Appendix D. Nonsampling and Sampling Errors

All numbers from the American Housing Survey (AHS), except for sample size, are estimates. As in other surveys, errors come primarily from the following sources:

- **Incomplete data.** Incomplete data are adjusted by assuming that the respondents are similar to those not answering and the size of these errors is estimated, to include coverage errors and missing data.

- **Wrong answers.** The U.S. Census Bureau does not adjust for wrong answers and does not estimate the size of the errors.

- **Sampling Variability.** Sampling errors are not adjusted and the size of the error is estimated.

Incomplete data and wrong answers are usually the largest source of errors, larger than sampling errors. For example, in the *American Housing Survey-National* (AHS-N), the changes in weighting in 1991 and 2003 corrected some of the error due to incomplete data; that one correction averaged 2.5 percent in 1991 and 1.0 percent in 2003. Worse errors from incomplete data and from wrong answers apply to some items, discussed below. Additional information on the quality of AHS data can be obtained from the U.S. Census Bureau, *American Housing Survey: A Quality Profile*, Series H121/95-1.

INCOMPLETE DATA

Coverage errors. Because of deficiencies with sampling lists, the housing units in the AHS do not represent all housing units in the country. The Census Bureau attempts to compensate for the deficiencies by adjusting the raw numbers from the survey proportionally so that the published numbers match independent estimates of the total number of housing units. See Appendix B, "Independent Total Housing Unit Adjustment".

Missing data. Some people refuse to answer some or all of the questions and some people do not know the answers to all of the questions. When entire interviews are missing, survey estimates are adjusted for them by assuming that they are similar to some group of housing units that did report data. With this assumption, housing units that responded are adjusted accordingly to account for non-response. This assumption is never exactly true, although it is usually better than ignoring the housing units that were not interviewed (see Appendix B, "Noninterview Adjustment").

Incompleteness or "missing answers", also known as item nonresponse, can cause large errors. For example, if 10 percent of housing units did not respond to a particular question, they represent about 13.2 million housing units (there are about 132 million housing units in the U.S.). For each case of item nonresponse, other similar interview answers are used to represent

those missing interview answers; this is, for most missing answers, an answer from a similar household is copied[1]. For other items not recorded in the interview, "Not reported" is used as an answer category. The items with the most missing data are primarily those that people forget or consider personal: mortgages, other housing costs, and income.

It is not surprising that large biases, as shown in Table D-2, are possible when the survey has data for only 50 to 90 percent of housing units for particular items. Readers should be wary of items with highly incomplete data.[2]

Rates of completeness were not computed for 2011. Table D-2 in Appendix D of *American Housing Survey for the U.S. in 1995* gives the completeness rates for 1995. Due to the change in data collection methodology, the rates for 2011 may be higher or lower than in the past. However, the items that were most incomplete in 1995 are probably still most incomplete for 2011.

Table D-1. **Poorly Covered Units**

Type of Unit	Type of Deficiency
Manufactured/mobile homes, boats, and recreational vehicles (RVs)	No coverage of new manufactured/mobile home parks, new marinas, and new RV parks since April 1980 for AHS-N in areas where addresses are complete and permits are required for new construction.
Conventional new construction in permit issuing areas	No coverage of permits issued fewer than 8 months before interviewing or housing units built without permits where permits are required. In addition, eligible units could be missed and ineligible units included because of incorrect answers to questions used to screen out ineligible units.
New construction in special places	Not covered in either permit-issuing or

[1]Hot deck imputation is used: missing answers are copied from the most recently processed similar household for the household with the missing items.

[2]Statistical note: The November 1990 paper, *How Response Error, Missing Data and Undercoverage Bias Survey Data,* estimates that 90 percent of errors from incomplete data are less than: 1.645 x (.0012 x U + .0363 x (lesser of A or U-A)) where A is any count from the AHS and U is the total number of housing units in the U.S. or metropolitan area (both in thousands, result also in thousands). Weights are adjusted to reduce these errors, but it is not known how much error remains. *How Response Error, Missing data and Undercoverage Bias Survey Data,* order number HUD-6458, is available by e-mailing helpdesk@huduser.org or calling 800-245-2691.

