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Valuing Owner-Occupied Housing: an empirical exercise using the American Community Survey (ACS) Housing files

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Introduction

In Aten (2017) the rental equivalence method was applied to the owner-occupied housing (OOH) stock in the United States to impute the flow of housing services for the period 2000-2015. The rents were based upon the American Community Survey and were broken into seven types of structure, vintage of construction, number of rooms and bedrooms and the home's broad geographic location. This paper expands on that methodology in several ways. First it explores variations on the rental equivalence method, under the assumption that the rents of high value homes are unlikely to fully reflect the flow of services from these dwellings. Second, it estimates the value of OOH based upon variations of the typical user cost approach, and third, it shows results based on an opportunity cost approach. The last sections are brief summaries. One compares the Public Use Microdata Sample of the American Community Survey (PUMS-ACS) with underlying microdata observations of the ACS[1], and the other shows state-level results for the different estimates before, during and after the housing crisis.

Background

The guiding principle in the 1993 System of National Accounts is "*housing services produced are deemed to be equal in value to the rentals that would be paid on the market for accommodation of the same size, quality and type.*" This general statement provides some leeway as to the method of implementation but the consensus has been to use the rental equivalence or user cost approaches to value dwelling services of owner-occupied homes. Many countries have attempted to introduce user cost into their Consumer Price Index (CPI) for the services of OOH. There is a large literature on the subject, of which Diewert (2008a, 2008b), Katz (2004) and Verbrugge (2008) are illustrative. Most empirical explorations of user cost have been in the context of CPI indexes over time and the possible replacement of rental equivalence with user cost. The focus here is on the value of the flow of dwelling services from OOH in a given year, an important component in the income and expenditure accounts as it is a large share of household consumption.

With no transactions costs there will be a tendency for arbitrage to equate user costs and rents for comparable dwellings. But there are substantial costs of buying and selling a home, and rental contracts are often renewed annually, to list just two sources of friction. Robert Gillingham (1983) asked the question of whether estimates of user costs approximate what the rent would be of owner-occupied homes, which he took to be the true user cost. This is similar to the question often asked of home owners, namely what rent would you expect to receive for your home? Gillingham (1983, p.262) concluded that he could not produce reasonable estimates of user costs using several variations of the standard formulation. His results were based upon data in the 1970s.

1 The Regional Prices Branch has direct access to the microdata by special agreement with the Census, and they have reproduced all the PUMS estimates at the state and national levels using these more extensive data files.

Using more recent data, Verbrugge (2008) found that comparing rents with a number of user costs measures from 1980 to 2004 generated differences that were large and not easy to explain. His conclusion is that "*statistical agencies responsible for compiling price statistics should use rental equivalence as their measure of homeowner user costs, when this is feasible*." In general, for consumer price indexes some form of rental equivalence is the most common method for countries that have granular rental markets. Countries where rental markets are thin such as many of the Commonwealth of Independent States (CIS) often use a user cost approach, though much simpler than employed by Gillingham or Verbrugge.

The sections below illustrate the calculation of the OOH in the United States using different approaches. The estimates are based on the publicly available data of the American Community Survey, known as PUMS-ACS, between 2000 and 2015. The Regional Prices Branch at BEA has access to the microdata of the ACS, and some of the differences between them are shown in Appendix B.

1. Variations on Rental Equivalence

The first approach is the basic rental equivalence method estimated across structure types and states for the United States from 2000 to 2015, reported in detail in Aten, 2017. We estimate the weighted mean tenant rents, net of utilities, for a stratified classification of housing in the PUMS-ACS file for each year, by type of structure, number of bedrooms, total number of rooms and age of the unit, and the units' location, by state. The owner-occupied units within each of the strata are assigned those estimated mean rents.

Use of the simple Rental Equivalence method, however, does not deal with the stylized facts of Glaeser and Gyourko (2009, p.17) that, "*rental units are generally quite different from owner-occupied housing and that renters and owners are very different people*." The American Household Survey of 2005 supports this statement, where incomes of renters are about half of home owners, and most renters were in center cities and most home owners were in detached housing in suburbs. This is partly evidenced by the lower rent-to-value ratios (annual rent divided by the estimated home value expressed as a percentage) as the value of dwellings rises, since homeowners have higher value dwellings.

Figure 1a illustrates the rent-to -value ratios as a percentage on the vertical axis, and median values on the horizontal axis, for all owner-occupied homes in the United States between 2000 and 2015, while ***Figure 1b*** excludes mobile homes. Observations are for each combination of structure type and number of bedrooms. Home values are estimates by owners, and contract rents are net of utilities, for the same structure type and number of bedrooms. The trend in both is for rent-to-value ratios to decrease as values increase. In ***Figure 1c*** the 2015 the rent-to-value ratios are shown by type of structure and number of bedrooms. For all types except mobile homes, the rent-to-value ratios follow an inverted U-shape as the number of bedrooms increase, peaking at two bedrooms for apartments and three bedrooms for single-family homes. ***Table 1*** lists the actual values for ***Figure 1c.***

One explanation is that monitoring rentals involves a fixed as well as a variable cost for landlords, and that cost rises less than proportionally with size of unit. This would lead to some decline in rent-to-value ratios for larger rental units. Owners estimate the value given the main features of dwellings that are also comparable to the features of rentals, such as broad geographic location[2], vintage, type and size as measured by bedrooms or all rooms. However, there are omitted variables that are very important in

2 In principle, the geographic location could be the county, or even the zip code in the ACS microdata, but the number of observations that contain the same characteristics for both owners and renters is very sparse below the metropolitan area.

the case of housing, like the number of bathrooms[3], size of the lot[4], special features of the structure, not to mention neighborhood location. It seems likely that owners value these characteristics positively, so that the rental equivalence method is likely to understate total rent expenditures for large homes with high quality features, many bathrooms, and in an exclusive neighborhood that has few rental properties. On the other hand, it is not hard to think of exceptions, like New York, San Francisco and Seattle, where many rental units and condominiums are of a quality at least as high as similar sized owner-occupied units in less densely populated areas outside the city center.

Two approaches are taken here to address this issue. One approach builds upon rental equivalence adding a percentage premium based upon the type of structure or based upon the value of dwelling. The second approach is to estimate the user cost of OOH. The first uses the owners' self-reported monthly costs that include mortgage payments, insurance and property taxes and the second replaces the mortgage payments with the 30-year mortgage interest rate applied to the estimated value of the home, also as reported by the owner. A depreciation rate is added to both approaches.

A special survey that asked renters to estimate the likely value of their dwelling and homeowners to estimate the likely rent of their dwelling was reported by Heston and Nakamura (2009a and 2009b). The survey respondents were employees of the Federal Government living in the so-called COLA areas, Alaska, Hawaii and the Caribbean, and a similar sample in the reference area, Washington D.C.[5] The survey generated 4276 useable responses, small but much more detailed than larger surveys, including number of bathrooms. In terms of effect on estimated or actual rent bathrooms was the single most important variable. Eighty-two percent of the respondents were homeowners, in contrast to about sixty-six percent for the United States as a whole.

The value of the dwelling was available for both owners and renters so that estimates could be made separately holding a large number of characteristics common. Owners consistently valued their dwellings more than renters by an average of 14 percent, with the premium in Washington with the largest sample, being 16 percent (Heston and Nakamura, 2009b, Table 3). The results were statistically significant except for Hawaii. The interpretation of this result is that omitted variables in applying rental equivalence to owner-occupied housing may significantly understate expenditures and imputed rents for dwelling services.

This study confirmed that rent-to-value ratios tend to decline with the value of housing when either renters or owners are making their respective estimates of rents and value. It suggests that studies pairing rents from renters with values from owners for a given structure and characteristics are capturing a real phenomenon. Heston and Nakamura (2009b, Table 4) found that moving from house

3 Unfortunately, the only variable related to bathrooms is whether or not there is a bathtub or shower, and whether there is indoor plumbing, consisting of hot and cold running water, a flush toilet, and a bathtub or shower. Units without indoor plumbing were not included in the estimates.

