

American Housing Survey

Break-in-Series Sample and Weighting Evaluation for the 2015 American Housing Survey

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U.S. Census Bureau, Department of Commerce
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Executive Summary

The year 2015 marks an important point in the history of the American Housing Survey (AHS). The prior AHS national longitudinal sample was in place from 1985 through 2013. In 2015, the Department of Housing and Urban Development (HUD) and the Census Bureau redesigned the AHS, including drawing new longitudinal samples for the nation and metropolitan areas.

A redesign of this magnitude requires evaluation. Most importantly, the HUD, Census Bureau, and AHS data users need to know if the 2015 AHS estimates are a continuation of the 1985 to 2013 series, or if 2015 marks a break in the series due to the changes implemented in the redesign. This evaluation uses information collected from a 2013 to 2015 bridge sample of 6,000 housing units and focuses primarily on the impact the new sample and weighting had on the AHS estimates.

The key findings of this evaluation are:

Many estimates examined exhibit no evidence of a general break-in-series due to the sample or the weighting. Many estimates examined are comparable with the 1985 to 2013 series and are consistent with estimates from other cross-sectional housing surveys. The general estimates examined include median income, median monthly housing costs without utilities, total housing units, occupied housing units, and vacant housing units.

Estimates of renter-occupied housing units and owner-occupied housing units demonstrate a change, which is most likely due to a change in the weighting. The 2015 AHS estimates differ from the 2015 AHS bridge sample under the 2013 weighting methodology. At the same time, the 2015 AHS bridge sample under the 2015 methodology is not different than either the 2015 AHS estimate or the 2015 bridge under 2013 methodology estimate. Previously in the weighting, the weights were adjusted for housing unit (HU) totals derived from the Current Population Survey by tenure and householder characteristics including age, sex, race, marital status and Hispanic origin. In 2015, this weighting adjustment was removed.

Estimates of single-attached housing units and multi-unit housing units show a change that is most likely due to a change in the questionnaire. There was an increase with single-attached housing units and a corresponding decrease with multi-unit housing units. This change is attributable to the known confusion with the concepts/definitions of the two types of housing units within the questionnaire; this may have caused some housing units that would have been classified as multi-unit housing units to be classified as single-attached housing units. The estimates of the AHS Bridge Sample (using 2013 methodology) also showed a similar increase with single-attached housing units and a similar decrease with multi-unit housing units, meaning that these changes cannot be attributed to weighting methodology.

Estimates by type of vacant housing units show a change, which is most likely due to a change in the weighting. Estimates of overall vacant housing units are comparable; however, estimates of different types of vacant housing units demonstrate a change that is likely due to a change in the weighting. The Year-Round Vacant Housing Unit domain saw a steep increase while, conversely, the Seasonally-Vacant Housing Unit domain had an offsetting decrease. Previously in the weighting, the weights were adjusted for the proportions of different types of vacant housing units from the Housing Vacancy Survey. In 2015, this weighting adjustment was removed.

1. Introduction

1.1 The American Housing Survey

The American Housing Survey (AHS), sponsored by the Department of Housing and Urban Development (HUD), underwent a major redesign in 2015 that included an entirely new sample of housing units, along with substantial revisions to the survey instrument and weighting methodology. The previous samples between 1985 and 2013 were comprised of the same core sample of housing units and relatively similar weighting methods in each biennial cycle of the survey.

Because the 2013 and 2015 AHS designs differed in several important aspects, a bridge sample was initiated to measure the changes to the survey in the event that the 2013 and 2015 estimates were incomparable. The bridge sample retained 6,000 housing units from the 2013 sample and interviewed them again in 2015 using the new 2015 questionnaire. Estimates consistent with both the 2013 and 2015 weighting methods were derived from this sample by applying the essential features of the 2013 and 2015 weights. The estimates from the bridge sample were then used to evaluate the impact of the 2015 sample design changes due to weighting methodology on the estimates.

Whenever possible, this evaluation compares similar estimates from other surveys for context. Ideally, the AHS estimates of various housing characteristics would be similar to those of the American Community Survey (ACS), the Current Population Survey (CPS), and the Housing Vacancy Survey (HVS), a supplement of the CPS. However, we do not expect the AHS estimates to match ACS, CPS, or HVS because they are different surveys with different priorities and different methodologies. A comparison of the other surveys with the AHS estimates can indicate whether any unexpected increases or decreases in AHS estimates stem from the changes made in 2015 or if they track changes noted in the other surveys.

1.2 Break-in-Series

A break-in-series is defined as a change in estimates from one survey cycle to the next that is substantial enough to make the results from the two cycles incomparable. A break-in-series may occur due to changes in the concept of a survey estimate, such as redefining a housing characteristic, or changes in the survey methodology.

This definition requires only that estimates be statistically, as opposed to materially, different to constitute a break-in-series. As discussed by Griffiths and Tadler (2016), material changes are those too large to ignore, regardless of their statistical significance. Formal determinations of materially different estimates typically rely on the judgment of subject matter experts, and hence are beyond the scope of this evaluation.

The bridge sample serves as an evaluation tool. If something unforeseen happened with the 2015 sample, such as a problem with the sample or the weighting, the estimates from the bridge sample could measure what the 2015 estimates would have looked like if we had not redesigned

the AHS sample. The next section describes some important limitations about using the bridge sample as an evaluation tool.

2. Limitations

Survey instrument. For a complete comparison of a break-in-series, a 2013 survey instrument should have been needed as a component in the bridge sample in 2015. Within our analysis, the instrument change and the sample design change that both occurred between 2013 and 2015 are confounded. Therefore, we may not be able to definitively assert that a change was due to the sample because it could also be due to a change in the instrument. The limitation of using only the 2015 survey instrument was due to cost constraints.

Some Primary Sampling Units were excluded from the sample. Also due to cost, some Primary Sampling Units were removed from the bridge sample. The number of counties removed was very small, and therefore this is unlikely to have had a substantial impact on the estimates.

No adjustment for multiple comparisons. Several statistical comparisons were made in the evaluation, and Bonferroni or other methods for multiple comparisons were not used. In an exploratory evaluation such as this, the use of multiple comparisons is not crucial. Statistically significant differences are only indicators of potential issues that should be explored further. Because significant differences are more likely to occur, the use of unadjusted statistical tests in this evaluation is a conservative approach that increases the strength of the findings.

Median Monthly Housing Cost. National medians were calculated from total monthly housing cost. Due to data imputation processing procedures, some utility costs were not calculated for the bridge sample cases using the same exact process as the AHS estimates. As a result, a median monthly housing cost metric without the cost of utilities was calculated for this analysis. A similar metric could not be calculated for other survey data or for the AHS data prior to 2011.

3. Bridge Sample Design

The bridge sample is a subsample of 6,000 completed interviews from the 2013 AHS national sample. It is nationally representative and can produce national-level estimates.

To reduce costs of interviewing for the bridge sample, the following alterations were made to the sample:

- 1) Eighteen counties were removed that were not in or adjacent to a 2015 Primary Sampling Unit and that were marked as particularly difficult to reach by regional office staff. It would have been prohibitively expensive to interview in these counties.
- 2) Only housing units successfully interviewed in the 2013 AHS were eligible for the bridge sample. This improved the chances of completing a future interview.

Within the remaining counties, the Census Bureau selected 6,000 sample housing units from the 2013 AHS sample proportional to an estimated population within each original 1980 stratum. The base weights of the bridge sample were then adjusted by the estimated current proportion of stratum population totals N_h by sample size n_h within each stratum h .

4. Weighting

This section describes the important aspects of the weighting methodology for the five different sets of weights and the resulting five sets of estimates used in this evaluation.

Estimates from ACS and HVS are included in this evaluation. For a full accounting of the ACS weights see U.S. Census Bureau (2014), and for the HVS weighting methodology see U.S. Census Bureau (2016).

Killion (2016) and Ash *et al.* (2017) provide the full specifications for the 2013 and 2015 AHS weighting methodologies, respectively. With both 2013 and 2015, each unit receives a basic weight, which reflects its probability of selection. This weight then undergoes a number of adjustments including:

- First-stage ratio adjustment to control totals
- Noninterview adjustment
- Raking adjustment to control totals

Table 1 summarizes the main differences between the cells of the 2013 and the 2015 of the noninterview adjustment within the weighting. For 2015, the nonresponse adjustment was updated based on research by Prunty (2016) that examined the variables used to form noninterview adjustment cells. With both 2013 and 2015, the completed interviews were adjusted by the noninterviews using weighted counts within cells formed by the variables listed in Table 2

Table 1: Comparison of the Cells of the 2013 and 2015 Noninterview Adjustments

2013	2015
<ul style="list-style-type: none"> (a) Occupied & No prior data <ul style="list-style-type: none"> - Inside/Outside Central City - Owner/renter - Type of Housing unit (b) Owner & Prior data <ul style="list-style-type: none"> - Metropolitan Status - Type of housing unit - Number of rooms (c) Renter & Prior data <ul style="list-style-type: none"> - Special Living/Not Special Living - Type of housing unit - Metropolitan Status - Inside/Outside Central City - Number of units in structure (d) Vacant housing units <ul style="list-style-type: none"> - Year-round/seasonal - Special Living/Not Special Living - Metropolitan Status - Inside/Outside Central City 	<ul style="list-style-type: none"> (a) Type of housing unit <ul style="list-style-type: none"> - House, apartment, flat - Mobile home - Other (b) Metropolitan Status <ul style="list-style-type: none"> - Metropolitan; Principal City - Metropolitan; not Principal City - Micropolitan (c) Urban/rural status <ul style="list-style-type: none"> - Urbanized Area - Urbanized Cluster - Rural (d) Tract-level quartiles of median income

Table 2 summarizes the main differences between the 2013 and the 2015 weighting methods with respect to the control totals used in the raking. The changes in the control totals used in the raking adjustment are discussed in Ash (2015).