(for example, college campuses, prisons)	nonpermit-issuing areas.
Group quarters and houses moved in	Eligible units could be missed because of incorrect answers to questions used to screen out ineligible units.
Conversions from nonresidential units	Minimal coverage of nonresidential units in buildings with no living quarters at the time of the 1980 census that converted to housing units by 1991 (and no coverage since 1991) in areas where addresses are complete and permits are required for new construction.
Within-structure additions	Some extra apartments created illegally or occupied by fugitives are probably missed because people do not report them for fear of penalties.
Whole structure additions not covered by permit sampling	These units are chosen with the aid of screening questions. Eligible units could be missed and ineligible units included because of incorrect answers to the screening questions.

Change over time. Several aspects of the AHS make estimates of change from previous data unreliable. These changes may elicit different answers from the past, even if nothing changed in the housing unit. Some examples of changes that may have affected answers include:

- Question wording
- Order of questions
- Switch from paper to computer questionnaire in 1997
- Lack of Spanish questionnaire, prior to 2009

WRONG ANSWERS

Wrong answers happen because people misunderstand questions, cannot recall the correct answer, or do not want to give the right answer. Table 1 in Appendix D of the *American Housing Survey for the United States in 1995* shows inconsistency rates for items. These results are from 1995, but the inconsistency rates for 2011 are probably similar.

SAMPLING ERRORS

Sampling errors definition. Error from sampling reflects how estimates from a sample vary from

the actual value. (Note: "Actual value" means the value derived if all housing units had been interviewed under the same conditions, rather than only a sample). A confidence interval is a range that contains the actual value with a specified probability. The range of nonsampling error is usually larger than this confidence interval. AHS utilizes three approaches to providing sampling errors:

- By publishing 2011 Standard Error Tables which provides a standard error value for each and every estimation cell in the AHS 2011 Metro Summary Tables;
- Providing Replicate Weights in the Public Use File (PUF) to allow users to calculate their own sampling errors they see fit; and
- By providing Generalized Variance Formulas (GVFs), so that a user can calculate sampling errors for any other estimate not provided in the 2011 Standard Error Tables. Note that using GVFs may be an overestimate, or a "conservative" estimate of sampling errors (Table D-4).

Counts. Most numbers from the AHS are counts of housing units (for example, units with basements or units with an elderly person). These counts have variation due to the sample selection methodology that we describe as the sampling errors. As with the other types of errors, readers should be wary of numbers with large errors from sampling.

Table D-3 gives a convenient list of associated sample estimates and standard errors for each of the 2011 AHS-MS metropolitan areas. For numbers not in Table D-3 uses the appropriate formula from Table D-4 for the applicable 2011 AHS-MS metropolitan area. In each formula, "A" is the estimate (a count of housing units in thousands) from the AHS. Remember that in any case that the total error is larger than sampling error.

The error from sampling is approximated using the following formula for constructing a 90-percent confidence interval:

$$1.645 \times \sqrt{.0300 \times \mathrm{A} - \ 0.000299 \times \mathrm{A}^2}$$

For example, suppose there were an estimated 688,000 owner-occupied housing units in the Baltimore, MD MSA (that is, A=688). The error from sampling for a 90 percent confidence interval for those 688,000 owner-occupied housing units is:

$$1.645 \times \sqrt{0.300 \times 688 - 0.000299 \times 688^2} = 13$$

The 90-percent confidence interval can then be formed by adding and subtracting this error to the survey estimate of 688 (that is, 688 plus or minus 13). Statements such as "the actual value is in the range 688 plus or minus 13 (675 to 701)," are right 90 percent of the time and wrong 10 percent of the time.[3]

[3]The formula in the text is based on 1.645 times the standard error from sampling. This formula gives "90-percent confidence interval errors." For 95-percent confidence interval errors, multiply by 1.96 instead of 1.645; for 99-percent confidence, multiply by 2.576 instead of 1.645.

Numbers in the publication are printed in thousands, so 688 means 688,000. The formulas are designed to use numbers directly from the publication; do not include zeros. The result is also in thousands, so 13 means 13,000.