4 The ACS responses sometime include lot size – under an acre, under 10 acres and greater than 10 acres, but less than 1% of responses are for lots over an acre, so we re-classified all dwellings into under or over an acre.

5 The rental survey was carried out as part of a Safe Harbor Agreement to resolve differences between the Office of Personnel Management (OPM) and Department of Justice and the employee organizations in the COLA (Cost-of-Living-Allowances) areas. Previously OPM had compared rents in Washington with Alaska, Hawaii and the Caribbean (Guam is also a COLA area but they were a minor part of the program) based upon prices for consumption goods including rents contracted to a private firm. OPM undertook the pricing in the 1990s. The special renter and owner survey was carried out in 1998 by Joel Popkin & Co. using a questionnaire agreed upon by the parties to the Safe Harbor Agreement.

values of $50,000 to $ 500,000 in 1998 the rent-to-value ratios fell by over 50 percent for both renters and owners in each of the 4 survey areas. The findings of this study can be used to modify the simple rental equivalence by applying an *owners' premium* based on either the structural characteristics of the dwelling or its value.

a) Owners' premium applied according to structural characteristics

For a dwelling of a given type, structure, vintage and size a premium has been added to the rental equivalence (RE) from the ACS. It is assumed that the owners' premium applies to all structures including mobile homes but that it rises with the number of bedrooms in any type of structure. ***Appendix 1a*** provides the owner premium numbers that have been used in the empirical work. They are derived from the Heston and Nakamura paper where the average premium when weighted across the COLA areas and Washington was 15 percent. The range of premium has been set at 5 percent for mobile homes up to 25 percent for dwellings of four or more bedrooms.

b) Owners' premium applied according to home values

Variation a) above applies the owners' premium to a common structural specification, whatever its location and value. If an adjustment is based upon the value of a dwelling across all locations it would not take into account the very substantial differences in median house prices across states. In this variation of premium adjustment, the assumption is that the premium is higher for a $200,000 home in a state where the median value is $150,000 than in a state where the median value is $300,000. Let β_{ij} be the home value divided by the median home value in state *i* for dwelling *j*. The adjustment to the rental equivalence (RE) value takes the following form:

Home value / Median value	Owners' Premium formula	Owners' Premium
$\beta_{ij} <= 0.5$	RE x 1.05	5%
$0.5 < \beta_{ij} <= 1.0$	RE x (1.05 + 0.20 ($\beta_{ij} - 0.5$))	5% - 15%
$1.0 < \beta_{ij}$	RE x (1.15 + 0.30 ($\beta_{ij} - 1.0$))	15% +

Source: adapted from Heston and Nakamura (2009a and 2009b) [6].

2. A Variation on User Costs

a) Owner estimates of User Cost

Owners provide their expenditures on taxes[7], insurance and mortgage payments (called Selected Monthly Owner Costs or SMOC[8] in the PUMS-ACS files). They are a first approximation of the main user costs an owner might incur on a regular basis. However, they will overstate costs to the extent that part of the mortgage payment is on the principal of the mortgage, and if a homeowner has no mortgage then the SMOC excludes the foregone interest on the value of the home. Further the SMOC understates user

6 The median owners' premium in Heston and Nakamura was 17%, equivalent to the value in Washington, DC. This is the premium when β_{ij} is between 1.0 and 1.1, that is, the home owner's valuation is equal to or less than 10% higher than the median value for the state in which it is located.

7 Annual insurance premiums for owner-occupied units are available in the PUMS-ACS files, but annual property taxes are recorded as a class variable: with $50 intervals up to $950, $100 intervals to $5,000, $1,000 intervals to $10,000 and top-coded at $10,000. We take the midpoints of the intervals and assume $15,000 for the top-coded units.

8 SMOC includes utilities, and these are subtracted from the total. Utilities include electricity, gas, other fuels and water and sewer costs.

costs because it does not include depreciation. We add a depreciation rate described below to more closely approximate user costs.

b) Simplified User Cost

As Verbrugge suggests, user costs has proved easier to recommend than to implement. A typical formulation of user cost over time is given below in equation (1).

$$u_{it} = P_{it}\,(r_t + \delta - \mathrm{E}\,[\beta_{it}]) \qquad (1)$$

- u_{it} is the user cost of house *i* in period *t*;
- P_{it} is the price of home *i* in period *t*;
- r_t is a nominal interest rate often taken as the 30 year mortgage rate;
- δ is the sum of annual depreciation, maintenance and repair if depreciable, insurance, and property taxes; and
- $E\,[\beta_{it}]$ represents the expected annual constant quality home appreciation rate for home *i* in period *t*, often taken as the Consumer Price Index (CPI) rate for the period: CPI_t/CPI_{t-1}.

Is (1) the appropriate formulation of user cost for the current purpose, namely to estimate the expenditures on owner-occupied housing (OOH)? The term $E[\beta_{it}]$, or appreciation rate for home ***i*** in period ***t*** is not relevant for the valuation of OOH in a given year unless it varied by type of housing. The term $E[\beta_{it}]$ is dropped in this formulation, simplifying it to equation (2).

$$u_{it} = P_{it}\,(r_t + \delta_i) \qquad (2)$$

- u_{it} is the user cost of house *i* in period *t*;
- P_{it} is the price of home *i* in period *t*;
- r_t is a nominal interest rate; and
- δ_i is the sum of two components: annual depreciation[9], by structure type and size of dwelling, and insurance and property taxes for dwelling unit *i*.

The nominal interest rate r_t is based on the U.S. 30-year Freddie Mac mortgage rate; the rates shown are for the annual average, a five-year, ten-year and fifteen-year average and a common constant average of 3.65%.[10], [11] These are listed in ***Appendix 1c.***

There are two main differences between equations (2) and (1) and other formulations of user cost. The first is that δ, the depreciation rate, is assumed to depend on the structure type and size of the dwelling, in part because the land portion of the house price increases relative to the value of the structure. The

[9] A maintenance rate was also estimated, adding an average of 1.3% to δ_i depending on the type of structure and size of dwelling. However, these are not included in the tables as our emphasis is on expenditures, not on the net rental incomes.

[10] Interest rates using ten, fifteen and twenty-year averages were also estimated, but their pattern is similar in that the interest rates decrease steadily from 2000 to 2015, and the results are not shown here for the sake of brevity.

[11] The 3.65% rate is the 2016 annual average 30-year mortgage rate from Freddie Mac, and is the lowest rate between 1981 and 2016.

second is that the insurance and property tax rates for each individual owner-occupied unit are observed, as part of the SMOC portion of the PUMS files. [12]

A note on depreciation by structure type and size

Depreciation of structures is often taken as 2 percent per year. Based on the state and metropolitan area data in the ***Appendix 2 and 3***, land would typically be 25 percent of the value of a home, so effective depreciation on land and structures would be 1.5 percent a year[13]. Land averages more than half of home values with a large dispersion, meaning that the share of land for higher value homes may be 200 percent or more, implying depreciation rates 0.25 percent or less on the total value of structures and land.[14] These calculations suggest that one component of δ will decline with the size of the home. ***Appendix 1b*** shows the assumed depreciation rates.

Unfortunately, in the PUMS files, land values and lot sizes are very sparse. But for the smaller structure types, if there is an indicator of lot size, and it is greater than one acre, we assume a depreciation of one percent rather than two percent.

Results

Table 2 shows the annual imputed rents, in billions of US dollars, of OOH for the years 2000-2015 for the main variants of rental equivalence, user costs and opportunity costs. Column (1) is estimated applying the basic rental equivalence and column (2) adds a premium to each owner-occupied unit based upon structure type and relative value of dwelling within each state. The latter is between 24% and 27% above the basic rental equivalence for the United States.

Column (3), Owner Costs, is based on the PUMS-ACS Selected Monthly Owner Costs (SMOC) to which depreciation has been added (and utilities subtracted) to provide another estimate of user cost. It includes mortgage payments, with the important caveat that there is no information on the size of the principal or the mortgage type and length. Column (3) totals are higher than any of the rental equivalence measures, probably because there are more owners that have some repayment of principal in their costs than owners who have no mortgage at all.

