Durable Housing and Filtering

Nathan Schiff
Shanghai University of Finance and Economics

Graduate Urban Economics, Week 15
June 6, 2019

Durable Housing

Glaeser and Gyourko (GG) note that nearly all urban economics models assume housing can be built and knocked down quickly (think about monocentric city)

However, in really housing is quite durable: once it's built it remains in a location for a very long time

GG argue that this durability affects spatial equilibrium: physical housing structures can have causal effects on economic outcomes

Rosenthal shows that houses are occupied by different income groups over time and that these income transitions occur fairly quickly

An implication is that once a house is built it can have a causal effect on who lives where

Glaeser Gyourko JPE 2005

Authors start by noting the extremely strong correlation between housing units and population: essentially housing is a direct measure of population

But, if a city experiences a decline (ex: productivity decline), the housing still remains. Empirically, this implies the population doesn't shrink–why?

Declining cities have an inelastic stock of housing–price (or rent) is independent of cost (can decline to zero)

These declining cities offer cheap housing, which attracts low human capital (low wage) workers

Kinked Supply Curve for Housing

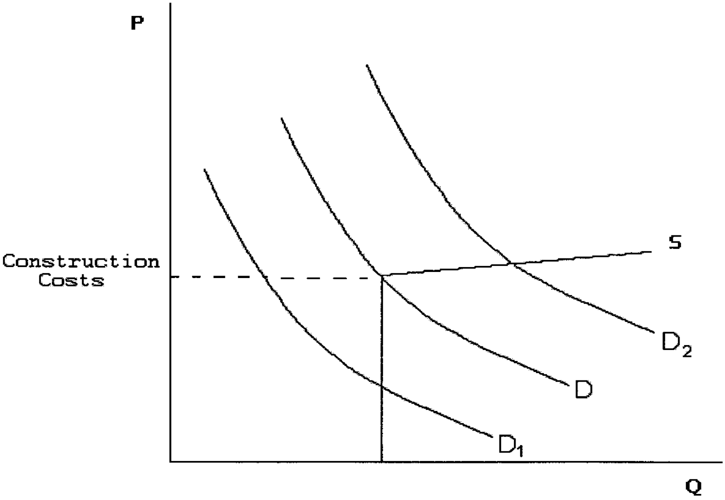


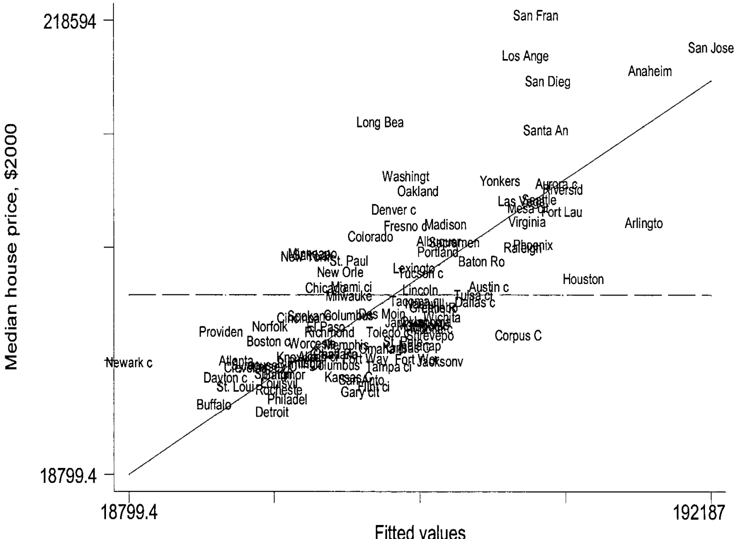
FIG. 1.—The nature of housing supply and construction costs

Implications of Model

Summary of model ideas:

1. Cities will grow faster in response to a positive shock than they will decline in response to a negative shock of the same size
2. Positive shocks increase population but have small effects on prices; negative shocks have large effects on prices but small effects on population
3. Supply curve is kinked at construction cost threshold–cities with housing prices below this threshold are “in decline” and will have rapid price decreases in response to negative shocks

Housing Prices Are Below Replacement Rates in Many Cities



Asymmetry between growing and declining cities

$$PriceAppreciation_{i,t} = \alpha_0 + \alpha_1 \times PopLoss_{i,t} + \alpha_2 \times PopGain_{i,t} + \alpha_3 \times \delta_t + \epsilon_{i,t}$$

TABLE 1
RELATIONSHIP BETWEEN PRICE CHANGES AND POPULATION CHANGES FROM EQUATION (3) (Part *b* of Proposition 1)

	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.

