004)	(0.004)	(0.004)	(0.004)	(0.002)
Log (assessed value)	1.05	1.06	1.06	1.05	0.01
	(0.06)	(0.06)	(0.06)	(0.06)	(0.04)
R^2	0.85	0.85	0.85	0.86	0.23
P-value[a]		0.001	0.002	0.0001	0.16

Notes: Value is obtained from the Boston assessor's office for the year of entry into LINK. All equations contain additional control variables for property attributes and time dummy variables. The time dummies in equations (1)–(3) are for the quarter of sale. Equation (4) includes dummy variables for the quarter of first listing. Equation (5) includes dummy variables for both the listing and sale quarters. Number of observations = 665.

[a] For the joint test of the hypothesis that all of the loan/value coefficients equal zero.

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Home Equity and Seller Behavior: Behavioral Explanation

- Owners try really hard to avoid nominal losses when they sell
  - Psychological loss aversion and non-rational money illusion
  - But the behavior is advantageous for reasonable discount rates
- Owners with an expected sale price below the original purchase price
  1. Set a higher asking price Table
     - Try to avoid 25%–35% of the expected loss
  2. Achieve a higher sales price Table
     - Manage to avoid 3–18% of the expected loss
  3. Have a lower per-period probability of selling Table
- The expected sale price is unobservable
  1. Hedonic regression of original purchase price on observable attributes
  2. Careful but imperfect strategies to overcome the resulting biases

LOSS AVERSION AND LIST PRICES
DEPENDENT VARIABLE: LOG (ORIGINAL ASKING PRICE),
OLS equations, standard errors are in parentheses.

Variable	(1) All listings	(2) All listings	(3) All listings	(4) All listings	(5) All listings	(6) All listings
LOSS	0.35	0.25	0.63	0.53	0.35	0.24
	(0.06)	(0.06)	(0.04)	(0.04)	(0.06)	(0.06)
LOSS-squared			−0.26	−0.26		
			(0.04)	(0.04)		
LTV	0.06	0.05	0.03	0.03	0.06	0.05
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Estimated value in 1990	1.09	1.09	1.09	1.09	1.09	1.09
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Estimated price index at quarter of entry	0.86	0.80	0.91	0.85		
	(0.04)	(0.04)	(0.03)	(0.03)		
Residual from last sale price		0.11		0.11		0.11
		(0.02)		(0.02)		(0.02)
Months since last sale	−0.0002	−0.0003	−0.0002	−0.0003	−0.0002	−0.0003
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
Dummy variables for quarter of entry	No	No	No	No	Yes	Yes
Constant	−0.77	−0.70	−0.84	−0.77	−0.88	−0.86
	(0.14)	(0.14)	(0.13)	(0.14)	(0.10)	(0.10)
R^2	0.85	0.86	0.86	0.86	0.86	0.86
Number of observations	5792	5792	5792	5792	5792	5792

LOSS is defined as the greater of the difference between the previous selling price and the estimated value in the quarter of entry, and zero. LTV is the greater of the difference between the ratio of loan to value and 0.8, and zero. The standard errors are heteroskedasticity robust and corrected both for the multiple observations of the same property and for the estimation of Estimated Value in 1990, Estimated Price Index at Quarter of Entry, LTV, and Residual of Last Sale.

Loss Aversion and Transaction Prices

DEPENDENT VARIABLE: LOG (TRANSACTION PRICE)
NLLS equations, standard errors are in parentheses.

Variable	(1) All listings	(2) All listings
LOSS	0.18	0.03
	(0.03)	(0.08)
LTV	0.07	0.06
	(0.02)	(0.01)
Residual from last sale price		0.16
		(0.02)
Months since last sale	−0.0001	−0.0004
	(0.0001)	(0.0001)
Dummy variables for quarter of entry	Yes	Yes
Number of observations	3413	3413

Nonlinear least squares estimation of the equation $P = X\beta + T\theta + mLOSS + gLTV$, where $LOSS = (P^0 - X\beta - T\theta)$, X is a vector of property attributes, T is a set of dummies for the quarter of sale. P^0 is the previous sale price, and LTV is as defined in Table II. In column (2) the right-hand side is expanded to include a term that for observations with a previous sale prior to 1990 equals the residual from the last sale, as in the previous tables, and for the remaining observations is equal to $(P^0 - X\beta - S\theta)$, where S is a set of dummies for the quarter of previous sale, of the same dimension and mapping as T. LTV is the greater of the difference between the ratio of loan to value and 0.80, and zero. The standard errors are heteroskedasticity robust and corrected for multiple observations of the same property.

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Loss Aversion and Hazard Rate of Sale

Duration variable is the number of weeks the property is listed on the market. Cox proportional hazard equations, standard errors are in parentheses.

Variable	(1) All listings	(2) All listings	(3) All listings	(4) All listings
LOSS	−0.33	−0.63	−0.59	−0.90
	(0.13)	(0.15)	(0.16)	(0.18)
LOSS-squared			0.27	0.28
			(0.07)	(0.07)
LTV	−0.08	−0.09	−0.06	−0.06
	(0.04)	(0.04)	(0.04)	(0.04)
Estimated value in 1990	0.27	0.27	0.27	0.27
	(0.04)	(0.04)	(0.04)	(0.04)
Residual from last sale		0.29		0.29
		(0.07)		(0.07)
Months since last sale	−0.003	−0.004	−0.003	−0.004
	(0.001)	(0.001)	(0.001)	(0.001)
Dummy variables for quarter of entry	yes	yes	yes	yes
Log likelihood	−26104.4	−26094.1	−26101.8	−26091.3
Number of observations	5792	5792	5792	5792

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Agency Problems

- It pays for sellers to wait for longer and ask for a higher price
- The agent has a strong incentive to sell quickly and move on
  - He bears the cost of selling and gets a small fraction of the sale price
- Information asymmetry: agents can convince owners to sell too quickly
- Levitt and Syverson (2008): agents selling their own house
  - 98,000 sales in Chicago suburbs, of which 3,300 are agent-owned
  - Wait 10% more (9.5 days) and achieve a 3.7% ($7,600) higher price
- Greater difference when information asymmetry is greater
  1. City blocks with more heterogeneous housing stock
  2. Periods with less internet penetration
  3. Sales to buyers without their own agent

Sales of Agent-Owned Houses

	(1)	(2)	(3)	(4)
	Dependent Variable: ln(Sale Price of Home)			
Coefficient on agent-owned home	0.048	0.042	0.038	0.037
(Standard error)	(0.004)	(0.004)	(0.003)	
R^2	0.856	0.886	0.896	0.958
	Variable: Days to Sale			
Coefficient on agent-owned home	16.89	11.03	10.25	9.47
(Standard error)	(2.42)	(2.40)	(2.39)	(2.25)
R^2	0.123	0.130	0.139	0.384
Controls included:				
City × year interactions	Yes	Yes	Yes	Yes
Basic house characteristics	Yes	Yes	Yes	Yes
Indicators of house quality	No	Yes	Yes	Yes
Keywords in description	No	No	Yes	Yes
Block fixed effects	No	No	No	Yes
"Excess return" of agent assuming a 20% annual discount rate	0.039	0.036	0.032	0.032

Notes: Regression coefficients are reported in the table, along with standard errors in parentheses. Results are based on a sample of 98,038 single-family home sales in 34 Cook County, Illinois, suburbs over the period 1992–2002. The dependent variable in the top panel of the table is the natural log of the sale price; the dependent variable in the bottom panel is the number of days on the market. Each coefficient reported in the table is from a separate regression. The other variables included in each specification are noted in the table, but the coefficients on these other variables are not reported here (table 3 presents a subset of coefficient estimates for these controls). See the appendix for a complete list. The table's bottom row reports the implied "excess return" accruing to agents selling their own homes, computed as the additional price received for a home adjusted for the extra time on the market, under the assumption of a 20% annual discount rate.

Impact of Agent Ownership by Subsample

(VALUES IN TABLE ARE COEFFICIENT ON AGENT-OWNED INDICATOR VARIABLE)

Subsample	Magnitude of Predicted Agent-Owned Distortion	Dependent Variable: ln(Sale Price)	Dependent Variable: Days to Sale	Implied "Excess Return" (20% Annual Discount Rate)
A. Heterogeneity of housing stock on the block				
High heterogeneity	High	0.043	9.45	0.038
		(0.005)	(3.68)	
Moderate heterogeneity	Medium	0.039	11.92	0.032
		(0.005)	(3.82)	
Low heterogeneity	Low	0.023	5.09	0.020
		(0.005)	(4.24)	
B. Time period				
On the market 1992–1995	High	0.049	15.20	0.041
		(0.007)	(6.11)	
On the market 1996–1999	Medium	0.032	7.99	0.028
		(0.005)	(4.14)	
On the market 2000–2002	Low	0.029	2.47	0.028
		(0.006)	(3.98)	
C. Buyer's agent presence				
Buyer's agent absent × agent-owned home	High	0.052	N/A	N/A
		(0.007)		
Buyer's agent present × agent-owned home	Low	0.033	N/A	N/A
		(0.003)		

Notes: All coefficients in the table correspond to variations on the specification reported in column 4 of table 2. Panels A and B divide the sample into mutually exclusive, exhaustive subsamples. The heterogeneity of a city block's housing stock is computed based on the Herfindahl index of styles of houses (such as Victorian, Georgian, or colonial) sold on the block in our sample period. Blocks with fewer than three home sales over the course of the sample are excluded from the analysis in panel A. The remaining sample is divided into equally sized groups based on the Herfindahl measure. Panel B divides the sample according to the year that a house is originally listed for sale. Panel C adds interactions between whether a buyer's agent is part of the transaction and the agent-owned variable to the baseline specification.

