

How can the American Community Survey (ACS) be used to improve the imputation of Owner-Occupied Rent Expenditures?

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There are currently two major agencies, the Bureau of Labor Statistics (BLS) and the Bureau of Economic Analysis (BEA), that produce estimates of the cost of shelter for renters and for owners on a regular basis. In addition, the Census Bureau is conducting a nation-wide survey, the American Community Survey (ACS) of rents and owner costs on a rolling five-year basis. This paper explores the feasibility of using the public use micro-data of the ACS for a relatively simple imputation of owner-occupied rent expenditures¹. A larger and more sophisticated effort to obtain owner-occupied rent expenditures using various other sources of housing information is being undertaken at the Census Bureau in collaboration with BLS².

Our motivation here is to obtain expenditures which are consistent with the ACS geography, that is, below the national level. This would enable us to better weight our current estimates of state and metropolitan level Regional Price Parities (RPPs) for Rents and Owner-Occupied Rents³. Once the Census-BLS collaboration results are available, we would switch to using those expenditure weights.

The term ‘rents’ in the text that follows will apply to both renter and owners, while Rents and Owner-Occupied Rents (OOR) will distinguish them. In addition, we add the term *expenditures* when referring to total expenditures on rents, and *per unit* when referring only to the average price component when it is important to separate the two.

The paper is organized as follows. **Section A** summarizes the main conceptual differences in the BLS and the BEA estimates, showing the national total expenditures on rents for tenant-occupied and owner-occupied dwellings. In **Section B** we highlight the BEA method of deriving OOR total expenditures and per unit averages, in part because this methodology is less-well known and documented outside BEA, and in part because it must be replaced in the near future, as it uses a Census

¹ We access the public use micro-data records of the 5-year ACS (approximately 8 million observations), at the Census Bureau, with the kind permission and collaboration of the Poverty Statistics Branch and the Housing and Household Economic Statistics Division.

² The Census-BLS collaboration will access administrative-level records in the ACS to match actual addresses of individual housing units across surveys.

³ In previous work (see Aten, Figueroa and Martin (2011)), we use BLS weights at the 38 index-area level, allocated uniformly by population across counties, then aggregated back up to states and metropolitan area levels. The ACS data would enable us to use expenditure weights directly estimated at the level of states and metropolitan areas.

housing survey that has been discontinued. The collaborative effort between BLS and Census, as well as the modest proposal outlined in [Section C](#), both make use of the new ACS housing data.

Section A

CE: The Consumer Expenditure (CE) survey of the Bureau of Labor Statistics (BLS) estimates owner-equivalent rent expenditures based primarily on quarterly interview surveys, which are in turn aggregated into biennial totals representing the US population. These biennial aggregates are averaged into annual expenditure weights and then transformed by the Consumer Price Index (CPI) program for use as weights in their time-to-time indexes of inflation. The transformation is needed because the CPI is calculated on a monthly basis for a number of larger metropolitan and urban regions of the US⁴, while the CE covers the entire US, including rural areas, but only over a longer period of time. The weights used in the CPI are known as **Cost Weights (CW)** to distinguish them from the biennial CE survey totals⁵.

PCE: The Personal Consumption Expenditures (PCE) series published by the Bureau of Economic Analysis (BEA) estimates the owner-equivalent rent expenditures for all owner-occupied housing units for a benchmark year, and then extrapolates them to non-benchmark years. The expenditures are calculated by estimating a relationship between the rental receipts of a sample of single-unit owner-occupied dwellings and their values, called a Rent to Value ratio. The Rent to Value ratios are multiplied by an average value for a larger group of housing units, resulting in an average rent valuation, and then multiplied by the total number of owner-occupied units in that group for the final imputed OOR total.

A systematic comparison between the CE and the PCE has been underway for several years, under the joint auspices of both agencies. See for example McCully, Moyer and Stewart (2007) and Garner, McClelland and Passero (2009). The comparison is not just for rents, but includes all other categories of consumption. We use this literature (Gieseman, 1987; Garner, Janini, Passero, Paszkiewicz, and Vendemia, 2006; Garner, McClelland, and Passero, 2009; Garner and Short, 2009; Houthakker and Taylor, 1966; Slesnick, 1992 and 1998; Attanasio, Battistin and Leicester, 2006; Meyer and Sullivan, 2009) to inform our brief discussion of the methods and reproduce some of their tables in the sections below.

One common feature of the estimates is that they rely on survey questions. The BLS on their CE survey which asks owners what they think their home would rent for, while the BEA has relied on the Residential Finance Survey (administered by the Census Bureau) that asks owners for their rental receipts and their estimate of the total value of their homes. The last BEA benchmark estimate of Rent

⁴ The monthly CPI is published by detailed expenditure heading for the overall urban US, by overall total for fourteen selected local areas and ten region/area size combinations, and semiannually for an additional thirteen local areas. (See for example Table 14, CPI Detailed Reports, available at <http://www.bls.gov/cpi/#tables>).

⁵ The process is described in detail in the CPI chapter of the BLS Handbook of Methods (pages 33-38).

to Value ratios is based on the 2001 Residential Finance Survey which has been discontinued, and on the 2000 decennial Census of Housing. BEA's extrapolation of PCE estimates to more recent years is done first by obtaining an imputed OOR per unit, then using the CE growth rate for OOR per unit up to 2008 and the CPI change in OOR from 2008 onwards.

Table 1 shows the aggregate national totals for three comparisons of Rents and OOR. We show the sum of the five-year totals in current dollars, and their annual average. This is because we will be comparing these values in *Section C* to the ACS estimates, which also span the 2005-2009 years⁶.

Table 1. Expenditures in billions of US\$ (2005-2009)						
	PCE National		CE National		CW 42 areas	
	Rents	OOR	Rents	OOR	Rents	OOR
5 year sum (2005 to 2009)	1543	5677	1570	6598	1393	5778
Annual average	309	1135	314	1320	279	1156
Annual average total	1444		1634		1434	

Notes:

1. *PCE Table 2.5.4u, line 152 (Rents) and line 156 (OOR) on BEA's website*
2. *CE National data for OOR are not on the CE website; OOR data from special tabulation*

The PCE National column is taken directly from published BEA data. The CE National numbers for OOR are from a special tabulation for PCE-CE comparisons⁷, while Rents are from the published CE data. Lastly, the CW figures are the cost weights derived from the CE for use in the CPI, and are summed over the 38 BLS index-areas and 4 rural regions.

The ratio of the CE to PCE for owner-occupied rent expenditures is 1.16 (1320 / 1135), while the ratio of CW to PCE is 1.02 (1156/1135). The relationship between Rents and OOR within PCE is 0.27 (309/1135) whereas in the CE and the CW the relationship between Rents and OOR are both equal to 0.24.

How comparable are these numbers? In 2007, the method for estimating OOR in the CE was changed to include the full rental equivalent of vacation homes that are not rented (and half the value of vacation homes that are rented), making it more similar in concept to the PCE OOR. This increased the total OOR in the CE and we would therefore expect an increase in the ratio of CE to PCE OOR expenditures. The CE to PCE ratio ranged from 1.23 in 1992 to 1.25 in 2004 and 1.30 in 2007 for owner-occupied dwellings in Garner, McClelland and Passero (2009), table 1b. More recent calculations for the individual years

⁶ The ACS values are also in current dollars, but the sampling is such that the observations do not span the entire U.S. every year, only over the 5 year period.

