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Government Regulation and Changes in the Affordable Housing Stock

1. Introduction

In terms of housing issues, the primary public policy focus of economists has been the affordability of homes, mortgage availability, land-use regulation, and rent control. Studies of land-use regulation focus on the effects of regulation on the price of owner-occupied housing. Work on low-income housing has concerned itself more with issues of measurement and the debate over supply-side versus demand-side subsidies.

In this paper, we look at the relationship between these two issues to examine how government regulation affects the dynamics of the low-income housing stock. We find that, consistent with theoretical models of housing, restrictions on the supply of new units lower the supply of affordable units. This occurs because increases in the demand for higher quality units raise the returns to maintenance, repairs, and renovations of lower quality units, as landlords have a stronger incentive to upgrade them to a higher quality, higher return housing submarket. This result is disturbing because it highlights how policies targeted toward new, higher income owner-occupied suburban housing can have unintended negative consequences for lower income renters.

Our research differs from most studies of affordable housing in that we are not concerned with identifying the size of the affordable stock or matching it to the number of low-income households. The gap between the housing needs of low-income households and the stock of units deemed affordable has been demonstrated in a considerable amount of other research.[1] Here, we build on the Somerville and Holmes (2001) study of the effects of the unit, neighborhood, and market characteristics on the probability that a unit will stay in the stock of rental units affordable to low-income households; we do so by looking at how government regulations affect this probability. Our approach is to look at individual units in successive waves of the American Housing Survey (AHS) metropolitan area sample. In doing so, we follow Nelson and Vandenbroucke (1996) and Somerville and Holmes (2001), who use the panel nature of the AHS metropolitan area survey data to chart the movements of individual units in and out of the low-income housing stock.

The remainder of the paper is structured as follows. First, we lay out the theoretical framework for our analysis. We follow with a discussion of our data. Finally, we present our empirical results, both for measures of constraints on the supply of new residential units and for the pervasiveness of rent control in an area.

2. Theoretical Framework

We model movements of units in and out of the stock of affordable housing as the filtering down of units through successive housing submarkets. The filtering model describes the housing market as a series of submarkets differentiated by

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unit quality. Rents fall as quality declines, so units that are lower on the quality ladder have lower rents than units of the same size in the same location at the top. Without expenditures on maintenance, renovation, and repairs, units decline in quality as they depreciate physically and technologically. As this occurs, the units move down the quality ladder. The cost to maintain a given level of quality is assumed to increase with unit age. Extra expenditures on maintenance and renovation can move units back up the ladder. Relative rents in the different submarkets vary with the distribution of income across households (demand) and the supply of units in that submarket. When quality is least expensive to provide at the time units are built, new units will be of high quality. The supply of the most affordable, lowest quality units will be those units built in earlier periods that have been allowed to depreciate and move down—to filter down—the quality ladder. Landlords will choose a level of maintenance to maximize profits, and that choice determines into which housing submarket their unit will fall. When incomes, population, and the housing stock raise rents in the submarket for higher quality units relative to those in the submarket for lower quality units, landlords in the latter submarket have a greater incentive to increase maintenance, renovation, and repair expenditures to cause units to filter up, that is, to move to the higher quality submarket. Reducing the supply of low-end affordable units can potentially exacerbate affordability problems for the least well-off. Although this may occur when the entire demand curve for a neighborhood's amenities shifts out, we do not formally model neighborhood gentrification, focusing instead on unit-specific decisions.

The focus of this paper is on use of the filtering model to explain the effect of restrictions on new construction and rent control on the movement in units in and out of the low-income housing stock. We expect that factors that lower the market's new-construction-supply response to increases in demand will reduce the affordable housing stock. This occurs because the increase in demand that is unmet with new construction raises the returns to landlords for moving units up the quality ladder. These factors can include explicit government land-use regulations that constrain the new supply or an area's market supply elasticity, which for reasons such as unobserved regulation, land supply, and builder industry organization can differ across markets.

One of the major forms of government regulation of housing markets with important implications for the affordable housing stock is rent control. The question of interest for this paper is what effect rent control has on the uncontrolled affordable housing stock. We know from Early and Phelps (1999) and Fallis and Smith (1984) that rent control lowers the supply of uncontrolled affordable housing because excess demand for units raises rents in this segment. This suggests that it raises the probability that in any time period the uncontrolled units that remain affordable will be more likely to filter up. Alternatively, there may be reasons why these units remain affordable and cannot filter up easily. The units could be of particularly low quality or there may be negative neighborhood effects from surrounding, poorly maintained rent-controlled buildings. Finally, an application of the labor markets' efficiency wage model suggests that some landlords who prefer to keep rents low to give themselves the advantage of selecting from a larger pool of prospective tenants increase their ability to weed out those who may be more likely to be bad tenants.

3. The Existing Literature

This paper draws from a wide variety of existing work. There is a literature on filtering stretching back to Ratcliff's (1949) discussion of the phenomenon. Government land-use regulation as it applies to new construction has spawned a voluminous theoretical and empirical literature looking at zoning restrictions on use and density, development fees, greenbelts, growth controls, and factors that delay and slow the new supply response to demand shocks. Furthermore, in an area where economists mostly agree with one another, there is a copious literature on rent control and its effect on rents, maintenance, and housing market equilibria. All of this work bears on our paper.

Sweeney (1974) is credited with the first thorough theoretical treatment of filtering, where the level of maintenance affects the rate of depreciation. The theoretical literature includes papers that expand his model to include other issues.[2] Most of the recent empirical filtering literature does not examine individual units directly, but looks for outcomes consistent with filtering. Phillips (1981) uses cross-sectional data to compare mean neighborhood income with descriptive statistics of the neighborhood housing stock. Weicher and Thibodeau (1988), using aggregate data, test for the effect of new construction on the low-income housing stock. A more targeted study is Susin's (1999) examination of the effect of Section 8 housing vouchers on rents for the least expensive third of units. Using the AHS neighborhood sample, he finds a fairly inelastic supply curve and little downward filtering as rents are clearly higher in the presence of vouchers. The notable exception to these studies with aggregate data is Somerville and Holmes (2001). They use micro data to describe the relationship between individual unit, neighborhood, and market characteristics, and the probability that units will filter up or down.

Here, we look at the effect of land-use regulations on filtering. Although no work has done this explicitly, a considerable body of research has studied the theoretical and empirical effects of various land-use regulations on urban form, development patterns, and the price of housing. Nearly all of the existing empirical work (see Fischel [1990] for a review) explores the impact of regulation on house prices, with the bulk of the papers finding that increased local regulation leads to higher house prices. Constraints on supply result in higher house prices, but so too does the capitalization of benefits that regulations provide for local residents. A much smaller literature looks specifically for the effects of regulation on new construction, and finds lower levels of construction in the presence of higher regulatory barriers and fees.[3] This latter literature is relevant for our analysis because we expect that restrictions on new development will affect the supply of affordable units from the existing stock by creating excess demand in the market for newer and higher quality units, which increases the incentives for landlords to upgrade their units.