Table 2: Comparison of the 2013 and 2015 Weighting Methods

Feature of the Weighting		2013	2015
Geography for raking		- Census Region	- Census Division/selected states/selected CBSAs
Control Totals for the Raking	New construction totals	- Jan 1980-Dec 1984 - Jan 1985-Dec 1989 - Jan 1990-Dec 1994 - Jan 1995-Dec 1999 - Jan 2000-Dec 2004 - Jan 2005-Dec 2009 - Jan 2010-June 2013	Prior four years only - 2011-2012 - 2013-2014
	Person totals	Housing unit totals from CPS by Census Division, tenure, and householder characteristics including age, sex, race, marital status, Hispanic origin.	- Total persons - Black persons, - Persons aged 65+ - Hispanic persons.
	Vacancy status	Used proportions from HVS	Did not use HVS or any other source.
	HUD totals	Not used	- Public Housing - Private Project Based - Voucher

Three different bridge weights were calculated for the bridge sample: two weights using an approximation of the 2013 methodology, and one weight using an approximation of the 2015 methodology. All three weights of the bridge sample preserve the essential features of the weights, although a sample size of 6,000 sample units could not support the same number of cells within the noninterview adjustment or the raking adjustment. These simplified bridge weights yield estimates from the bridge sample that are comparable to the weights, albeit with larger variances.

The basic weight for bridge sample (BW_{bridge}) was calculated as

$$BW_{bridge} = BW_{year} \times NAF_{year} \times \frac{N_h}{n_h}$$

where

BW_{year} base weight of the AHS weights for year 2013 or 2015

NAF_{year} noninterview adjustment factor for the AHS weights for 2013 or 2015

5. Statistical Comparisons

Testing for a break-in-series requires statistical comparisons of different estimates. Table 3 describes the three statistical comparisons used in this evaluation and the conclusions that can be derived from each comparison.

Table 3: Types of Statistical Comparisons in the Evaluation

A statistical difference between...		...implies...
2015 AHS	2015 Bridge with 2013 Weighting Method	There is a change in the weighting or the sample; there may be a change in the instrument
2015 Bridge with 2013 Methodology	2015 Bridge with 2015 Weighting Method	There is a change in the weighting
2015 AHS	2015 Bridge with 2015 Weighting Method	The weighting for the 2015 bridge was implemented incorrectly.

The first two comparisons are included in the results section below. The third comparison of the 2015 AHS and 2015 bridge sample estimates is only in the Appendix because it is an internal check on the weighting methodology and not an indicator of a break-in-series. None of the differences in the estimates in the third comparison were significant.

In addition to making these internal AHS comparisons, we also included estimates to other Census surveys, particularly the American Community Survey (ACS) and the Housing Vacancy Survey supplement to the Current Population Survey (HVS). The estimates from other surveys were used to examine whether AHS was generally tracking the same trends as the other surveys; however, strict statistical comparisons of the trends were not made.

All formal statistical comparisons were made at a 90% confidence level.

In all tables, the numbers after estimates in parentheses represent the estimated standard error of the estimate.

6. Results

The key findings of this evaluation are:

Many estimates examined exhibit no evidence of a general break-in-series due to the sample or the weighting. Many estimates examined are comparable with the 1985 to 2013 series and are consistent with estimates from other cross-sectional housing surveys. The general estimates examined include median income, median monthly housing costs without utilities, total housing units, occupied housing units, and vacant housing units.

Estimates of renter-occupied housing units and owner-occupied housing units demonstrate a change, which is most likely due to a change in the weighting. The 2015 AHS estimates differ from the 2015 AHS bridge sample under the 2013 weighting methodology. At the same time, the 2015 AHS bridge sample under the 2015 methodology is not different than either the 2015 AHS estimate or the 2015 bridge under 2013 methodology estimate. Previously in the weighting, the weights were adjusted for HU totals derived from the CPS by tenure and householder characteristics including age, sex, race, marital status and Hispanic origin. In 2015, this weighting adjustment was removed.

Estimates of single-attached housing units and multi-unit housing units show a change that is most likely due to a change in the questionnaire. There was an increase with single-attached housing units and a corresponding decrease with multi-unit housing units. This change is most likely attributable to the known confusion with the concepts/definitions of the two types of housing units within the questionnaire; this may have caused some housing units that would have been classified as multi-unit housing units to be classified as single-attached housing units. The estimates of the AHS Bridge Sample (using 2013 methodology) also showed a similar increase with single-attached housing units and a similar decrease with multi-unit housing units, meaning that these changes cannot be attributed to weighting methodology.

Estimates by type of vacant housing units show a change, which is most likely due to a change in the weighting. Estimates of overall vacant housing units are comparable; however, estimates of different types of vacant housing units demonstrate a change that is likely due to a change in the weighting. The Year-Round Vacant Housing Unit domain saw a steep increase while, conversely, the Seasonally-Vacant Housing Unit domain had an offsetting decrease. Previously in the weighting, the weights were adjusted for the proportions of different types of vacant housing units from the Housing Vacancy Survey. In 2015, this weighting adjustment was removed.

Table 4 summarizes the four findings of this evaluation, the domains or groups of housing units that apply to those findings, and the sections of this document that provide the details.

Table 4: Summary of Break-in-Series Results

Domains	Finding	Section
Total Housing Units		
Total Occupied Housing Units	No Break-in-series	6.1
Total Vacant Housing Units		
Median Household Income		
Renter-Occupied Housing Units	Change in Weighting	6.2
Owner-Occupied Housing Units		
Single-Attached Housing Units	Change in Definition	6.3
Multi-Unit Housing Units		
Seasonally-Vacant Housing Units	Change in Weighting	6.4
Year-Round Vacant Housing Units		

6.1 No Break-in-Series

With only a few exceptions, the newly selected sample and new weighting methodology did not appear to cause a break-in-series of AHS national sample estimates. A discussion of the key estimates along with the small, yet significant exceptions, are discussed in the following sections.

6.1.1 Total Housing Units

Figure 1 shows estimates of total housing units for survey years 2007 to 2015.



Figure 1 shows the 2015 AHS value of 134,789,944 housing units is closer to the ACS estimate of 134,793,665 housing units (0.003 percent difference) than the Bridge 2013 method estimate of 134,832,735 housing units (0.032 percent difference).

The changes of the estimates are also similar across surveys. From 2013 to 2015, the AHS total housing unit estimate increased 1.47 percent, from 132,832,000 to 134,789,944. ACS estimates changed from 132,808,137 to 134,793,665, representing a 1.49 percent increase. HVS estimates increased 1.19 percent, from 133,276,000 to 134,857,000 (see Table 6).

Table 5: Estimates of Total Housing Units, 2013 and 2015

Estimate [thousands]	Data Collection Years	
	2013	2015
AHS	132,832	134,790
AHS Bridge 2013	132,814	134,833
AHS Bridge 2015	(X)	134,790
ACS	132,808	134,794
HVS	133,276	134,857

(X) denotes an estimate that is not applicable.

These estimates indicate that there is no break-in-series for total housing units.

This is an expected result because the AHS and ACS are controlled to the same set of housing unit counts produced as part of the Census Bureau population estimates. Therefore they have no standard error and significance testing is not applicable. Differences between the AHS and ACS are due to rounding in the ACS.

6.1.2 Total Occupied Housing Units

Figure 2 shows estimates of total occupied housing units for survey years 2007 to 2015.