⁷ Bill Passero, 2011, Table 1. Summary comparison of aggregate Consumer Expenditures (CE) and Personal Consumption Expenditures 9PCE), www.bls.gov/cex/cecomparison.htm.

between 2005 and 2009 show that the ratio decreased to 1.16 in 2005, increased to 1.22 in 2007 and then dropped again to 1.11 in 2009. These are shown in [Table 2](#).

Table 2. OOR Expenditures in billions of US\$ (2005-2009)						
	2005	2006	2007	2008	2009	Total 2005-2009
PCE	1044	1111	1141	1179	1201	5677
CE	1215	1294	1396	1363	1330	6598
CW	997	1098	1135	1264	1285	5778
CE/PCE ratio	1.16	1.16	1.22	1.16	1.11	1.16
CW/PCE ratio	0.95	0.99	0.99	1.07	1.07	1.02

One explanation for this is that the increase in the total CE OOR appears to be offset by the change in the way the PCE was extrapolated. Recall from above that the PCE non-benchmark years were extrapolated using the CE growth rate for OOR per unit up until 2008, and then the extrapolation switched to the CPI OOR per unit for subsequent years⁸. So, if the CPI for OOR per unit is significantly higher than the CE OOR per unit growth rate, the CE to PCE ratio could be reduced. [Table 3](#) appears to suggest that this is the case, although Table 3 only shows growth rates for total OOR expenditures, not the implied per unit price changes.

[Table 3](#) shows the year to year growth rates for owner-occupied rent expenditures corresponding to the three national totals: PCE, CE and CW.

Table 3. Growth Rate of OOR expenditures total (2005-2009)				
	2005-06	2006-07	2007-08	2008-09
PCE	1.064	1.027	1.033	1.019
CE	1.065	1.078	0.977	0.975
CW	1.101	1.034	1.114	1.017

Note that the CW growth rates are not exactly the CPI growth rates but they are closer to the CPI than to the CE rates. It is at the critical juncture between 2007 and 2008 that the CE growth rate is below one while the PCE growth rate (and the CW used in the CPI) is above one. This is also true for 2008-09.

Did the OOR per unit growth rates for CE and CPI also diverge between 2007 and 2008? The first line of [Table 4](#) shows the CE estimated percent change in the monthly rental value of owned homes and the second line shows the CPI percent change in the Owners' Equivalent rent of primary residence.

⁸ It is not yet clear to us whether the extrapolation using the CPI is in current or in constant prices. We assume the CE growth rates are in constant prices.

Table 4. Growth Rate as a % of previous year for OOR per unit (2005-2009)				
	2005-06	2006-07	2007-08	2008-09
CE	4.8	2.9	-2.3	-2.4
CPI	3.5	3.4	2.5	1.7

Source:

- CE: *Multiyear Tables 2000-2005, 2006-2009, Average annual expenditures and characteristics of all consumer units. Line item under 'Other Financial Information: Estimated monthly rental value of owned home'. The values are \$833, \$873, \$898, \$877, \$856 for 2005-2009 respectively.*
- CPI: *Annual Average Indexes, 2006, 2007, 2008, 2009, Table 1A, Consumer Price Index for all Urban Consumers (CPI-U). Line item under Shelter 'Owners' equivalent rent of primary residence'.*

If the PCE had continued to use the CE growth rate, it would have led to a lower estimate, and hence the CE to PCE ratio would have remained at least as large as it was prior to 2007. **Table 3** suggests that the PCE OOR estimates are more comparable to the CW than to the CE, both in terms of absolute levels and in terms of growth rates.

We return to the question of which set of expenditures to use as weights for Rents and OOR in our estimates of regional price parities? We have used the CW up until 2009, and they are the most appropriate one for our estimates up to this point as they most closely correspond to the CPI data structure. From the above analysis, it seems that they are more closely in line with the PCE estimates of OOR than to the CE.⁹

However, if we are to estimate a set of price parities based on a PCE structure rather than a CPI structure, it would be more consistent to use weights derived from the PCE-methodology rather than on the perhaps serendipitous alignment of the CW with the PCE.

The two issues that we face are

- i. The current methodology for PCE estimates of Rents and OOR is under revision
- ii. There are no state and metropolitan PCE estimates of Rents and OOR expenditures

The ACS is the only up-to-date survey to bridge that gap. We focus below on using the ACS to estimate Rents and OOR expenditures for states and metropolitan areas. First, we describe in some detail the PCE methodology and the feasibility of translating it into the ACS, and then we describe our proposed estimates.

⁹ The PCE OOR includes vacation homes while the CW excludes them from OOR (they are included in the CW and in the CPI but as a separate category).

Section B: Estimation of Owner-Occupied Rent Expenditures in the PCE

The PCE OOR was based on the Residential Finance Survey (RFS) which has been discontinued as of 2001 and on the 2000 Decennial Census of Housing. It was derived in three stages.

1. Rent to Value ratios: an estimate of the Rent to Value ratios is obtained for 13 value classes. The value classes refer to the value of the owned-housing unit, ranging from less than \$20,000 to over \$500,000 (in 2001 prices). These Rent to Value ratios are estimated from the discontinued (as of 2001) RFS.
2. Owner-occupied housing units: an estimate of the number of owned housing units was made for each value class. These estimates were obtained from the American Housing Survey of the Census Bureau.
3. Owner-Occupied Rent (OOR) expenditures: the Rent to Value ratio is multiplied by the midpoint value of a value class, then by the number of units, resulting in an expenditure estimate for the value class. Summing these gives us the total of OOR expenditures across all value classes.

Stage 1, which estimates the Rent to Value ratios, consists of the following:

- a) A count of the number of tenant-occupied single-home units in each value class (from the RFS 2001);
- b) The distribution of these units into 8 categories of 'Rental Receipts as a Percent of Value'. For example, number of units with rental receipts that are less than 5% of the value of the unit, 5-9%, on up to 40% or more of the value of the unit (also from the RFS).
- c) The Rent to Value ratios are the mid-points of b) weighted by a). This is done for the 13 value classes (from <\$20,000 to over \$500,000).

To illustrate, **Figures 1-3** titled *Raw RFS Data* summarize Stage 1a) and b) for three of the 13 value classes: <\$20,000, \$125,000-149,999 and \$500,000 and over, corresponding to the lowest, the median and the largest value classes respectively.