We also examine the relationship between rent control and filtering. There is a copious literature that highlights aspects of the aggregate welfare losses associated with rent control.[4] Olsen (1998) provides a brief of summary of the economics of rent control; other important work is Glaeser (1996) and Glaeser and Luttmer (1997) on the welfare losses from the misallocation of housing under rent control, and the seminal empirical analysis by Olsen (1972).

4. Data Description

We use the AHS metropolitan surveys to create a data set of individual rental units in metropolitan statistical areas (MSAs) from 1984 to 1994 for those MSAs for which we have land-use regulation data. An "observation" is an individual rental unit that is included in two successive surveys. Each MSA is surveyed every three or four years in waves of approximately eleven MSAs per survey, so that we have potentially two observations per unit for twenty-three of the MSAs and one observation per unit for the remaining twenty-one. As a result, our time periods of analysis are not constant across MSAs. However, our right-hand-side variables are either survey-period-specific or assumed to be time-invariant within an MSA. Observations per unit are constrained by the introduction of a new survey questionnaire in 1984 and a new sample in 1995.[5] When examining rent control, we look only at those MSAs that include jurisdictions that impose significant rent control.

In this paper, we define the affordable housing stock as those units for which the gross rents are less than or equal to 30 percent of household income for a household with 35 percent of the median MSA household income. We map this cutoff to different unit sizes using the Department of Housing and Urban Development's methodology for calculating differences in fair market rents by unit size.[6] Throughout, we use rent to refer to gross rents.[7] Although there are a variety of approaches to defining affordability, we have a taken a naïve approach. We do not believe that how we define the housing stock should cause problems. Our test is of the effect of a vector of variables on the probability that a unit will cross a threshold, relative to not doing so. How we define the threshold only matters if the effect of explanatory variables varies systematically along the quality ladder.

This study analyzes how restrictions on new construction and rent control affect the evolution of the affordable stock. Units must appear in at least two surveys to be included in our sample. As a result, we exclude units that for whatever reason appear in only one survey. A unit identified as affordable in the first survey year can have one of four outcomes in the subsequent survey year, assuming that the occupants respond to the second survey. First, it can remain affordable. Second, the unit's rent can exceed the affordability cutoff, that is, filter up. Third, a unit can become owner-occupied. Fourth, it can either be abandoned, or demolished or converted.[8] For rental units that were identified as unaffordable in the first survey year, we have a similar set of possible outcomes, except that the baseline remains unaffordable and option two is to filter down and become affordable.

We employ a mixed strategy to private-market units where the occupant receives a subsidy. Work by McArdle (n.d.) indicates that in many cases in the AHS, one cannot distinguish between the actual gross rent and the gross rent paid (net of the subsidy). We choose to exclude units where the occupant receives a subsidy in the first survey year. However, a unit whose occupying household did not receive a subsidy in the first survey, but did in the second survey, is considered to be affordable in the second survey. This approach does not result in bias, as treating subsidized units as a separate category into which units can move does not qualitatively change our results.

Table 1 shows the frequency of each outcome for movements out of the affordable housing stock and out of the unaffordable stock between any two AHS metropolitan surveys. Similar to Nelson and Vandenbroucke (1996), we find substantial movement in and out of the affordable stock. Not surprisingly, units in the unaffordable stock are less likely to become government-subsidized or be demolished, but are more likely to convert to owner-occupancy than are units initially classified as affordable. These figures show an increase

Table 1
Changes in the Affordable Housing Stock

	Number	Percentage
Units beginning as affordable		
Remain affordable	4,171	45.3
Become unaffordable	2,928	31.8
Become subsidized	760	8.3
Become owner-occupied	506	5.5
Are demolished or converted	837	9.1
Total	9,202	
Units beginning as unaffordable		
Remain unaffordable	54,298	78.1
Become affordable	6,007	8.6
Become subsidized	3,185	4.6
Become owner-occupied	4,703	6.8
Are demolished or converted	1,369	2.0
Total	69,562	

Notes: Only units that had observations for two consecutive years are included; units that were initially government subsidized or classified as public housing are excluded. A unit is defined as affordable if the sum of rent and utilities is less than 30 percent of household income for a household at 35 percent of the median income for four-person families for that year in that city. To account for different unit sizes, we make an adjustment based on the number of bedrooms. These aggregate data are likely to underestimate the number of units that become unaffordable because rents tend to increase more when tenants change, but new tenants are less likely to become American Housing Survey respondents.

of approximately 1,700 units. This result may be misleading because the AHS will tend to exclude units with a change in occupants in successive surveys; this leads to bias because these are the units most likely to experience rent increases.[9]

In Table 2, we present the distribution of rent-controlled units for those MSAs with rent-control policies. The number of rental units subject to rent control varies widely, from a low of 4 percent in Boston to a high of more than 25 percent in San Francisco. The principal determinant appears to be whether the central city itself imposes rent control. Even in cities with little rent control, there is at least one zone for which rent-controlled units make up more than 10 percent of the rental stock.

In the analysis, we include unit and neighborhood variables that enter into the landlord's optimal maintenance and renovation decision as well as the MSA land-use and supply restriction variables. All regressions also include a set of control variables. We include unit characteristics such as a dummy variable for the unit if it is defined as adequate by AHS standards, unit age, a dummy for multiunit buildings, and the number of units in the structure. Adequacy is an AHS-coded summary variable based on responses to questions about physical problems in the unit. The lack of hot piped water or a flush toilet would classify a unit as severely inadequate, while multiple leaks and holes in the floor and walls would classify the unit as moderately inadequate.

Neighborhood effects enter the decision to invest in a unit's quality. We use AHS zones—socioeconomically homogeneous areas of approximately 100,000 people—as our definition of a neighborhood. Although larger than a neighborhood, this is the most geographically disaggregated variable available in the AHS metropolitan survey. For each zone, we estimate the ratio of rental units to all units, affordable units to all rental units, public housing units to all rental units, and subsidized units to all rental units in the zone. We also measure the average age of the rental stock, the percentage of households headed by an African-American, and the median household income in the zone.

Both market and unit measures act as control variables. The first controls for the effect of aggregate MSA changes in house prices and rents in causing movements of individual units into and out of the affordable stock. We use DiPasquale and Somerville's (1995) methodology to generate hedonic price

Table 2
Rent-Control Descriptive Statistics
Percentage of Rent-Controlled Units in Rental Stock

			Percentage of Rent-Controlled Rental Units in Zone				
Metropolitan Statistical Area (MSA)	MSA Mean (Percent)	Number of Zones in MSA	Average across Zones	25th Percentile across Zones	Median across Zones	75th Percentile across Zones	90th Percentile across Zones
Boston	4.0	31	2.3	0.0	0.0	1.8	5.7
Los Angeles	25.0	44	19.2	2.1	8.0	39.0	47.9
New York	17.1	83	11.6	0.0	9.3	18.0	28.7
San Francisco	25.5	22	17.6	0.9	4.2	36.1	56.4
San Jose	10.1	10	9.2	5.5	6.9	12.7	16.5
Washington, D.C.	9.3	23	6.6	0.8	2.0	4.1	25.9

and rent series from the AHS, with mean values of the affordable stock used to describe the bundle. The second is the ratio of a unit's rent to the affordability conditions that the most marginally affordable units are more likely to filter up.