Cartel Pricing and Inefficient Entry

- U.S. real estate agents have fixed commissions at 6% ▸ Figure
- There are essentially no barriers to entry into the sector
- Inefficient entry chases the rents created by fixed commissions

Hsieh and Moretti (2003): house prices rise but commission rates don't fall

1. Agents' income from each sale mechanically increases
2. More agents enter the sector to chase the commissions ▸ Figure
3. Agents' productivity (sales per year) declines ▸ Figure
4. Agents' real income does not change ▸ Figure

- The average time houses remain for sale declines ▸ Figure
  - Changes in productivity do not seem due to changes in service quality

Fixed Commission Rates

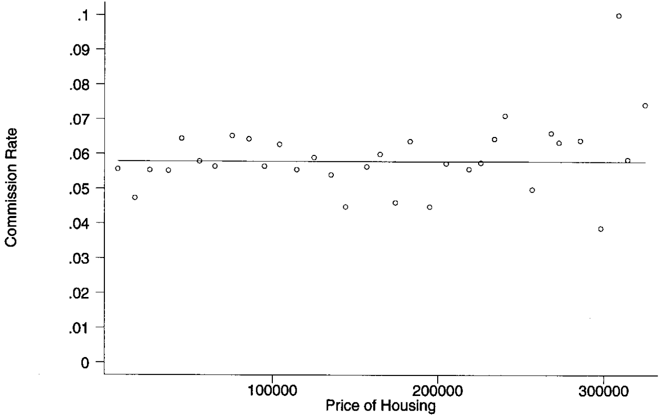

FIG. 4.—Commission rates and price of housing in the CEX. Each point in the figure is the average commission rate within intervals in housing price \$10,000 wide. The superimposed fit is taken from a household-level regression of commission rates on housing prices (N=406).

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House Prices and the Relative Number of Realtors

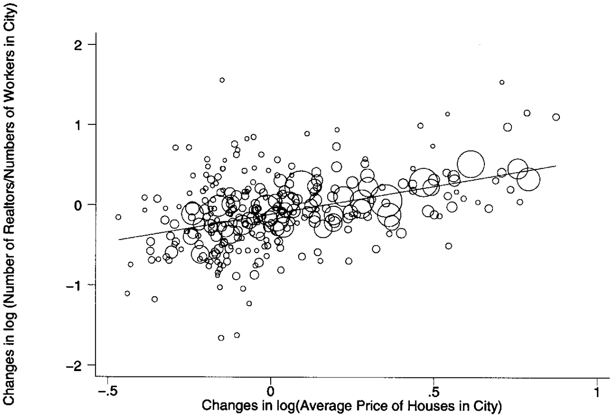

FIG. 6.—1980–90 changes in the percentage of real estate agents in the labor force and changes in the average cost of housing. Each bubble represents a metropolitan area. The size of the bubble is proportional to the metropolitan area population. There are 282 metropolitan areas. Data are taken from the 1980 and 1990 Census of Population and Housing.

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House Prices and Realtors' Productivity

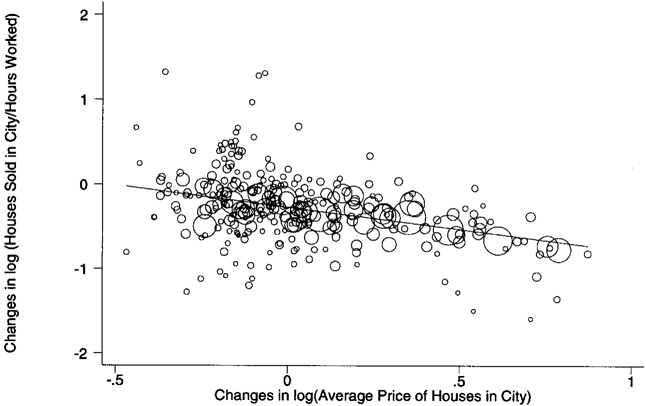

FIG. 1.—1980–90 changes in the productivity of real estate agents (houses sold in the city/hours worked) and changes in the cost of housing. Each bubble represents a metropolitan area. The size of the bubble is proportional to the metropolitan area population. There are 282 metropolitan areas. Data are taken from the 1980 and 1990 Census of Population and Housing.

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House Prices and Realtors' Relative Wage

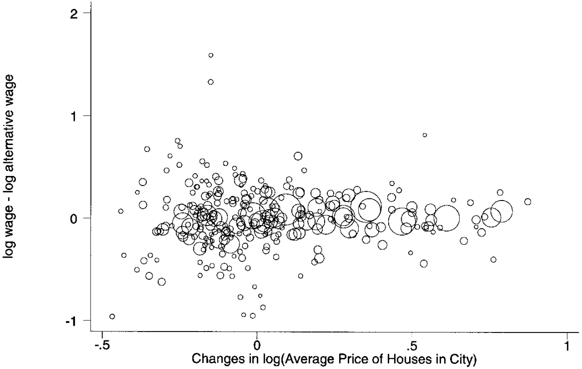

FIG. 9.—Average earnings of real estate agents and average price of housing in 282 cities in 1990. Each bubble represents a metropolitan area. The size of the bubble is proportional to the metropolitan area population. There are 282 metropolitan areas. The *y*-axis is the log difference between average earnings in a city and brokers' reservation wage. The reservation wage of real estate agents is a weighted average of the wages of workers in all other occupations in the same city. We assign weights to individuals in the sample who are not brokers on the basis of how similar their observable characteristics are to the observable characteristics of brokers.

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House Prices and Time on the Market

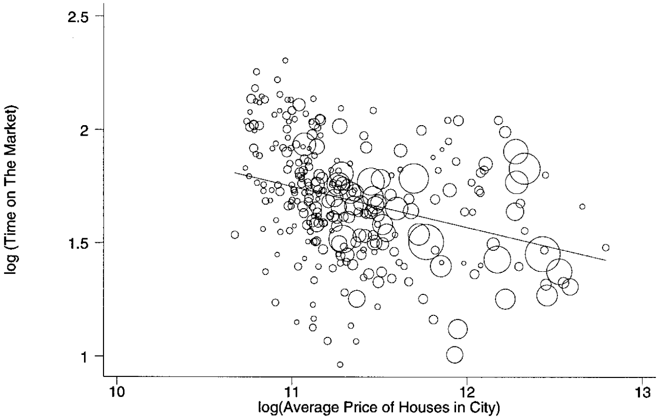

FIG. 10.—Cost of housing in 282 metropolitan areas and vacancy time. Each bubble represents a metropolitan area. The size of the bubble is proportional to the metropolitan area population. There are 282 metropolitan areas. Data are taken from the 1990 Census of Population and Housing.