Figure 1. Value Class: < \$20,000

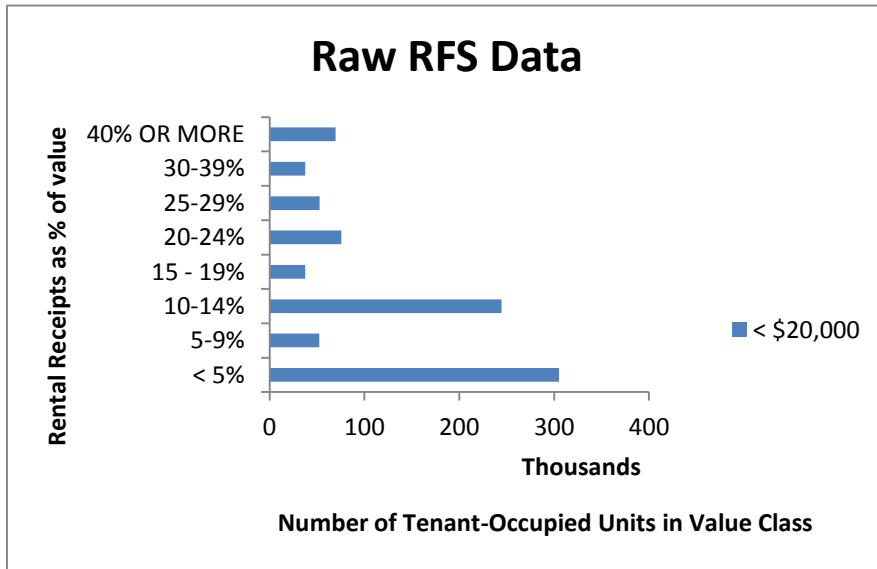


Figure 2. Value Class: \$125,000-149,999

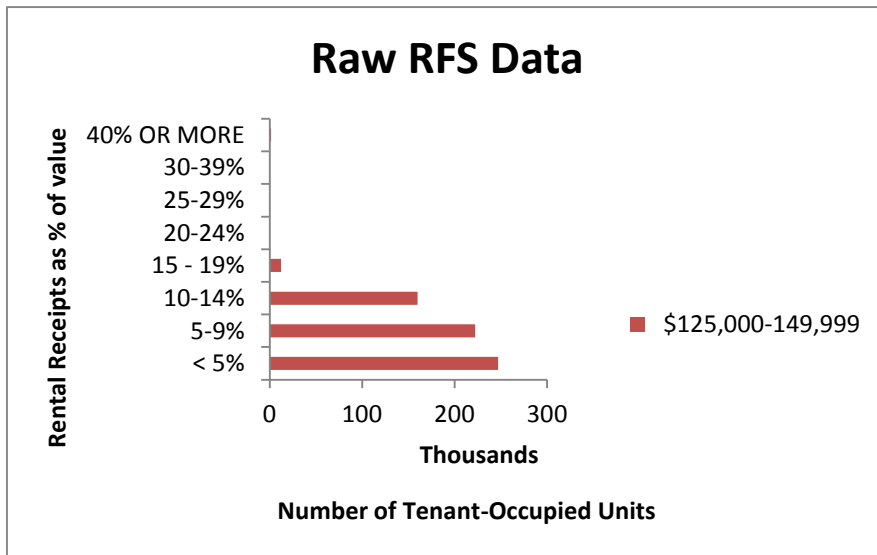
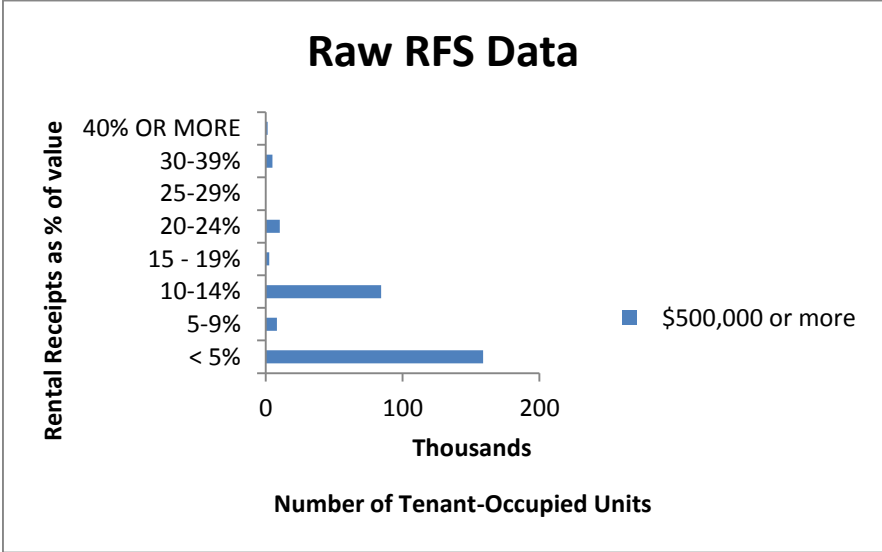


Figure 3. Value Class: >\$500,000



The raw RFS data contain the Rental Receipts as a % of the value of the unit, in 8 discrete categories, shown on the vertical axis of *Figures 1-3*. For each Value Class, it also contains the number of Tenant-Occupied Units¹⁰, shown on the horizontal axis.

BEA finds the weighted average of the Rental Receipts as a % of the value of the unit by assuming a midpoint value for each of the 8 discrete categories, and using the proportion of units as the weight. The midpoints assigned to each category are as follows:

1. < 5% : midpoint = 4%
2. 5-9%: midpoint = 7%
3. 10-14%: midpoint = 12%
4. 15-19%: midpoint = 17%
5. 20-24%: midpoint = 22%
6. 25-29%: midpoint = 27%
7. 30-39%: midpoint = 35%
8. 40% or more: midpoint = 45%

The transformed RFS data with these midpoints and proportions are shown in *Figures 4-6*.

¹⁰ BEA uses only Property size 1 units in the RFS, which are only single unit dwellings, for properties with and without mortgages, and excludes mobile homes.

Figure 4. Value Class: < \$20,000.