Figure 2: Total Occupied Housing Units by Survey, 2007 to 2015

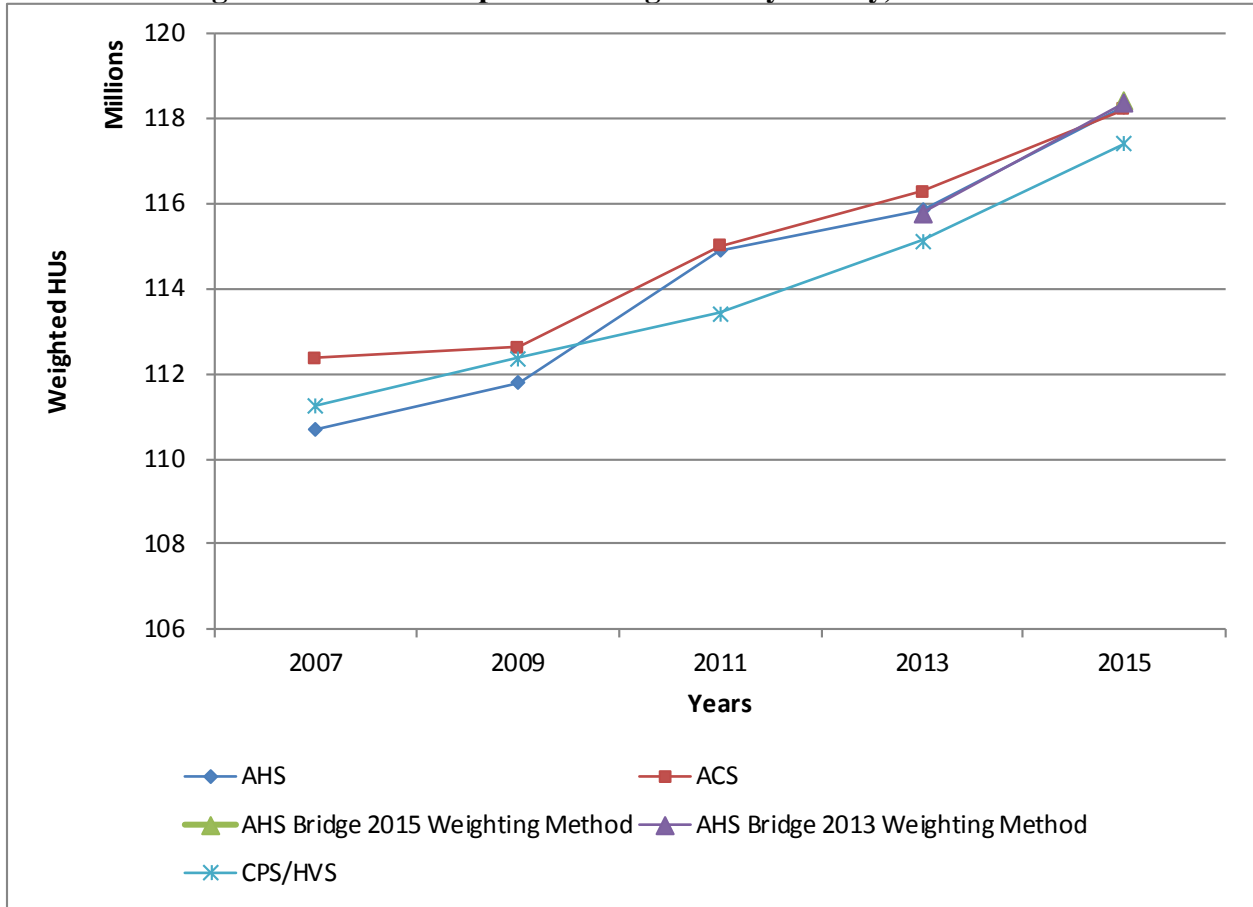


Figure 2 shows the 2015 AHS value of 118,289,879 total occupied housing units is closer to the ACS estimate of 118,208,250 housing units (0.069 percent difference) than the Bridge 2013 method estimate of 118,368,400 (0.135 percent difference). This shows that the 2015 AHS estimate is more aligned with the ACS estimate for total occupied housing units which is likely due to an improvement in the 2015 AHS weighting methodology.

The changes of the estimates are also similar across surveys, as seen in Figure 2. From 2013 to 2015, the AHS total occupied housing unit estimate increased 2.1 percent, from 115,852,000 to 118,289,879 housing units. Equivalent ACS estimates increased 1.65 percent, from 116,291,033 to 118,208,250 housing units. Similarly, the HVS estimates increased 1.97 percent, from 115,140,000 to 117,406,000 housing units.

These estimates for total occupied housing units are similar to those of total housing units for both the AHS and ACS. This is important because, unlike total housing units, estimates of occupied housing units were not controlled to a set of housing unit counts. The 2015 estimates for AHS, both the AHS and the bridge, are similar to each other and also similar to the ACS. This means that the ratio of occupied to vacant housing units was approximately the same before any raking adjustments for all three samples: AHS, bridge sample, and the ACS. It should be noted that the three surveys have similar definitions of occupied and vacant housing units.

Table 6 shows the estimates of the total number of occupied housing units for 2013 and 2015, along with standard errors.

Table 6: Estimates of Total Occupied Housing Units, 2013 and 2015

Estimate [thousands]	Data Collection Years	
	2013	2015
AHS	115,852 (438)	118,290 (247)
AHS Bridge 2013	115,788	118,368 (1,223)
AHS Bridge 2015	(X)	118,425 (699)
ACS	116,291	118,208

(X) denotes an estimate that is not applicable and the standard error of an estimate follows the estimate in parenthesis.

Table 7 shows the results of significance testing of occupied housing unit estimates for 2015 across AHS, the Bridge 2013 method, and the Bridge 2015 method. Neither of the differences tested were statistically significant.

Table 7: Significance Testing of Total Occupied Housing Units

Sample	Tested by Percent Difference	
	AHS and Bridge 2013	Bridge 2013 and Bridge 2015
AHS	-0.07 (0.858)	(X)
AHS Bridge 2013	Not significant	0.05 (0.933)
AHS Bridge 2015	(X)	Not significant

(X) denotes an estimate that is not applicable and the standard error of an estimate follows the estimate in parenthesis.

There is no break-in-series for total occupied housing units.

6.1.3 Total Vacant Housing Units

Figure 3 shows estimates of total vacant housing units in millions by survey years 2007 to 2015.

Figure 3: Total Vacant Housing Units by Survey, 2007 to 2015

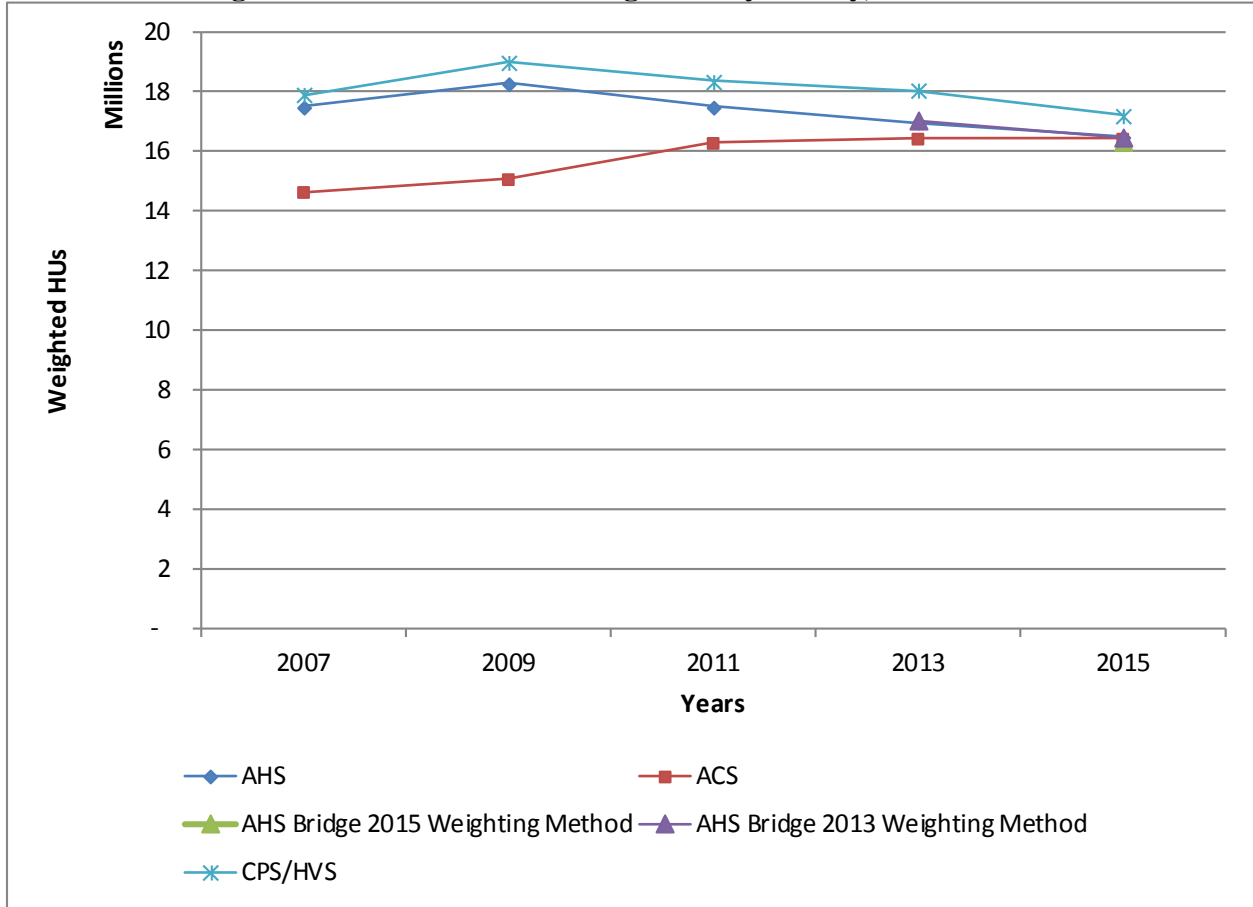


Figure 3 shows the 2015 AHS estimate of 16,500,065 total vacant housing units is closer to the ACS estimate of 16,425,535 housing units (0.045 percent difference) than the Bridge 2013 method estimate of 16,464,335 (0.24 percent difference). This shows an improvement in the 2015 weighting method due to better consistency of total vacant housing units compared to ACS.

The changes of the estimates show decreasing trends across surveys, as shown in Figure 3. From 2013 to 2015, the AHS total vacant housing unit estimate decreased 2.83 percent, from 16,981,000 to 16,500,065. Equivalent ACS estimates decreased 0.13 percent, from 16,447,558 to 16,425,535. The HVS estimates decreased 4.53 percent, from 18,043,000 to 17,225,000.

Estimates of total vacant housing units are the complement of total occupied housing units. As a result, all conclusions concerning occupied housing units also apply to vacant housing units. Like occupied housing units, the estimates of total vacant housing units were consistent among the samples despite not being controlled to counts of vacant housing units.

Table 8 shows the estimates of the total number of vacant housing units for 2013 and 2015, along with standard errors.

Table 8: Estimates of Total Vacant Housing Units, 2013 and 2015

Estimate [thousands]	Data Collection Years	
	2013	2015
AHS	16,981 (575)	16,500 (247)
AHS Bridge 2013	17,025	16,464 (1,221)
AHS Bridge 2015	(X)	16,364 (699)
ACS	16,447	16,425

(X) denotes an estimate that is not applicable and the standard error of an estimate follows the estimate in parenthesis.