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[12] Verbrugge (2008) uses 7 percent as the value of δ_i for all i, but provides no breakdown. If one assumes an interest rate of 3% per year, the Verbrugge estimates implies total user costs of at least 10% per year. Nick Wallace in Smartasset.com (https://*smartasset.com/mortgage.price-to-rent-ratio-in-us-cities*) estimates Price-to-Rent ratios (the inverse of the rent-to-value ratios), in 76 U.S. cities in 2016. San Francisco leads with a Price-to-Rent ratio of nearly 46 (equal to the lowest rent-to-value ratio of 2.1%) and Detroit, MI is on the other end of the spectrum with the highest (16%) rent-to-value. Wallace estimates the current rate in 2016 to be 5.2% rent-to-value and the pre-housing crisis average to be 6.7% nationally. It is not clear from the blog post how those numbers are estimated, but the source is listed as the Census Bureau.

[13] ***Appendix 2a*** from the Lincoln Land Institute shows the share of land to total value of land and structure for 46 metropolitan areas for the first quarter of 2016. The median share is 26.4 percent in Charlotte, the low is 6.2 percent in Rochester and the high is 80.9 percent in San Francisco. The situation is similar in the states as shown in ***Appendix 2b***. Georgia is the median state at 24.0 percent, Alaska the low at 6.3 percent, and the high is the District of Columbia followed by Hawaii and California, 77.6, 70.0, and 61.1 percent respectively. The range of land shares is less for the states but still quite large.

[14] The above numbers are suggestive and it would be useful to look further into these relationships. Many property tax bills distinguish between the value of land and structure in their assessments and are source of such information. No attempt is made to account for the tax advantage that homeowners receive in the United States.

Columns (4) and (5) use insurance and taxes from each unit, plus depreciation, plus two interest rates: a constant 2.5% rate and an annual average of the 30-year mortgage rate[15] All three user cost estimates rise significantly from 2005-2008 during the housing boom because home owners are raising their self-valuation of their homes.

In column (6) and (7) we implement a suggestion following Diewert (2008a)[16] of combining rental equivalence and user costs by taking the maximum value of the two. This means comparing the assigned Rental Equivalence with the observed owner cost and with the estimated user cost for each of 867,000 owner-occupied housing observations (representing over 75.8 million units in the PUMS-ACS sample) in 2015, for example.

The opportunity cost between the Rental Equivalence in column (1) and the Owner Cost in column (3) is in column (6). Similarly, the opportunity cost between Rental Equivalence and the User Cost in column (4) using a constant interest rate of 2.5% per year, is shown in column (7).

The values in column (6) must equal or exceed both rental equivalence in (1) and owner cost (3) because *lower values of each series are being removed.* The same applies to the values in column (7) compared to columns (1) and (4). When home owners' reported values rose dramatically during the housing boom, user cost estimates went up correspondingly. This is less true of owner costs where only depreciation is based on the value of the home, while insurance, taxes and mortgage payments are observed.

The graphs in **Figure 2** illustrate the trends in ***Table 2***. ***Figure 2a*** focuses on the rental equivalence and owner cost measures: columns (1) through (3), while ***Figure 2b*** shows columns (4) and (5) plus a 3.5% interest rate, highlighting the user cost estimates. The graphs include the annual totals in the NIPAs, for reference. ***Figure 2c*** shows the opportunity cost estimates, using the maximum between the basic rental equivalence and various user cost estimates under different interest rate assumptions.

The cyclical nature of the owner cost variations is closer to the user cost measures than to rental equivalence because they are influenced by the housing boom. But user cost estimates appear to fluctuate more over the period because they involve owners' valuation of their homes.

It has been argued that rental equivalence tends to understate the dwelling services that are provided by larger or more expensive homes. This pattern may be seen in ***Table 3*** depicting the percentage of units where the rental equivalent estimate was higher than the alternative estimate (owner-cost and user-cost estimate under the constant 2.5% annual interest rate). Only selected years are shown: 2001, 2008 and 2015.

The first three columns show the total number of owner-occupied units. The next three columns are for the Opportunity cost approach using the maximum between the owner cost and rental equivalence, and the last three columns for the approach using the maximum between user costs and rental equivalents. For example, the first row shows the totals for Mobile/Other types of homes, with 5.8 million units in 2001, 5.2 million in 2008 and 4.9 million in 2015. Rental equivalent values were higher than owner or

[15] A number of different interest rate assumptions were tested, ranging from 2.0% to 4.0% constant rates, and 1,5,10,15, and 20-year annual average rates for the 30-year Freddie Mac mortgage rate.

16 Diewert (2008a, p.495) "*In conclusion, we suggest that the best pricing concept for the services of OOH is the opportunity cost approach, which is equal to the maximum of the market rental and the ex-ante user cost for any particular property*."

user costs in all three years – between 58% and 86% of all units. The percentages are much lower for other types of structures, and they tend to be lowest for the larger units.

During the housing crisis, the proportion of units with rental equivalence maxima drops and then begins to rise again to 2015, especially in the last column relative to user costs, where for detached single-family homes with 2 or 3 bedrooms, 58% of the units have a higher rental equivalence.

PUMS-ACS estimates compared to Microdata ACS estimates of OOH

The ACS data files are available from 2005 to 2016 as one, three and five-year files depending on the geographic level of detail: state, metropolitan statistical areas and counties, respectively. They are rolling year surveys and easily accessed from the Census website.[17] Prior years are also available but were experimental and are in less standardized form. The microdata are accessed at Census, by special agreement with the Social, Economic and Housing Statistics Division. In 2015, the number of observations of owner-occupied units in the PUMS was just over 860 thousand, while the microdata contained nearly 1.5 million observations. In weighted terms, they theoretically represent all U.S. owner occupied dwellings, or about 76 million units. The number of rent units was approximately 44 million in 2015.

The differences in the datasets are largest during the housing crisis, when the PUMS rental equivalence of OOH expenditures are 1.1% higher than when using the microdata in 2008, decreasing to 0.33% in 2015.

At the national level, the differences in estimated OOH expenditures between the public and microdata across all the methods examined in this paper exceed 2% only in 2000 for owner-cost methods, where the PUMS understates the microdata. The average difference across the years and methods is 0.3%. The simple average over the years is 0.6%.

The first two columns of ***Table 4*** show the differences between the public use and the microdata estimates of rental equivalence expenditures for OOH, by year. The PUMS estimates are higher than the microdata, and peak in 2009. The other four columns show the percent differences in methods for Owner Costs, User Costs using the one-year average 30-year mortgage rate and the two Opportunity Cost approaches that take the maximum between the rental equivalence estimate and the owner or user cost approaches for each unit.

Selected State-level Results

In Section 1 and ***Figures 1a, 1b, 1c***, and ***Table 1***, the rent-to-value ratios – using the simple rental equivalence rents) were shown for 2015 by type of structure, and they ranged from over 14% in the Mobile/Other category to under 5% for large, detached, single-family homes. In general, the two-bedroom homes, both apartments and single-family units, tend to have the highest rent-to-value ratio, which then declines as the number of bedrooms increases.

The variation in rent-to-value rates across the years and across states is shown in ***Figure 3a***. The years are on the horizontal axis and in each year there are 50 states, plus the District of Columbia. The trough in the trend line occurs during 2006-2008, reflecting the high valuation of owner homes.

17 The PUMS files are available for download from https://www.census.gov/programs-surveys/acs/data/pums.html.

Figure 3b highlights three years: 2001, 2008 and 2015 and shows how the pattern across states is relatively persistent during this period. The rent-to-values on the dotted line representing 2008 are nearly always below those of 2001, except for some states such as North Dakota (ND), when rents grew as quickly as housing values. Texas (TX) has the highest rent-to-value ratios, around 7%, as does Florida (FL), but the latter drops to 5.1% in 2008. The District of Columbia (DC) has one of the lowest rent-to-value ratios, dropping to 2.6% in 2008 from 4.0% in 2001 and remaining low at 2.9% in 2015.