GG JPE 2005: Conclusions

Authors conduct many exercises to try and show robustness of argument (we've seen versions of these analyses in more recent Glaeser papers, so skipping)

Main result of asymmetry between growth and decline seems stable

Perhaps main contribution of paper is to emphasize the importance of the durability of housing itself–influenced many subsequent papers examining this idea

Rosenthal: how should government provide housing assistance for low income households?

If the government wants to help, should it provide vouchers (payment for housing) or build low income housing directly?

Many economists would argue that unless there is market failure, it's better to provide aid as money, rather than government production of a product

However, there is evidence that most new housing construction is not developed for low income households

Instead, the market provides housing for low-income households through a process called "filtering"

The question is then: is filtering fast enough to provide adequate housing for these households?

Filtering (Sweeney, JUE 1974)

Housing is a “hierarchical good” in quality, roughly meaning consumers agree on ranking of each house

As soon as a house is built, it starts to deteriorate so that the same unit offers less value to a consumer over time (fewer housing services)

Owners can affect the rate of deterioration through maintenance expenditure; they choose the level of maintenance to maximize profits

As a house deteriorates, households with higher incomes move out and lower income households move in

Eventually, the house deteriorates beyond a minimum quality and it is then knocked down and removed from the market

Filtering, Low Income HH's, and Renters

Developers may not build new housing for low income households or renters ("purpose built rental")

Many explanations for this, including high land values, financing difficulties (pre-sales help developers to get loans),

However, if filtering transitions are fairly quick, then even new luxury housing benefits low income owner-occupiers and renters

Important policy question because housing assistance can be provided as vouchers (US: Section 8 Housing) or through direct provision (government owned buildings, or credits to developers like Low Income Housing Tax Credit)

Rosenthal AER 2014: Main Idea

Provide first direct evidence on filtering by analyzing a panel of houses from 1985-2011

Includes information on occupants (used for looking at income transitions), "tenure" of house (do occupants rent or own), extensive info on characteristics of house (incl. age)

Uses methodology similar to repeat sales method to deal with heterogeneity of housing

Shows filtering rate can be decomposed into function of income elasticity and price elasticity of housing demand, along with basic depreciation rate of housing services (deterioration rate)

Argues that in many markets filtering is sufficiently quick to provide low income housing, but in most expensive markets it's significantly slower. Suggests direct provision of low income housing is inefficient in most markets (possibly excepting most expensive)

Data

American Housing Survey (public government data) biennial panel, 1985-2011 (14 waves)

Gives *current* income of occupants, thus first observation of a house does not provide information of income when occupants first arrived. In estimation mostly uses houses observed at least three times.

As always, repeat sales methods only use entities (houses) observed multiple times

Intended to be nationally representative, uses MSA (city) fixed effects in all regressions

Summary Stats

TABLE 1—SUMMARY STATISTICS BY TURNOVER TYPE[a]

	Rent-to-rent turnovers[b]	Own-to-own turnovers[b]	Pooled renter and owner turnovers incl. tenure transitions[b]
Years between all turnover pairs[c]	4.17	7.18	4.47
Distribution of number of turnover pairs per home (percent)[c]			
1 pair (2 turnovers)	24.88	57.00	23.44
2 pairs (3 turnovers)	19.65	29.57	20.03
3 pairs (4 turnovers)	14.94	9.64	15.32
4+ pairs (5 or more turnovers)	40.53	3.79	41.21
log change in nominal income between turnover pairs[c]	0.063	0.157	0.074
log change in real income between all turnover pairs (US$(2011))[c]	−0.118	−0.075	−0.106
Age of home at time of turnovers (years)	37.37	31.06	36.04
Percent of homes that experience at least 1 tenure change	—	—	36.45
Distribution of tenure transitions across all turnovers (percent)			
Rent to rent	—	—	74.76
Own to own	—	—	16.85
Rent to own	—	—	3.31
Own to rent	—	—	4.06
Owner-occupancy rate across all home-year observations[d]			
All homes	—	—	67.7
Homes under 5 years in age	—	—	76.4
Homes age 5 to 50 years	—	—	68.7
Homes over age 50	—	—	64.1
Number of homes	19,041	9,789	28,072
Observations	56,139	13,782	72,170

Renters vs Owners (Online Appendix)