Data on land-use regulation come from the Wharton Urban Decentralization Project Data Set (Linneman and Summers 1991). These data summarize surveys sent to local planners in a sample of sixty MSAs, of which we have price data and American Housing Survey information for thirty-eight. We include two measures of regulation, a count of the number of ways in which growth management techniques have been introduced in the MSA, and whether development or impact fees are imposed in the cities in the MSA. The number of growth management techniques is the sum of five different dummy variables, each of which indicates whether one of the following approaches to introducing growth management policies is prevalent in the MSA: citizen referendum; legislative action by municipalities, counties, and the state; and administrative action by public authorities. We assume that the more types of actions taken and the greater the number of groups that act to control development, the more constrained the regulatory environment. These variables vary by MSA, but are constant over time. This forces us to assume that the regulatory environment described by these variables is time-invariant.

In Table 3, we present descriptive statistics for these variables separately for affordable units and unaffordable units. Comparing these two sets, we note that the difference of means *t*-tests rejects equality of means for nearly all variables.

Table 3
Descriptive Statistics

	Affordable Units			Unaffordable Units			
Variable	Count	Mean	Standard Deviation	Count	Mean	Standard Deviation	*t*-Test on Mean Difference
Unit							
Adequacy of unit (1 if adequate, 0 otherwise)	9,202	0.72	0.45	69,562	0.90	0.30	37.44
Age of unit	9,202	46.56	19.58	69,562	27.91	20.64	85.33
Unit is part of multiunit building (1 if yes, 0 if no)	9,202	0.70	0.46	69,562	0.76	0.43	12.43
Number of units in building	9,202	8.35	19.00	69,562	13.63	29.19	23.25
Neighborhood							
Ratio of subsidized units to rental units in zone	9,202	0.11	0.06	69,562	0.10	0.06	19.52
Average age of rental units in zone	9,202	37.15	13.67	69,562	28.28	12.92	58.85
Ratio of public housing units to rental units in zone	9,202	0.07	0.07	69,562	0.04	0.05	39.15
Ratio of rental units to all units in zone	9,202	0.48	0.17	69,562	0.44	0.15	21.53
Ratio of affordable units to rental units in zone	9,202	0.31	0.17	69,562	0.14	0.13	92.42
Percentage African-American heads of household in zone	9,202	0.27	0.30	69,562	0.13	0.18	44.67
Median household income in zone	9,202	21,487	8,665	69,562	27,650	8,998	63.83
Regulation							
New single-family permits—supply elasticity	7,502	15.96	8.64	56,552	14.37	7.38	15.25
Jurisdictions in MSA use impact fees (dummy)	8,571	0.36	0.48	61,708	0.51	0.50	27.35
Number of approaches to growth management	8,215	0.54	0.83	59,713	0.69	0.89	14.66
Percentage rent control in zone greater than 10 percent (1 if yes, 0 if no)	761	0.47	0.50	8,302	0.30	0.46	9.04
Percentage rent control in zone	761	0.14	0.16	8,302	0.10	0.14	6.67
Control							
Hedonic price change in MSA (affordable units)	9,202	0.07	0.38	69,562	0.08	0.34	1.95
Hedonic rent change in MSA (affordable units)	9,202	0.23	0.11	69,562	0.21	0.12	19.54
Number of years current resident has occupied unit	7,878	6.33	8.60	60,907	2.92	4.96	34.39
Ratio of rent to cutoff of affordability	9,202	0.76	0.20	69,562	1.62	0.46	319.24

Notes: Only units that were included in two consecutive surveys are included; units that dropped out of the sample in successive surveys are excluded. All price and rent changes are measured in nominal dollars. The mean values in the affordable units column and the unaffordable units column for the hedonic price and rent changes differ because these two categories of units are not distributed identically across metropolitan statistical areas (MSAs). Rent-control variables are only for Boston, Los Angeles, Newark, San Francisco, San Jose, and Washington, D.C., American Housing Surveys. Supply elasticities and regulation variables are only available for thirty-eight of forty-four American Housing Survey MSAs.

Qualitatively, affordable units are in poorer condition and in older and smaller buildings. Tenants have a notably longer mean stay in the affordable units, 6.3 versus 2.9 years. Affordable units are both more concentrated in space than are rental units in general and are much more likely to be in areas with a higher proportion of African-Americans. Although other differences are statistically significant, they are not meaningful. The rent changes, which are calculated at the zone rather than at the unit level, differ by class because affordable and nonaffordable units do not have the same distribution across space, while price and rent changes vary by area. Those MSAs with more affordable units are likely to have higher supply elasticities and less land-use regulation.

5. Empirical Results

We estimate the model using a multinomial logit specification where any observation $i = 1$ to n can fall into one of k groups. For a unit currently in the low-income stock, these groups are remaining in the low-income stock, filtering up (defined as having a rent that surpasses the affordability threshold), converting to owner-occupied, or being demolished. For each observation, we have a probability:

$$(1) \qquad Pr(i \in j) = \frac{e^{X\beta_j}}{\sum_{j=1}^{k} e^{X\beta_k}} \text{ for all } k = 1 \text{ to } 4 \text{ groups.}$$

Equation 1 is unidentified unless we set $e^{X\beta_1} = 1$. The standard procedure is to present the odds ratio, the ratio of the probability that $i \in k(k \neq 1)$ relative to the probability that $i \in 1$. For instance:

$$(2) \qquad \frac{Pr(i \in 2)}{Pr(i \in 1)} = \frac{e^{X\beta_2}}{1 + \sum_{j=2}^{k} e^{X\beta_k}} \Big/ \frac{1}{1 + \sum_{j=2}^{k} e^{X\beta_k}} = e^{x\beta_2}.$$

The multinomial regression results are presented in the appendix. There, Tables A1 and A2 show the effects of land-use regulation on affordable and unaffordable units, while Table A3 does the same for the effect of the rent-control variables. The relatively small number of degrees of freedom at the MSA level causes us to separate these two into distinct tables.

Multinomial logit regression output can be difficult to interpret. The coefficients are both exponentiated and relative to the baseline outcome, which, in our case, is when the unit's affordability status remains unchanged. We present the results in a set of tables that show the sensitivity of relative probabilities to given changes in the values of right-hand-side variables. These describe the percentage-point change in the probability of outcome *i*, relative to remaining affordable, for a 10 percent change in the explanatory variables. These results are like elasticities, but are applied to relative rather than to absolute probabilities.