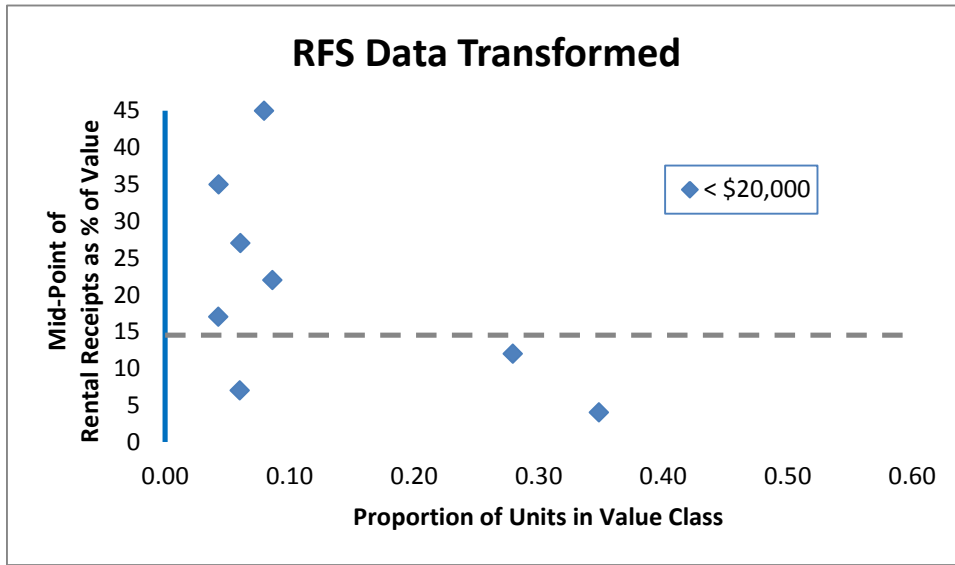


Figure 5. Value Class: \$125,000-149,999

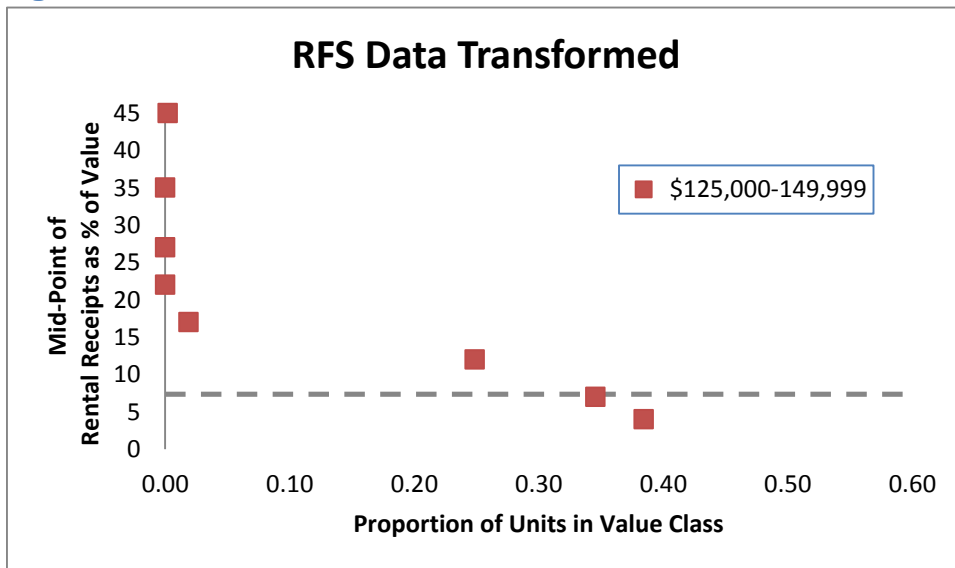
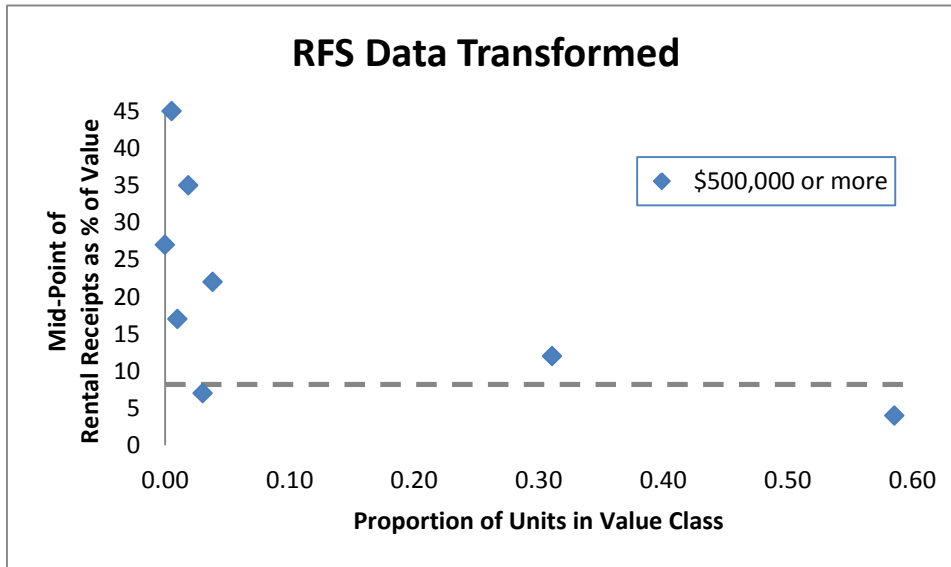


Figure 6. Value Class: >\$500,000



The dashed horizontal line in each figure represents the weighted average of the points. These weighted averages are the average annual rental receipts as a % of the value of the unit, or Rent to Value %s for short. For example, in [Figure 4](#), Value Class <\$20,000, the horizontal line is at 14.5%, while in [Figures 5 and 6](#) they are at 7.36% and 8.21% respectively. They all refer to the 2001 RFS survey for single unit dwellings, excluding mobile homes.

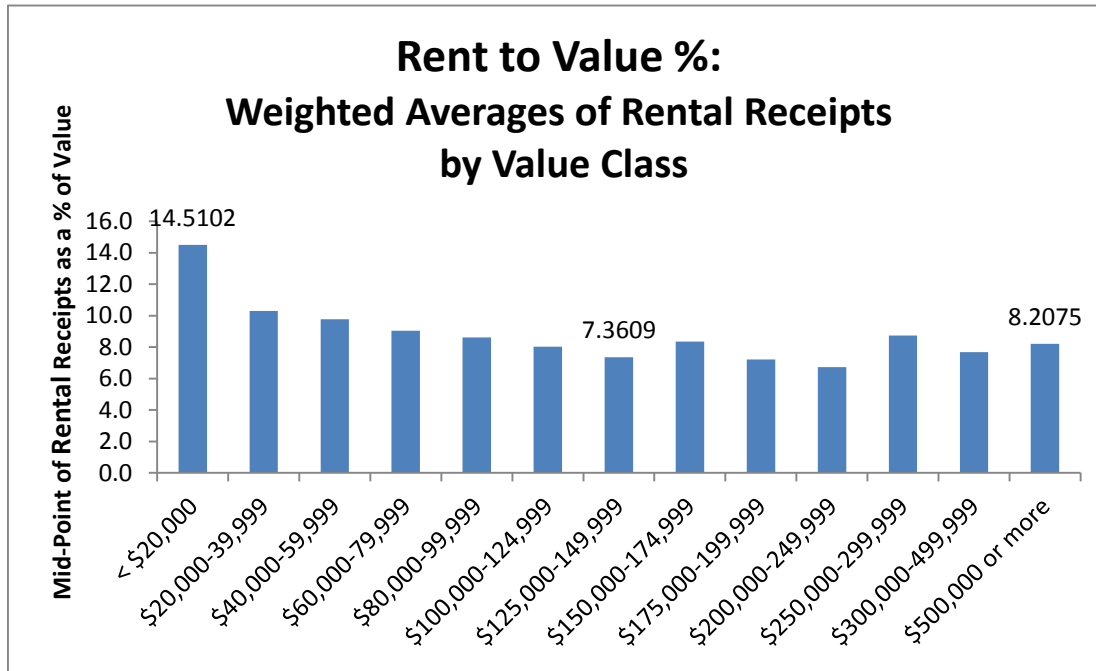
The Rent to Value %s are obtained by the equation shown below:

$$Rent\ to\ Value\ \%_j = \sum_{i=1}^{40\% \text{ or more}} (Midpoint_i * Proportion\ of\ Units_i)_j$$

Where i=1,2,...,8 categories of Rental Receipts as a % of Value, and j=13 Value Classes.

The Rent to Value %s derived from the transformed RFS, for all value classes, are illustrated in [Figure 7](#).