	Renter Occupied	Owner Occupied
Rent (monthly) in $2011	784	-
Sale Price in $2011 (in 0,000s)	-	171,754
Age of house (years)	37.37	31.06
Single Family Detached	0.176	0.765
Single Family Attached	0.010	0.029
Multi-Family	0.789	0.115
Mobile Home	0.026	0.091
Garage	0.165	0.353
Rooms	3.78	5.575
Baths	1.09	1.53
Bars on windows	0.015	0.008
Bldgs within ½ block have bars	0.053	0.017
Bldgs within ½ block 7+ stories	0.005	0.001
Bldgs within ½ block 4-6 stories	0.010	0.002
Waterfront	0.003	0.005
Public housing	0.011	-
Rent controlled	0.010	-
Family income ($2011 in 0,000s)	27.70	67.47
Age of household head (years)	34.69	39.60
Married	0.332	0.680
Single female	0.225	0.075
School age children present	0.150	0.145
White	0.664	0.866
Asian	0.030	0.025
Black	0.146	0.039
Hispanic	0.136	0.062
Other non-white	0.023	0.009
Less than high school	0.187	0.093
High school degree	0.316	0.281
Some college	0.271	0.252
College degree	0.164	0.249
College degree or more	0.061	0.123
Observations	56,139	13,782

[a]All individual-specific variables (e.g. Age) pertain to the household head.

Depreciation Rates

$$\log p_{it} = X_{it}'\beta + \gamma age_{it} + \epsilon_{it}$$

TABLE 2—HEDONIC REGRESSIONS OF HOUSE RENT AND HOUSE PRICE

	Rental units: log of gross rent			Owner-occupied units: log of sale price		
	All	Multifamily	Single family	All	Multifamily	Single family
House age (years)	−0.0035**	−0.0031**	−0.0051**	−0.0084**	−0.0051*	−0.0090**
	(0.0002)	(0.0002)	(0.0006)	(0.0012)	(0.0022)	(0.0012)
Structural attributes[a]	Yes	Yes	Yes	Yes	Yes	Yes
Neigh attributes[a]	Yes	Yes	Yes	Yes	Yes	Yes
MSA FE	147	147	139	147	103	147
Year FE	27	27	27	27	27	27
Within R^2	0.159	0.131	0.226	0.446	0.128	0.298
Observations	56,139	44,280	10,417	13,782	1,583	10,946

Full Hedonic Table (Online Appendix)

	Rental Units Dependent Variable: Log of Gross Rent			Owner-Occupied Units Dependent Variable: Log of Sale Price		
	All	Multi-family	Single Family	All	Multi-family	Single Family
House age (yrs)	-0.0035** (0.0002)	-0.0031** (0.0002)	-0.0051** (0.0006)	-0.0084** (0.0012)	-0.0051* (0.0022)	-0.0090** (0.0012)
SFA	0.0476 (0.0760)	- -	- -	0.0093 (0.0821)	- -	- -
SFD	-0.0283 (0.0344)	- -	- -	0.0220 (0.0483)	- -	- -
MH	-0.3409** (0.0188)	- -	- -	-1.4292** (0.0311)	- -	- -
Garage	0.1236** (0.0225)	0.1284** (0.0285)	0.1285** (0.0107)	0.2261** (0.0228)	0.2020** (0.0482)	0.1865** (0.0345)
Number rooms	0.0906** (0.0050)	0.0829** (0.0069)	0.1125** (0.0044)	0.1713** (0.0069)	0.1553** (0.0219)	0.1678** (0.0079)
Number baths	0.2069** (0.0164)	0.2013** (0.0092)	0.2000** (0.0413)	0.2289** (0.0166)	0.2294** (0.0430)	0.1967** (0.0138)
Bars on windows	-0.0225 (0.0142)	-0.0306 (0.0159)	-0.0237 (0.0381)	0.0249 (0.0829)	0.1896 (0.1262)	-0.0216 (0.1037)
Bldgs within ½ block have bars	-0.0637** (0.0113)	-0.0626** (0.0124)	-0.0876* (0.0409)	-0.0973 (0.0646)	-0.0878 (0.2024)	-0.1334* (0.0620)
Bldgs within ½ block 7+ stories	0.0691 (0.0402)	0.0689 (0.0407)	0.3565** (0.1271)	0.3588* (0.1542)	0.2749 (0.2081)	-0.3663** (0.0285)
Bldgs within ½ block 4-6 stories	0.0727* (0.0350)	0.0703* (0.0316)	0.1092 (0.1246)	0.4153** (0.1312)	0.2437 (0.2142)	0.4532** (0.1198)
Waterfront	0.1418** (0.0423)	0.1517** (0.0557)	0.1083* (0.0463)	0.0483 (0.0535)	0.0374 (0.0715)	0.1244 (0.0689)
Public housing	-0.6330** (0.0281)	-0.6242** (0.0288)	-0.8434** (0.1196)	- -	- -	- -
Rent controlled	0.0059 (0.0388)	-0.0050 (0.0448)	0.1538* (0.0747)	- -	- -	- -
MSA Fixed Effects	147	147	139	147	103	147
Year Fixed Effects	27	27	27	27	27	27
R-squared	0.159	0.131	0.226	0.446	0.128	0.298
Observations	[illegible]	44,280	10,417	13,782	1,583	10,946