There is a great deal of variation within the U.S., with a range of 5% between Texas and DC. Other states with consistently high rent-to-value ratios are Florida, Nevada, and Michigan; while those with low rent-to-values include Hawaii, California, Massachusetts and Washington State.

Conclusions

These results for rental equivalence, user cost and opportunity costs are internally consistent in several ways. They reflect the ups and downs of the housing market during a volatile period, and the opportunity cost approach also shows that the proportion of homes for which user or owner costs are higher than their rental equivalence rises with the size and value of the home for each type of structure. Is there a better choice among the alternatives shown here? For example, by taking different maxima when estimating opportunity costs, or by making different assumptions about depreciation rates and premiums?

A preliminary conclusion is that the most plausible range of estimates is between a floor of rental equivalence and an opportunity cost measure. The latter may be estimated using owner costs or user costs. Owner cost approaches relies on an independent set of values as reported by owners, but has no observed flow of owner services. User costs rely heavily on assumptions about interest rates and depreciation rates, as well as home valuations, and are very sensitive to the rate that is chosen. Rental equivalence rests on actual renter observations, but no actual values of owner-occupied units, with linkages based on a broad match of characteristics of the housing units, such as the structure type and number of bedrooms.

Comparisons between the public-use files (PUMS) and the microdata underling the ACS are encouraging in that the differences in total expenditures are relatively small (below 1%) at the national level. Work is underway to compare the two datasets at the state level. Preliminary sub-national estimates of expenditures and rent-to-value ratios show that there are regional patterns and a large variation across states over the period. It may be possible to stratify the sample into finer geographic detail, such as at the metropolitan statistical area, for example. This will have the advantage of building up market rents and implicit owner-occupied rents to a national total that is consistent with metropolitan as well as state totals. It is hoped that comments on this draft can be integrated to produce a version that can guide improvements to future estimates.

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Tables and Figures

Figure 1a. Rent-to-value (%) all Homes U.S. (2000-2015)

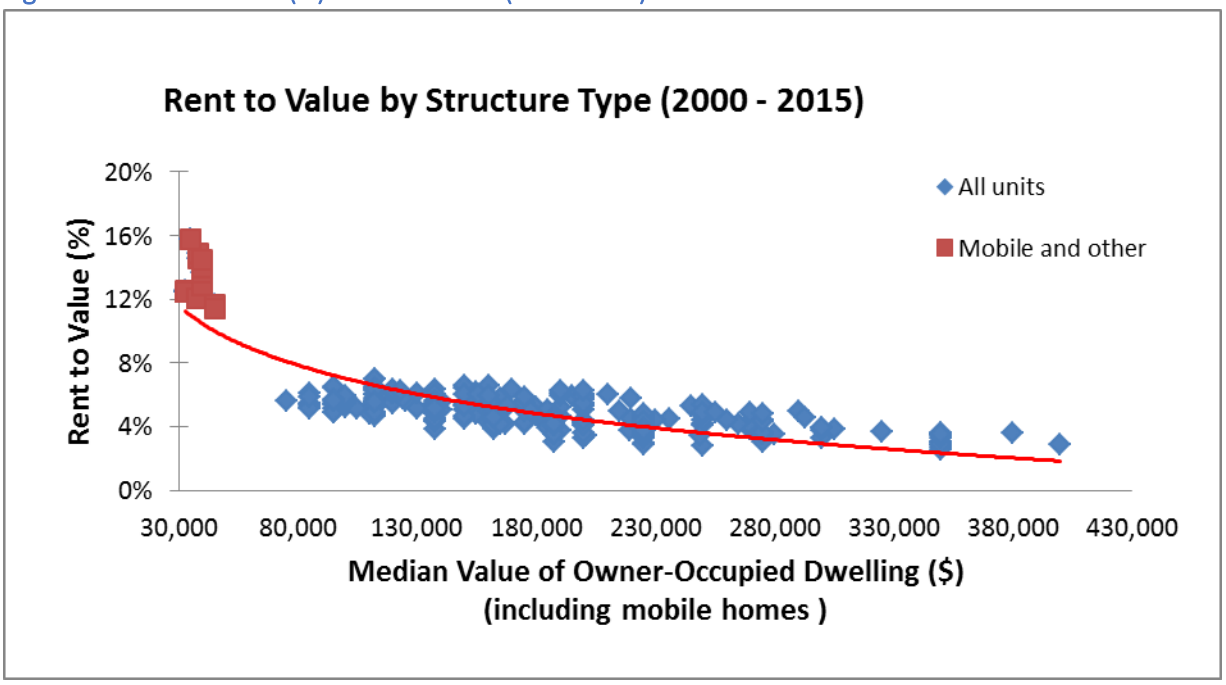


Figure 1b. Rent-to-value (%) Excluding Mobile Homes U.S. (2000-2015)

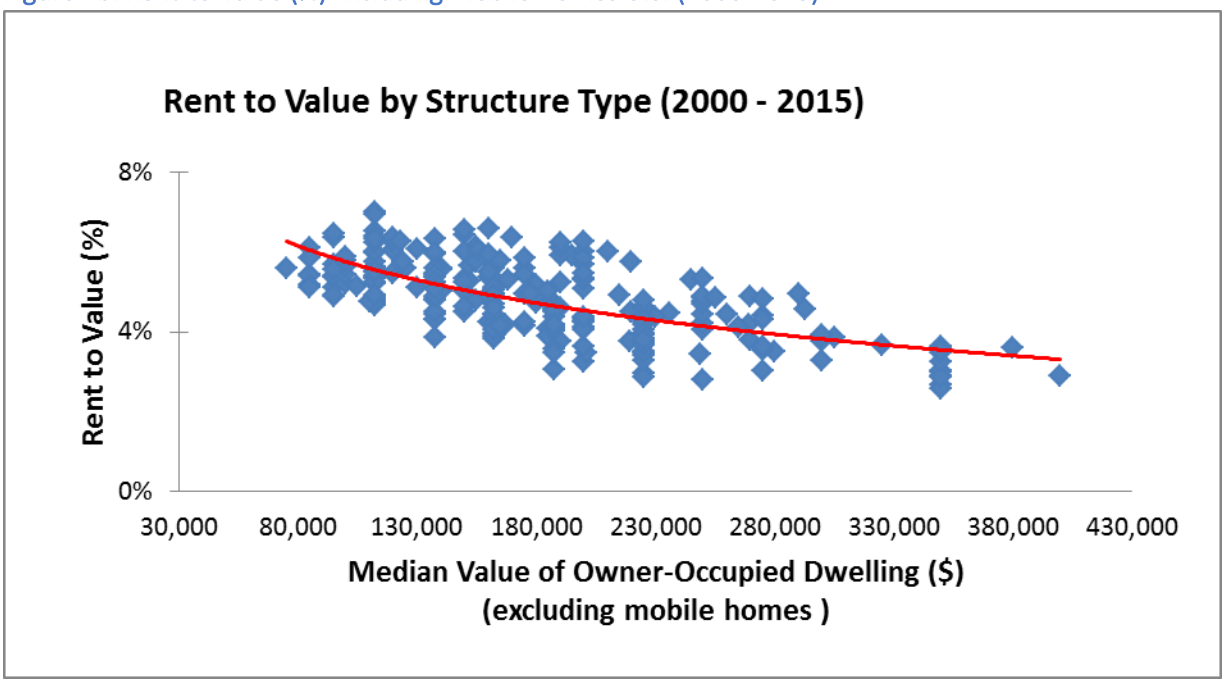


Figure 1c. Rent-to-value (%) by Structure Type U.S. (2015)

