

The Owner-Premium Adjustment in Housing Imputations

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Abstract	This paper describes an alternative to the rental equivalence and the user cost approaches for imputing consumer expenditures on owner-occupied housing services. The alternative uses the estimated value of the dwelling relative to the median value of similar homes as an adjustment to the rental equivalence method.
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1. Housing Services in National Accounts: A Brief Background

Consumer expenditures on housing services in national accounts consist of tenant contract rents and imputed rental services of owner-occupied housing (OOH). On the income side of the accounts, the contract rents show up in part in proprietors' income, where as on the production side, housing services become the output of the real estate sector. The rental services of OOH are the largest imputation in the U.S. national accounts, currently over \$1.4 trillion annually, almost three times the total of contract rents and 11.4 percent of household consumption in 2017. In terms of units, homeowners accounted for about 77 million and renters accounted for 43 million dwelling units in 2017.

The 1993 United Nations *System of National Accounts* recommended that countries base their housing service estimates on the user cost (UC) approach or collect contract rents and use the rental equivalence (RE) method. The UC approach takes the value of the housing stock of a country and builds up the owner costs as the sum of foregone earnings of the capital plus insurance costs, property taxes, and depreciation to arrive at the estimated flow of housing services.

The methods countries use to estimate their flow of housing services differ depending on the nature of their housing markets, as illustrated by the European Union (EU). EU countries with competitive rental markets use the rental equivalence method. However, some new member and candidate countries have very small rental markets with highly subsidized rents. In these countries a UC approach is used and no distinction between rented and owned housing is made. Their basis for the value of housing stock is not very detailed nor up to date, so these UC estimates are considered less reliable than estimates from countries using current rental and housing stock surveys.

Erwin Diewert (2009) proposed taking the maximum of the UC and the RE for each unit, or what he termed the opportunity cost (OC) approach. Aten (2018) showed that it was possible to estimate OC with the American Community Survey (ACS) in the United States, but that it suffered from the same disadvantages as the UC, such as volatility during housing bubbles and sensitivity to the assumptions on foregone capital earnings. It is also not practical for most statistical agencies as it requires estimation of both RE and UC at the individual dwelling unit level.

This paper describes an alternative to the RE and the UC approach that we call an owner's premium (OP) adjustment (OPA). Section 1.1 describes the background of RE in the United States and the need for an upward adjustment to the RE, while section 1.2 provides an empirical illustration and a proposed adjustment for OOH benchmark estimates.

1.1 Rental Equivalence in the United States

The method used for the rental component of the Consumer Price Index (CPI) by the Bureau of Labor Statistics (BLS) in 1973 “*was based on house prices, mortgage interest rates, property taxes, insurance, and maintenance costs. This treatment captures elements of both the service flow and asset investment aspects of housing expenditures*” (Gillingham and Lane 1982). The year 1973 was memorable for the end the gold standard and the formation of the Organization of Arab Petroleum Exporting Countries, later OPEC, that embargoed shipments of oil to those nations that supported Israel in the Yom Kippur War from October 1973 to March 1974. This first oil shock was followed by a second shock—the 1979 oil crisis. The events exerted upward pressure on prices and by 1979 the CPI inflation rate was above 11 percent annually and rose even higher in the next 2 years. This led the Federal Reserve Bank under Paul Volcker to raise the lending rate to banks to 20 percent, with mortgage rates not far behind.

All of this made the housing component of the CPI highly volatile, leading to widespread criticism of the index and ultimately to change. Both the UC and RE methods were considered. The UC approach is conceptually the preferred method of imputation of the flow of services from any capital good including dwellings (Diewert and Shimizu 2018). However, it has been particularly hard in practice to obtain agreement on how to apply UC to housing, such as which interest rates and depreciation rates to use on an annual basis, and how often they should be revised, which is why most statistical agencies have opted for RE or some other method. The conclusion of Gillingham (published in 1983 but circulated several years earlier) was that various implementations of UC on U.S. data were not consistent with the movement of contract rents.

Using more recent data, Verbrugge (2008) showed that comparing rents with various UC 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.*” The adoption of the RE approach by both BLS and the Bureau of Economic Analysis (BEA) was mainly because the UC method proved very difficult to apply in periods of fluctuating house prices.