Repeat Income Specification

Let occupant income in year t, Y_t, be a function of house characteristics and a depreciation rate γ:

$Y_t = e^{\gamma_t} f(\mathbf{X}_t; \beta_t)$, $Y_{t+\tau} = e^{\gamma_{t+\tau}} f(\mathbf{X}_{t+\tau}; \beta_{t+\tau})$ Equations 1a,1b

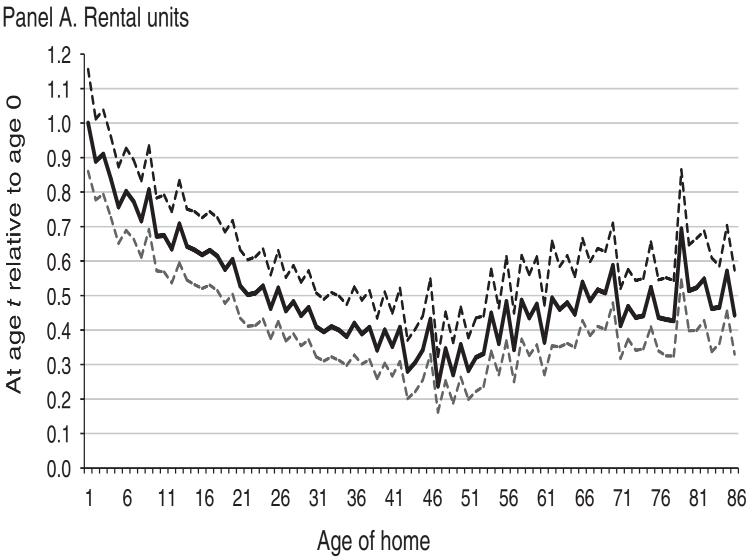
$$\log\left(\frac{Y_{t+\tau}}{Y_t}\right) = \gamma_{t+\tau} - \gamma_t + \omega_{t+\tau} \tag{2}$$

This can be re-written for any consecutive observations of the same house i in t and $t + \tau_i$ (“turnover pair”):

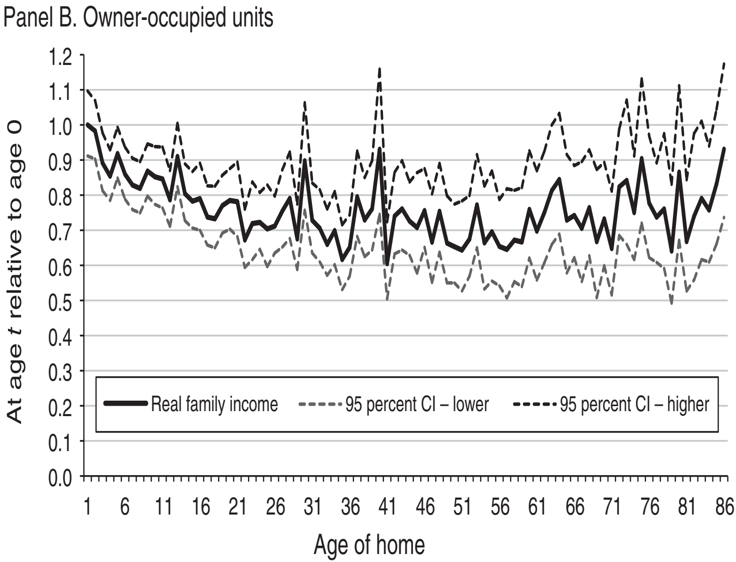
$$\log\left(\frac{Y_{t+\tau,i}}{Y_t, i}\right) = \sum_{t=1}^{\tau_i} \gamma_t D_{t,i} + \omega_{t,i} \tag{4}$$

where D_t is -1 for first period of pair, 1 for second period of pair, and 0 otherwise

Repeat Income Estimates for Rental Housing (γ)



Repeat Income Estimates for Owner-Occupied (γ)



A puzzle: low depreciation rates but fast filtering

Rental units depreciate at 0.35% each year; a 50 yr-old rental rents for $1 - exp(0.0035 * 50) = 83.9\%$ of a just built rental

New housing depreciates at 0.84%; a 50 yr-old house sells for 65.6 of new price

But the people renting a 50 year-old house have just 30% of income of new house renters; 50 year-old owner occupiers have 70% of income of new home owner-occupiers.