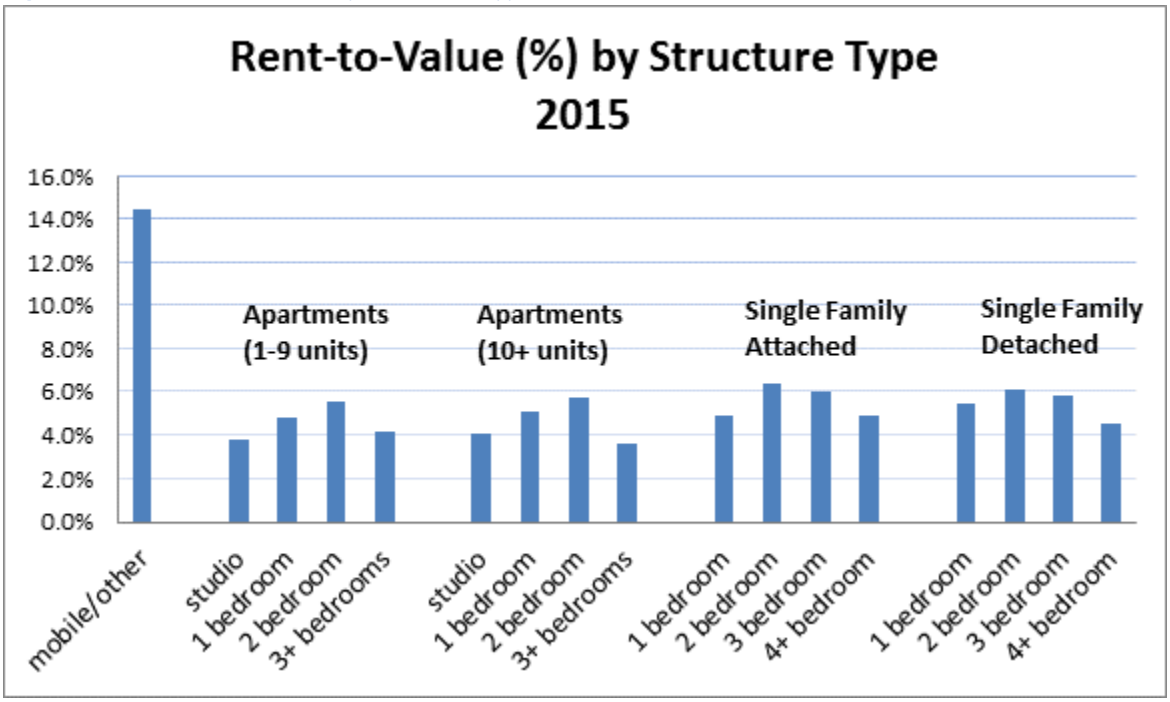


Table 1. Rent-to-value (%) by Structure Type U.S. (2015)

Structure Type	Bedrooms	Median Value	Rent-to-value Ratio
Mobile/Other	Any	$ 40,000	14.5%
Apartments (1-9 units)	0	$ 190,000	3.8%
	1	$ 180,000	4.8%
	2	$ 175,000	5.6%
	3+	$ 269,000	4.2%
Apartments (10 + units)	0	$ 265,000	4.1%
	1	$ 200,000	5.1%
	2	$ 220,000	5.8%
	3+	$ 380,000	3.6%
Attached single family	1	$ 160,000	4.9%
	2	$ 170,000	6.4%
	3	$ 210,000	6.0%
	4+	$ 290,000	5.0%
Detached single family	1	$ 120,000	5.5%
	2	$ 130,000	6.1%
	3	$ 175,000	5.8%
	4+	$ 293,000	4.6%

Table 2. U.S. estimated annual OOH expenditures (in $ billions), 2000-2015

Year	Annual totals in $ billions							OO units
	Rental Equivalence	Premium	Owner Cost w/Dep	User Cost		Opportunity Cost		
	RE	Beta	OC	2.5%	1-yr	max RE-OC	max RE - UC2.5%	(millions)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
2000	460	571	690	520	1114	784	608	70
2001	487	606	753	558	1074	845	648	71
2002	516	645	807	615	1133	902	705	72
2003	544	676	864	682	1158	957	769	73
2004	584	724	931	769	1312	1028	855	74
2005	631	785	1017	872	1502	1122	958	76
2006	672	834	1119	961	1772	1229	1044	77
2007	712	880	1195	1002	1829	1313	1090	77
2008	730	921	1216	1000	1755	1341	1107	77
2009	744	940	1183	946	1448	1315	1072	76
2010	753	951	1157	929	1349	1296	1064	76
2011	765	967	1124	907	1268	1270	1056	76
2012	778	987	1104	904	1116	1256	1063	75
2013	794	1006	1073	921	1199	1241	1090	75
2014	817	1037	1084	961	1289	1259	1132	75
2015	841	1067	1124	1032	1317	1297	1188	76

Figure 2a. Annual OOH expenditures ($ billions), 2000-2015: rental equivalence, rental premiums by type of structure and value, and owner cost estimates

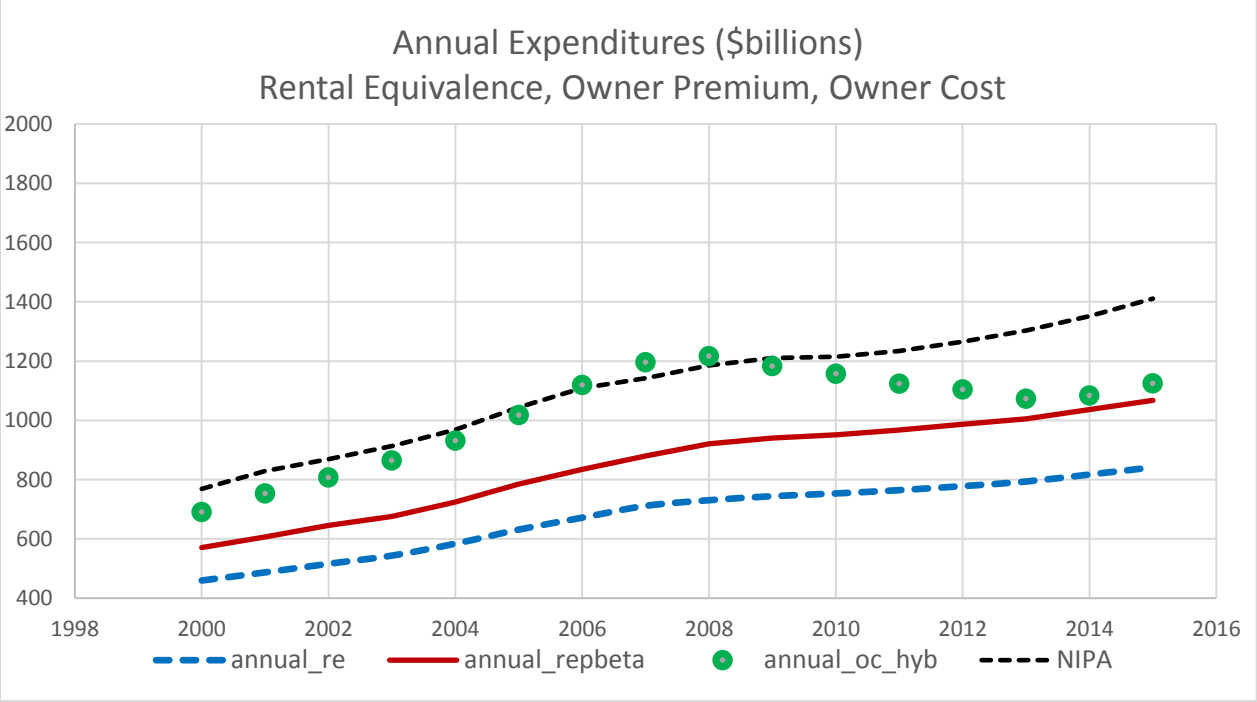


Figure 2b. Annual OOH expenditures ($ billions), 2000-2015: user cost estimates with 2.5%, 3.5% and 1-year average annual mortgage rates.