Table 9 shows the results of significance testing comparisons of total vacant housing unit estimates for data year 2015 across AHS, the Bridge 2013 method, and the Bridge 2015 method. Neither of the differences tested were statistically significant. The values in parenthesis after estimates represent the standard error of the estimates in Table 9.

Table 9: Significance Testing of Total Vacant Housing Units

Sample	Tested by Percent Difference	
	AHS and Bridge 2013	Bridge 2013 and Bridge 2015
AHS	-0.22 (6.96)	(X)
AHS Bridge 2013	Not significant	0.61 (6.80)
AHS Bridge 2015	(X)	Not significant

(X) denotes an estimate that is not applicable and the standard error of an estimate follows the estimate in parenthesis.

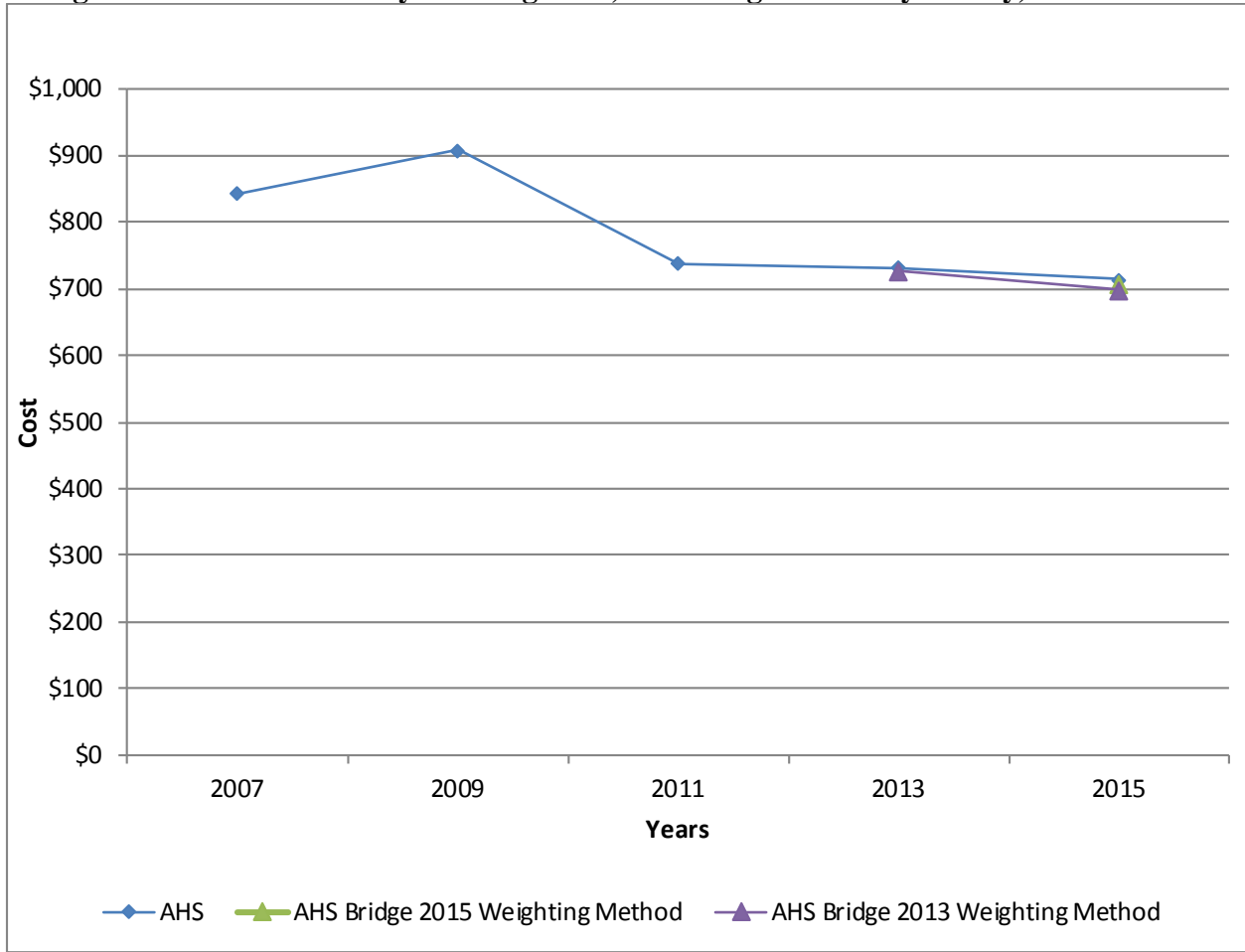
There is no break-in-series for total vacant housing units.

6.1.4 Median Monthly Housing Cost – Excluding Utilities

In the AHS, median monthly housing cost is defined as the summation of applicable monthly utility costs, property taxes, insurance payments, homeowner association fees, lot fees, rent or mortgage, maintenance, and other reported housing costs. Due to the cost and complexity of imputing values of utilities for the bridge sample, utilities were not imputed for the bridge sample. To ensure a proper comparison, utility costs were removed from both the AHS and the bridge estimates of median monthly housing cost.

Figure 4 shows estimates of median monthly housing costs, excluding utilities, by survey years 2007 to 2015.

Figure 4: Median Monthly Housing Cost, Excluding Utilities by Survey, 2007 to 2015



The consistency of AHS data for median monthly housing cost without utilities from 2013-2015 was also analyzed. Figure 4 shows that the estimates were similar for AHS and the bridge sample. From 2013 to 2015, the AHS estimate of median monthly housing cost without utilities decreased 2.19 percent, from \$731 to \$715. Equivalent estimates from the bridge sample changed from \$727 to \$699, a 3.85 percent decrease. The 2015 AHS bridge estimate was \$707.

Table 10 shows the estimates of the median monthly housing cost without utilities for 2013 and 2015, along with standard errors.

Table 10: Estimates of Median Monthly Housing Cost for 2013 and 2015, Excluding Utilities

Estimate	Data Collection Years	
	2013	2015
AHS	\$731 (5.47)	\$715 (4.98)
Bridge 2013	\$727	\$699 (10.78)
Bridge 2015	(X)	\$707 (14.01)

(X) denotes an estimate that is not applicable and the standard error of an estimate follows the estimate in parenthesis.

Table 11 shows the results of significance testing comparisons of median monthly housing cost without utilities estimates for data year 2015 across AHS, the Bridge 2013 method, and the Bridge 2015 method. Neither of the differences tested were statistically significant.

Table 11: Significance Testing of Median Monthly Total Housing Cost, Excluding Utilities

Sample	Tested by Total Difference	
	AHS and Bridge 2013	Bridge 2013 and Bridge 2015
AHS	\$641 (1,713)	(X)
AHS Bridge 2013	Not significant	\$1,619 (1,822)
AHS Bridge 2015	(X)	Not significant

(X) denotes an estimate that is not applicable and the standard error of an estimate follows the estimate in parenthesis.

There is no break-in-series for median monthly housing cost without utilities.

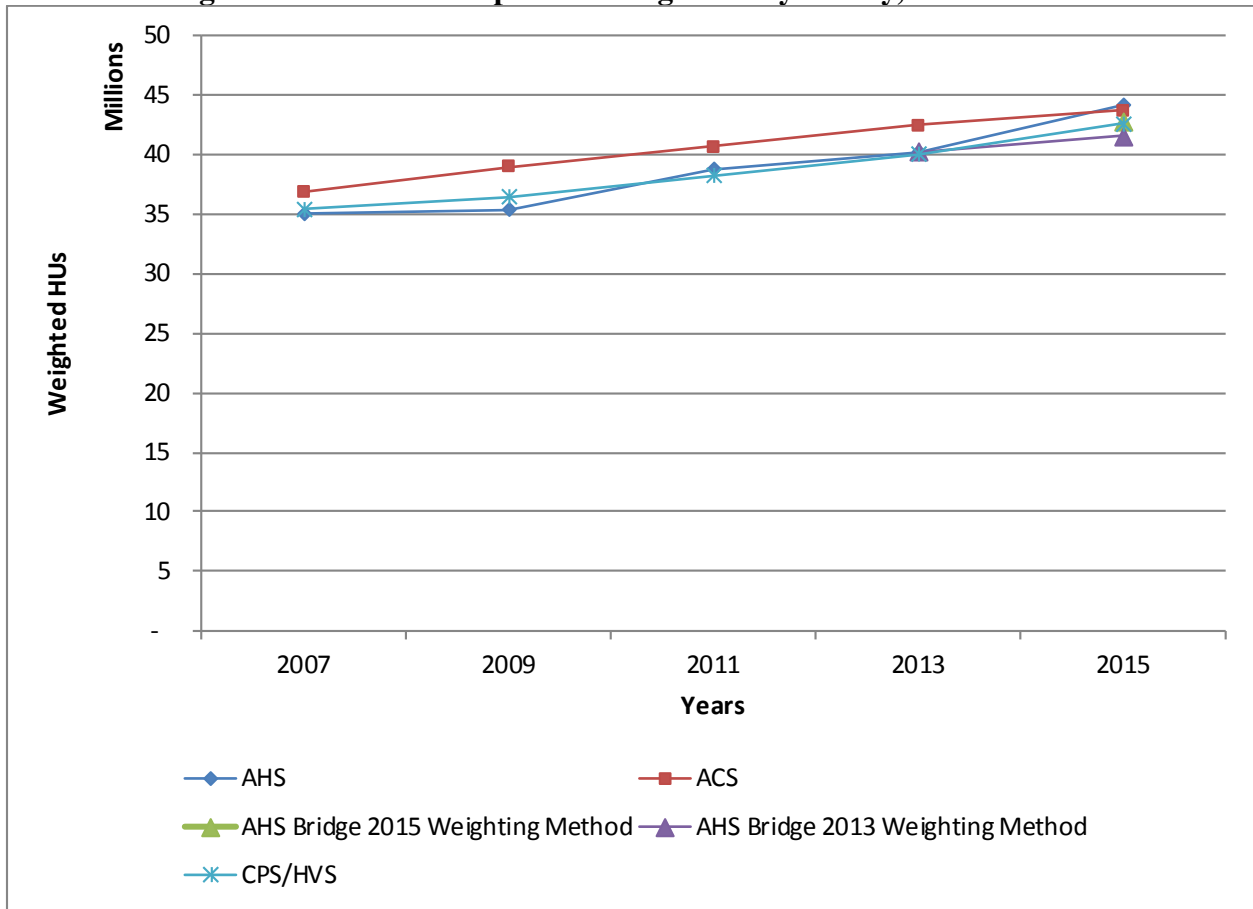
6.2 Change in the Weighting – Renter- and Owner-Occupied Housing Units