BLS announced in 1980 that it would introduce the RE method, experimentally based upon new rent surveys, and implement the revised index in 1983. This had a major impact on many workers whose labor contracts tied their wages and salary increases to the CPI. In this same period, BEA made use of a decennial survey of the Census called the Residential Finance Survey (RFS) that sampled commercial landlords renting to consumers and a very small sample of single-family homeowners. The RFS was carried out in 1981, 1991, and discontinued after 2001. BEA built up estimates of OOH from the FRS rent-to-value ratios at the national level, which were termed RE estimates (Katz 2017). The OOH estimates have been extrapolated by the CPI’s owner equivalent rent index since 2008, as the RFS is no longer available.²

2. From 2001 to 2007, the Consumer Expenditure Survey’s housing index was used, but beginning in 2008 BEA switched to the CPI housing series and also began including a capital stock adjustment to the OOH imputations. The latter added approximately 12 percent to the total OOH in 2017.

It is logical to use RE as a benchmark estimate for a time-to-time index because it is likely that contract and homeowner rent imputations move together from year to year. However, extrapolations that span longer periods can become problematic as the composition and distribution of the housing stock is likely to change, resulting in the need for a new benchmark of the total housing flow. In the following paragraphs we argue that the RE imputation of OOH at one point in time is much less plausible, as it understates the total flow of rental services.

Glaeser and Gyourko (2009, 17) state that, “rental units are generally quite different from owner-occupied housing and that renters and owners are very different people.” The average income of owners is significantly higher than that of renters. In 20 European Union countries and the United States, the average income of owners and renters for 2016 reveals differences of 30 percent or more, with some exceptions like Greece and Switzerland, where imputed rental income is taxed. Heston and Nakamura (2009) provided empirical evidence that contract rents for several locations in the United States understated the flow of rental services, and the idea was further developed by Aten (2018). Both papers suggested adding a premium to the RE estimates of the rents of homeowners for larger more expensive dwellings. Arnold Katz (2017) provides a discussion of the current homeowner rental imputation of BEA and develops an alternative approach that implies a homeowner’s premium of over 30 percent.

Further support for an upward adjustment comes from rent-to-value ratios for dwellings. Surveys show that in the United States and elsewhere the rent-to-value rate declines with the value of dwellings (Davis, Lehner, and Martin 2008). Aten (2017) has shown that the rent-to-value ratios for all owner-occupied homes in the United States declined with size, as measured by the number of bedrooms, between 2000 and 2015, and that Zillow data also showed a similar pattern except for 1-bedroom units during the housing crisis (figure 2, Aten 2017). Geographic variation of the rent-to-value ratios across the states is substantial, ranging from under 3 percent to over 7 percent in 2015. The decline of the rent-value rate with median or mean rents in the United States is often observed and accepted as a regularity without question as to why it should exist.

Our suggestion is that lower rent-to-value ratios for more expensive housing partly reflect omitted variables that are very important in the case of housing, like the number of bathrooms and size of the lot.^{3, 4} The RE method pairs dwellings of roughly similar characteristics, such as broad geographic location, vintage, type, and size that are observed, but is constrained by the scope and size of the housing survey. The observed differences in income levels between owners and renters means that there are generally fewer tenant-occupied units for very large homes, and conversely fewer owner-occupied units in the smaller apartments, except in large metropolitan areas. Rental equivalence therefore attributes to larger and more expensive homes a

3. Unfortunately, the only variable related to bathrooms in the ACS is whether 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.

4. The ACS responses sometimes include lot size—under an acre, under 10 acres, and greater than 10 acres, with less than 1 percent of responses for lots over an acre.

smaller flow of housing services than is justified by their unobservable characteristics, including quality of construction, and neighborhood amenities.⁵

Section 1.2 illustrates empirically the relationship between RE, UC, and home values, and proposes an owner premium adjustment to the RE that is based on what we term *Beta* (β) values.

1.2 The Owner's Premium (OP)

Aten [2018] has provided experimental estimates of the OOH rental equivalence totals using the public use files of the ACS from its inception in 2000 through 2017.⁶ The tenant and OOH units were divided into strata by structure type (mobile homes, single-family homes, and apartments), number of bedrooms, total number of rooms, and age of the building. Weighted averages of the contract rents in the tenant-occupied units were estimated for each stratum within the U.S. states, plus the District of Columbia (D.C.). These average rents were then applied to the owner-occupied homes in their corresponding strata and summed to a total of OOH. Parallel computations were made for user costs under different interest rate assumptions as well as for the corresponding OCs. The concept of an owner's premium was also introduced.