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Durable Housing and Skewness

- House prices are largely predicted by demand: amenities and income
- But supply matters: prices are often below construction costs ▸ Figure
- Housing supply is kinked, and vertical in declining regions ▸ Figure
- Glaeser and Gyourko (2005): skewed response to demand shocks
  - Rapid population growth with moderate price increases
  - Slow population contraction with sharp price declines

1. Higher price elasticity for negative changes ▸ Table ▸ Figure
2. When consumer valuation of an amenity changes ▸ Weather
   - The impact on population is convex: greater when positive
   - The impact on price is concave: greater when negative

▸ Decline

Median Price Regression and Construction Costs

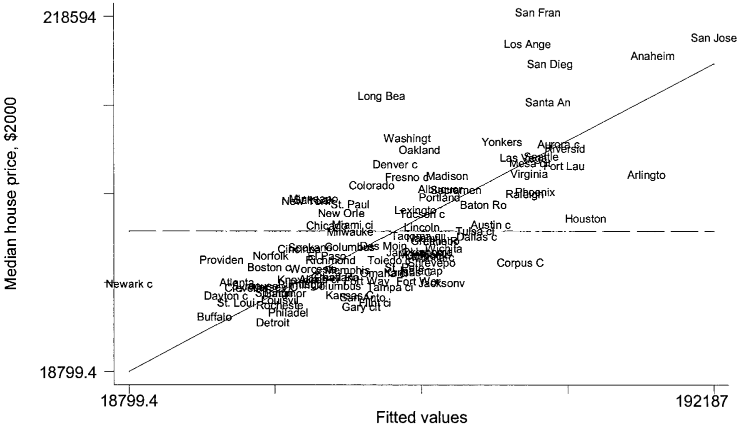
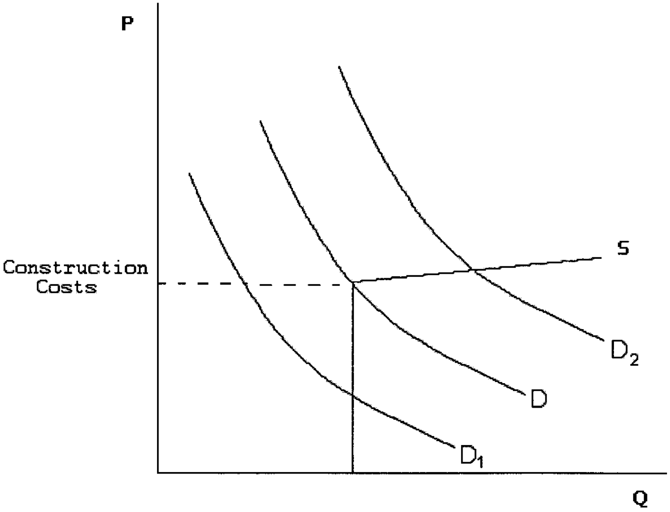


FIG. 2.—Median price regression and construction costs. The dashed horizontal line represents the $97,974 construction costs (in 2000 dollars) for a modest-quality, 1,200–square foot single-family home estimated by R. S. Means (2000*a*). The observation for Honolulu is not plotted for ease of presentation.

Housing Supply and Construction Costs



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Price Changes and Population Changes

	α_1 (1)	α_2 (2)	Test for $\alpha_1 = \alpha_2$ (3)	R^2 (4)
Results from pooled decadal observations ($N = 963$)*	1.80 (.20)	.23 (.05)	$F(1, 320) = 45.20$ Prob $> F = .00$	.19
Results from three-decade change ($N = 321$)†	1.64 (.19)	.09 (.04)	$F(1, 320) = 55.16$ Prob $> F = .00$	.15

NOTE.—Standard errors (in parentheses) are based on clustering at the city level. There are 321 city clusters in each regression. Specifications are estimated using data on cities with at least 30,000 residents in 1970. There are 963 observations on the pooled decadal changes and 321 observations on the 30-year changes. Population and house prices are obtained from the decennial censuses. Decadal dummy coefficients and intercepts are suppressed throughout. Full results are available on request. See the text for added detail on the specification.

* Observations pertain to the 1970s, 1980s, and 1990s.

† Observations pertain to 1970–2000.

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Housing Supply and Construction Costs

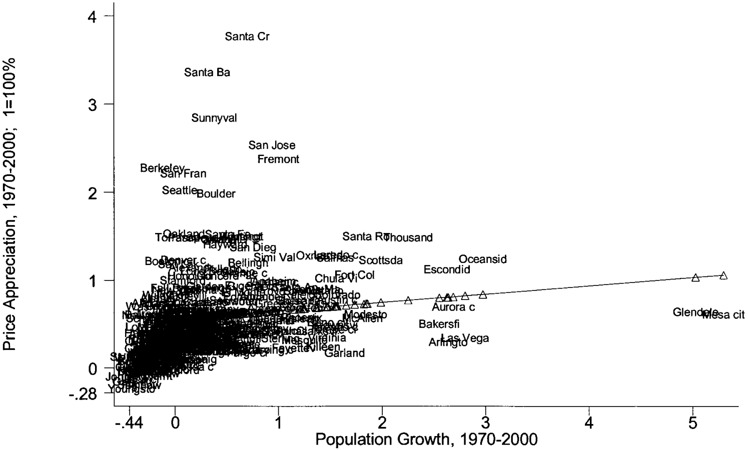

Fig. 3.—Price appreciation and urban growth

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Population and Price Growth and the Weather

A. Based on Equation (4)

	α_1 (1)	α_2 (2)	Test for $\alpha_1 = \alpha_2$ (3)	R^2 (4)
Population growth results	.0008 (.0020)	.0069 (.0012)	$F(1, 261) = 4.79$ Prob $> F = .03$	.15

B. Based on Equation (5)

	β_1 (1)	β_2 (2)	Test for $\beta_1 = \beta_2$ (3)	R^2 (4)
House price appreciation results	.0060 (.0016)	.0023 (.0011)	$F(1, 261) = 2.39$ Prob $> F = .12$	.11

Note.—Standard errors (in parentheses) are based on clustering at the metropolitan area level. There are 262 metropolitan area clusters in each regression. Specifications are estimated using data on 321 cities with at least 30,000 residents in 1970. There are 963 observations across the three decades of the 1970s, 1980s, and 1990s. Population and house prices are obtained from the decennial censuses. Mean January temperature is a 30-year average that was collected from the 1992 County and City Data Book. This variable does not vary over time. Decadal dummy coefficients and intercepts are suppressed throughout. Full results are available on request. See the text for added detail on the specifications.

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Durable Housing and Urban Decline

- Population decline is more persistent than growth ▸ Table
  - Negative productivity shocks cause gradual population declines
- The share of the housing stock valued below construction cost negatively predicts population growth ▸ Table
  - It does not negatively predict house price growth
  - The prediction is robust to controls including median house price
  - Hence it does not seem due purely to forward-looking house prices
- Declining cities are characterized by poverty and social distress
  - The most productive workers flee negative productivity shocks
  - The least productive workers stay in cheap houses
- The share of high-skill workers falls in declining cities ▸ Table
  - It rises more slowly, if at all, in growing cities
  - The effect is explained by median house price, but not by other controls

▸ Skewness

Persistence of Population Decline

	α_1 (1)	α_2 (2)	$\alpha_1 = \alpha_2$ (3)	R^2 (4)
Results from pooled decadal observations	1.001 (.076)	.455 (.039)	$F(1, 320) = 29.0$ Prob $> F = .00$	.51

NOTE.—Standard errors (in parentheses) are based on clustering at the city level. There are 321 city clusters. Specifications are estimated using data on 321 cities with at least 30,000 residents in 1970. In this table, population growth rates from the 1980s and 1990s are regressed on transformed lags of their respective growth rates and a single decadal dummy as described in the text. There are 642 decadal observations. All population data were obtained from decennial censuses. The time dummy coefficient and the intercept are suppressed throughout. All results are available on request.

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Distribution of House Prices and Population Decline

	Specification	
	(1)	(2)
α_1	−.270	−.267
	(.042)	(.084)
R^2	.20	.55

NOTE.—Standard errors (in parentheses) are based on clustering at the city level. There are 127 city clusters. Specifications are estimated using data on 215 cities—123 with 1980s data and 92 with 1990s data. Population data are taken from the decennial censuses. House price data are taken from the IPUMS maintained by the University of Minnesota. Construction cost data on single-family homes are taken from R. S. Means (2000*a*, 2000*b*). Various adjustments to both the numerator and denominator are made in creating the ratio of price to construction cost in the −house q variable. See the text and App. A for the details. Specification 1 is taken from eq. (7). The local controls included in specification 2 include the log of median house price at the beginning of the decade, the percentage of the city housing stock at the beginning of the decade composed of single-unit dwellings, census region dummies, the log of city population at the beginning of the decade, the city's family poverty rate at the beginning of the decade, and 30-year averages for January temperature, July temperature, and annual rainfall. The time dummy coefficient and the intercept are suppressed throughout. All results are available on request.

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Human Capital, Cheap Housing, and Urban Decline

	Specification		
	(1)	(2)	(3)
α_1	8.28	.30	8.35
	(1.86)	(1.80)	(2.03)
α_2	.83	−.25	1.99
	(.58)	(.56)	(.61)
F-tests	$F(1, 320) = 12.75$	$F(1, 320) = .08$	$F(1, 261) = 9.33$
	Prob > F = .00	Prob > F = .78	Prob > F = .00
R^2	.15	.26	.25

NOTE.—Standard errors (in parentheses) are based on clustering at the city level in the first two specifications and at the metropolitan area level in the third specification. There are 321 city clusters and 262 metropolitan area clusters. Clustering by metropolitan area occurs when weather-related variables are included in the specification. Specifications are estimated using data on 321 cities with at least 30,000 residents in 1970. Specification 1 is based on eq. (8). Specification 2 adds median house price (at the end of each decade) to the basic model in eq. (8). Specification 3 includes city population; the family poverty rate; the change in Hispanic population share; weather conditions as reflected in mean January temperature, mean July temperature, and average annual rainfall; and region dummies. College graduate shares and the family poverty rate were obtained from various issues of the County and City Data Book and Housing and Urban Development's State of the Cities data system. Population, house prices, and Hispanic share were obtained from the decennial censuses. All weather variables represent 30-year averages that were collected from the County and City Data Book. Time dummy coefficients and the intercept are suppressed throughout. All results are available on request.