Estimates of owner-occupied housing units decreased and renter-occupied housing units increased. Additionally, the increase and decrease of the renter and owner-occupied estimates were off-setting because estimates of total occupied housing units show no evidence of a break (see section 6.1.2). The questions in the survey instrument about tenure status have not changed but the weighting methodology did change with respect to tenure. In the 2013 methodology, the weights were controlled to housing unit totals derived from the CPS that included tenure status and also included Census Division and characteristics of the householder including age, sex marital status, and Hispanic origin. One change of the 2015 weighting method included not using the CPS estimates that included tenure status. The bridge sample also provides evidence that supports the conclusion that the weighting caused a break with the occupied owner and renter estimates. The 2015 estimates derived from the same bridge sample but using the 2013 and 2015 weighting methods showed a percent increase of 2.67% for renter-occupied estimates. The analogous owner estimates were not significant but the renter-occupied estimates do support the conclusion that the change in the weighting methodology had an impact on the estimates of owners and renters.

6.2.1 Renter-Occupied Housing Units

Figure 5 shows estimates of renter-occupied housing units by survey years 2007 to 2015.

Figure 5: Renter-Occupied Housing Units by Survey, 2007 to 2015



There is a difference in the two 2015 AHS estimates of renter-occupied housing units. As shown in Figure 5, the AHS estimate was 44,157,408 housing units in 2015 while the bridge sample using the previous design weighting method was 41,593,414. This difference of 2,563,994 housing units, or 5.81 percent, is solely due to changes in the weighting. The ACS estimate was 43,737,053.

Compared to the ACS, the 2015 AHS estimate is much closer than the Bridge 2013 estimate. The difference between the ACS and the 2015 AHS estimate is 0.96 percent, compared to nearly 5 percent for the Bridge 2013. This indicates an improvement in the 2015 AHS weighting method for the estimate of renter-occupied housing units.

In addition, the changes among the AHS, ACS, and HVS estimates of renter-occupied housing units from 2013-2015 were also analyzed. Figure 5 shows that the changes of these estimates were similar across surveys. From 2013 to 2015, the AHS estimate increased 9.84 percent, from 40,201,000 housing units to 44,157,408. The ACS estimates increased about 3 percent, from 42,446,227 housing units to 43,737,053. Also showing an increasing trend, the HVS estimate increased 6.57 percent, from 40,001,000 housing units to 42,628,000.

Table 12 shows the estimates of the total number of renter-occupied housing units for 2013 and 2015, with standard errors.

Table 12: Estimates of Renter-Occupied Housing Units, 2013 and 2015

Estimate [thousands]	Data Collection Years	
	2013	2015
AHS	40,201(166)	44,157 (291)
AHS Bridge 2013	40,191	41,593 (1,062)
AHS Bridge 2015	(X)	42,732 (945)
ACS	42,446	43,737

(X) denotes an estimate that is not applicable and the standard error of an estimate follows the estimate in parenthesis.

Table 13 shows the results of significance testing of renter-occupied housing unit estimates for 2015 across AHS, the Bridge 2013 method, and the Bridge 2015 method. The AHS estimate was significantly different from the Bridge 2013 estimate.

Table 13: Significance Testing of Renter-Occupied Housing Units

Sample	Tested by Percent Difference	
	AHS and Bridge 2013	Bridge 2013 and Bridge 2015
AHS	5.81 (2.59)	(X)
AHS Bridge 2013	Significant	2.67 (2.29)
AHS Bridge 2015	(X)	Not significant

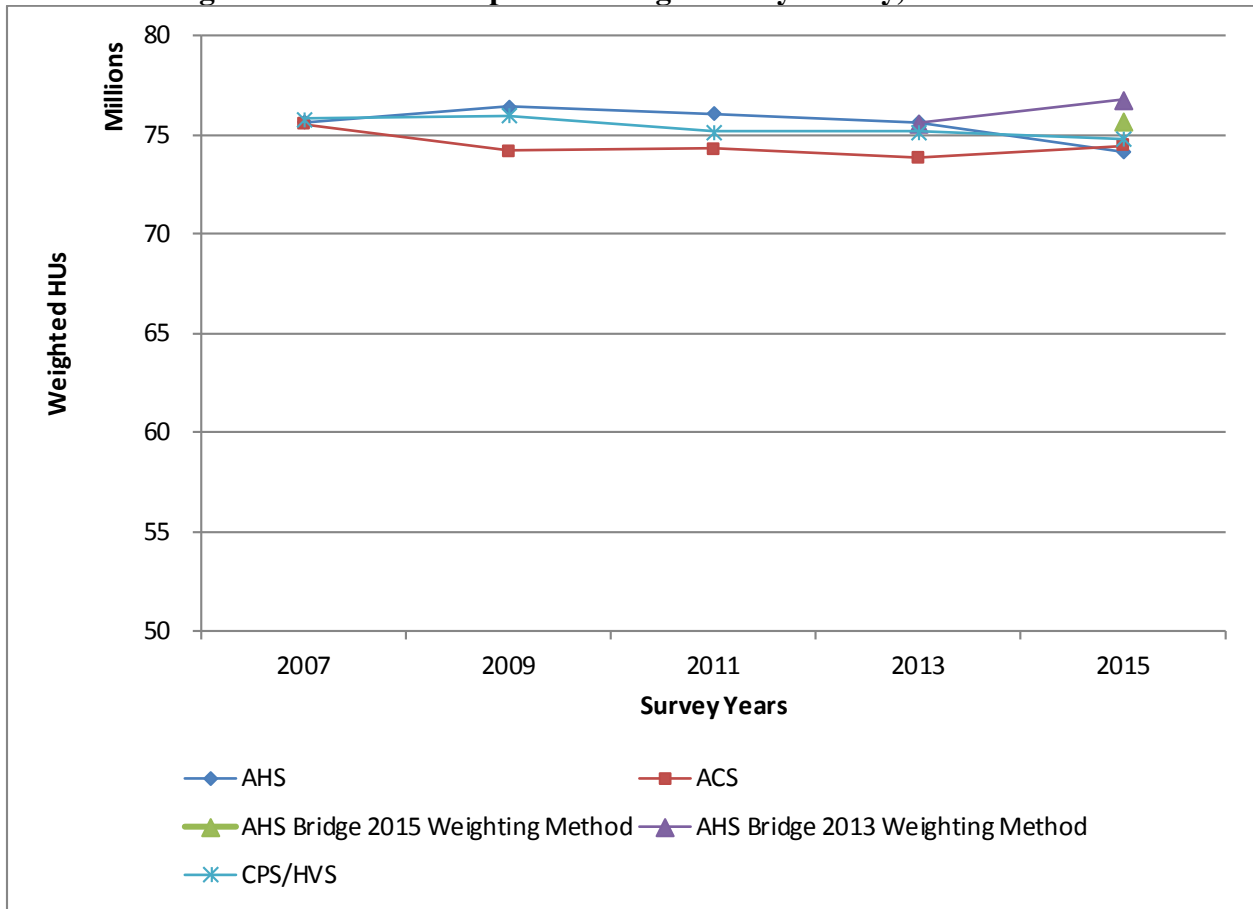
(X) denotes an estimate that is not applicable and the standard error of an estimate follows the estimate in parenthesis.

There is a break-in-series for estimate of renter-occupied housing units due to the changes in the weighting method. It should be noted that the 2015 AHS estimate is more consistent with the ACS.

6.2.2 Owner-Occupied Housing Units

Figure 6 shows estimates of owner-occupied housing units in millions by survey years 2007 to 2015.

Figure 6: Owner-Occupied Housing Units by Survey, 2007 to 2015



There is a difference in the two 2015 AHS estimates of owner-occupied housing units. As shown in Figure 6, the AHS estimate was 74,132,471 housing units in 2015 while the bridge sample using the previous design weighting method was 76,774,987, a difference of 2,642,516 housing units or 3.56 percent.

The 2015 AHS estimate is closer to the ACS estimate of 74,471,198 housing units, a 0.45 percent difference. The difference between the Bridge 2013 method and the ACS is 3.09 percent. This indicates an improvement in the 2015 AHS design when compared to the ACS.

In addition, the changes among the AHS, ACS, and HVS estimates for owner-occupied housing units from 2013-2015 were also analyzed. Figure 6 shows the changes in these estimates across surveys. From 2013 to 2015, the AHS estimate decreased 2.01 percent, from 75,650,000 housing units to 74,132,471. The ACS estimate increased 0.85 percent, from 73,844,806 housing units to 74,471,198. The HVS decreased slightly, 0.47 percent, from 75,140,000 housing units to 74,778,000.

Table 14 shows the estimates of the total number of owner-occupied housing units for 2013 and 2015, with standard errors.