The UC for each unit is its value multiplied by the sum of an interest rate and a depreciation rate, plus the insurance and property tax rates.⁷

$$UC_{it} = P_{it} (r_t + \delta_i) \quad (1)$$

- where UC_{it} is the user costs 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_i is the sum of the rates of annual depreciation, maintenance and repair, insurance, and property taxes of the unit⁸

5. Glaeser and Gyourko (2018, 9–10) discuss the cost differences between building economy, average, custom, and luxury housing as estimated by RSMean, a firm that publishes building cost models for the construction industry each year for different U.S. geographic regions. The costs per square foot of average quality and luxury quality are about 25 percent and 90 percent above economy construction. It seems reasonable to suppose that most tenants rent in buildings that are at the economy level of construction and that the level of construction is higher for many owners, in part because of their higher incomes.

6. The Census Bureau warns users about using the ACS prior to 2005 because it was still in development.

7. In theory, these rates would be specific to each dwelling unit. The ACS does have property taxes and insurance costs for the units, but not the terms and length of mortgages, so a common interest rate was applied in the UC estimates.

8. When user costs for rents from the income side are entered on the expenditure side for these countries, the repairs and maintenance costs would be transferred to expenditure headings of materials and labor.

If the value is very low, the UC can be lower than its RE. The OC takes the maxima of the RE and the UC and is therefore always an upward adjustment. The owner premium adjustments proposed in Aten (2018) were also always positive (see table 2 and figures 2a-2c in Aten 2018).

Unlike the UC and OC, where the absolute value of each unit is the basis of the adjustment, the owner premium uses the relative value of the unit. This relative value we term *Beta* (β). It equals the home value of individual dwelling i (P_i), divided by the median home value of all owner-occupied dwellings in state j with structure type k and number of bedrooms n ($\text{median}(P_{jkn})$).⁹ During periods of rapid price growth or decline, both the numerator and the denominator will change, moderating the size of the premium on each individual unit, and thus on the sum of total expenditures.

Below we show that the *Beta* and the UC are systematically related, increasing as the ratio of user costs to rental equivalence increases. Furthermore, this relationship is strongly positive, meaning that the UC rises relative to RE for more valuable dwellings.

Let Y be the ratio of the individual owner-occupied dwelling's UC divided by the RE equivalence assigned to that unit, where the RE is equal to the mean of the tenant contract rents.¹⁰ We regress Y on *Beta*, weighted by the individual observation's housing sampling weight. For 2017, the total number of observations is over 800,000, representing about 73 million owner-occupied units.¹¹

$$Y_i = \alpha + \delta \text{Beta}_i + \varepsilon_i \quad (2)$$

$$\text{where } Y_i = \frac{UC_i}{RE_i}; \text{Beta}_i = \frac{P_i}{(\text{median}(P_{jkn}))}$$

9. There are five structure-type/bedroom combinations: mobile homes, apartments with less than two bedrooms, apartments with two or more bedrooms, single-family homes with less than three bedrooms, and single-family homes with three or more bedrooms.

10. In the calculation of RE means, the strata are further subdivided by total number of rooms and the age of the building. For the Beta, the median is only estimated for three main strata: state, type of structure, and number of bedrooms.

11. Equation 2 is estimated after eliminating about 5 percent of the sample in which annual insurance plus taxes as a share of the dwelling value were less than 0.3 percent or greater than 7 percent.

Table 1 provides the number of observations and weights in each regression, the average value of *Beta*, and the median dwelling value for each year, estimated across all U.S. dwelling units.

Table 1

	2017	2014	2011	2008	2005
N observations	817,770	791,825	805,422	817,694	818,549
Weighted N (millions)	72.5	69.6	71.1	71.5	71.1
Mean <i>Beta</i>	1.30	1.33	1.29	1.27	1.27
Median housing value	\$210,000	\$180,000	\$175,000	\$199,000	\$125,000

Source: American Community Survey (ACS) Public Use Microdata Files.

Table 2 shows the estimated parameters from equation 2.

Table 2. Parameter Estimates

	2017	2014	2011	2008	2005
Mean Y	1.24	1.18	1.17	1.32	1.34
R ²	0.74	0.73	0.74	0.70	0.57
Parameter	<i>Estimate</i>				
	<i>(Standard Error)</i>				
α (intercept)	0.328	0.315	0.295	0.358	0.464
	(0.0009)	(0.0009)	(0.0008)	(0.0010)	(0.0011)
δ (delta)	0.703	0.650	0.678	0.761	0.696
	(0.0005)	(0.0004)	(0.0005)	(0.0006)	(0.0007)

Source: American Community Survey (ACS) Public Use Microdata Files with authors' own calculations.

When *Beta* is equal to 1, the predicted Y is also close to 1, or 1.031 in 2017. The highest predicted Y when *Beta* is 1 was 1.160 in 2005, and the lowest was 0.965 in 2014. The results in table 2 support our hypothesis that the *Betas* and the gap between UCs and RE are strongly and positively related. In other words, as relative home values increase, so does the understatement of the RE relative to the UC.