Figure 7. Rent to Value %s: all Value Classes



Stage 2 estimates the number of housing units in each value class from the American Housing Survey (AHS). However, the AHS value classes are different from the ones in the Residential Finance Survey (RFS) used in Stage 1, so an adjustment is done to make them comparable.¹¹

- a) The highest AHS value class is \$300,000 and above, so they are split by the distribution in the RFS 2001 survey.
- b) The RFS value classes for \$100,000-124,999 and \$125,000-149,999 are consolidated into one, as are the \$150,000-174,999 and \$175,000-199,999 value classes.
- c) These new classes are assigned a midpoint value

Stage 3 is the final step. This time a different midpoint value is assumed, for each of the value classes shown on the horizontal axis of **Figure 7** and in **Table 5**. The midpoint value is multiplied by the Rent to Value %s, resulting in an average imputed OOR per unit for each value class. The OOR per unit are multiplied by the corresponding number of owner-occupied units, resulting in the imputed OOR expenditure total for each class.

¹¹ An adjustment is also made in Stage 1c) for the three Value Classes above \$250,000, where the RFS data on units receiving more than 15% of their estimated value were not deemed reliable. If these units are counted, the Rent to Value ratios would be 8.728, 7.673 and 8.208 respectively, instead of 7.342, 6.734 and 6.288 as shown in **Table 5**. The OOR expenditures would increase from the total in **Table 5** (\$848,202,197) to \$908,979,052, a 7.17% increase.

Table 5. Rent to Value %s by Value Class

Value Class (1)	Mid-Point (2)	OO Units (‘000s) (3)	Rent to Value % (4)	Imputed OOR Expenditures (‘000s) (5)
< \$20,000	\$ 10,000	3,095	14.510	\$ 4,490,907
\$20,000 - \$39,999	\$ 30,000	3,520	10.291	\$ 10,867,085
\$40,000 - \$59,999	\$ 50,000	5,206	9.762	\$ 25,411,007
\$60,000 - \$79,999	\$ 70,000	7,984	9.047	\$ 50,561,874
\$80,000 - \$99,999	\$ 90,000	8,434	8.617	\$ 65,409,718
\$100,000 - \$149,999	\$ 125,000	15,496	7.771	\$ 150,523,885
\$150,000 - \$199,999	\$ 175,000	10,091	7.939	\$ 140,200,353
\$200,000 - \$249,999	\$ 225,000	5,699	6.727	\$ 86,262,486
\$250,000 - \$299,999	\$ 275,000	3,719	7.342	\$ 75,084,379
\$300,000 - \$499,999	\$ 400,000	5,930	6.734	\$ 159,711,523
\$500,000 +	\$ 500,000	2,534	6.288	\$ 79,678,980
Total		71,708		\$ 848,202,197

The total of just over \$ 848 billion refers to 2001 and is not directly comparable in level to the \$1,135 billion shown in *Table 1*. However, the Rent to Value % remains fixed throughout the period. We look more closely at what this implies for the OORs.

First, the Imputed OOR per unit is shown in column (2) of Table 6 (equal to column (5) divided by column (3) in Table 5). Dividing by 12 we obtain an imputed monthly mean rent (column 3) for each Rent to Value category. The average OOR per unit for the 2001 data is \$ 986, shown on the last line of *Table 6*¹².

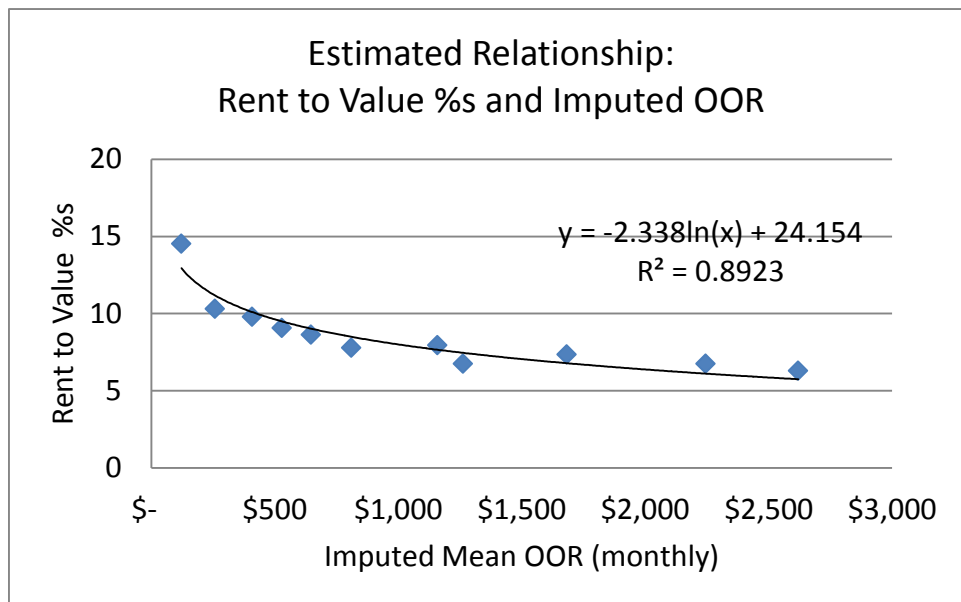
<i>Table 6. Imputed Owner-Occupied Rents, by Rent to Value %s</i>		
Rent to Value % (1)	Imputed OO Annual Rent Per unit (2)	Imputed OO Monthly Rent Per unit (3)=(2) / 12
14.510	\$ 1,451	\$ 121
10.291	\$ 3,087	\$ 257
9.762	\$ 4,881	\$ 407
9.047	\$ 6,333	\$ 528
8.617	\$ 7,755	\$ 646
7.771	\$ 9,714	\$ 809
7.939	\$ 13,894	\$ 1,158
6.727	\$ 15,136	\$ 1,261
7.342	\$ 20,189	\$ 1,682

¹² In contrast, the estimated monthly rental value of owned home from the CE for 2001 is \$690 and the estimated value of the home is \$103,975. (See Multiyear Tables 2000-2005: Average annual expenditure and characteristics of all consumer units, Consumer Expenditure Survey, 2000-2005, line item under ‘Other financial information’.)

Rent to Value % (1)	Imputed OO Annual Rent Per unit (2)	Imputed OO Monthly Rent Per unit (3)=(2) / 12
6.734	\$ 26,935	\$ 2,245
6.288	\$ 31,438	\$ 2,620
Average	\$ 11,829	\$ 986

The relationship between the Rent to Value % and the imputed mean monthly OOR is shown in *Figure 8*.

Figure 8. Rent to Value % and Imputed Monthly Owner-Occupied Rent



The Rent to Value percentages decrease (vertical axis) as the estimated value of the owner-occupied dwellings increase (horizontal axis).

If we assume this relationship holds for more recent years, namely 2005-2009, we can take the OOR per unit that BLS uses (from the CE or from the CPI) and estimate the Rent to Value %s implied by those units. This in turn will give us an estimated value of the owner-occupied dwelling.

For example, if the Imputed Mean OOR (monthly) is \$1000, with annual gross receipts of \$12,000, the Rent to Value % would be approximately 8% ($-2.338 * \ln(1000) + 24.154$). The estimated value of the unit would therefore be \$150,000 ($12,000/0.08$).

The relationship outlined above is simply a log-linear transformation. A future research topic would be to (a) analyze more thoroughly the variance of the Rent to Value % with respect to the assumptions about the mid-point values assigned in Stage 1 (for the 8 Rental Receipts to Value categories), and in

Stage 3 (for the 13 Value Classes as they are re-arranged across surveys), and (b) to perform a more careful modeling of the relationship.