Table 14: Estimates of Owner-Occupied Housing Units, 2013 and 2015

Estimate [thousands]	Data Collection Years	
	2013	2015
AHS	75,650 (308)	74,132 (301)
Bridge 2013	75,597	76,774 (1,025)
Bridge 2015	(X)	75,693 (1,042)
ACS	73,845	74,471

(X) denotes an estimate that is not applicable and the standard error of an estimate follows the estimate in parenthesis.

Table 15 shows the results of significance testing of owner-occupied housing unit estimates for 2015 across AHS, the Bridge 2013 method, and the Bridge 2015 method. There was a statistically significant difference between the 2015 AHS estimate and the Bridge 2013. The values in parenthesis after estimates represent the standard error of the estimates in Table 15.

Table 15: Significance Testing of Owner-Occupied Housing Units

Sample	Tested by Percent Difference	
	AHS and Bridge 2013	Bridge 2013 and Bridge 2015
AHS	3.56 (1.48)	(X)
AHS Bridge 2013	Significant	1.43 (1.05)
AHS Bridge 2015	(X)	Not significant

(X) denotes an estimate that is not applicable and the standard error of an estimate follows the estimate in parenthesis.

There is a break-in-series for estimate of owner-occupied housing units.

6.3 Change in Definition

The estimates discussed in this section have some difference that may be due to definitional changes in housing unit classifications.

From 2013 to 2015, the AHS estimate of single-attached housing units increased almost 30 percent, and the estimate of multi-unit housing units had a decrease of 0.46 percent. There is potential that this is due to the confusing nature of the two housing unit classifications and data collection instrument redesign.

The definitions of detached and attached housing units and a multi-unit structure are given below and can be found in U.S. Census Bureau and HUD (2011).

A housing unit is...

Detached, if it has open space on all four sides.

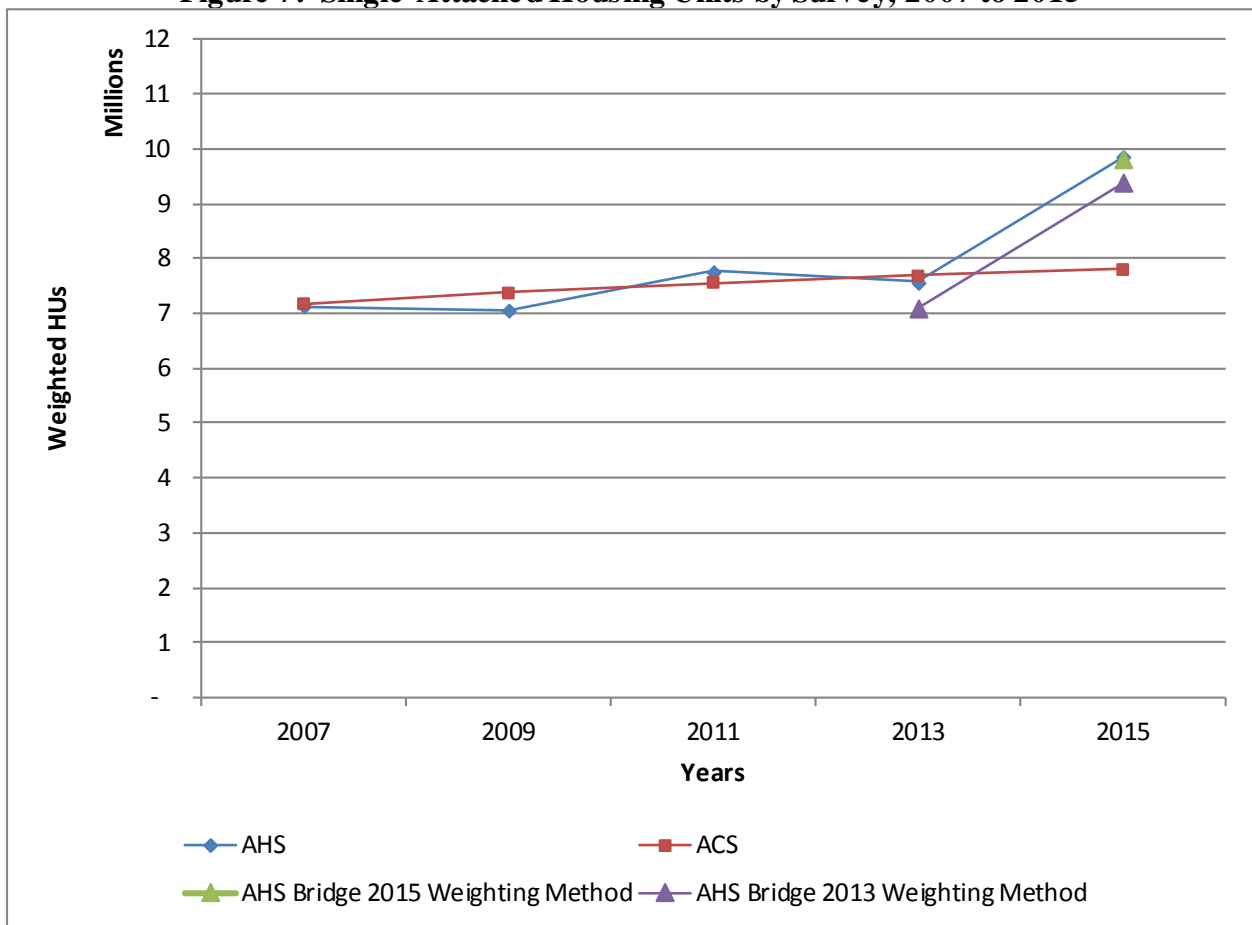
Attached, if it has unbroken walls extending from the ground to the roof that divide it from other adjoining structures as in many row houses or townhouses. If a unit shares a furnace or boiler with adjoining units, then the walls are pierced by pipes or ducts, and all of the units thus are included in one structure.

Multi-unit structure – A building that contains more than one housing unit (for example, an apartment building).

6.3.1 Single-Attached Housing Units

Figure 7 shows estimates of single-attached housing units for survey years 2007 to 2015.

Figure 7: Single-Attached Housing Units by Survey, 2007 to 2015



Estimates show that there is little difference in the two 2015 AHS estimates of single-attached housing units. As shown in Figure 7, the AHS estimate was 9,845,221 housing units in 2015 while the bridge sample using the previous design weighting method was 9,373,098 housing units. This difference of 472,123 housing units, or 4.80 percent, is due to changes in the weighting.

The 2015 AHS estimate was almost 26 percent higher than the ACS estimate, farther from the ACS estimate than the Bridge 2013 method, which is almost 20 percent greater than the ACS.

In addition, the changes of the AHS and ACS estimates of single-attached housing units from 2013-2015 were also analyzed. Figure 7 shows that the changes of these estimates were not similar across surveys. From 2013 to 2015, the AHS estimate increased nearly 30 percent, from 7,581,000 housing units to 9,845,221. Equivalent estimates from the ACS increased slightly, from 7,686,000 housing units to 7,814,000.

Table 16 shows the estimates of the total number of single-attached housing units for 2013 and 2015, along with standard errors.

Table 16: Estimates of Single-Attached Housing Units, 2013 and 2015

Estimate [thousands]	Data Collection Years	
	2013	2015
AHS	7,581 (153)	9,845 (161)
AHS Bridge 2013	7,100	9,373 (560)
AHS Bridge 2015	(X)	9,834 (560)
ACS	7,686	7,814

(X) denotes an estimate that is not applicable and the standard error of an estimate follows the estimate in parenthesis.

Table 17 shows the results of significance testing of single-attached housing unit estimates for 2015 across AHS, the Bridge 2013 method, and the Bridge 2015 method. There were no significant differences.

Table 17: Significance Testing of Single-Attached Housing Units

Sample	Tested by Percent Difference	
	AHS and Bridge 2013	Bridge 2013 and Bridge 2015
AHS	4.80 (5.70)	(X)
AHS Bridge 2013	Not significant	4.68 (2.87)
AHS Bridge 2015	(X)	Not significant