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Regulation and the Rise in Housing Prices

- In growing cities house prices equal the cost of supply
- House price = land price + construction cost + residual
- In the U.S. construction costs used to be 80% of the story
  - Their relative importance has been declining since at least 1970
- Growing cities in the Sun Belt have built a lot with little price growth
  - Housing supply accounts for the region's rise (Glaeser and Tobio 2008)
- Growing cities on the coasts have built little with huge price growth
  - Coastal geography reduces supply elasticity (Saiz 2010)
  - Regulation increases prices (Katz and Rosen 1987)
- Focus on the residual: regulatory tax
  - It might also be monopoly power, but the industry is highly competitive
  - Geography should show up in land prices and construction costs

Land Prices and Zoning Taxes

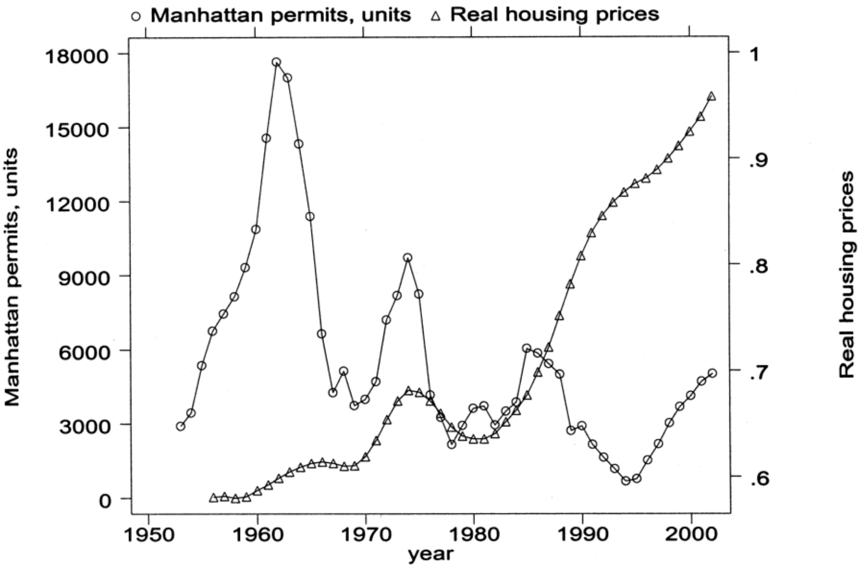
Metropolitan Area	Year (1)	Hedonic Price of Land ($/Square Foot) (2)	Average House Value ($) (3)	Zoning Tax/ House Value (4)
Baltimore	1998	.88	154,143	.018
Birmingham	1998	.13	114,492	0
Boston	1998	.68	236,231	.186
Chicago	1999	1.62	187,669	.057
Cincinnati	1999	.40	133,050	0
Detroit	1999	.37	144,686	0
Houston	1998	.15	103,505	0
Los Angeles	1999	2.59	260,744	.339
Minneapolis	1998	.38	144,719	0
New York	1999	1.38	253,232	.122
Newport News (Va.)	1998	.48	127,475	.207
Oakland	1998	2.34	284,443	.321
Philadelphia	1999	.81	135,862	0
Pittsburgh	1998	.70	100,060	0
Providence	1998	.56	148,059	0
Rochester	1998	.21	109,050	0
Salt Lake City	1998	.83	167,541	.119
San Francisco	1998	4.10	418,890	.531
San Jose	1998	3.92	385,021	.469
Tampa	1998	.37	103,962	0
Washington, D.C.	1998	.64	213,281	.219

NOTE.—Hedonic prices of land were estimated using data from the metropolitan area surveys of U.S. Census Bureau, American Housing Survey (AHS) (1998, 1999). In some cases, areas were over sampled and included in the 1999 national file of the AHS. Four hedonic models were estimated. See the text and note 19 *supra* for those details. The prices reported here reflect the average of the prices associated with the second- and third-highest estimates across all four specifications (that is, we discarded the highest and the lowest estimates and report the mean of the two remaining estimates). The housing price for each metropolitan area is the mean for the sample of single-unit homes with lot sizes less than 2 acres. The computation of the zoning tax as a fraction of mean house value is as follows for each area *j:*

$$\frac{\text{ZoningTax}_j}{\text{MeanHouseValue}_j} = \frac{(\text{MeanHouseValue}_j - \text{CC}_j) - \text{HedonicLandPricePerSqft}_j \times \text{MeanLotSize}_j}{\text{MeanHouseValue}_j}.$$

MeanHouseValue and MeanLotSize are specific to a metropolitan area and pertain to the sample of single-unit, owner-occupied residences with less than 2 acres of land.

Prices and Permits in Manhattan



Regulatory Tax on Manhattan Apartments

- The price of land must be inferred through standard hedonics
  - Bias if lot size correlates with unobserved house attributes
- In Manhattan, no land is required (or available) for construction
- The marginal cost is merely the construction cost of building up
  - Buildings could easily be taller: they used to be Figure
- Prices are substantially above construction costs Figure
- Supply used to respond to price but no longer does, or can Figure
- Probably due to rent-seeking homeowners' political clout
  - Seemingly smaller if any wedge for commercial real estate
  - Unjustified by estimates of negative externalities

Boston

Construction of Tall Residential Buildings in Manhattan

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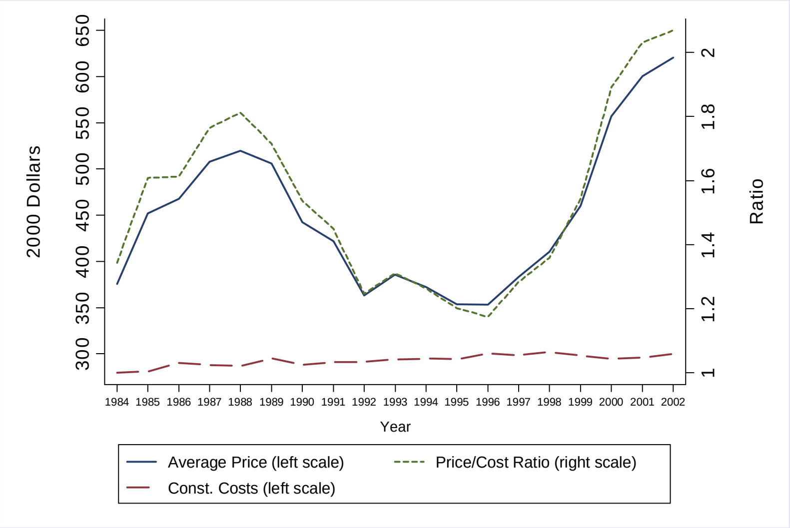
Sales Prices and Construction Costs in Manhattan



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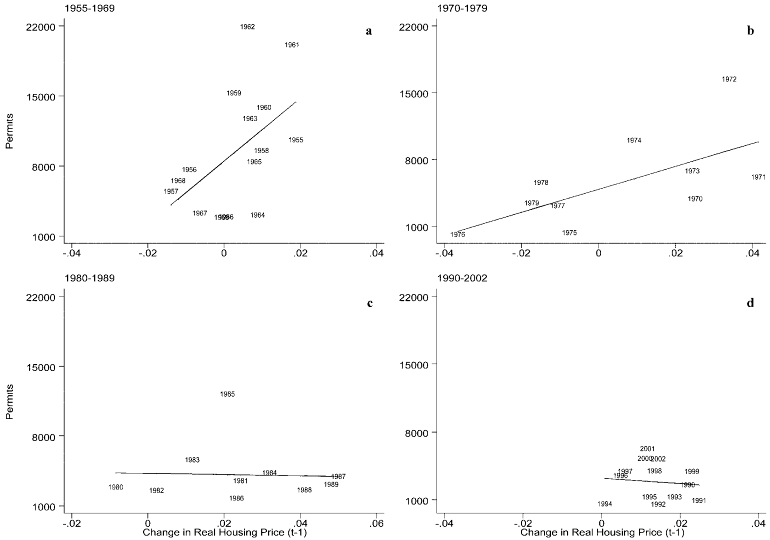
Manhattan Permits and Lagged Price Changes