Table 4 shows the effects of the unit characteristics, neighborhood quality measures, and control variables. Adding the government regulation variables to these variables does not change the results, so for clarity of presentation, we show them just once. The results in column 1 describe the sensitivity that an affordable unit filters up, relative to staying affordable. Several factors stand out. Older units are less likely to filter up, as the cost of improving quality is higher. Neighborhood effects matter: filtering up is more likely to occur in neighborhoods with lots of rental units, but less likely if those units are mostly affordable. The control variables matter: units are more likely to become unaffordable if rents are rising in the market and if the unit's initial survey rent is closer to the cutoff. Being in better shape relative to the neighborhood also matters. From columns 2 and 3, the older the zone average, controlling for the unit's own age, the more likely the unit is to become owner-occupied, and the less likely it is to be demolished, though conversion to owner-occupancy is falling and demolition or conversion is rising in the unit's own age. For units initially unaffordable—columns 3-6—median zone income and market conditions are extremely important. Units are dramatically less likely to filter down or be demolished/converted the higher the median zone income is and the greater the increase in rents is.

Table 5 presents the effects of changes in regulation measures on changes in the stock of affordable units. All of the regression specifications used in Table 5 include the full set of unit, neighborhood, and control variables in Table 4. The results here are consistent with the filtering model: the more constrained the supply response for new residential units to demand shocks, the greater the probability that an affordable unit will filter up and out of the affordable stock relative to staying in the stock. Explicitly, the greater the supply elasticity of new single-family construction, the lower this relative probability will be, as builders are able to respond much more quickly to demand shocks. With more units coming in more quickly in response to an increase in demand, relative rents between high- and low-quality markets diverge less, reducing the returns to upgrading a unit so that it can filter up. The sign is robust across specifications, though the coefficient is not uniformly statistically different from zero. We find this a compelling result, clearly identifying the linkage between construction of new high- and standard-quality homes and the affordable stock consisting of lower quality units.

In regressions 2 and 3, we add the two measures of government land-use regulation, the presence of impact fees, and measures of the number of growth management

Table 4

Percentage Change in Relative Probabilities

10 Percent Change in Mean Values

	Affordable Units			Unaffordable Units		
Variable	Filters up—Becomes Unaffordable (1)	Converts to Owner-Occupied (2)	Converted or Demolished (3)	Filters down—Becomes Affordable (4)	Converts to Owner-Occupied (5)	Converted or Demolished (6)
Adequacy of unit	2.28	NS	-5.26	NS	NS	-7.36
Age of unit	-5.03	-6.38	8.35	1.90	NS	9.63
Unit is part of multiunit building	1.24	-10.82	-2.37	-2.91	-14.55	-5.46
Number of units in building	-0.68	NS	NS	0.26	NS	NS
Ratio of subsidized units to all units in zone	NS	NS	NS	2.32	NS	NS
Average age of rental units in zone	NS	5.98	-10.38	1.00	NS	-7.66
Ratio of public housing units to rental units in zone	NS	NS	NS	0.25	0.37	NS
Ratio of rental units to all units in zone	6.89	NS	NS	-1.22	-1.97	NS
Ratio of affordable units to rental units in zone	-4.62	NS	NS	0.89	1.48	1.03
Percentage African-American heads of household in zone	-0.96	-2.17	NS	0.45	-0.80	0.94
Median income in zone	0.00	0.00	NS	-24.16	NS	-24.16
Hedonic price change in MSA (affordable units)	0.13	NS	NS	0.35	NS	NS
Hedonic rent change in MSA (affordable units)	4.89	2.64	NS	-39.01	13.62	-26.17
Number of years current resident has occupied unit	-0.90	—	-1.10	0.17	0.28	-0.54
Ratio of rent to cutoff of affordability	5.29	NS	-6.27	0.00	0.00	0.00

Notes: The table reports changes in the odds ratios due to a 10 percent increase from the mean and due to an increase equal to one standard deviation from the mean. The odds ratios are relative to the outcome with the unit remaining affordable or becoming subsidized. The metropolitan statistical area (MSA) dummies are used in specification 1 but are not reported. NS indicates that the variable was not significant at the 5 percent level; the dash indicates that the variable was not used in this specification.

techniques used in the MSA. We argue that both describe constraints on supply. In both cases, greater regulation results in an increase in the probability that an affordable rental unit will filter up to become unaffordable. This is consistent with the predictions of the filtering model, as the constraints on new development can be expected to increase the returns to maintenance and renovation because with less new construction, relative rents for units of higher quality will be greater. The effects of elasticity and regulation variables on the relative probability of conversion to owner-occupied status or being demolished or converted are not statistically different from their effect on a unit remaining affordable.

We believe that the negative effect of supply regulations is more pronounced than is suggested by the absolute magnitude of these coefficients. When we compare the quasi-elasticities in Table 5 with those in Table 4, 10 percent increases in each of the elasticity and regulations variables have no more than one-quarter the effect of a similar increase in unit age and less than half the effect for unit quality. The effect is also less than one-quarter that of the neighborhood measures, mix of rental, owner-occupied, and affordable units in the zone. However, to say that the effects of regulations are unimportant would be erroneous. Our regulation measures are quite crude, yet they still provide robust, theoretically compelling results. More important, an increase in these measures affects all units in the affordable stock, so that even with a small effect per unit, the aggregate effect on affordable housing can be substantive. In contrast, unit age or quality affects the unit alone.

In Table 6, we present the same results for units unaffordable to low-income renters. Regulation variables have no effect on the relative probability that one of these will leave the stock. However, the new-construction-supply elasticity does matter. Higher end rental units are less likely to become owner-occupied and less likely to be demolished or converted when the supply response to a given demand shock is greater. This is consistent with the spirit of the filtering model, particularly if we think of the purchase of an existing rental unit and its conversion to an owner-occupied unit and the redevelopment of an existing structure as inferior to new greenfield development.

Table 7 presents the effects of rent control. Our prior is that in a rent-controlled environment, uncontrolled units are more likely to filter up. Early and Phelps (1999) and Fallis and Smith (1984) demonstrate that rent control increases the rents for uncontrolled rental units. However, we find that an uncontrolled unit in an area with more rent control is less likely to filter up or become owner-occupied and more likely, though the effect is not statistically different from zero, to be demolished or converted. In trying to explain this outcome, the other results do shed some light on the apparent paradox. Although not robust in significance, as the percentage of rental units subject to rent control in an area rises, uncontrolled units are less likely to convert to ownership, relative to remaining affordable, and more likely to be demolished or converted. Given that rents for uncontrolled units will be higher, and that rent control is typically imposed in locations where rents are high and rising, this suggests two possible explanations. First, uncontrolled units that remain affordable in the presence of rent control are more likely to be very low-quality units, suggesting selection bias. Despite the presence of rent control, the quality of these units indicates that they are less appealing for owner-occupants, unable to filter up, and more likely to be

Table 5

Effect of a 10 Percent Change in Regulation Variables

Affordable Units

	Specification (Percent)		
Variable	1	2	3
Filters up			
New single-family permits—supply elasticity	-1.19*	-0.53	-1.23**
Jurisdictions in MSA use impact fees (dummy)		0.92***	
Number of approaches to growth management			0.33*
Converts to owner-occupied			
New single-family permits—supply elasticity	1.46	1.55	1.40
Jurisdictions in MSA use impact fees (dummy)		0.15	
Number of approaches to growth management			-0.28
Demolished or converted			
New single-family permits—supply elasticity	0.83	1.20	0.80
Jurisdictions in MSA use impact fees (dummy)		0.50	
Number of approaches to growth management			-0.34

Notes: The table reports the percentage change in the odds ratios due to a 10 percent increase from the mean. The odds ratios are relative to the outcome with the unit remaining affordable or becoming subsidized. MSA is metropolitan statistical area.