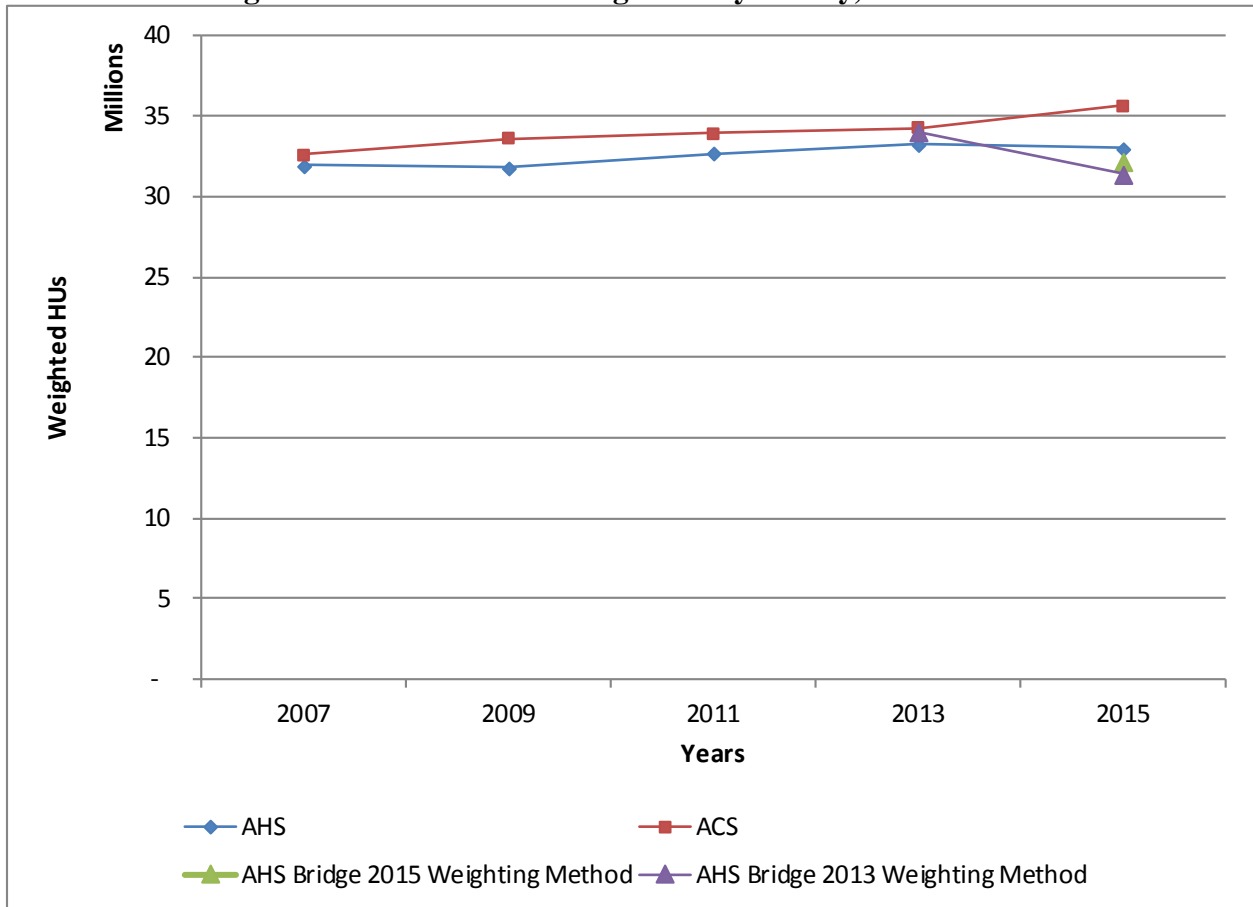
(X) denotes an estimate that is not applicable and the standard error of an estimate follows the estimate in parenthesis.

There is a no break-in-series for estimates of single-attached housing units, yet it is noted that there is a consistency issue when compared to the ACS.

6.3.2 Multi-Unit Housing Units

Figure 8 shows estimates of multi-unit housing units in millions for survey years 2007 to 2015.

Figure 8: Multi-Unit Housing Units by Survey, 2007 to 2015



There is little difference in the two 2015 AHS estimates of multi-unit housing units. As shown in Figure 8, the AHS estimate was 33,101,174 housing units in 2015 while the bridge sample using the previous design weighting method calculated an estimate of 31,412,231 housing units. This difference of 1,688,943 housing units, or 5.10 percent, is due to the change in the weighting.

The 2015 AHS estimate of 33,101,174 housing units is closer to the ACS estimate of 35,660,000 than the Bridge 2013 method estimate of 31,412,231. This shows an improvement in the 2015 design due to better consistency in multi-unit housing unit estimates compared to ACS.

In addition, the changes of the AHS and ACS estimates of multi-unit housing units from 2013-2015 were also analyzed. Figure 8 shows that the changes of these estimates were not similar across surveys. From 2013 to 2015, the AHS estimate decreased 0.46 percent, from 33,255,000 housing units to 33,101,174. Equivalent estimates from the ACS increased about 4 percent, from 34,277,000 housing units to 35,660,000.

Table 18 shows the estimates of the totals number of multi-unit housing units in 2013 and 2015, along with standard errors.

Table 18: Estimates of Total Multi-Unit Housing Units: 2013 and 2015

Estimate [thousands]	Data Collection Years	
	2013	2015
AHS	33,255 (638)	33,101 (286)
AHS Bridge 2013	33,994	31,412 (670)
AHS Bridge 2015	(X)	32,205 (839)
ACS	34,277	35,660

(X) denotes an estimate that is not applicable and the standard error of an estimate follows the estimate in parenthesis.

Table 19 shows the results of significance testing comparisons of multi-unit housing unit estimates for 2015 across AHS, the Bridge 2013 method, and the Bridge 2015 method. The AHS estimate was significantly different from the Bridge 2013 estimate.

Table 19: Significance Testing of Total Multi-Unit Housing Units

Sample	Tested by Percent Difference	
	AHS and Bridge 2013	Bridge 2013 and Bridge 2015
AHS	4.88 (2.18)	(X)
AHS Bridge 2013	Significant	2.46 (2.54)
AHS Bridge 2015	(X)	Not significant

(X) denotes an estimate that is not applicable and the standard error of an estimate follows the estimate in parenthesis.

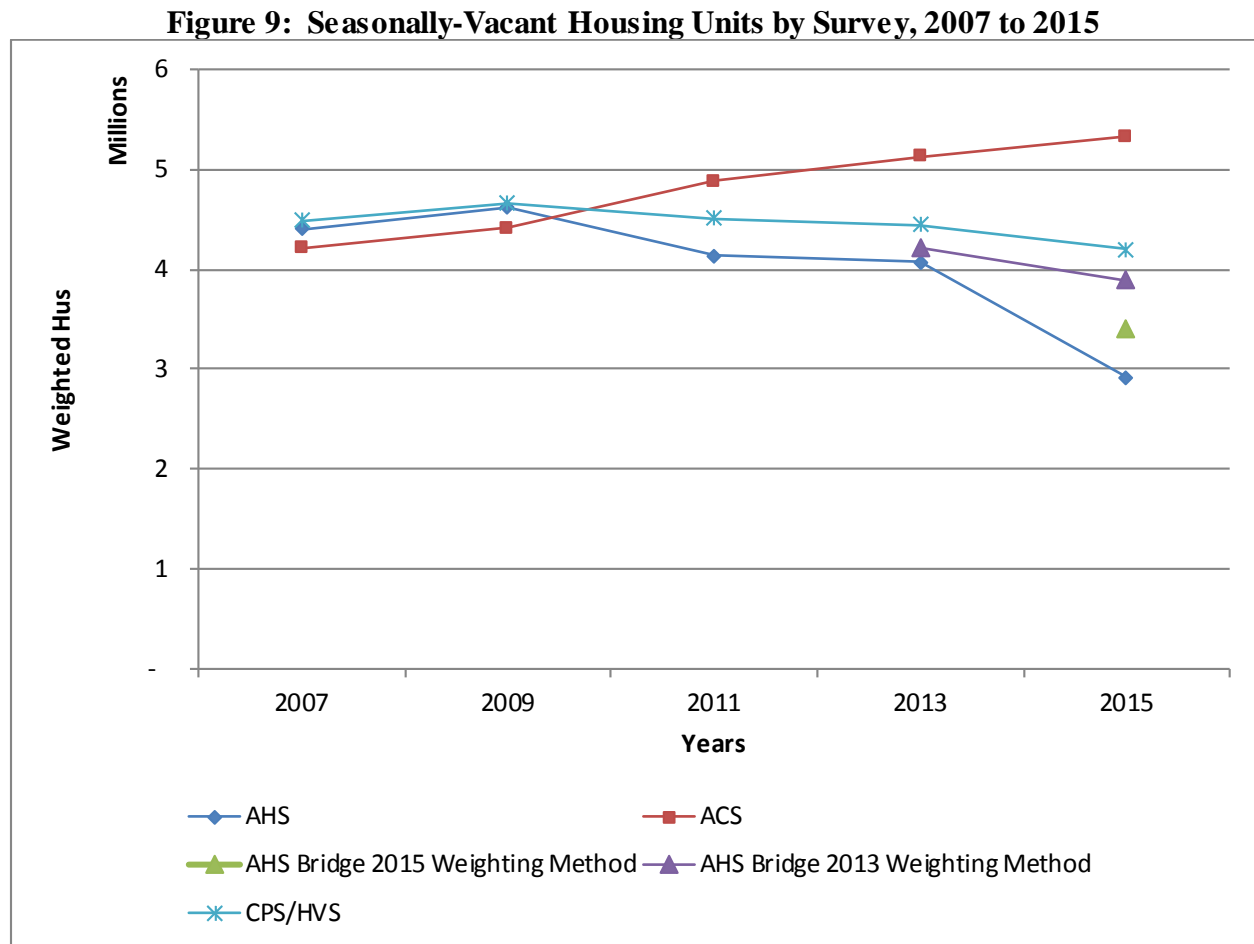
There is a break-in-series for estimates of multi-unit housing units and there is a consistency issue when compared to the ACS. It should be noted that the 2015 AHS estimate is more consistent with the ACS.

6.4 Change in Weighting – Vacant Housing Units

Estimates of different types of vacant housing units changed. Although the types of vacant housing units changed, the overall estimate of vacant housing units did not change (see section 6.1.3). The questions about vacant housing units have not changed but the weighting methodology did change. In the 2013 methodology, the weights were controlled so that the proportion of vacant housing units by type of vacant was consistent with the same proportions from the Housing Vacancy Survey. In 2015, this was changed and the weights are no longer adjusted to the proportions of vacant housing units from HVS.

6.4.1 Seasonally-Vacant Housing Units

Figure 9 shows estimates of seasonally-vacant housing units in millions by survey years 2007 to 2015.



There is a difference in the two 2015 AHS estimates of seasonally-vacant housing units. As shown in Figure 9, the AHS estimate was 2,921,506 housing units in 2015 while the bridge sample using the previous design weighting method was 3,885,040. This difference of 963,534 housing units, nearly 33 percent, is due to the changes in the 2015 AHS weighting.

The 2015 AHS estimate is farther from the ACS estimate of 5,329,103 housing units than the Bridge 2013 method. The AHS estimate is about 45 percent lower than the ACS, while the Bridge 2013 is 27 percent lower.