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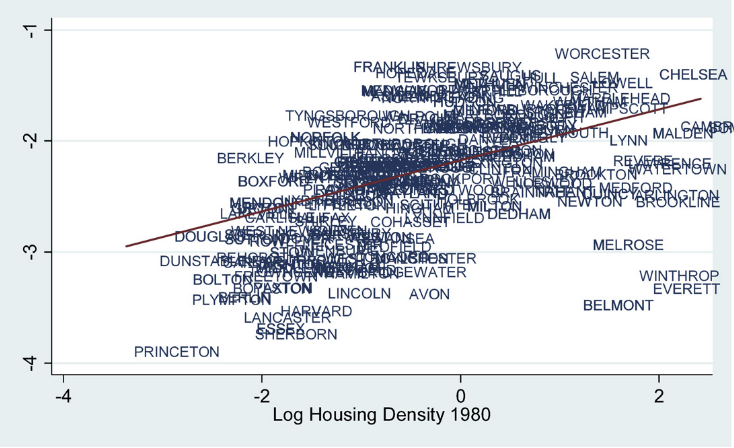
Land Use Regulation in Greater Boston

- Another U.S. city with a supply problem: prices rise, permits fall
- The limit to housing supply is not lack of land ▸ Figure
  - The cities with lowest initial density allow the least construction
  - Initial price is also negatively correlated with construction
  - An acre of land is worth \$16,000, or \$300,000 if under a house
- Increasing and increasingly complex regulation ▸ Figure
  - Minimum lot sizes: typically one acre $\Rightarrow$ 3 houses per Eixample block!
  - Wetlands protection, septic systems, subdivision requirements
- Regulation seems rather random
  - Historical density is the main predictor of minimum lot size ▸ Table
  - No valid instrument for regulation in a price or construction regression

▸ Manhattan ▸ Consequences

Lack of Land vs. Lack of Permits



Source. US Census Bureau.

Fig. 2. Relationship between log single family permits 1980–2002 per acre and log 1980 housing density.

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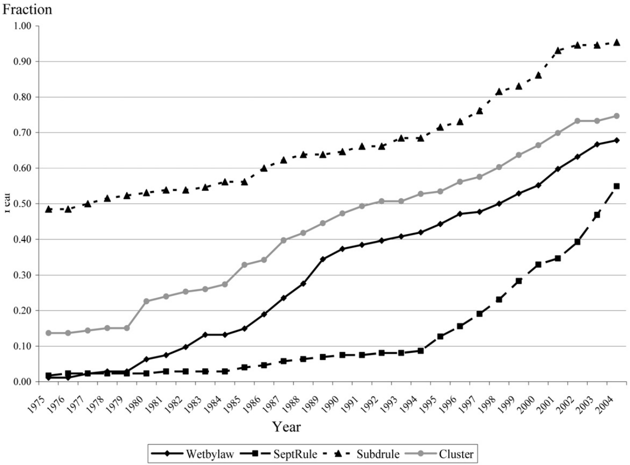
Growth of Regulation



Source. Pioneer Institute's Housing Regulation Database for Massachusetts Municipalities in Greater Boston. Communities who adopt provisions at unknown dates are excluded from fraction.

Fig. 4. Fraction of communities with wetlands, septic, subdivision, and cluster provisions, 1975–2004.

▸ Back

Causes of Land Use Regulation

1915, 1940 determinants of average minimum lot size and 1970 determinants of wetland bylaws, septic rules, and cluster zoning.

	(1) Average minimum	(2) Lot size	(3) Wetland bylaws	(4) Septic rules	(5) Cluster provisions
ln(Town Area)	0.0152	0.0108	−0.0592	−0.1811	0.1803
	[0.0490]	[0.0394]	[0.1098]	[0.1726]	[0.0959]
ln(Housing Density)	−0.2425	−0.2683	0.0371	−0.3849	0.1259
	[0.0269]**	[0.0209]**	[0.0551]	[0.0846]**	[0.0470]**
Distance to Boston	0.0027	−0.0029	−0.002	−0.0085	0.0032
	[0.0027]	[0.0024]	[0.0050]	[0.0065]	[0.0039]
Pct. white	−0.0129	0.0086	0.0066	−0.048	−0.009
	[0.0108]	[0.0086]	[0.0233]	[0.0471]	[0.0191]
Pct. foreign born	−0.0063	−0.005	−0.0284	−0.0202	−0.0119
	[0.0032]	[0.0048]	[0.0183]	[0.0271]	[0.0148]
Pct. mfg	−0.0652	−0.1917			
	[0.1590]	[0.0962]*			
Pct. owner occupied		−0.0064	−0.0016	−0.0037	−0.0016
		[0.0019]**	[0.0040]	[0.0056]	[0.0031]
Pct. BA or higher			0.0076	0.0053	0.0078
			[0.0041]	[0.0055]	[0.0034]*
ln(acres water-based recreation + 1)			0.0615	0.0868	−0.0126
			[0.0253]*	[0.0341]*	[0.0196]
ln(acres water + wetlands + 1)			0.0414	0.1643	0.0492
			[0.0554]	[0.0820]*	[0.0468]
ln(acres of new development 1971–1985 + 1)			0.1104	0.0956	0.0203
			[0.0524]*	[0.0846]	[0.0393]
Constant	3.0573	−0.1748			
	[1.2204]*	[0.9382]			
Control year	1915	1940	1970 or 1971	1970 or 1971	1970 or 1971
Observations	185	182	186	186	186
R-squared	0.64	0.71			

Notes. (1) Standard errors in brackets.

(2) Dependent variable for (1) and (2) is average minimum lot size. Dependent variable for (3), (4) and (5) is a 0/1 variable indicating the existence of the regulation. Standard errors are clustered at the town level for regressions (3), (4) and (5).

(3) Data is from the Pioneer Institute's Housing Regulation Database for Massachusetts Municipalities in Greater Boston at http://www.masshousingregulations.com/, MassGIS, the Harvard Forest Survey of Massachusetts and the US Census Bureau.

* Significant at 5%.

** Significant at 1%.

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Direct Consequences of Land Use Regulation

1. Regulation restricts housing supply
   - As lot size rises by an acre, permits fall by 40% ▸ Table
   - The impact of other rules is imprecisely estimated but negative
2. The impact of regulation on house prices should not be too local
   - Restrictions are predicted to increase prices in the region
   - No effect on the single adopting town if there are close substitutes
   - There is an effect but richer controls make it disappear ▸ Table
   - Consistent with regional price growth

- Is it good or bad to create an elitist boutique city?
  - Good or bad for whom?

▸ Regulation ▸ Forward

Minimum Lot Size and the Housing Stock

	(1) ln(total single family permits)	(2)	(3)	(4) ln(total permits)	(5)	(6)
	1980–2002	1980–1989	1990–1999	1980–2002	1980–1989	1990–1999
Acres per lot	−0.3982	−0.402	−0.361	−0.3085	−0.3123	−0.3384
	[0.1392]**	[0.1541]**	[0.1696]*	[0.1346]*	[0.1559]*	[0.1642]*
Log of Town Area	0.8498	0.7907	0.9367	0.7028	0.5834	0.9056
	[0.0892]**	[0.0987]**	[0.1101]**	[0.0884]**	[0.1023]**	[0.1138]**
Distance to Boston	0.0057	0.0053	0.0046	−0.0043	−0.0057	0.0014
	[0.0050]	[0.0055]	[0.0058]	[0.0047]	[0.0055]	[0.0057]
Major university	0.048	0.0897	−0.4595	0.1303	−0.0212	−0.3603
	[0.2306]	[0.2552]	[0.2773]	[0.2168]	[0.2510]	[0.2633]
Log of Housing Stock (Initial period)	0.3105	0.3615	0.365	0.4205	0.5336	0.3863
	[0.0745]**	[0.0824]**	[0.0968]**	[0.0769]**	[0.0890]**	[0.1032]**
Pct. <18 (Initial period)	0.0498	0.0428	0.0595	0.0447	0.0369	0.0506
	[0.0128]**	[0.0142]**	[0.0179]**	[0.0133]**	[0.0154]*	[0.0176]**
Pct. BA+ (Initial period)	−0.0044	−0.0032	−0.0005	−0.0071	−0.0099	0.0007
	[0.0031]	[0.0035]	[0.0033]	[0.0033]*	[0.0038]**	[0.0034]
Pct. white (Initial period)	0.0183	0.0052	0.0374	0.0299	0.0187	0.0253
	[0.0124]	[0.0137]	[0.0087]**	[0.0131]*	[0.0151]	[0.0090]**
Share of single family housing (1980)				−0.0086	−0.006	−0.0049
				[0.0032]**	[0.0037]	[0.0036]
Constant	−6.5124	−5.7276	−10.5979	−5.9161	−5.2229	−8.607
	[1.4627]**	[1.6188]**	[1.3023]**	[1.4615]**	[1.6920]**	[1.2536]**
Observations	185	185	185	185	185	185
R-squared	0.69	0.62	0.66	0.71	0.68	0.65

Notes. (1) Standard errors in brackets.