In the next paragraphs we discuss how the *Betas* can be used to adjust the RE to provide an estimate of OP. The *Beta* is simply a relative value and we assume that the OP adjustment should be higher for a \$200,000 home in a state where the median value is \$120,000, such as West Virginia, than in a state where the median value is \$600,000, such as Hawaii, or in Washington, D.C.

In the simplest case, we can just adjust the RE by the unit relative value, that is, multiply the RE times the *Beta* (REB). For example, if a single-family 2-bedroom owner-occupied unit has a RE of \$1,000/month in West Virginia, where the median is \$120,000 as in the example above, and the home is valued at \$200,000, the REB will be \$1,667/month ($\$1,000 \times \text{Beta}=1.67$). A unit of similar value and RE in Hawaii or Washington, D.C. would decrease to \$333/month ($\$1,000 \times \text{Beta}=0.33$).

In the second adjustment introduced in Aten (2017, 2018), the OP is a function of the *Beta*, instead of the *Beta* itself. In addition, the adjustment is always positive. This is shown in table 3.

Table 3. Owners Premium With an Adjustment Using *Beta*

Beta	Owners Premium	Owners Premium Adjustment (OPA)
$\beta < 0.5$	RE x 1.05	5%
$0.5 < \beta < 1.0$	RE x (1.05 + 0.20 ($\beta - 0.5$))	5%-15%
$1.0 < \beta$	RE x (1.15 + 0.30 ($\beta - 1.0$))	15% +

Source: Adapted from Heston and Nakamura (2009).

When the value of an occupied unit is at the median ($\beta=1$) the premium is 15 percent, and it increases 30 percent for each additional unit of *Beta*. If below the median, the premium decreases to a minimum of 5 percent. In the numerical example, the West Virginia home would have an adjustment of 35 percent or \$1,350 ($\beta=1.67$), and the Hawaii or Washington, D.C. home would be adjusted by 5 percent to \$1,005 ($\beta=0.33$).

Table 4 shows the results for OOH totals in the United States, using the RE, UC and the *Beta* adjustments (simple REB and OPA). The unit characteristics, rents, and values rely on the ACS public use microdata files and are updated from Aten (2018).¹² The UC is estimated using a 2.5 percent annual interest rate that is constant across all the years. The OPA is based on table 3. Both are calculated at the individual dwelling unit and summed to obtain an annual total, shown in billions of U.S. dollars.

12. Estimates shown here attempt to more closely resemble the classifications used in BEA's national and income accounts.

**Table 4. Total Owner-Occupied Housing Expenditures United States:
RE, OP and UC estimates**

	Units	RE rental equivalence	REB RE x <i>Beta</i>	OPA owner premium adjustment	UC user cost at 2.5% interest rate	<i>Beta</i>	OP/RE	UC/RE
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	(\$ millions)	(\$ billions)						
2005	74.3	701	895	879	1,010	1.28	1.25	1.44
2006	75.1	739	933	924	1,110	1.26	1.25	1.50
2007	75.5	779	978	973	1,156	1.26	1.25	1.48
2008	75.3	805	1,070	1,024	1,155	1.33	1.27	1.43
2009	74.9	817	1,098	1,042	1,088	1.34	1.28	1.33
2010	74.9	828	1,102	1,053	1,068	1.33	1.27	1.29
2011	74.4	838	1,124	1,069	1,042	1.34	1.28	1.24
2012	74.2	854	1,158	1,093	1,039	1.36	1.28	1.22
2013	73.9	871	1,174	1,115	1,062	1.35	1.28	1.22
2014	74.1	895	1,215	1,147	1,110	1.36	1.28	1.24
2015	74.6	924	1,263	1,185	1,191	1.37	1.28	1.29
2016	75.1	963	1,307	1,233	1,252	1.36	1.28	1.30
2017	76.8	1,009	1,361	1,289	1,338	1.35	1.28	1.33