Author notes this is a puzzle: why don't the filtering rates match depreciation rates, and how can rental filtering rates be so high?

Housing Demand Model and Income Transitions

To try and explain this puzzle, author uses a simple model of housing demand to think about the factors affecting filtering

$$\log(h_{t,i}) = \theta_Y \log(Y_{t,i}) + \theta_q \log(q_{t,i}) \tag{4}$$

Variable $h_{t,i}$ is *total* housing services (quality adjusted), $Y_{t,i}$ is income of occupant, and $q_{t,i}$ is price of a *single unit* of housing services

To get an expression for filtering we solve for Y and then difference across two time periods.

Define the rate of depreciation as $\log(h_{t+\tau,i}/h_{t,i}) = d\tau_i$, then:

$$\log\left(\frac{Y_{t+\tau,i}}{Y_{t,i}}\right) = \frac{d}{\theta_Y}\tau_i - \frac{\theta_q}{\theta_Y}\log\left(\frac{q_{t+\tau,i}}{q_{t,i}}\right) + \omega_{t,i} \tag{5}$$

Components of the filtering rate

$$\log\left(\frac{Y_{t+\tau,i}}{Y_{t,i}}\right) = \frac{d}{\theta_Y}\tau_i - \frac{\theta_q}{\theta_Y}\log\left(\frac{q_{t+\tau,i}}{q_{t,i}}\right) + \omega_{t,i} \quad (5)$$

If prices are constant ($q_t = q_{t+\tau}$) then filtering is the depreciation rate (presumably negative), scaled by the income elasticity of demand θ_Y.

If this is elastic ($\theta_Y > 1$) then filtering is faster because richer households wish to consume more housing (depreciated house offers insufficient housing services)

If prices are increasing ($q_t < q_{t+\tau}$) then this offsets depreciation and houses can even filter up. Note that we assume $\theta_q < 0, \theta_Y > 0$

Lastly, author notes that over sample period housing price growth was much less than depreciation. Effect of income elasticity on filtering can be approximated by d/θ_Y^2, thus annual filtering faster than depreciation when $\theta_Y < 1$

Instrumenting for Price Growth

Equation of housing demand requires price of *housing services*, q, but housing price p data is actually a measure of expenditure: $p = q * h$ (ex: bigger houses have higher prices).

This introduces bias because housing services depreciate and affect price p, which in turns affects filtering equation (extra $d\tau_i$):

$$\log(p_{t+\tau,i}/p_{t,i}) = \log(q_{t+\tau,i}/q_{t,i}) + d\tau_i \quad (7)$$

$$\log\left(\frac{Y_{t+\tau,i}}{Y_{t,i}}\right) = \frac{d}{\theta_Y}(1+\theta_q)\tau_i - \frac{\theta_q}{\theta_Y}\log\left(\frac{p_{t+\tau,i}}{p_{t,i}}\right) + \omega_{t,i} \quad (8)$$

Author uses MSA index of house price growth as instrument for housing price: should give price growth without depreciation specific to house i

Main Estimates

Table 3—Real Change (log) in Arriving Occupant Income[a]