(2) Dependent variable for regressions (1)–(3) is the ln(single permits) for the years indicated above, and the dependent variable for regressions (4)–(6) is the ln(total permits) for the years indicated above.

(3) Data from US Census Bureau, MassGIS, and the 2005 *US News and World Report* college and university rankings.

* Significant at 5%.

** Significant at 1%.

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Regulations and House Prices

	(1) Ln(Sales Price, $2005)	(2)	(3)	(4)
Acres per lot	0.1218	−0.0685	0.0548	−0.0685
	[0.0659]	[0.0439]	[0.0704]	[0.0438]
Combined regulation index			0.085	−0.0001
			[0.0345]*	[0.0152]
ln(Total Number of Rooms)	0.2432	0.1632	0.2386	0.1632
	[0.0403]**	[0.0263]**	[0.0392]**	[0.0262]**
ln(Interior Square Feet)	0.6103	0.5071	0.6074	0.5071
	[0.0313]**	[0.0210]**	[0.0314]**	[0.0209]**
ln(Lot Size)	0.0967	0.0757	0.0906	0.0757
	[0.0166]**	[0.0093]**	[0.0163]**	[0.0092]**
ln(Town Area)	−0.069	−0.0291	−0.0973	−0.0291
	[0.0507]	[0.0251]	[0.0473]*	[0.0277]
Distance to Boston	−0.0143	−0.0085	−0.0147	−0.0085
	[0.0046]**	[0.0016]**	[0.0042]**	[0.0017]**
Major university	0.4117	0.1067	0.4137	0.1067
	[0.1019]**	[0.0363]**	[0.0844]**	[0.0363]**
Pct. <18 years old (2000)		−0.0063		−0.0063
		[0.0025]*		[0.0025]*
Pct. white (2000)		0.0016		0.0016
		[0.0009]		[0.0008]
Pct. BA+ (2000)		0.0125		0.0125
		[0.0006]**		[0.0006]**
Log of Housing Stock (2000)		0.0155		0.0155
		[0.0212]		[0.0217]
Constant	7.4231	7.5798	7.636	7.5797
	[0.4075]**	[0.2274]**	[0.4029]**	[0.2354]**
Observations	55296	55296	55296	55296
R-squared	0.31	0.37	0.31	0.37

Notes. (1) Robust standard errors in brackets. Standard errors are clustered by town.
(2) Year Fixed Effects were included.
(3) Excludes towns >30 miles away from Boston.
(4) Dependent variable is the log of sales prices for 2000–2005 housing sale transactions, in 2005 dollars.
(5) Data from Data is from the Pioneer Institute's Housing Regulation Database for Massachusetts Municipalities in Greater Boston at http://www.masshousingregulations.com/, Banker and Tradesman data on housing transactions, the US Census Bureau, MassGIS and the 2005 *US News and World Report* college and university rankings.
* Significant at 5%.
** Significant at 1%.

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Indirect Consequences of Land Use Regulation

Restricted housing supply:

1. Lower or negative population and employment growth
   - One household, one house
   - Housing depreciation and decreasing household size
   - Permits must be 0.5% of the stock for zero growth
2. More volatile house prices in response to demand shocks
   - Volatility affects quantity or price depending on supply elasticity

Higher house prices:

1. Higher nominal wages to preserve spatial equilibrium
   - This eventually implies fewer firms, in theory and in practice
2. Only the wealthy can afford the area's big, expensive houses
   - More educated but less diverse region
   - Seemingly not older nor less open to outsiders

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Negative Externalities and Land Use Regulation

- Consider an economy with two locations: the city and the hinterland
  - The city hosts fraction N of the population
  - Congestion externalities lead to urban utility $V(N)$ with $V' < 0$
  - The hinterland yields reservation utility $\bar{U}$
- With constant construction cost C, the free market yields

$$V(\bar{N}) - C - \bar{U} = 0$$

- Utilitarian social welfare maximization is

$$\max_{N} \{N[V(N) - C] + (1 - N)\bar{U}\}$$

- The social optimum is

$$N^* < \bar{N} \text{ such that } V(N^*) - C - \bar{U} + N^* V'(N^*) = 0$$

- Restrictive regulation is useful to correct negative externalities

Political Economy of Land Use Regulation

- Let the city start with $N_0 \ll N^*$ residents: their utility is $V(N)$
- The owners of an undeveloped plot can earn $V(N) - C - \bar{U}$
- The political process maximizes a weighted social welfare function
  - Weight λ on residents and $1 - \lambda$ on owners of undeveloped land
  - Easy to microfound with probabilistic voting, lobbying, etc.
- The policymaker's problem is

$$\max_N \left\{ \lambda N_0 V(N) + (1-\lambda)(N - N_0)\left[V(N) - C - \bar{U}\right] \right\}$$

- Enacted policy is

$$\hat{N} \text{ such that } V(\hat{N}) - C - \bar{U} + \hat{N} V'(\hat{N}) + \frac{2\lambda - 1}{1 - \lambda} N_0 V'(\hat{N}) = 0$$

assuming that $\hat{N} > N_0$ to disregard a potential corner solution

Distortions in Land Use Regulation

- If $\lambda = 1/2$ the social welfare optimum is achieved trivially
- If $N_0 = 0$ the Henry George Theorem applies and $\hat{N} = N^*$
  - Competitive developers maximize aggregate land value from scratch
- If $N_0 > 0$ and $\lambda < 1/2$ there is over-development: $\hat{N} > N^*$
  - Developers ignore the negative externality they impose on residents
- If $N_0 > 0$ and $\lambda > 1/2$ there is under-development: $\hat{N} < N^*$
  - Residents ignore the interests of developers and prospective residents
- Failure of the political Coase theorem
  - If residents owned all undeveloped land then N^* would be attained
  - Transfers from developers to residents are difficult or even illegal
- Boston seems to display under-development (Glaeser and Ward 2009)

Externalities with Two Cities

- An important further complication if we move past the small open city
- With two cities the free market yields $V_1\left(\bar{N}_1\right) = V_2\left(1 - \bar{N}_1\right)$
- Nation-wide welfare maximization is

$$\max_{N_1} \left\{ N_1 V_1\left(N_1\right) + \left(1 - N_1\right) V_2\left(1 - N_1\right) \right\}$$

- The social optimum is N_1^* such that

$$V_1\left(N_1^*\right) + N_1^* V_1'\left(N_1^*\right) = V_2\left(1 - N_1^*\right) + \left(1 - N_1^*\right) V_2'\left(1 - N_1^*\right)$$

- It no longer makes sense to consider one city in isolation
- The free market might reach an optimum even with externalities
  - Even with asymmetric externalities: $V_i\left(N_i\right) = V_0^i N_i^{-\delta}$

A Cautionary Tale

- Assume linear congestion

$$V_i\left(N_i\right) = V_0^i - vN_i$$

- The free-market outcome is

$$\bar{N}_1 = \frac{1}{2}\left[1 + \frac{1}{v}\left(V_0^1 - V_0^2\right)\right]$$

- Utility is equalized across locations at

$$\bar{V} = \frac{1}{2}\left(V_0^1 + V_0^2 - \nu\right)$$

- The Pigovian tax in city i is vN_i
- The optimum is attained if both cities levy the Pigovian tax

Inefficiency of One-Sided Pigovian Intervention

- Let the Pigovian tax be levied in city 1 only, and rebated nationwide
- The equilibrium outcome is

$$\hat{N}_1 = \frac{1}{3}\left[1 + \frac{1}{v}\left(V_0^1 - V_0^2\right)\right]$$

- Utility is equalized across locations at

$$\hat{V} = \frac{1}{9}\left[\frac{1}{v}\left(V_0^1 - V_0^2\right)^2 + 5V_0^1 + 4V_0^2 - 5v\right]$$

- The equilibrium is Pareto inferior to the free-market solution if

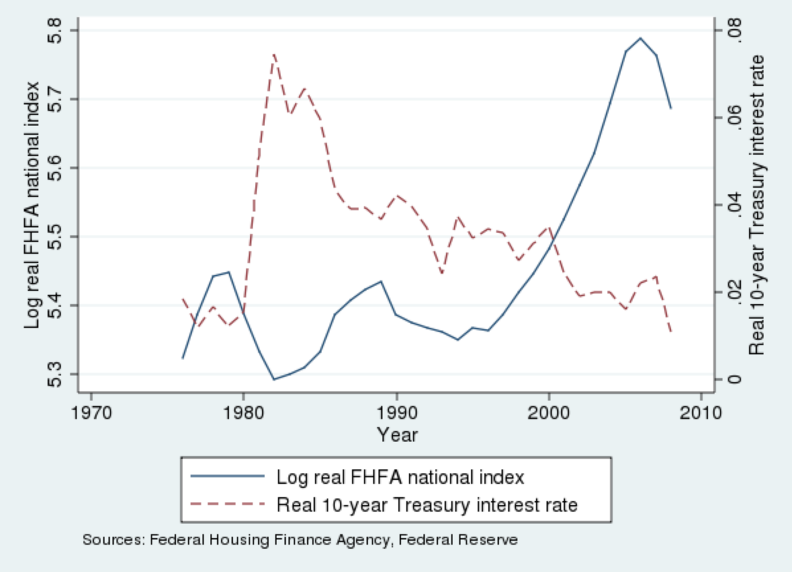
$$\frac{2}{v}\left(V_0^1 - V_0^2\right)^2 < V_0^2 - V_0^1 + v$$