In addition, the changes in the AHS, ACS, and HVS estimates of seasonally-vacant housing units from 2013-2015 were also analyzed. Figure 9 shows that the changes in these estimates were not similar across surveys. From 2013 to 2015, the AHS estimate decreased about 28 percent, from 4,067,000 housing units to 2,921,506. The ACS estimate increased 4 percent, from 5,122,778 housing units to 5,329,103. The HVS estimate decreased 5.36 percent, from 4,441,000 housing units to 4,203,000.

Table 20 shows the estimates of the total number of seasonally-vacant housing units for 2013 and 2015, along with standard errors.

Table 20: Estimates of Seasonally-Vacant Housing Units, 2013 and 2015

Estimate [thousands]	Data Collection Years	
	2013	2015
AHS	4,067 (205)	2,922 (165)
Bridge 2013	4,213	3,885 (394)
Bridge 2015	(X)	3,400 (338)
ACS	5,123	5,329
HVS	4,441	4,203

(X) denotes an estimate that is not applicable and the standard error of an estimate follows the estimate in parenthesis.

Table 21 shows the results of significance testing comparisons of seasonally-vacant housing unit estimates for 2015 across AHS, the Bridge 2013 method, and the Bridge 2015 method. The 2015 AHS estimate is statistically significantly different from the Bridge 2013.

Table 21: Significance Testing of Seasonally-Vacant Housing Units

Sample	Tested by Percent Difference	
	AHS and Bridge 2013	Bridge 2013 and Bridge 2015
AHS	32.98 (15.89)	(X)
AHS Bridge 2013	Significant	14.25 (7.96)
AHS Bridge 2015	(X)	Not significant

(X) denotes an estimate that is not applicable and the standard error of an estimate follows the estimate in parenthesis.

For the adjustments that involved vacancy status with the 2013 weighting methodology, no known totals of vacant housing units or different types of vacant housing units were available. As shown in Table 2, the 2013 weighting used estimated proportions of different types of vacant housing units from the HVS. Ratio adjustments were applied to the 2013 weights so that the

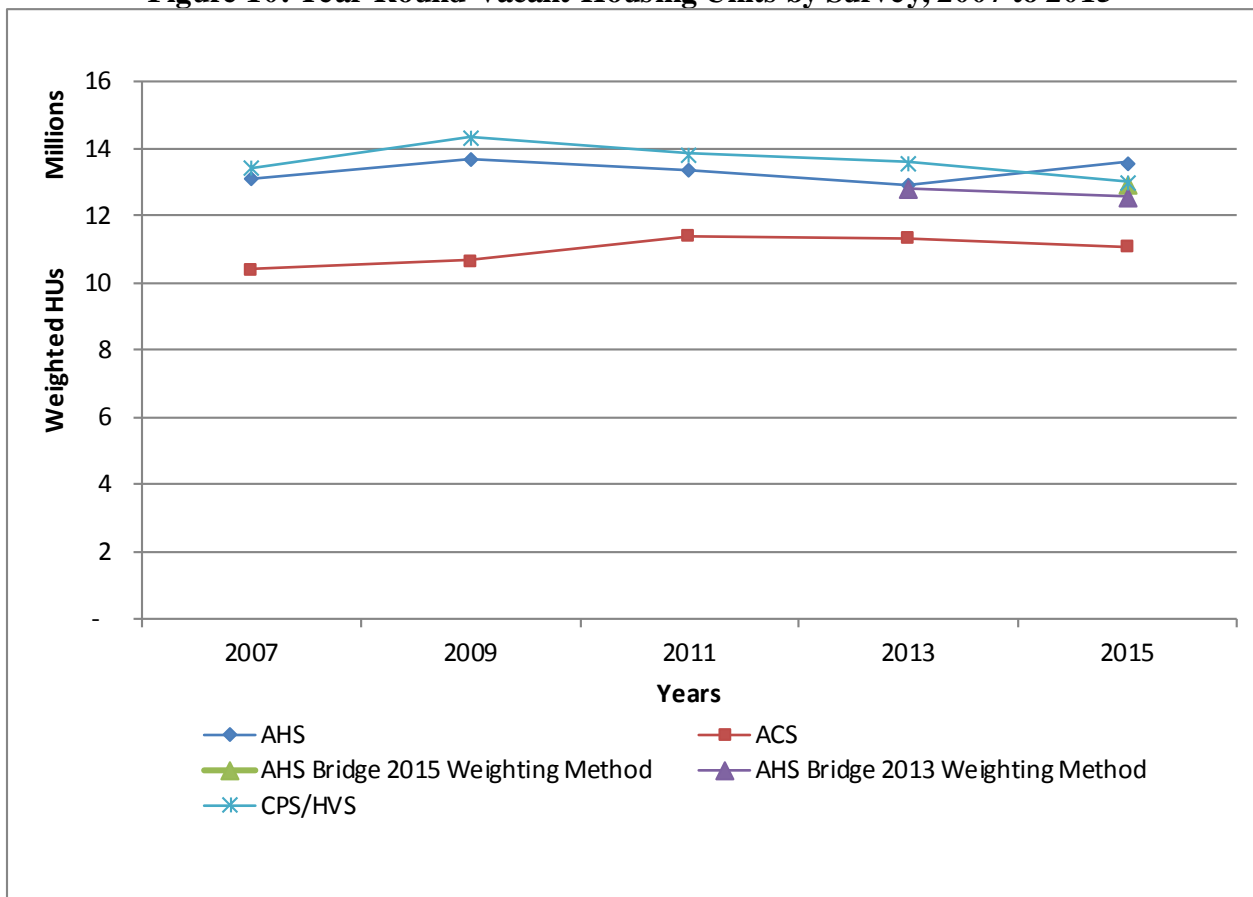
estimated proportions from AHS were equivalent to the proportions from HVS. In contrast, the 2015 weighting made no special adjustment for any type of vacant housing units.

There is a break-in-series for estimates of seasonally-vacant housing units between 2013 and 2015. Since the only difference between the two different designs is the raking methodology for weighting, this is the most likely explanation of this break-in-series.

6.4.2 Year-Round Vacant Housing Units

Figure 10 shows estimates of Year-Round Vacant housing units in millions for survey years 2007-2015.

Figure 10: Year-Round Vacant Housing Units by Survey, 2007 to 2015



There is a difference in the two 2015 AHS estimates of year-round vacant housing units. As shown in Figure 10, the AHS estimate was 13,578,559 housing units in 2015 while the bridge sample using the previous design weighting method was 12,579,295. This difference of 999,266 housing units, or 7.94 percent, is due to the changes in the weighting.

The 2015 AHS estimate is farther from the ACS estimate of 11,096,432 housing units than the Bridge 2013 method. The AHS estimate is about 22 percent higher than the ACS, while the Bridge 2013 is about 13 percent higher.

In addition, the changes of the AHS, ACS, and HVS estimates for year-round vacant housing units from 2013-2015 were also analyzed. Figure 10 shows that the changes of these estimates were not similar across surveys. From 2013 to 2015, the AHS estimate increased 5.15 percent, from 12,914,000 to 13,578,559 housing units. The ACS estimate decreased about 2 percent, from 11,324,810 to 11,096,432 housing units. The HVS estimate decreased 4.28 percent, from 13,603,000 to 13,021,000 housing units.

Table 22 shows the estimates of the total number of year-round vacant housing units in 2013 and 2015, with standard errors.

Table 22: Estimates of Year-Round Vacant Housing Units: 2013 and 2015

Estimate [thousands]	Data Collection Years	
	2013	2015
AHS	12,914 (370)	13,579 (200)
Bridge 2013	12,812	12,579 (1,083)
Bridge 2015	(X)	12,963 (608)
ACS	11,325	11,096
HVS	13,603	13,021

(X) denotes an estimate that is not applicable and the standard error of an estimate follows the estimate in parenthesis.

Table 23 shows the results of significance testing of year-round vacant housing unit estimates for 2015 across AHS, the Bridge 2013 method, and the Bridge 2015 method. There were no significant differences.

Table 23: Significance Testing of Year-Round Vacant Housing Units

Sample	Tested by Percent Difference	
	AHS and Bridge 2013	Bridge 2013 and Bridge 2015
AHS	7.36 (7.44)	(X)
Bridge 2013	Not significant	2.97 (4.26)
Bridge 2015	(X)	Not significant

(X) denotes an estimate that is not applicable and the standard error of an estimate follows the estimate in parenthesis.

Unlike seasonally-vacant housing units, there is no break-in-series for estimates of year-round vacant housing units, even with the 2015 weighting method change.

7. References

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Table A1: Comparisons of 2015 AHS and Bridge Sample Estimates

Estimate	2015 AHS	Bridge 2015	Percent Difference*	Significant?
Total housing units	134,789 (0.00)	134,789 (0.001)	0	No
Total occupied housing units	118,289 (247)	118,425 (699)	0.115	No
Total vacant housing units	16,500 (247)	16,364 (699)	0.823	No
Median household income	\$50,994 (426)	\$51,972 (752)	\$978	No
Median monthly housing cost, excluding utilities	\$715 (4.98)	\$707 (14.01)	\$8	No
Renter-occupied housing units	43,930 (287)	42,732 (944)	2.727	No
Owner-occupied housing units	74,359 (297)	75,693 (1,041)	1.794	No
Single-attached housing units	9,838 (160)	9,833 (559)	0.045	No
Multi-unit housing units	33,023 (283)	32,204 (839)	2.48	No
Seasonal-vacant housing units	2,921 (165)	3,400 (338)	16.39	No
Year-round vacant housing units	13,579 (200)	12,963 (608)	4.527	No

*Percent differences were not applicable for median estimates; total differences were used.