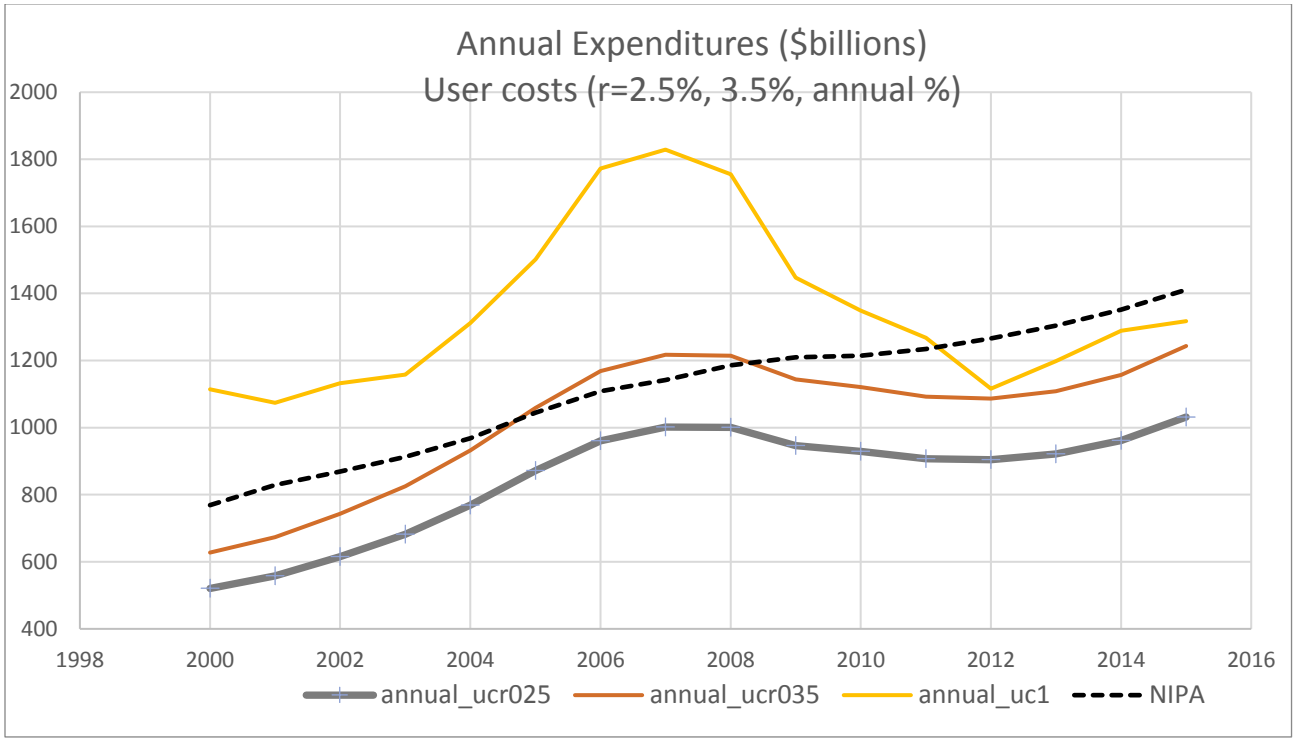


Figure 2c. Annual OOH expenditures ($ billions), 2000-2015: opportunity cost estimates using maximum of rental equivalence and various user cost rates

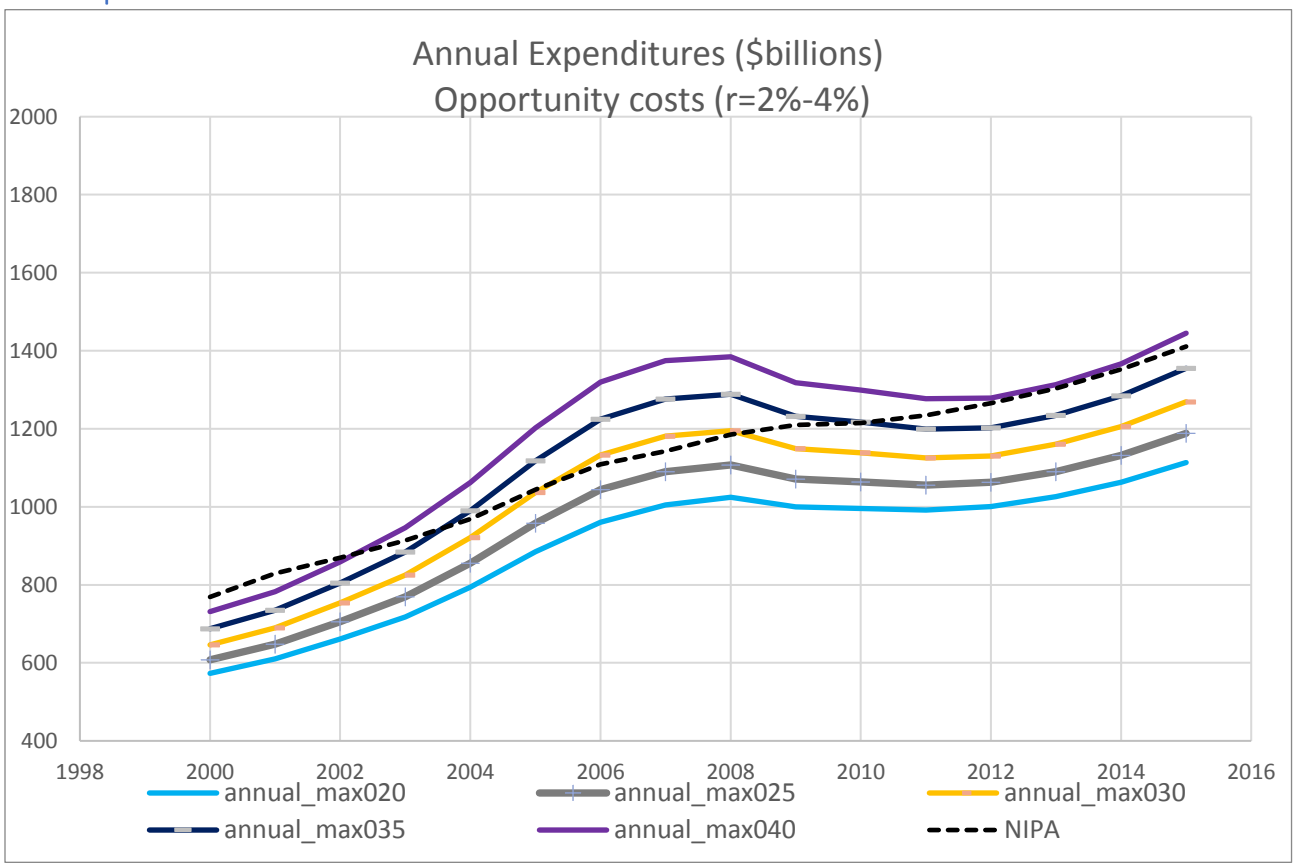


Table 3. Percentage of Units where Rental Equivalence exceeds Owner and User Costs in U.S. 2000-2015

Type of structure	Number of bedrooms	*Owner-Occupied Units (millions)*			% units where Rental Equivalence is higher than Owner Cost			% of units where Rental Equivalence is higher than User Cost at r=2.5%		
		2001	**2008**	**2015**	**2001**	**2008**	**2015**	**2001**	**2008**	**2015**
Mobile/Other		*5.8*	*5.2*	*4.9*	67%	58%	66%	86%	82%	86%
Apartments (1-9 units)	**0**	*0.0*	*0.0*	*0.0*	41%	26%	33%	42%	19%	30%
	1	*0.3*	*0.3*	*0.2*	31%	27%	34%	42%	29%	39%
	2	*1.2*	*1.2*	*1.1*	29%	24%	31%	44%	28%	43%
	3+	*0.9*	*0.9*	*0.8*	23%	19%	25%	25%	19%	28%
Apartments (10+ units)	**0**	*0.1*	*0.1*	*0.1*	38%	32%	35%	60%	28%	36%
	1	*0.5*	*0.6*	*0.5*	34%	25%	35%	56%	31%	43%
	2	*0.9*	*1.1*	*1.1*	35%	29%	37%	61%	37%	50%
	3+	*0.2*	*0.2*	*0.2*	23%	17%	22%	36%	19%	30%
Attached	**1**	*0.2*	*0.1*	*0.1*	24%	27%	37%	40%	29%	39%
	2	*1.5*	*1.7*	*1.6*	30%	27%	37%	52%	35%	53%
	3	*1.9*	*2.2*	*2.2*	28%	25%	35%	52%	34%	49%
	4+	*0.4*	*0.5*	*0.5*	27%	25%	35%	44%	31%	43%
Detached	**1**	*1.1*	*0.8*	*0.8*	46%	47%	52%	49%	43%	47%
	2	*9.0*	*8.5*	*8.0*	52%	48%	56%	62%	51%	58%
	3	*30.5*	*32.5*	*31.9*	40%	38%	48%	58%	49%	58%
	4+	*16.3*	*20.7*	*21.7*	31%	30%	38%	49%	41%	48%
Total U.S.		***70.6***	***76.8***	***75.8***	40%	37%	45%	57%	47%	55%