  - The two cities are similar: $V_0^1 \approx V_0^2$
  - Externalities are strong: large v
- Development is shifted, not eliminated

Housing Supply and Housing Bubbles

- Glaeser, Gyourko, and Saiz (2008): an advantage of supply rigidity
- An irrational housing bubble is an exogenous demand shock
  - Unwarranted temporary increase in optimism about future prices
  - No rational bubbles with unbounded supply and bounded demand
- Boom and bust from any temporary positive demand shock
  1. Temporary increase in price and construction
  2. Subsequent undershooting of prices and construction
- If housing supply is less elastic
  - The boom in house prices is larger
  - Total housing investment during the boom is smaller
  - The welfare cost is lower, since it is caused by overbuilding
- A possible positive effect of elastic supply: shorter bubbles
  - If bubbles are due to backward-looking expectations of price growth

Prices and Interest Rates



The Credit Market View

- Were low interest rates responsible for the housing bubble?
  - Prominent economists have been associated with this view
- Basic logic: the cost of carrying a home is

$$\nu \equiv \delta + \kappa + (1-\theta)(\mu + i) - \pi$$

- No arbitrage between ownership and rental

$$\dot{Q} = \nu Q - R$$

- Price rises offset interest rate declines
- This justified high boom prices as real rates fell to very low levels
  - Decline of 190 basis point from 2000 to 2005
  - Himmelberg, Mayer and Sinai (2005) have a semi-elasticity of 20

A More Comprehensive Dynamic Model

Several factors weaken the link between price and interest rates

1. Short-run elasticity of housing supply
   - Prices remain driven by construction costs, quantity adjusts instead
2. Expected mobility with volatile and mean-reverting interest rates
   - Buyers with low i anticipate having to sell with higher i
3. The ability to refinance with volatile and mean-reverting interest rates
   - Mortgages with high i will be renegotiated with lower i
4. Disconnect between private discount rates and market interest rates
   - Buyers are credit constrained

- Glaeser, Gottlieb, and Gyourko (2010) cut the semi-elasticity by 3/4
- Ultimately an empirical question

Semi-Elasticity of U.S. House Prices

Dependent variable: log national house prices

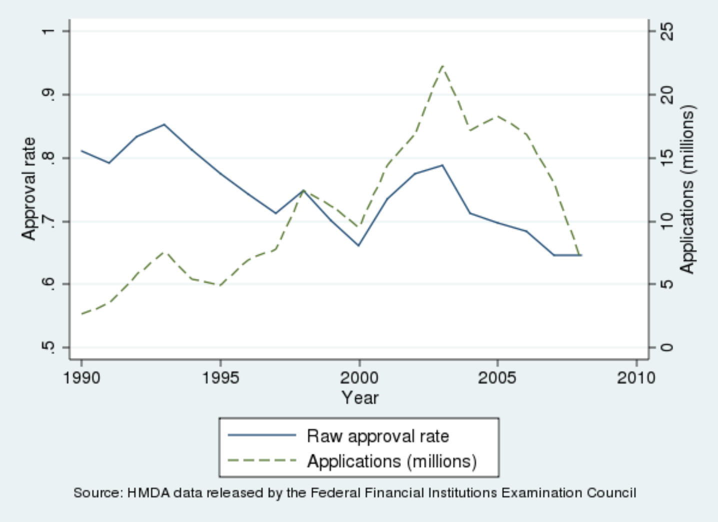
	(1) Log Price	(2) Log Price	(3) Log Price	(4) Log Price	(5) Log Price	(6) Log Price	(7) Log Price	(8) Log Price
Real 10-year rate	-6.82**	-1.82	-10.5**	-1.16				
	(1.85)	(1.16)	(2.58)	(3.17)				
Change in real 10-year rate					-1.44*			
					(0.53)			
Real 10-year rate, <3.45%						-13.3**	-8.00**	
						(3.73)	(1.98)	
Real 10-year rate, >3.45%						-3.05**	1.48	
						(0.85)	(1.56)	
Linear time trend		0.012**		0.016			0.012**	
		(0.0036)		(0.0068)			(0.0027)	
Romer and Romer shock								0.36
								(1.37)
Constant	5.70**	5.47**	5.82**	5.42**	0.0081	5.86**	5.63**	0.0075
	(0.088)	(0.055)	(0.096)	(0.14)	(0.0090)	(0.13)	(0.052)	(0.011)
Observations	29	29	24	24	29	29	29	29
R^2	0.50	0.72	0.57	0.71	0.16	0.61	0.81	0.0048
Years	1980-2008	1980-2008	1985-2008	1985-2008	1980-2008	1980-2008	1980-2008	1980-2008

Standard errors, in parenthesis, are adjusted for heteroskedasticity and autocorrelation using the Newey-West method with 2 lags.
**p<0.01 *p<0.05 +p<0.1

Credit Markets and Housing Prices in U.S. Data

- From 1996 to 2006 Q rose by 53% and i fell by 120 basis point
- The long-run link between Q and i is around 7% per 100 basis points
- Slightly larger at low i and in inelastic housing markets: 8%
- This semi-elasticity explains a 10% price increase—not the boom
  - Not even cherry-picking 2000–05 for the maximum swing in i
- Other credit market conditions were changing too, albeit moderately
  1. Mortgage approval rates ▸ Figure
  2. Downpayment requirements ▸ Table
- The impact is modest in the model, and apparently in the data too
  - Substantial endogeneity and selection effects
- We are left with over-optimism (Case and Shiller 2003). But why?

Mortgage Applications and Approval Rates



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Distribution of Loan-to-Value Ratios Over Time

89 Metropolitan Area Sample, 1998-2008

Year	# of Obs.	Distribution of LTVs Using First Mortgage Only						Distribution of LTVs Using Up to Three Mortgages					
		10th	25th	50th	75th	90th	Mean	10th	25th	50th	75th	90th	Mean
1998	1,558,354	0%	67%	80%	97%	100%	73%	0%	68%	86%	97%	100%	74%
1999	1,749,790	0%	68%	80%	97%	100%	74%	0%	69%	87%	98%	100%	75%
2000	1,685,717	0%	65%	80%	95%	100%	72%	0%	66%	85%	97%	100%	73%
2001	1,794,506	0%	68%	80%	95%	99%	73%	0%	69%	88%	97%	100%	75%
2002	1,967,336	0%	63%	80%	95%	99%	70%	0%	65%	85%	96%	100%	73%
2003	2,127,516	0%	60%	80%	94%	99%	69%	0%	63%	82%	96%	100%	72%
2004	2,751,095	0%	52%	80%	85%	98%	65%	0%	56%	80%	95%	100%	69%
2005	3,039,726	0%	60%	80%	80%	95%	65%	0%	64%	86%	99%	100%	71%
2006	2,421,704	0%	68%	80%	80%	98%	68%	0%	70%	90%	100%	100%	74%
2007	1,777,035	0%	63%	80%	95%	100%	69%	0%	66%	90%	100%	100%	73%
2008	1,410,082	0%	38%	80%	98%	99%	65%	0%	40%	80%	98%	99%	67%

Source: Authors' calculations using DataQuick microdata. See the text for more detail on the sample and variable construction

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Challenging Stylized Facts

1. Price changes are predictable (Case and Shiller 1989)
   - Short-run persistence: 60–80% momentum in annual data
   - Mean reversion at lower frequencies: 20–30% over five years
2. Quantity changes are also predictable
   - Strong momentum in population and the housing stock
   - Persistence when prices mean revert
3. High volatility within a market over time
   - Prices are most volatile in coastal markets
   - Construction is most volatile in the Sun belt
4. Most price variation is not national but local, market-specific
   - Year fixed effects account for merely 8% of the variance of prices
   - and 27% of the variance price changes