The BLS OOR estimates are not aggregated by the value class of the units, but it is possible to find the average OOR per unit by other characteristics of the units, for example, by the type of structure (apartment, attached house, detached house) and number of bedrooms.

If we assume that the Rent to Value relationship holds across types of structures, we could obtain the mean value of owner-occupied units by structure and bedrooms. Since the BLS breaks down their national estimates into 38 index areas, the exercise would provide a rough guide to housing prices that could be checked against other sources of real estate prices available from commercial sources.

In [Section C](#) we suggest a way of obtaining OOR expenditures using a Rent to Owner relationship, similar to what was done in the PCE, except that instead of total value, we use the monthly owner-equivalent rents of the BLS applied to the category of the units, namely whether they are apartments or houses and the number of bedrooms they contain.

Section C: Owner-Occupied Rent Expenditures in the ACS

This section outlines a method for imputing OOR expenditures using only the existing BLS and the ACS Rent data. One merit of this method is that it depends on current surveys rather than on a decennial census, and does not require the imputation of mid-point housing values between two different surveys. The main steps consist of the following:

- i) estimate the relationship between OOR and Rents in the BLS data, by the type of structure and number of bedrooms;
- ii) multiply the OOR to Rents ratio by the Rents in the ACS data.

This gives us an imputed OOR by type of structure and number of bedrooms. The imputed OOR multiplied by the number of owner-occupied units in each category will result in an estimate of total OOR expenditures.

There are two main variations to steps i) and ii). First, we can use a geometric mean of the Rents and OOR in the BLS data, or we can use a quality-adjusted mean. The latter is found by estimating a hedonic regression with additional characteristics, such as number of bathrooms and the length of occupancy of the units by their tenants. Secondly, we can use different ACS Rents estimates: again, the geometric mean or the quality-adjusted mean for each structure-bedroom combination.

Note that the sum of all reported gross rents will give us the total expenditures on Rents. This total is directly comparable to the Rents reported in [Table 1](#) that are used in the PCE estimates of Rents at BEA and the CE estimates of Rents at BLS.

Although using the simple weighted geometric means (GM) from both surveys is the most straightforward method, the quality-adjusted (QA) means allow us to make a more accurate comparison between similar units, as they take into account differences in other characteristics of the units, such as number of baths, total number of rooms and the approximate age of the structure.

Once we obtain the ratio of OOR to Rents (from the BLS data), it is multiplied by the ACS rents to give us the imputed OOR in the ACS. These imputed OOR values are then multiplied by the number of owner-occupied units to get the total OOR expenditures.

Recall that the BLS data consist of annual values, whereas the ACS spans the 2005-2009 period. We find the geometric mean over the five years, and include a year dummy as an independent variable when estimating the quality-adjusted means. Martin (2011) has a detailed description of numerous BLS and ACS Rent regressions with their estimated parameters and variances.

Table 7, columns (1) and (2), show the ratio of OOR to Rents using the BLS data. Column (1) is the ratio of the weighted geometric means, labeled GM, while (2) uses the quality-adjusted weighted geometric means, labeled QA. The QA ratios are slightly lower for Apartments and slightly higher for both Attached and Detached houses.

Column (3) is the weighted geometric mean of the monthly Rents in the ACS data while column (4) is the corresponding quality-adjusted mean using a hedonic regression. Column (5) is equal to column (1) times column (3), that is, the ratio of the BLS geometric means applied to the ACS geometric means, while column (6), is the equivalent calculation using the quality-adjusted means.

In all but the 1 and 2 bedroom detached homes, the imputed OORs are lower when using the quality adjusted means.

Table 7. OOR:Rent ratios and Imputed OOR

Type Structure	Bedrooms	BLS (OOR:Rent)		ACS Rent (Monthly \$)		ACS Imputed OOR (Monthly \$)	
		GM	QA	GM	QA	GM	QA
		(1)	(2)	(3)	(4)	(5)	(6)
Apartment	0	1.346	1.330	627	620	844	825
	1	0.939	0.939	652	629	612	590
	2	0.946	0.947	817	775	773	734
	3	0.974	0.972	892	791	870	769
Attached	1	0.894	0.905	645	634	577	574
	2	1.000	0.996	887	837	887	834
	3	1.009	1.016	1,072	933	1,082	948
Detached	1	1.028	1.033	620	639	637	660
	2	1.095	1.119	769	774	842	866
	3	1.140	1.137	986	918	1,124	1,044
	4	1.052	1.064	1,211	1,051	1,274	1,118

The BLS OOR:Rent ratio for studio apartments is significantly higher than the ratios in all other categories. We look at this in more detail below. [Table 8](#) shows the breakdown of OOR and Rent values for the BLS data.

Table 8. Monthly OOR and Rents: Geometric Means and Quality-Adjusted Means, BLS

Type Structure	Bedrooms	GM			QA		
		OOOR (\$)	Rent (\$)	OOOR:Rent ratio	OOOR (\$)	Rent (\$)	OOOR:Rent ratio
Apartment	0	933	693	1.346	1,198	901	1.330
	1	663	705	0.939	792	844	0.939
	2	768	811	0.946	784	828	0.947
	3	1,009	1,035	0.974	900	926	0.972
Attached	1	508	568	0.894	614	678	0.905
	2	714	714	1.000	730	733	0.996
	3	998	989	1.009	818	805	1.016
Detached	1	579	563	1.028	697	675	1.033
	2	695	635	1.095	764	683	1.119
	3	1,002	879	1.140	884	778	1.137
	4	1,357	1,289	1.052	967	909	1.064

The Geometric Mean for OOR for studio apartments is higher than that for 1 and 2-bedroom apartments (\$933 compared with \$663 and \$768 respectively), but this is not true for Rents. The Quality-Adjusted OOR mean for studio apartments is also higher for 1, 2 and 3-bedroom apartments (\$1,198 compared to \$792, \$784 and \$900, respectively), but in addition, is higher for Rents compared to 1 and 2 bedroom apartments. When we take their OOR:Rent ratio, it exaggerates this gap between studios and other-sized apartments.

It is not clear from the data exactly why these differences arise. Some possible explanations might be from the sampling distribution. Only about 2% of the sample is for studio apartments, compared with 25% for 1-bedroom apartments and nearly 30% for 2-bedroom apartments. In addition, most of the sampled studio apartments are in the metropolitan areas, especially in New York and Miami. Although we control for the number of baths and the length of occupancy, as well as whether the structure is very old or new, there are likely some significant unobserved characteristics, such as building amenities, that we cannot measure.