Table 4. Differences between PUMS and Microdata ACS for OOH expenditure estimates in U.S. 2000-2015

Year	Rental Equivalence		Owner Cost	User Cost 1-yr	Opportunity Cost: RE-OC	Opportunity Cost RE-UC1
	PUMS-Micro ($billion)	PUMS/Micro (%)				
2000	3.0	0.7%	-2.2%	1.3%	-0.9%	1.3%
2001	1.3	0.3%	-1.1%	0.0%	-0.6%	0.0%
2002	2.0	0.4%	-1.0%	0.0%	-0.5%	0.0%
2003	3.4	0.6%	0.1%	0.0%	0.2%	0.1%
2004	3.2	0.6%	0.1%	0.1%	0.2%	0.1%
2005	2.5	0.4%	0.1%	0.1%	0.1%	0.1%
2006	3.4	0.5%	-0.1%	-0.1%	0.0%	-0.1%
2007	4.9	0.7%	0.2%	0.0%	0.3%	0.1%
2008	7.9	1.1%	0.2%	0.0%	0.3%	0.1%
2009	3.1	0.4%	0.2%	0.1%	0.3%	0.1%
2010	5.1	0.7%	0.2%	0.1%	0.3%	0.3%
2011	5.6	0.7%	0.2%	0.1%	0.4%	0.3%
2012	6.7	0.9%	0.3%	0.1%	0.4%	0.4%
2013	5.9	0.7%	0.2%	0.2%	0.4%	0.4%
2014	6.4	0.8%	0.2%	0.0%	0.3%	0.3%
2015	2.8	0.3%	0.3%	0.3%	0.3%	0.3%
average	$ 4.2	0.6%	-0.1%	0.1%	0.1%	0.2%

Figure 3a. Rent-to-Value ratios (%) for U.S. states and D.C., 2000-2015

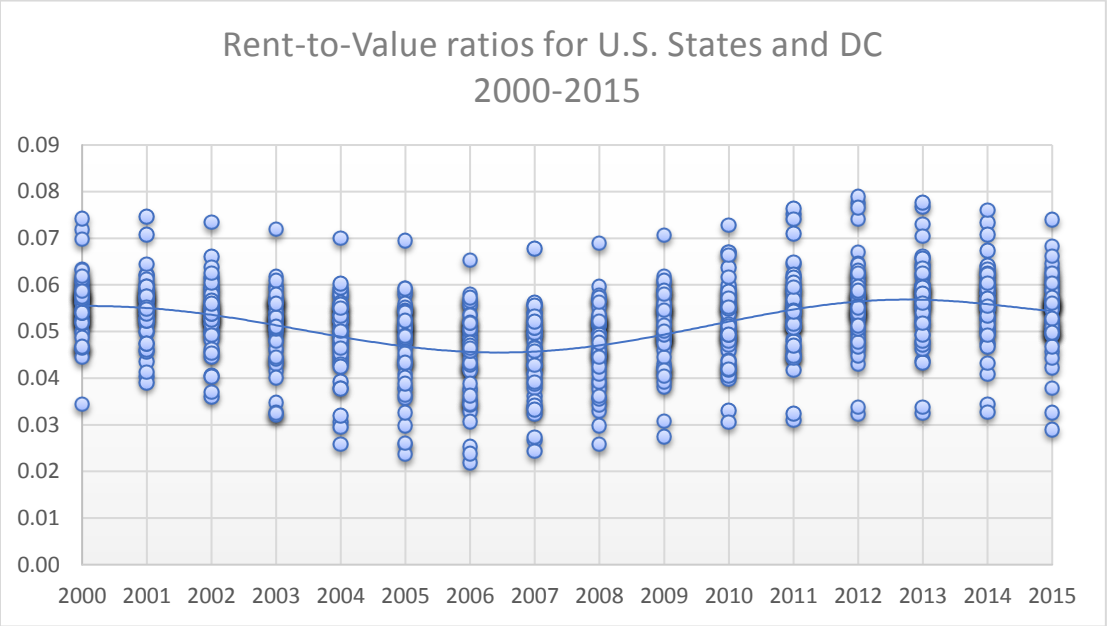
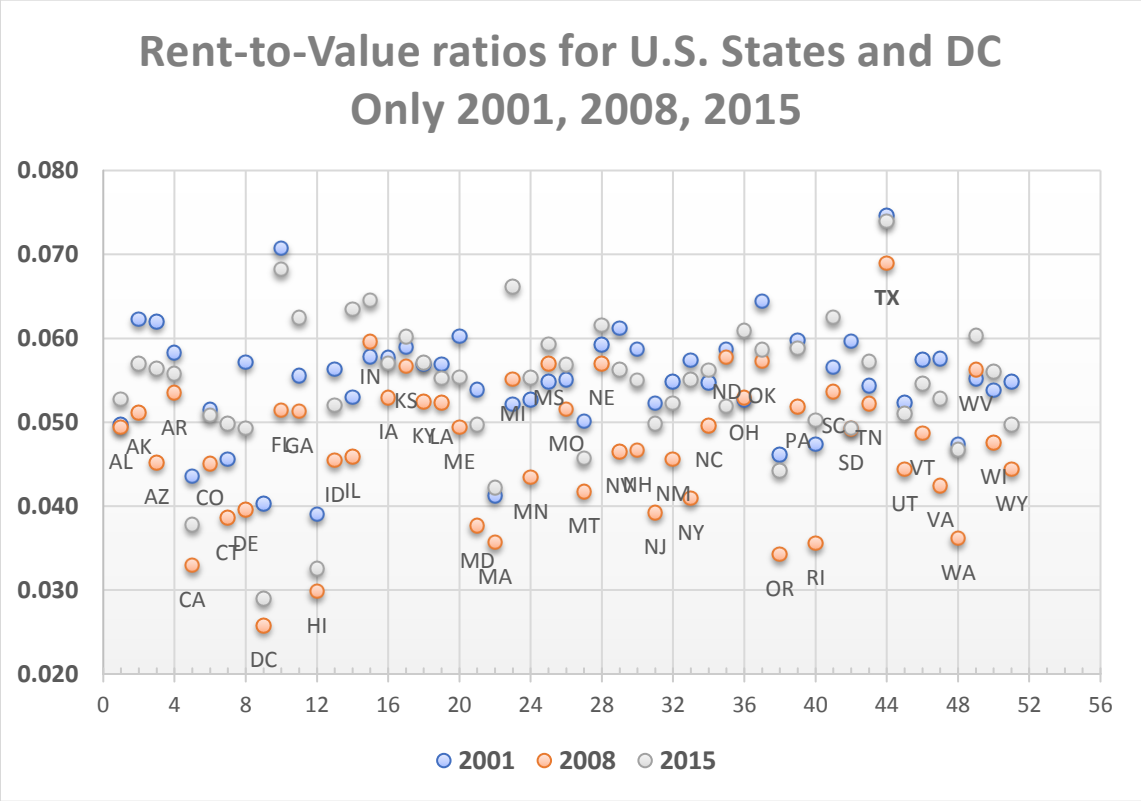


Figure 3b. Rent-to-Value ratios (%) for U.S. states and D.C.: 2001,2008, and 2015



Appendix

Appendix 1a: Owners' Premium (%) by Structure Type and Bedrooms

Premium (%)	Number of Bedrooms				
Structure Type	Less than 1	1	2	3 or more	4 or more
Mobile/Other	5	5	5	5	5
Apartments (1-9 units)	10	10	15	20	20
Apartments (10 + units)	10	10	15	20	20
Attached single family	-	10	15	20	25
Detached single family	-	10	15	20	25