***Statistically significant at the 1 percent level.

**Statistically significant at the 5 percent level.

*Statistically significant at the 10 percent level.

Table 6

Effect of a 10 Percent Change in Regulation Variables

Unaffordable Units

	Specification (Percent)		
Variable	1	2	3
Filters down			
New single-family permits—supply elasticity	-0.38	-0.27	-0.38
Jurisdictions in MSA use impact fees (dummy)		0.24	
Number of approaches to growth management			0.10
Converts to owner-occupied			
New single-family permits—supply elasticity	-0.92**	-0.88**	-0.92**
Jurisdictions in MSA use impact fees (dummy)		0.09	
Number of approaches to growth management			0.00
Demolished or converted			
New single-family permits—supply elasticity	-1.25	-1.48*	-1.26*
Jurisdictions in MSA use impact fees (dummy)		-0.58	
Number of approaches to growth management			-0.18

Notes: The table reports the percentage change in the odds ratios due to a 10 percent increase from the mean. The odds ratios are relative to the outcome with the unit remaining affordable or becoming subsidized. MSA is metropolitan statistical area.

***Statistically significant at the 1 percent level.

**Statistically significant at the 5 percent level.

*Statistically significant at the 10 percent level.

Table 7
Effect of a 10 Percent Change in Rent-Control Measures
Affordable Units

Variable	Specification (Percent) 1	2
Filters up		
Percentage of units in zone that are rent-controlled is greater than 10 percent	-3.65***	
Percentage of units in zone that are rent-controlled		-2.18*
Converts to owner-occupied		
Percentage of units in zone that are rent-controlled is greater than 10 percent	-4.99*	
Percentage of units in zone that are rent-controlled		-5.25
Demolished or converted		
Percentage of units in zone that are rent-controlled is greater than 10 percent	0.32	
Percentage of units in zone that are rent-controlled		1.02

Notes: All regressions have metropolitan statistical area (MSA) fixed effects and a dummy if the unit is in the MSA's central city. The table reports the percentage change in the odds ratios due to a 10 percent increase from the mean. The odds ratios are relative to the outcome with the unit remaining affordable or becoming subsidized.

***Statistically significant at the 1 percent level.

**Statistically significant at the 5 percent level.

*Statistically significant at the 10 percent level.

demolished. Second, if there are strong negative neighborhood externalities from being in an area with an undermaintained rent-controlled stock, this might reduce the returns to maintenance and renovation on uncontrolled units. Even though there is an incentive for the rents to rise, this second effect would work in the opposite direction. Both of these approaches allow for uncontrolled rents to be higher, while the returns to maintenance, for filtering up, to be lower. We are reluctant without a better sense of the data to reach any strong conclusion from this result, and we caution readers to use discretion when interpreting it.

6. Conclusion

This paper takes a new approach to studying the effects of land-use regulation. Instead of focusing on the effects of supply restrictions, both explicit and implicit, on new construction, we examine how they affect the filtering process. This allows us to examine the dynamics of the relationship between housing affordable to low-income households and local-government-imposed land-use regulations. Our approach, which borrows from Somerville and Holmes (2001), looks at how regulation affects the probability that a rental unit currently deemed affordable will become unaffordable, owner-occupied, or demolished, relative to staying affordable.

We find that regulation does matter: when new construction is more constrained, as measured either by a lower supply elasticity or the presence of certain regulations, affordable units are more likely to filter up and become unaffordable, relative to remaining in the affordable stock. We find this result to be quite compelling and to offer an important lesson for policymakers. The effects of land-use regulation are not limited to raising the price of owner-occupied housing and reducing access to homeownership. They also have a clear negative impact on the most vulnerable. Given the ample efforts to document the difficult and worsening affordability crisis for the least well-off, this has to be a concern.

There are a number of aspects of this paper that should caution against using this work to predict the effects of any new policies on the affordable stock. We examine the dynamics of the stock, but our supply control variables are MSA-specific and time-invariant. Consequently, we know little of the timing of these processes. Given the long-run nature of the filtering process, this suggests that the outcome of short-run changes in policy would be hard to predict. Still, through our examination of changes in the stock of affordable units across MSAs—rather than the size of the MSA stock itself—we are able to avoid some of the more egregious problems of MSA-level, excluded-variable bias.