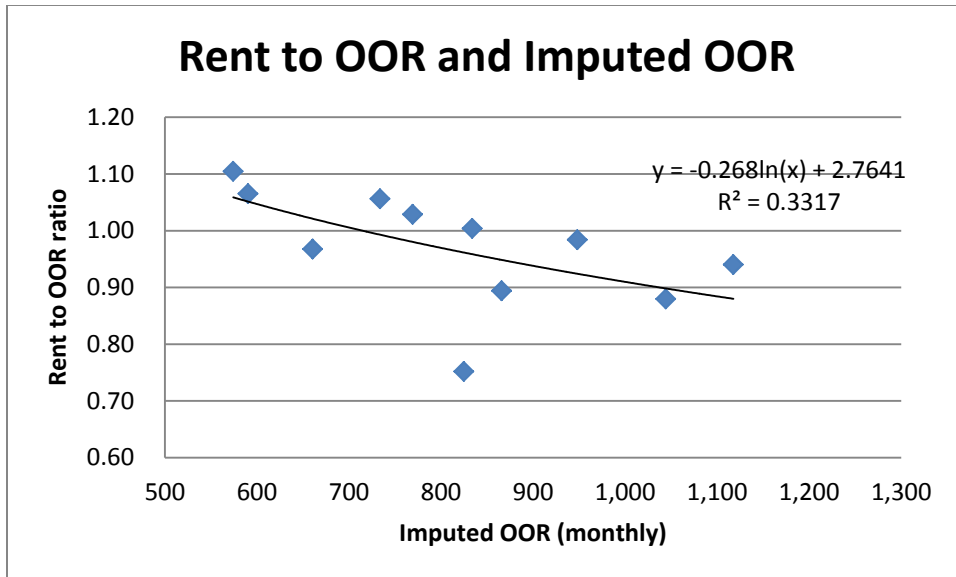
Note that even the geometric mean for OOR of studio apartments is higher than that of 1 and 2-bedroom attached and detached houses, so it is not simply the quality-adjustment that is causing the differences between studio apartments and other units.

[Figures 9 and 10](#) illustrate the relationship between Rent to Owner-Occupied Rents and the Imputed OOR in [Table 7](#), for the Quality-Adjusted values. The vertical axis is the inverse of the OOR:Rent ratio (to be consistent with the Rent to Value % in [Figure 8, Section B](#)), while the horizontal axis is the imputed OOR. The trend line is the simple log-linear relationship. [Figure 10](#) is exactly the same as [Figure 9](#) but removes the observation on studio apartments.

Section B showed how the Rent to Value % relationship declined with the Imputed OOR values from the RFS survey, and here we show a similar relationship using the BLS and ACS data. However, our observations are on the type of structure and number of bedrooms of the units, not on the value of the units, so the relationship is only similar **IF** values are correlated with the type of structure and number of bedrooms. We return to this point at the end of the section.

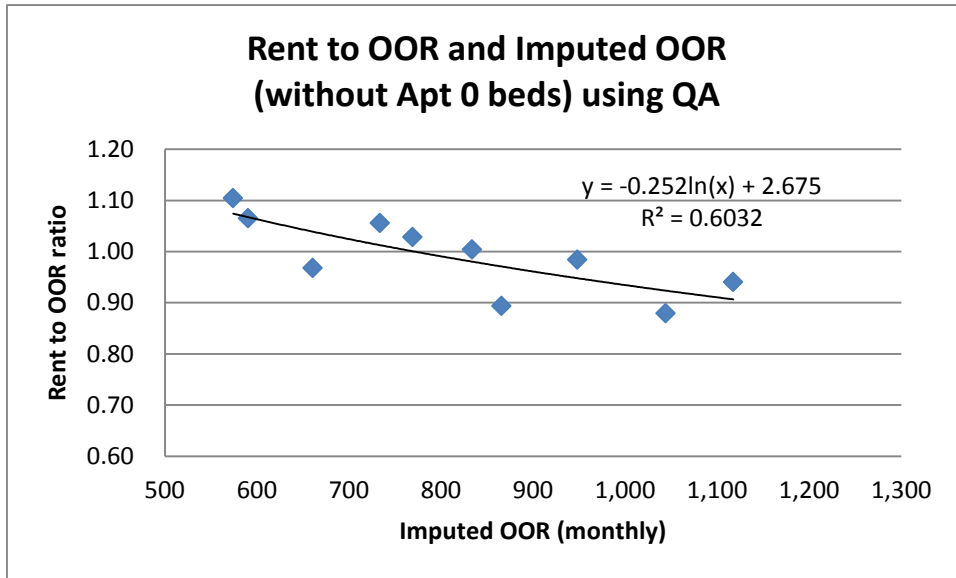
The horizontal axis in *Figure 9* corresponds to the QA Imputed OOR in the ACS, and with the exception of studio apartments, increase with the number of bedrooms. In *Figure 10*, we remove studio apartments. There is clearly less variance around the relationship in *Figure 10* compared to *Figure 9*.

Figure 9. Estimated Relationship: Rent to OOR ratio and Imputed OOR using Quality Adjusted Means



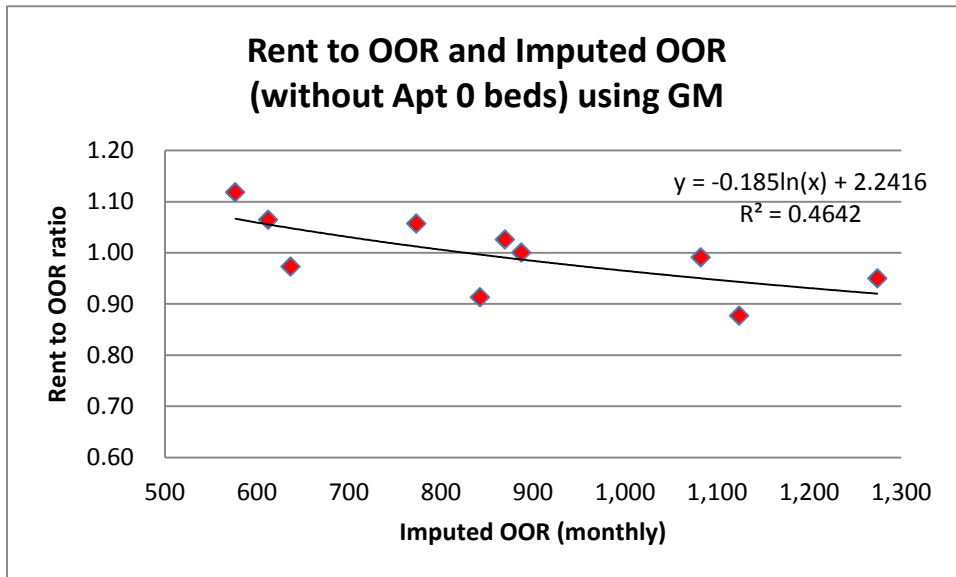
The simple R^2 in *Figure 10* jumps to 0.60 compared with 0.33 in *Figure 9*. The number of studio apartments in the BLS data is only about 2% of the total number of units, and in the ACS, studio apartments total 3.8% of tenant-occupied units and only 0.07% of owner-occupied units. A weighted estimated relationship would more closely approximate the line shown on *Figure 10*.

Figure 10. Estimated Relationship: Rent to OOR ratio and Imputed OOR, excluding 0 bedroom Apartments, using Quality Adjusted Means



In **Figure 11**, the Geometric Means are used instead of the Quality Adjusted means, again excluding the studio apartments. The Geometric Means are more spread out than the Quality Adjusted means, with a range of \$698 (\$1,274 - \$577) compared to \$543 (\$1,118 - \$574). The simple R^2 shown in **Figure 11** is 0.46, lower than the equivalent for the Quality-Adjusted relationship. The order of increasing Imputed OOR using the Geometric Means is not as well-behaved as the Quality-Adjusted order, in the sense that 2-bedroom detached houses have lower imputed OORs than both 2-bedroom attached houses and 3-bedroom apartments. Using QA means, the 2-bedroom detached houses are higher than 2-bedroom attached houses which are in turn higher than 3-bedroom apartments.