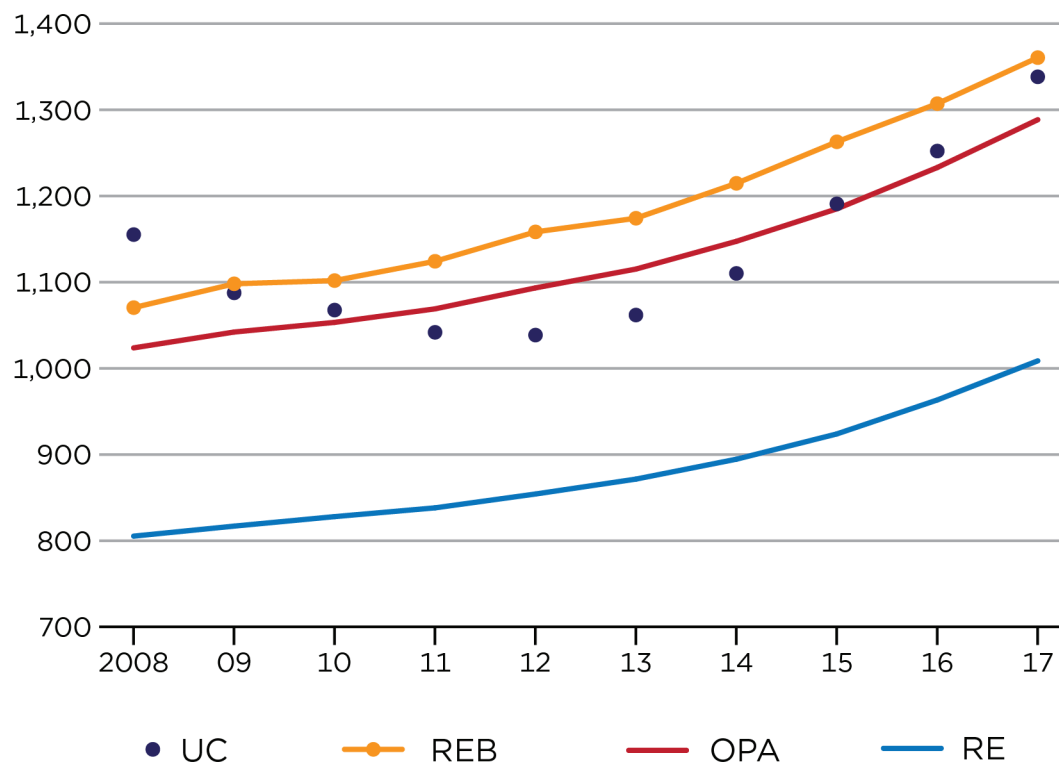
The number of units are the weighted owner-occupied dwellings. The last three columns are the ratios of the total expenditures (REB, OPA, and UC) relative to the RE (column 2) expenditures.¹³ Figure 1 depicts the results in table 4. The UC is clearly the series with the greatest fluctuation during the housing crisis. The REB reduces some of the variance in the UC, but is also less stable than the OPA, particularly after 2008. This is in part due to a change in the ACS, which prior to 2008 was top-coded at \$1 million for the value of a home and increased to \$10 million dollars from 2008 onward.

13. Preliminary research on Zillow estimates, conducted jointly with the Penn Institute of Urban Research at the Wharton School, show that the average of the Betas using ACS across apartments and single-family homes is 1.32, and for Zillow-transacted values it is 1.35. The OPAs values for ACS are 1.27 and for Zillow are 1.28. These results are for the state of California only, and for the first half of 2017.

Figure 1. Total OOH Expenditures in the United States, 2008-2017

U.S. housing expenditures (\$b)
Owner-Occupied units only

Annual total (\$billions)



- OOH** Owner-occupied housing
- UC** User cost
- REB** Rental equivalence times the Beta
- OPA** Owner's premium adjustment
- RE** Rental equivalence

2. Conclusions

The ACS, established in 2005, has enabled the estimation of alternative housing expenditures based on individual dwelling units. The need for alternative measures arose in part because of the discontinuation of a decennial federal survey (the RFS) in 2001, that paired commercial rental properties with their rental income and the landlords' estimated value of the buildings. The pairing had enabled the estimation of rent-to-value ratios for the United States and informed the imputation of a nationwide average annual rent for OOH units. This average has since been extrapolated and adjusted by indexes found in the Consumer Expenditures survey and the CPI, plus a capital stock adjustment calculated by BEA. In previous work Aten (2018) describes how the ACS might be used for alternative estimates of OOH expenditures that are current and geographically more detailed.

Section 1.1 of this paper focused on evidence that the rental equivalence method for level estimates are likely to understate the flow of services to owners, particularly for higher-value homes. In section 1.2 we showed how the UC method reflects this understatement and proposed an alternative that uses the relative value of a home, termed a *Beta* adjustment. One adjustment simply multiplies the RE by its relative value (REB), leading to both increases and decreases in the RE, and the other is a function of the *Beta*, called an OPA, that is always positive. Using the ACS data from 2005–2017, we illustrate how both adjustments take higher value homes into account but are less subject to the fluctuations of a housing bubble, and how unlike the UC or the OC approach, they require no assumptions on interest rates or depreciation rates.

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