Appendix 1b: Depreciation (%) by Structure Type and Bedrooms

Depreciation* (%)	Number of Bedrooms				
Structure Type	Less than 1	1	2	3 or more	4 or more
Mobile/Other	2	2	2	2	2
Apartments (1-9 units)	2	2	2	2	2
Apartments (10 + units)	2	2	2	2	2
Attached single family	-	2	2	2	1.5
Detached single family	-	1.5	1	1	0.5

Appendix 1c: Average 30-year Mortgage Interest rates (%)

Interest rate (%)	Annual 30-year Rate			
Year	1-year	5-year	20-year	Constant rate
2000	8.05	7.56	9.78	3.65
2001	6.97	7.39	9.36	3.65
2002	6.54	7.17	8.95	3.65
2003	5.83	6.92	8.59	3.65
2004	5.84	6.6	8.23	3.65
2005	5.87	6.19	7.92	3.65
2006	6.41	6.09	7.74	3.65
2007	6.34	6.05	7.56	3.65
2008	6.03	6.09	7.36	3.65
2009	5.04	5.92	7.10	3.65
2010	4.69	5.66	6.83	3.65
2011	4.45	5.26	6.59	3.65
2012	3.66	4.71	6.32	3.65
2013	3.98	4.34	6.13	3.65
2014	4.17	4.17	5.92	3.65
2015	3.85	4.01	5.71	3.65
2016	3.65	3.86	5.5	3.65

Source: Freddie Mac, annual 30-year mortgage rates

Appendix 2a. Home Value and Land Share: Metropolitan Areas, 2016

MSA	Home Value	Structure Cost	Land Value	Land Share
ROCHESTER	$162,236	$152,105	$10,130	6.2%
PITTSBURGH	$162,632	$151,876	$10,756	6.6%
BUFFALO	$177,692	$164,973	$12,719	7.2%
CLEVELAND	$182,489	$168,265	$14,224	7.8%
MILWAUKEE	$214,072	$197,363	$16,709	7.8%
MEMPHIS	$144,520	$133,169	$11,351	7.9%
BIRMINGHAM	$181,095	$166,849	$14,246	7.9%
CINCINNATI	$191,984	$175,848	$16,136	8.4%
OKLAHOMA CITY	$142,293	$129,894	$12,400	8.7%
INDIANAPOLIS	$147,204	$134,049	$13,155	8.9%
ST LOUIS	$182,225	$163,864	$18,360	10.1%
CHICAGO	$272,694	$239,964	$32,730	12.0%
COLUMBUS	$217,562	$187,835	$29,727	13.7%
KANSASCITY	$187,296	$160,976	$26,319	14.1%
HARTFORD	$252,104	$214,999	$37,105	14.7%
SANANTONIO	$167,376	$141,892	$25,484	15.2%
PHILADELPHIA	$274,649	$222,462	$52,187	19.0%
MINNEAPOLIS STPAUL	$265,247	$211,744	$53,503	20.2%
FORT WORTH	$206,066	$159,918	$46,148	22.4%
HOUSTON	$250,745	$187,835	$62,911	25.1%
TAMPA	$222,748	$165,426	$57,322	25.7%
CHARLOTTE	$241,816	$177,889	$63,927	26.4%
SALTLAKECITY	$306,710	$221,274	$85,436	27.9%
ATLANTA	$216,880	$154,958	$61,923	28.6%
DALLAS	$262,912	$185,671	$77,240	29.4%
DETROIT	$158,381	$111,637	$46,744	29.5%
NEW ORLEANS	$197,034	$138,380	$58,654	29.8%
PHOENIX	$298,432	$206,292	$92,141	30.9%
SAN BERNADINO	$368,876	$240,200	$128,676	34.9%
NORFOLK	$264,902	$172,268	$92,634	35.0%
PROVIDENCE	$303,013	$195,511	$107,502	35.5%
DENVER	$370,002	$233,188	$136,815	37.0%
SACRAMENTO	$387,075	$241,721	$145,354	37.6%
BALTIMORE	$367,358	$204,485	$162,873	44.3%
WASHINGTON DC	$541,935	$289,896	$252,038	46.5%
NEW YORK	$526,833	$276,647	$250,187	47.5%
PORTLAND	$406,822	$199,293	$207,529	51.0%
SEATTLE	$507,654	$239,275	$268,379	52.9%
MIAMI	$403,142	$187,085	$216,056	53.6%
BOSTON	$575,503	$229,037	$346,466	60.2%
SAN DIEGO	$657,284	$221,192	$436,092	66.3%
LOS ANGELES	$684,089	$200,397	$483,692	70.7%
OAKLAND	$870,322	$250,901	$619,421	71.2%
SANTA ANA	$886,235	$213,535	$672,700	75.9%
SAN JOSE	$1,212,272	$278,519	$933,754	77.0%
SAN FRANCISCO	$1,346,489	$257,243	$1,089,246	80.9%

Appendix 2b. Home Value and Land Share: States and DC, 2016

STATE	Home Value	Structure Cost	Land Value	Land Share
AK	$243,292	$228,064	$15,228	6.3%
NH	$192,564	$179,442	$13,122	6.8%
WV	$169,073	$154,157	$14,916	8.8%
OK	$161,126	$145,912	$15,214	9.4%
AL	$195,946	$175,061	$20,886	10.7%
WI	$214,252	$190,294	$23,958	11.2%
MS	$175,271	$155,215	$20,056	11.4%
KY	$190,532	$168,134	$22,398	11.8%
IL	$253,097	$223,329	$29,768	11.8%
IA	$176,476	$155,686	$20,790	11.8%
LA	$195,901	$171,955	$23,946	12.2%
AR	$186,002	$162,662	$23,341	12.5%
KS	$184,068	$160,726	$23,342	12.7%
MO	$198,811	$173,168	$25,643	12.9%
OH	$184,971	$160,212	$24,759	13.4%
NE	$178,669	$152,263	$26,407	14.8%
IN	$212,142	$178,353	$33,788	15.9%
MN	$216,721	$181,873	$34,848	16.1%
NM	$233,272	$189,137	$44,135	18.9%
ME	$232,980	$187,222	$45,757	19.6%
TX	$221,114	$176,045	$45,069	20.4%
RI	$267,431	$207,351	$60,080	22.5%
VT	$242,570	$185,910	$56,659	23.4%
TN	$241,862	$184,355	$57,507	23.8%
GA	$226,050	$171,883	$54,167	24.0%
PA	$264,164	$197,901	$66,263	25.1%
MI	$201,966	$150,310	$51,657	25.6%
NY	$338,762	$233,202	$105,560	31.2%
FL	$304,481	$208,825	$95,656	31.4%
NC	$271,751	$185,788	$85,962	31.6%
SC	$268,250	$183,264	$84,986	31.7%
SD	$230,264	$157,110	$73,154	31.8%
AZ	$310,230	$209,341	$100,889	32.5%
MT	$287,808	$187,997	$99,810	34.7%
WY	$286,158	$186,615	$99,543	34.8%
ID	$315,583	$205,489	$110,094	34.9%
ND	$240,762	$155,541	$85,221	35.4%
MA	$358,075	$228,490	$129,585	36.2%
CT	$351,944	$219,599	$132,345	37.6%
VA	$320,922	$199,632	$121,290	37.8%
NJ	$359,279	$222,073	$137,206	38.2%
UT	$347,753	$214,376	$133,377	38.4%
DE	$388,663	$231,060	$157,603	40.6%
NV	$344,256	$200,411	$143,845	41.8%
CO	$389,276	$220,944	$168,331	43.2%
WA	$437,380	$238,898	$198,481	45.4%
MD	$396,660	$206,687	$189,973	47.9%
OR	$448,949	$218,013	$230,936	51.4%

STATE	Home Value	Structure Cost	Land Value	Land Share
CA	$668,486	$259,726	$408,760	61.1%
HI	$1,030,081	$288,066	$742,015	72.0%
DC	*$932,435*	*$209,208*	*$723,227*	*77.6%*

Source: Lincoln Land Institute