Mean Reversion of House Prices

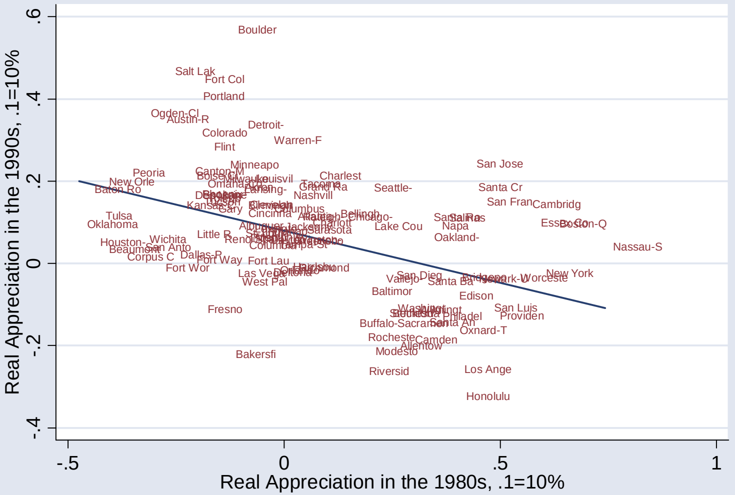


Figure 1: Real House Price Appreciation in the 1980s and 1990s

Persistence of Growth in the Housing Stock

Figure 2: Housing Unit Growth in the 1980s and 1990s

The Glaeser–Gyourko Modelling Approach

- Fit the data with a dynamic rational expectation model
  - How many features of housing dynamics can it match?
- An urban economics model
  - Alonso–Rosen–Roback: relative willingness to pay for different locations
  - Rents determined endogenously by local wages and amenities
  - Incorporate endogenous housing supply
  - Focus on higher frequency price dynamics
- Current version: Glaeser, Gyourko, Morales, and Nathanson (2010)
  - An ambitious project that has been going on for a few years

Preferences

- A worker in city i at time t has utility

$$V_t^i = A_t^i - a^i N_t^i + w_t^i - H_t^i + \frac{1}{1+r}\mathbb{E}H_{t+1}^i$$

  - Exogenous amenities A_t^i
  - Agglomeration amenities or disamenities given city population N_t^i
  - Nominal wage w_t^i
  - House price H_t^i, constant interest rate r and no maintenance costs

- Spatial equilibrium with perfect mobility: for all i and t

$$V_t^i = \bar{U}_t - \frac{r}{1+r}C$$

  - A reservation locale with exogenous utility
  - House prices equal constant construction costs C

Production Technology

- Firms produce a costlessly tradable numeraire
  - Exogenous maximum firm size $\bar{E}$ employees
  - Homogeneous productivity per employee W_t^i
  - Heterogeneous fixed cost $\bar{K}_j$ with city-specific distribution $U\left[0, \bar{E}^2\omega^i\right]$
- The number of firms is

$$\frac{1}{\bar{E}\omega^i}\left(W_t^i - w_t^i\right)$$

- The market clearing wage is

$$w_t^i = W_t^i - \omega^i N_t^i$$

Construction Technology

- The housing stock does not depreciate

$$N_{t+1}^{i} = N_t^i + I_t^i$$

- Construction I_t^i is carried out by builders with
  - Exogenous capacity to build $\bar{B}$ houses per period
  - Homogeneous cost per house $C + c_0^i t + c_2^i N_t^i$
  - Heterogeneous fixed cost $\bar{K}_j$ with city-specific distribution $U\left[0, \bar{B}^2 c_1^i\right]$
- Zero profits for the marginal entrant imply housing supply

$$\mathbb{E} H_{t+1}^{i} = C + c_0^i t + c_1^i I_t^i + c_2^i N_t^i$$

- Assume that $c_1^i > c_2^i$, so prices react more to current construction

Housing Demand

- The spatial equilibrium condition can be written as housing demand

$$\begin{aligned} H_t^i - \frac{1}{1+r}\mathbb{E}H_{t+1}^i - \frac{r}{1+r}C &= A_t^i + W_t^i - \bar{U}_t - \left(a^i + \omega^i\right) N_t^i \\ &= \bar{x}^i + x_t^i + q^i t - \alpha^i N_t^i \end{aligned}$$

- Agglomeration diseconomies $\alpha^i \equiv a^i + \omega^i > 0$ by assumption
- Exogenous evolution of relative appeal $A_t^i + W_t^i - \bar{U}_t \equiv \bar{x}^i + x_t^i + q^i t$
  - City fixed effect $\bar{x}^i$
  - City specific trend q^i
  - ARMA(1,1) stochastic process

$$x_t^i = \delta x_{t-1}^i + \varepsilon_t^i + \theta \varepsilon_{t-1}^i \text{ with } \delta \in (0,1)$$

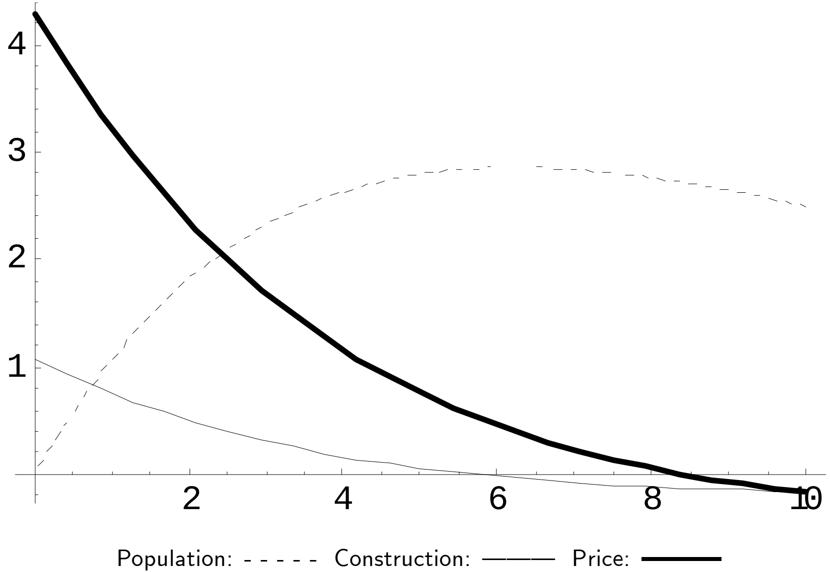
- Transversality condition $\lim_{s \to 0} \left(1+r\right)^{-s} \mathbb{E}H_{t+s}^i = 0$: no bubbles

Dynamic Equilibrium

- Housing market dynamics are described by a linear system
  - It can be solved in terms of shocks and deviations from the steady state
- The ARMA(1,1) process enables momentum and then mean reversion

1. Innovations ε affect both prices H and construction I
   - The relative impact depends on the rigidity of housing supply c_1^i
2. Prices are predictable because so are wages and construction
   - If only because of convergence to their steady state values
   - Inelastic housing supply (higher c_1^i, also c_2^i) slows down convergence
3. The impulse responses of both H and I involve overshooting
   - For a positive shock, the city eventually becomes too large
   - So prices and construction fall below their steady state levels

Impulse Response Functions



Persistent Quantities and Mean-Reverting Prices

The model can match the long-run, decadal pattern in the data

1. Positive serial correlation in population growth
2. Negative serial correlation in price growth

- Positive correlation in quantities is driven by heterogeneous trends
  - The variance of the trends overcomes the variance of the shocks
- Trends have little impact on price changes, since they are anticipated
  - Price movements are driven mostly by temporary shocks.
  - As long as c_2^i is low enough, prices mean revert

Volatility and Serial Correlation in House Prices

	Coastal		Sunbelt		Interior	
Horizon	Model	Data	Model	Data	Model	Data
	Volatility of House Price Changes ($)					
1 year	18,000	17,700	4,000	3,900	6,000	6,000
3 year	30,000	43,200	6,000	7,000	10,000	14,000
5 year	37,000	61,700	7,000	8,500	11,000	19,000
	Serial Correlation of House Price Changes					
1 year	-0.00	0.80	-0.13	0.59	-0.06	0.81
3 year	-0.16	0.38	-0.35	0.03	-0.25	0.36
5 year	-0.24	-0.68	-0.45	-0.50	-0.36	-0.57

Volatility and Serial Correlation in Construction

	Coastal		Sunbelt		Interior	
Horizon	Model	Data	Model	Data	Model	Data
			Volatility of Construction (units)			
1 year	1,800	2,400	4,300	6,300	2,200	2,300
3 year	4,200	5,900	10,600	15,200	5,800	5,300
5 year	5,900	8,300	15,200	20,400	8,800	7,100
			Serial Correlation of Construction			
1 year	0.50	0.82	0.61	0.88	0.74	0.83
3 year	0.17	0.35	0.31	0.38	0.49	0.33
5 year	-0.04	-0.66	0.09	-0.50	0.28	-0.56

Calibration Results

- The calibration matches short-run but not long-run price volatility
  - The underprediction is worst where supply is least elastic
- The strong short-run price momentum remains a complete puzzle
  - The model predicts mean reversion in the short term too
- Underpredicted volatility of construction, especially at longer horizons
- The model does predict positive serial correlation of construction
  - Qualitatively right, quantitatively insufficient

Two open puzzles

1. Persistence in high-frequency price changes over one year
2. High volatility in both prices and quantities over the long term