Figure 11. Estimated Relationship: Rent to OOR ratio and Imputed OOR, excluding 0 bedroom Apartments, using Geometric Means



The log-linear relationships in [Figures 9-11](#) suggest that Rent to OOR ratios decline with increasing Imputed OOR, where the observations are for type of structure and number of bedrooms. In addition, the Imputed OOR generally increase, with one exception, as we go from apartments to detached houses, and from 1 bedroom units to 3 or 4 bedroom units.

The exception is for studio apartments, as they have a low Rent to OOR ratio but a relatively high Imputed OOR. We describe this as an exception because we are implicitly assuming that values increase as we increase the number of bedrooms and as we move from apartments to detached houses. But if the value of studio apartments is higher than the value of 1, 2 and 3-bedroom apartments, studio apartments would not be an ‘exception’ and the above results would also be consistent with the RFS computations. Also, the number of studio apartments in the BLS and in the ACS, for both tenant and owner-occupied units is very low, averaging about 2% of the sample. If we posit a more sophisticated relationship, taking into account the weight of the 11 observations, we would further reduce the variance in the simple log-linear equation depicted in [Figures 9 and 11](#).

In [Table 9](#) we show the actual ACS observations on rent expenditures by type of structure and number of bedrooms and the corresponding number of tenant-occupied units (Column 1) and owner-occupied units (Column 3). The annual average Rent expenditures are equal to just over \$366 billion dollars, for about 33.6 million rental units.

Table 9. ACS Housing Units and Annualized Rent Expenditures 2005-2009

Type Structure	Bedrooms	# Rent units (1)	% Rent units	Annualized Gross Rent Expenditures (US\$ billions) (2)	# OOR units (3)	% OO units
Apartment	0	1,285,500	3.8%	10.344	75,782	0.1%
	1	9,178,185	27.3%	82.837	813,325	0.8%
	2	10,152,178	30.2%	111.201	2,179,215	2.1%
	3	2,639,590	7.9%	32.819	1,136,520	1.1%
Attached	1	236,336	0.7%	2.066	111,489	0.1%
	2	936,964	2.8%	11.088	1,696,898	1.6%
	3	859,938	2.6%	12.479	2,568,116	2.5%
Detached	1	585,692	1.7%	4.762	771,652	0.7%
	2	2,422,123	7.2%	24.532	8,521,006	8.2%
	3	3,902,134	11.6%	50.902	32,261,303	31.1%
	4	1,393,986	4.1%	22.988	19,892,274	19.2%
Total		33,592,626	100.0%	\$ 366.018	70,027,580	100.0%

By taking the number of OOR units from column (3) and multiplying by the imputed OOR (times 12 months), we obtain the data in [Table 10](#). Column (1) uses the Geometric Mean Imputed OOR (Column 5, [Table 7](#)), while Column (2) uses the Quality-Adjusted Imputed OOR (Column 6, [Table 7](#)). The total of

US\$ 922 billion (GM) and US\$ 848.8 billion (QA) are relatively close to the total of US\$ 848.2 billion shown in *Table 5*, Section B, but the latter refers to 2001.

Table 10. Imputed OOR Expenditure totals (US\$ billions)

Type Structure	Bedrooms	Imputed OOR Expenditures (US\$ billions)	
		GM (1)	QA (2)
Apartment	0	0.767	0.750
	1	5.974	5.760
	2	20.219	19.185
	3	11.859	10.489
Attached	1	0.771	0.768
	2	18.064	16.980
	3	33.349	29.218
Detached	1	5.895	6.115
	2	86.136	88.533
	3	435.144	404.224
	4	304.165	266.761
Total		922.345	848.783

Finally, *Table 11* summarizes the Rents and Imputed OOR Total annual expenditures from the last lines of *Tables 9 and 10*; and the PCE totals from *Table 1* from the beginning of this paper. The imputed OOR expenditures using Geometric Means are in column (1) while column (2) shows the estimates using the Quality-Adjusted means. The Rent expenditures are observed, not imputed, in the ACS, so they are the same.

Table 11. Total Annual Expenditures in billions of US\$ (2005-2009)

	ACS		PCE
	GM (1)	QA (2)	
Rent Expenditures	366	366	309
Imputed OOR Expenditures	922	849	1,135
Total	1,288	1,215	1,444

The total expenditures on Rents and OOR is US\$ 1.288 trillion using the geometric means and US\$ 1.215 trillion using the Quality-Adjusted means. These compare to the US \$1.444 trillion estimate by BEA for the annual average of the PCE over the 2005-2009 period.

Section D: Conclusions

The main goal of this paper was to outline a method for obtaining expenditure weights that are consistent with state and metropolitan level data available in the American Community Survey (ACS). Such weights will allow us to better estimate Regional Price Parities (RPPs) below the national level. As we look more closely at sub-national expenditures for Rents and Owner-Occupied Rents for RPPs, we also estimate national totals, which we then compare to existing measures published by the Bureau of Labor Statistics (BLS) and the Bureau of Economic Analysis (BEA).

In *Section A*, we describe the current estimates of Rent and Owner-Occupied Rent (OOR) expenditures at the national level, and *in Section B* we focus on describing the estimation of OOR expenditures in the Personal Consumption Expenditures total published by BEA.

The method used by BEA for Owner-Occupied Rent expenditures relied on a relationship based on data from a survey that was discontinued in 2001, the Residential Finance Survey. Research is underway, through a joint collaboration between BLS and the Census Bureau, to replace those estimates using administrative-level records underlying the ACS. However, the collaboration is still in its early stages.

The other source of source of expenditure weights for Rents and Owner-Occupied Rents at the national level is from the biennial Consumer Expenditure (CE) survey of the BLS. The CE is then adjusted for use in the Consumer Price Index (CPI) so that annual (and monthly) weights can be estimated.

In *Section C*, we propose a new way of estimating OOR expenditures using the BLS and the ACS data. The advantage of our proposed method is that it can be done immediately, using current surveys, and it is applicable at different geographic levels, namely at the state and metropolitan levels.

Our method consists of estimating a simple relationship between Rents and OOR in the BLS data, by type of structure (apartments, attached and detached houses) and number of bedrooms. The relationship is then applied to the observed Rents in the ACS, and a new set of imputed OOR expenditures is calculated. Our results show a relatively strong relationship between the Rent to OOR ratio from the BLS data and the imputed OOR in the ACS data, with the ratio decreasing with increasing size and type of structure, especially when we use quality-adjusted means rather than geometric means.

The main disadvantage of the proposed method is that the geographic coverage of the ACS data is only comprehensive over a five-year period. More research is needed to obtain annual estimates of OOR expenditures using the ACS, perhaps by adjusting the sampling proportions for states and metropolitan areas using their annual surveys. Another research direction is to obtain estimates of mean housing values by type of structure and number of bedrooms from current surveys, and to correlate them with our estimated imputed OOR expenditures.

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