Percents. Any subgroup can be shown as a percent of a larger group. For AHS-MS metropolitan areas, use the appropriate formula in table D-4. In each formula, p is the percent and A is the base of the percent in thousands.

For example, suppose that of the 688,000 owner-occupied housing units in the Baltimore MSA, 40% were 3-bedroom units. The error from sampling for a 90 percent confidence interval for 40 percent of 687.722 (meaning 688,000) is:

$$1.645 \times \sqrt{\frac{0.300 \times 40 \times (100 - 40)}{688}} = 1.7$$

Statements such as "the actual percent is in the range 38.3 percent to 41.7 percent" are right 90 percent of the time.

This formula is an overestimate for most items. To get a more accurate estimate for AHS-MS, use the appropriate formula from the Percents column for specified domain from Table D-4.[4]

Note that when a ratio C/D is computed where C is not a subgroup of D (for example, the number of Hispanics as a ratio of the number of Blacks), the error from sampling is different.[5]

Medians. The steps in Table D-5 calculate the error from sampling for a 90 percent confidence interval for medians. This is an approximation of the error.

For small bases, the confidence interval on medians cannot be estimated reliably. To estimate a median's sampling error more accurately, use Table D-6 to find the sampling error on 50 percent and apply it to compute the 90 percent confidence interval for the median.

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[4]This formula is actually $1.645 \times \sqrt{p(100-p)/n}$, since 0.300/A adjusts the data to the effective sample size.

[5]The error from sampling for a 90 percent confidence interval for a ratio C/D is:

$$\mathrm{C/D}\sqrt{(\text{error for C/C})^2 + (\text{error for D/D})^2}$$

when the error for C should be interpreted as the error for a 90 percent confidence interval for C. Likewise, the error for D should be interpreted as the error for a 90 percent confidence interval for D.

Differences. Two numbers from the AHS, like 210 and 324, or 34 percent and 55 percent, have a "statistically significant" difference if their ranges of error from sampling for a 90 percent confidence interval do not overlap.[6]

Formulas for error from sampling. The letter "A" in the formulas in Tables D-4, D-5, and D-6 represents a number (a count of housing units in thousands) from AHS (see "Sampling Errors" text for an example of how "A" is used).

For a 90 percent confidence interval on zero for the 2011 AHS-MS, refer to table D-3 where the size of the estimate is zero. If a formula gives an error smaller than the error for zero, use the error for zero.

The formulas in this appendix give the errors for a 90 percent confidence interval. For a 95 percent confidence interval, multiply by 1.960 instead of 1.645. For a 99 percent confidence interval, multiply by 2.576 instead of 1.645.

Some domains did not have enough sample to generate an accurate GVF. As a result, in table D-4, domains with less than 100 housing units have been suppressed.

Replicate Weights. For the 2011 AHS-MS, for the first time, a file of replicate weights is provided at http://www.census.gov/programs-surveys/ahs/data.html. Additionally, this website provides a detailed explanation on how to use the replicate weight file. This file is merged with the Public Use File to calculate the exact errors used to calculate confidence intervals. These replicate weights simulate the drawing of multiple samples from the population; these multiple simulations are used to estimate the variability observed in repeated sampling. Note that one year's replicate weight file is specific to that year, and the replicate weights are not used to calculate population estimates.

REVISION HISTORY

The 2011 AHS-MS was issued in September 2013. In 2016, the Census Bureau updated the 2011 weighting methodology by applying the same methodology used in 2013. While the original 2011 methodology supplemented the AHS-National sample with the entire AHS-Metropolitan sample, the 2013 methodology only supplemented the AHS-National sample with sample from six large metropolitan areas in the 1985 design. In 2013, five of these six large metropolitan

[6] When ranges of error from sampling for a 90 percent confidence interval do overlap, numbers are still statistically different if the result of subtracting one from the other is more than:

$$\sqrt{(\text{error for first number})^2 + (\text{error for second number})^2}$$

The error for the first and second numbers should be interpreted as the error for a 90 percent confidence interval for the first and second numbers respectively.

areas were selected; the Chicago, Detroit, New York, Northern New Jersey, and Philadelphia metropolitan supplemental samples were interviewed and augmented with the AHS-National sample. In 2011, one of the six large metropolitan areas, Los Angeles, was selected and incorporated into the AHS-National sample. In addition to the change in 2011 methodology, the following changes were made to this appendix:

- Generalized variance function parameters were updated throughout the document.
- Tables D-2 and D-3 were updated.
- Home improvement GVFs were removed from table D-4.