Appendix: Multinomial Regression Results

Table A1

Affordable Rental Units

Multinomial Logit/Excluded Option/Remain Affordable

Variable	Specification 1 Pseudo R^2 = 7.94 Percent			Specification 2 Pseudo R^2 = 8.01 Percent			Specification 3 Pseudo R^2 = 7.98 Percent		
	Rent Rises	Owner-Occupied	Demolished/ Converted	Rent Rises	Owner-Occupied	Demolished/ Converted	Rent Rises	Owner-Occupied	Demolished/ Converted
Adequacy of unit (1 if adequate, 0 otherwise)	1.4121	1.2719	0.5504	1.4045	1.2731	0.5488	1.4134	1.2773	0.5507
	(4.26)	(1.54)	(5.38)	(4.19)	(1.54)	(5.40)	(4.27)	(1.56)	(5.37)
Average resident's evaluation of unit (scale of 1-10: 1 is worst, 10 is best)	0.9936	1.0340	0.8649	0.9945	1.0341	0.8652	0.9940	1.0334	0.8643
	(0.48)	(1.28)	(7.21)	(0.41)	(1.28)	(7.20)	(0.46)	(1.26)	(7.24)
Age of unit	0.9899	0.9856	1.0198	0.9900	0.9856	1.0198	0.9899	0.9857	1.0200
	(5.16)	(3.92)	(5.70)	(5.09)	(3.91)	(5.71)	(5.17)	(3.89)	(5.74)
Unit is part of multiunit building (1 if yes, 0 if no)	1.1901	0.2005	0.7236	1.1924	0.2006	0.7245	1.1894	0.2006	0.7245
	(2.40)	(11.80)	(2.79)	(2.42)	(11.80)	(2.78)	(2.39)	(11.80)	(2.78)
Number of units in building	0.9930	0.9902	0.9975	0.9927	0.9902	0.9973	0.9929	0.9903	0.9977
	(3.93)	(1.78)	(0.73)	(4.06)	(1.78)	(0.78)	(3.96)	(1.77)	(0.66)
Ratio of subsidized units to rental units in zone	1.6727	2.2670	0.4304	1.2908	2.1206	0.3801	1.6012	2.3343	0.4278
	(0.85)	(0.72)	(0.81)	(0.42)	(0.65)	(0.92)	(0.78)	(0.74)	(0.81)
Average age of rental units in zone	0.9982	1.0118	0.9752	1.0003	1.0121	0.9764	0.9975	1.0121	0.9757
	(0.45)	(1.49)	(3.65)	(0.08)	(1.50)	(3.40)	(0.60)	(1.52)	(3.56)
Ratio of public housing units to rental units in zone	0.6161	0.9293	5.2494	0.6336	0.9471	5.5030	0.5255	1.0082	6.0647
	(0.74)	(0.06)	(1.73)	(0.70)	(0.04)	(1.78)	(0.98)	(0.01)	(1.86)
Ratio of rental units to all units in zone	4.0005	1.5240	0.8627	3.3228	1.4826	0.7920	3.8044	1.6012	0.8900
	(4.96)	(0.72)	(0.30)	(4.20)	(0.66)	(0.47)	(4.76)	(0.79)	(0.23)
Ratio of affordable units to rental units in zone	0.1852	0.8163	0.6334	0.1771	0.8132	0.6191	0.2046	0.7675	0.5854
	(6.08)	(0.39)	(1.04)	(6.22)	(0.40)	(1.09)	(5.61)	(0.50)	(1.19)
Average resident's evaluation of neighborhood (scale of 1-10: 1 is worst, 10 is best)	1.0298	1.3643	0.8603	1.0852	1.3724	0.8874	1.0296	1.3590	0.8596
	(0.41)	(2.13)	(1.22)	(1.11)	(2.11)	(0.94)	(0.41)	(2.10)	(1.23)
Percentage African-American heads of household in zone	0.7339	0.4705	0.9249	0.8793	0.4789	1.0162	0.7493	0.4635	0.9080
	(2.03)	(2.44)	(0.31)	(0.79)	(2.23)	(0.06)	(1.89)	(2.48)	(0.38)
Median income in zone	1.0000	1.0000	1.0000	(0.79)	1.0000	1.0000	1.0000	1.0000	1.0000
	(3.22)	(0.52)	(0.20)	(0.79)	(0.44)	(0.02)	(3.04)	(0.61)	(0.27)
Hedonic price change in MSA (affordable units)	0.9855	1.8291	0.8197	(0.79)	1.8519	0.8390	0.9892	1.8245	0.8283
	(0.12)	(2.50)	(0.87)	(0.79)	(2.54)	(0.77)	(0.09)	(2.50)	(0.83)
Hedonic rent change in MSA (affordable units)	6.6865	2.5710	0.7265	(0.79)	2.6750	0.8462	6.3513	2.6997	0.7892
	(5.16)	(1.36)	(0.56)	(0.79)	(1.36)	(0.28)	(4.99)	(1.42)	(0.41)

Table A1 (continued)

Affordable Rental Units

Multinomial Logit/Excluded Option/Remain Affordable

	Specification 1 Pseudo R^2 = 7.94 Percent			Specification 2 Pseudo R^2 = 8.01 Percent			Specification 3 Pseudo R^2 = 7.98 Percent		
Variable	Rent Rises	Owner-Occupied	Demolished/ Converted	Rent Rises	Owner-Occupied	Demolished/ Converted	Rent Rises	Owner-Occupied	Demolished/ Converted
New single-family permits—supply elasticity	0.9925	1.0091	1.0052	(0.79)	1.0097	1.0075	0.9923	1.0087	1.0050
	(1.96)	(1.23)	(0.78)	(0.79)	(1.23)	(1.06)	(2.01)	(1.19)	(0.76)
Jurisdictions in MSA use impact fees (dummy)				(0.79)	1.0421	1.1484			
				(0.79)	(0.26)	(1.00)			
Number of approaches to growth management							1.0623	0.9490	0.9395
							(1.69)	(0.71)	(0.97)
Number of years current resident has occupied unit	0.9877	1.0044	0.9823	0.9876	1.0043	0.9823	0.9874	1.0047	0.9826
	(3.23)	(0.65)	(2.57)	(3.26)	(0.65)	(2.57)	(3.30)	(0.70)	(2.52)
Ratio of rent to cutoff of affordability	2.0477	0.8783	0.3351	2.1028	0.8805	0.3388	2.0585	0.8782	0.3331
	(4.16)	(0.40)	(4.07)	(4.31)	(0.39)	(4.03)	(4.19)	(0.40)	(4.09)

Notes: Number of observations: 6,168. The dependent variable has four possible values: 1) an affordable rental unit can remain affordable, 2) become unaffordable because of increases in its rent relative to the affordability cutoff, 3) become owner-occupied, or 4) be demolished or converted to another use. The excluded (base) outcome is to remain affordable. The top number reported is the unit odds ratio e^b; the bottom number (in parentheses) is the *Z*-statistic. The odds ratio is the probability of outcome *i* divided by the probability of the null (or excluded) outcome, and is equal to e^{XB}. The unit odds ratio is the odds ratio for a one-unit increase to the independent variable. Thus, it is not *b* that is reported in the table, but *eb*. The *Z*-statistic is based on the null hypothesis that $b = 0$, which is equivalent to the unit odds ratio $e^b = 1$. MSA is metropolitan statistical area.