	OLS (1)	OLS (2)	OLS (3)	2SLS[b] (4)	OLS[d] (5)
Panel A. Renter occupied					
Years between turnover (d/θ_Y)	−0.0181**	−0.0194**	−0.0237**	−0.0271**	−0.0299**
	(0.0022)	(0.0021)	(0.0018)	(0.0020)	(0.0027)
Percent change in FHFA Index[c]	—	—	0.2522**	—	0.2528**
	—	—	(0.0489)	—	(0.0368)
log change in rent (θ_q/θ_Y)	—	0.1876**	—	1.289**	—
	—	(0.0105)	—	(0.1374)	—
MSA fixed effects	147	147	147	147	—
House fixed effects	—	—	—	—	12,861
KP weak inst. F-statistic	—	—	—	270.98	—
First-stage coeff on %ΔFHFA index	—	—	—	0.1957**	—
	—	—	—	(0.0302)	—
Root MSE	1.289	1.286	1.289	1.403	1.409
Observations	56,139	56,139	56,139	56,139	49,959
Panel B. Owner occupied					
Years between turnover (d/θ_Y)	−0.0027	−0.0030*	−0.0058**	−0.0049**	−0.0007
	(0.0014)	(0.0013)	(0.0018)	(0.0014)	(0.0047)
Percent change in FHFA Index[c]	—	—	0.1744**	—	0.2310**
	—	—	(0.0523)	—	(0.0819)
log change in price (θ_q/θ_Y)	—	0.0899**	—	0.2485**	—
	—	(0.0115)	—	(0.0563)	—
MSA fixed effects	146	146	146	146	—
House fixed effects	—	—	—	—	2,953
KP weak inst. F-statistic	—	—	—	335.39	—
First-stage coeff on %ΔFHFA index	—	—	—	0.8012	—
	—	—	—	(0.0555)	—
Root MSE	1.047	1.031	1.046	1.039	1.171
Observations	13,781	13,206	13,781	13,206	6,946

Pooling Data: Allows Tenure Transitions

TABLE 4—REAL CHANGE (LOG) IN ARRIVING OCCUPANT INCOME ALLOWING FOR TENURE TRANSITIONS[a]

	Turnovers with a change in tenure	Turnovers without a change in tenure	All turnovers	All turnovers	All turnovers[c]
Years between turnover	−0.0306**	−0.0176**	−0.0173**	−0.0185**	−0.0289**
	(0.0063)	(0.0014)	(0.0016)	(0.0016)	(0.0023)
Percent change in FHFA Index[b]	0.3043**	0.2423**	0.2422**	0.2483**	0.2572**
	(0.1127)	(0.0448)	(0.0447)	(0.0461)	(0.0329)
Change tenure from rent to own	—	—	0.2802**	—	—
	—	—	(0.0221)	—	—
Change tenure from own to rent	—	—	−0.2319**	—	—
	—	—	(0.0246)	—	—
MSA fixed effects	132	147	147	147	—
House fixed effects	—	—	—	—	16,706
Root MSE	1.260	1.235	1.235	1.236	1.367
Observations	3,947	68,213	72,170	72,170	60,804

Income Elasticity of Demand: Renters and Owners

Estimated income elasticities are much lower than 1

TABLE 5—HOUSING DEMAND REGRESSIONS

	Renter occupied (Dep. var.: log rent)	Owner occupied (Dep. var.: log price)
log family income (θ_Y)	0.1236**	0.4126**
	(0.0098)	(0.0349)
Socioeconomic household attributes[a]	Yes	Yes
MSA fixed effects	147	147
Year fixed effects	27	27
Within R^2	0.150	0.254
Observations	56,139	13,782

Simulation: Effect of Different Price Growth

TABLE 6—SIMULATED REAL ANNUALIZED FILTERING RATES 1975–2011 ALLOWING FOR HOUSE PRICE INFLATION

		Filtering rates by housing tenure		
	Annualized real % change in house price (1975 to 2011)[a] (1)	Renter occupied[b] (2)	Owner occupied[b] (3)	Pooled renter and owner occupied allowing for tenure transitions[b] (4)
USA	0.66	−2.20	−0.48	−1.69
New England	2.02	−1.86	−0.25	−1.35
Middle Atlantic	1.26	−2.05	−0.38	−1.54
South Atlantic	0.35	−2.28	−0.54	−1.76
East South Central	−0.07	−2.39	−0.61	−1.87
East North Central	0.02	−2.37	−0.60	−1.85
West South Central	−0.08	−2.39	−0.61	−1.87
West North Central	0.21	−2.32	−0.56	−1.80
Mountain	0.46	−2.25	−0.52	−1.74
Pacific	2.24	−1.81	−0.21	−1.29

Conclusions

Generally in the US, the filtering rate is fairly high: the overall pooled rate is 2.9 when allowing for tenure transitions (Table 4)

Further, rental housing filters (2.5%) much more quickly than owner-occupied housing (0.5)

However, filtering can be offset both by high income elasticities of demand and high house price growth

Author estimates income elasticities much less than one, but house price growth varies dramatically across the country

Author concludes that in most locations high filtering rates suggest the market can provide housing for low income households, but possibly not in places with high house price growth