Table A2

Unaffordable Rental Units

Multinomial Logit/Excluded Option/Remain Unaffordable

	Specification 1 Pseudo R^2 = 14.58 Percent			Specification 2 Pseudo R^2 = 14.59 Percent			Specification 3 Pseudo R^2 = 14.58 Percent		
Variable	Rent Falls/ Subsidized	Owner-Occupied	Demolished/ Converted	Rent Falls/ Subsidized	Owner-Occupied	Demolished/ Converted	Rent Falls/ Subsidized	Owner-Occupied	Demolished/ Converted
Adequacy of unit (1 if adequate, 0 otherwise)	0.8675 (2.93)	1.0149 (0.19)	0.4966 (7.11)	0.8685 (2.91)	1.0153 (0.19)	0.4953 (7.13)	0.8680 (2.92)	1.0150 (0.19)	0.4966 (7.11)
Average resident's evaluation of unit (scale of 1-10: 1 is worst, 10 is best)	1.0016 (0.22)	1.0284 (2.71)	0.9096 (5.48)	1.0018 (0.25)	1.0285 (2.71)	0.9092 (5.51)	1.0017 (0.24)	1.0284 (2.70)	0.9094 (5.50)
Age of unit	1.0082 (8.58)	1.0021 (1.66)	1.0336 (13.61)	1.0082 (8.59)	1.0021 (1.65)	1.0336 (13.60)	1.0082 (8.59)	1.0021 (1.66)	1.0337 (13.61)
Unit is part of multiunit building (1 if yes, 0 if no)	0.6930 (10.14)	0.1333 (43.85)	0.4521 (9.27)	0.6931 (10.14)	0.1333 (43.84)	0.4516 (9.29)	0.6932 (10.14)	0.1333 (43.85)	0.4517 (9.28)
Number of units in building	1.0016 (2.74)	0.9991 (0.94)	1.0007 (0.35)	1.0016 (2.74)	0.9991 (0.95)	1.0007 (0.37)	1.0016 (2.75)	0.9991 (0.94)	1.0007 (0.35)
Ratio of subsidized units to rental units in zone	8.0568 (7.44)	0.6546 (1.08)	0.2030 (1.94)	7.7836 (7.29)	0.6535 (1.08)	0.2141 (1.87)	7.9195 (7.36)	0.6545 (1.08)	0.2078 (1.90)
Average age of rental units in zone	1.0032 (1.64)	1.0028 (1.05)	0.9732 (5.34)	1.0036 (1.83)	1.0029 (1.09)	0.9720 (5.48)	1.0031 (1.57)	1.0028 (1.05)	0.9734 (5.29)
Ratio of public housing units to rental units in zone	1.3729 (0.88)	1.2864 (0.43)	0.0738 (2.73)	1.3555 (0.84)	1.2731 (0.41)	0.0734 (2.73)	1.3328 (0.79)	1.2862 (0.43)	0.0777 (2.66)
Ratio of rental units to all units in zone	0.6826 (2.79)	0.4465 (4.06)	0.8638 (0.41)	0.6644 (2.95)	0.4429 (4.08)	0.9040 (0.28)	0.6763 (2.85)	0.4465 (4.06)	0.8693 (0.39)
Ratio of affordable units to rental units in zone	2.6278 (5.88)	4.1712 (5.47)	3.7485 (3.15)	2.5791 (5.74)	4.1394 (5.43)	3.9768 (3.27)	2.6867 (5.93)	4.1674 (5.39)	3.5933 (3.00)
Average resident's evaluation of neighborhood (scale of 1-10: 1 is worst, 10 is best)	1.0327 (0.89)	0.9513 (0.95)	0.9293 (0.77)	1.0430 (1.14)	0.9561 (0.83)	0.9040 (1.03)	1.0344 (0.93)	0.9511 (0.95)	0.9267 (0.80)
Percentage African-American heads of household in zone	1.4736 (4.54)	0.5119 (4.18)	1.8318 (2.84)	1.5326 (4.70)	0.5225 (3.86)	1.6618 (2.22)	1.4840 (4.60)	0.5118 (4.15)	1.8133 (2.79)
Median income in zone	1.0000 (6.80)	1.0000 (1.31)	1.0000 (4.44)	1.0000 (6.92)	1.0000 (1.36)	1.0000 (4.24)	1.0000 (6.84)	1.0000 (1.31)	1.0000 (4.41)
Hedonic price change in MSA (affordable units)	1.3389 (4.94)	1.1121 (1.37)	1.0197 (0.12)	1.3478 (5.04)	1.1140 (1.39)	1.0070 (0.04)	1.3404 (4.95)	1.1122 (1.37)	1.0225 (0.14)
Hedonic rent change in MSA (affordable units)	0.1328 (13.40)	1.8894 (3.24)	0.3134 (3.10)	0.1379 (12.90)	1.9044 (3.26)	0.2891 (3.26)	0.1305 (13.38)	1.8912 (3.19)	0.3240 (2.98)

Table A2 (Continued)

Unaffordable Rental Units

Multinomial Logit/Excluded Option/Remain Unaffordable

	Specification 1 Pseudo R^2 = 14.58 Percent			Specification 2 Pseudo R^2 = 14.59 Percent			Specification 3 Pseudo R^2 = 14.58 Percent		
Variable	Rent Falls/ Subsidized	Owner-Occupied	Demolished/ Converted	Rent Falls/ Subsidized	Owner-Occupied	Demolished/ Converted	Rent Falls/ Subsidized	Owner-Occupied	Demolished/ Converted
New single-family permits—supply elasticity	0.9973 (1.37)	0.9936 (2.32)	0.9913 (1.64)	0.9981 (0.92)	0.9939 (2.11)	0.9897 (1.89)	0.9974 (1.33)	0.9936 (2.32)	0.9912 (1.66)
Jurisdictions in MSA use impact fees (dummy)				1.0474 (1.26)	1.0184 (0.39)	0.8917 (1.23)			
Number of approaches to growth management							1.0141 (0.84)	0.9996 (0.02)	0.9743 (0.58)
Number of years current resident has occupied unit	1.0105 (3.92)	1.0162 (4.04)	0.9610 (3.89)	1.0104 (3.88)	1.0161 (4.03)	0.9612 (3.88)	1.0104 (3.89)	1.0162 (4.04)	0.9612 (3.87)
Ratio of rent to cutoff of affordability	0.1101 (45.98)	1.9436 (15.53)	0.5795 (5.07)	0.1100 (45.99)	1.9413 (15.46)	0.5827 (5.01)	0.1099 (45.95)	1.9438 (15.43)	0.5829 (4.99)

Notes: Number of observations: 48,347. The dependent variable has four possible values: 1) an unaffordable rental unit can remain unaffordable, 2) become affordable because of decreases in its rent relative to the affordability cutoff, 3) become owner-occupied, or 4) be demolished or converted to another use. The excluded (base) outcome is to remain unaffordable. The top number reported is the unit odds ratio e^b; the bottom number (in parentheses) is the Z-statistic. The odds ratio is the probability of outcome i divided by the probability of the null (or excluded) outcome, and is equal to e^{XB}. The unit odds ratio is the odds ratio for a one-unit increase to the independent variable. Thus, it is not b that is reported in the table, but eb. The Z-statistic is based on the null hypothesis that $b = 0$, which is equivalent to the unit odds ratio $e^b = 1$. MSA is metropolitan statistical area.

Table A3

Affordable Rental Units

Multinomial Logit/Excluded Option/Remain Affordable

Variable	Specification 1 Pseudo R^2 = 10.79 Percent			Specification 2 Pseudo R^2 = 10.35 Percent		
	Rent Rises	Owner-Occupied	Demolished/ Converted	Rent Rises	Owner-Occupied	Demolished/ Converted
Adequacy of unit (1 if adequate, 0 otherwise)	2.1860	1.2212	0.4240	2.0122	1.0494	0.4315
	(2.74)	(0.29)	(1.74)	(2.47)	(0.07)	(1.71)
Average resident's evaluation of unit (scale of 1-10: 1 is worst, 10 is best)	0.9240	1.1128	0.9087	0.9282	1.1147	0.9095
	(1.86)	(0.95)	(1.12)	(1.77)	(0.97)	(1.11)
Age of unit	0.9976	0.9697	1.0114	0.9973	0.9698	1.0117
	(0.37)	(2.11)	(0.84)	(0.41)	(2.10)	(0.86)
Unit is part of multiunit building (1 if yes, 0 if no)	1.7279	0.1558	0.2353	1.6745	0.1617	0.2357
	(2.19)	(3.03)	(2.77)	(2.09)	(3.02)	(2.75)
Number of units in building	0.9911	0.9973	0.9954	0.9915	0.9968	0.9950
	(1.77)	(0.33)	(0.42)	(1.72)	(0.39)	(0.45)
Ratio of subsidized units to rental units in zone	0.7921	0.0002	0.2915	0.4865	0.0001	0.2465
	(0.13)	(2.05)	(0.28)	(0.41)	(2.20)	(0.32)
Average age of rental units in zone	0.9698	0.9700	0.9290	0.9735	0.9829	0.9262
	(1.66)	(0.67)	(1.76)	(1.42)	(0.36)	(1.78)
Ratio of public housing units to rental units in zone	0.0040	0.0318	0.1173	0.0122	0.0915	0.0888
	(2.39)	(0.73)	(0.43)	(1.97)	(0.53)	(0.50)
Ratio of rental units to all units in zone	0.7950	4.9530	104.5796	0.9647	8.5545	77.8929
	(0.23)	(0.71)	(1.99)	(0.03)	(0.92)	(1.83)
Ratio of affordable units to rental units in zone	0.7486	11.9466	1.9007	0.5920	13.4601	1.9701
	(0.25)	(0.81)	(0.23)	(0.45)	(0.84)	(0.24)
Average resident's evaluation of neighborhood (scale of 1-10: 1 is worst, 10 is best)	1.1137	1.2297	1.1343	1.1639	1.4238	1.0564
	(0.49)	(0.43)	(0.27)	(0.66)	(0.69)	(0.11)
Percentage African-American heads of household in zone	0.4929	0.0373	0.2794	0.4870	0.0352	0.2909
	(1.11)	(1.82)	(0.88)	(1.12)	(1.79)	(0.87)
Median income in zone	0.9999	0.9999	1.0000	0.9999	0.9999	1.0000
	(2.63)	(1.49)	(0.21)	(2.46)	(1.33)	(0.22)
Hedonic price change in MSA (affordable units)	0.7749	0.2247	5.0766	0.7991	0.2322	4.9279
	(0.43)	(1.07)	(0.98)	(0.38)	(1.05)	(0.96)
Hedonic rent change in MSA (affordable units)	0.0368	0.0000	0.0000	0.2773	0.0000	0.0000
	(0.51)	(1.23)	(0.93)	(0.20)	(0.99)	(0.96)
Dummy variable = 1 if percentage of units in zone that are rent-controlled is greater than 10 percent	0.4516	0.3349	1.0714			
	(3.04)	(1.85)	(0.12)			
Percentage of units in zone that are rent-controlled				0.2057	0.0210	2.0694
				(1.66)	(1.62)	(0.35)
Dummy variable = 1 if zone is in central city	1.4884	2.7934	1.3968	1.2578	2.5738	1.3405
	(1.33)	(1.50)	(0.50)	(0.78)	(1.39)	(0.45)
Dummy variable = 1 for Washington, D.C.	0.4480	0.0682	0.1614	0.5596	0.1001	0.1613
	(0.68)	(0.99)	(0.87)	(0.50)	(0.84)	(0.87)

Table A3 (Continued)

Affordable Rental Units

Multinomial Logit/Excluded Option/Remain Affordable

Variable	Specification 1 Pseudo R^2 = 10.79 Percent			Specification 2 Pseudo R^2 = 10.35 Percent		
	Rent Rises	Owner-Occupied	Demolished/ Converted	Rent Rises	Owner-Occupied	Demolished/ Converted
Dummy variable = 1 for New York City	0.6799	0.5997	0.6003	0.6866	0.4254	0.7762
	(0.55)	(0.32)	(0.37)	(0.52)	(0.52)	(0.17)
Dummy variable = 1 for San Francisco	0.4021	0.0914	0.2025	0.4563	0.1195	0.1935
	(0.97)	(1.10)	(0.94)	(0.84)	(0.96)	(0.97)
Dummy variable = 1 for San Jose	0.3275	0.1017	0.2308	0.4102	0.1489	0.2342
	(1.26)	(1.04)	(0.88)	(1.00)	(0.86)	(0.87)
Dummy variable = 1 for Boston	1.2361	5.1691	3.2279	1.2339	3.4391	4.1158
	(0.34)	(1.14)	(0.88)	(0.32)	(0.83)	(0.94)
Number of years current resident has occupied unit	0.9990	0.9866	1.0083	0.9982	0.9859	1.0080
	(0.11)	(0.55)	(0.39)	(0.19)	(0.58)	(0.38)
Ratio of rent to cutoff of affordability	0.6567	1.0654	1.1459	0.6721	1.1626	1.0885
	(0.90)	(0.06)	(0.13)	(0.85)	(0.14)	(0.08)

Notes: Number of observations: 592. The dependent variable has four possible values: 1) an affordable rental unit can remain affordable, 2) become unaffordable because of increases in its rent relative to the affordability cutoff, 3) become owner-occupied, or 4) be demolished or converted to another use. The excluded (base) outcome is to remain affordable. The top number reported is the unit odds ratio e^b; the bottom number (in parentheses) is the *Z*-statistic. The odds ratio is the probability of outcome *i* divided by the probability of the null (or excluded) outcome, and is equal to e^{XB}. The unit odds ratio is the odds ratio for a one-unit increase to the independent variable. Thus, it is not *b* that is reported in the table, but *eb*. The *Z*-statistic is based on the null hypothesis that $b = 0$, which is equivalent to the unit odds ratio $e^b = 1$. The excluded metropolitan statistical area (MSA) dummy is for Los Angeles.

Endnotes

1. Among the many papers in this literature are Bogdon, Silver, and Turner (1994) on the relationship between affordability and adequacy, Nelson (1994) on the association between the affordable stock and low-income households, O'Flaherty (1996) on the economics of homelessness, and especially Nelson and Vandenbroucke's (1996) seminal work charting the size of and change in the aggregate low-income housing stock.

2. The older empirical treatments of filtering are well surveyed by Brzeski (1977). Arnott, Davidson, and Pines (1983) allow for maintenance and rehabilitation, and Braid (1981) studies filtering in rental housing markets. Among a number of their papers on this topic, Bond and Coulson (1989) analyze neighborhood change in a model where the value of housing is related to neighborhood characteristics.

3. Mayer and Somerville (2000b) formally test the effects of regulation on the dynamics of the supply response to demand shocks.

4. An exception is Arnott (1995), who identifies several potential welfare benefits of rent control.

5. DiPasquale and Somerville (1995) demonstrate how to merge the 1974-83 AHS data with those from 1984-94, but the earlier period does not report precise rents. Combining the two sets would bias our results because we must set a precise cutoff for affordability.

6. Rents are a percentage of the four-person family, 30 percent cutoff as follows: zero bedrooms, 70 percent; one bedroom, 75 percent; two bedrooms, 90 percent; three bedrooms, 104 percent; four bedrooms, 116 percent; then increasing by 12 percentage points for each additional bedroom up to fourteen bedrooms.

7. In 1989, the survey question about utility costs was changed, resulting in a shift in responses. To correct for this change, we follow Nelson and Vandenbroucke (1996) and adjust reported utility costs for 1989 and later years.

8. The category "demolished or converted" includes units that were converted to business use, eliminated in a conversion, abandoned, destroyed by disaster, demolished, or condemned. It also includes units with an interior now exposed to the elements and mobile-home sites that no longer have a home on them.

9. We expect that a new occupant is less likely to respond to the AHS than an occupant who has responded in the past. Rents for a unit tend to increase more with unit turnover. Thus, we are likely to undercount units whose rents rise, resulting in an undercount of those units that move out of the affordable stock because the new rent exceeds the affordability cutoff.

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