REFERENCES

Schenker, Nathaniel and Gentleman, Jane F. (2001). On Judging the Significance of Differences by Examining the Overlap Between Confidence Intervals. *The American Statistician*, 55(3), 182-186

Table D-2. **Errors for Incomplete Data Bias: 2011 AHS-MSAs, using 1995 model (Numbers in thousands)**

Size of estimate	Anaheim - Santa Ana, CA	Atlanta, GA	Birmingham, AL	Buffalo, NY	Cincinnati, OH	Cleveland, OH	Columbus, OH	Dallas, TX
0	2.1	4.3	1.0	1.0	1.8	1.9	1.6	3.3
10	2.7	4.9	1.6	1.6	2.4	2.5	2.2	3.9
100	8.1	10.3	7.0	7.0	7.8	7.9	7.5	9.3
250	17.0	19.2	15.9	16.0	16.7	16.8	16.5	18.3
500	31.9	34.2	1.1	2.2	27.0	29.3	19.4	33.2
750	20.2	49.1			12.1	14.4	4.5	48.1
1,000	5.3	64.0						44.6
2,000		14.8						
3,450								

Size of estimate	Denver, CO	Fort Worth, TX	Indianapolis, IN	Kansas City, MO	Los Angeles, CA	Memphis, TN	Milwaukee, WI	New Orleans, LA
0	2.1	1.7	1.5	1.8	6.8	1.1	1.3	1.1
10	2.7	2.3	2.1	2.4	7.4	1.7	1.9	1.7
100	8.1	7.7	7.5	7.7	12.8	7.1	7.3	7.0
250	17.0	16.6	16.4	16.7	21.8	16.0	16.3	16.0
500	32.0	23.0	17.4	25.3	36.7	4.2	11.7	3.8
750	21.0	8.0	2.4	10.3	51.6			
1,000	6.1				66.5			
2,000					93.9			
3,450					7.3			

Size of estimate	Norfolk, VA	Phoenix, AZ	Pittsburgh, PA	Portland, Or	Providence, RI	Riverside - San Bernardino, CA	San Diego, CA	San Francisco, CA
0	1.4	3.6	2.2	1.8	1.2	3.0	2.3	1.5
10	2.0	4.2	2.8	2.4	1.7	3.6	2.9	2.1
100	7.3	9.6	8.2	7.8	7.1	9.0	8.3	7.5
250	16.3	18.5	17.1	16.8	16.1	17.9	17.3	16.4
500	13.0	33.5	32.0	27.8	6.1	32.8	32.2	17.4
750		48.4	23.4	12.8		47.8	28.4	2.5
1,000		52.7	8.4			33.5	13.5	
2,000								
3,450								

Size of estimate	San Jose, CA	St. Louis, MO	Charlotte, NC	Oakland, CA	Sacramento, CA
0	1.3	2.5	1.5	2.0	1.7
10	1.9	3.1	2.1	2.6	2.3
100	7.3	8.4	7.4	7.9	7.7
250	16.2	17.4	16.4	16.9	16.7
500	10.6	32.3	16.3	31.5	24.7
750		32.2	1.3	16.6	9.7
1,000		17.3		1.6	
2,000					
3,450					

Table D-3. **Errors from Sampling: 2011 AHS-MSAs (Numbers in thousands)**

Size of estimate	Anaheim - Santa Ana, CA	Atlanta, GA	Birmingham, AL	Buffalo, NY	Cincinnati, OH	Cleveland, OH	Columbus, OH	Dallas, TX
0	30.9	1.7	0.3	1.6	0.7	0.7	0.5	6.2
1	6.1	1.4	0.6	1.4	0.9	0.9	0.8	2.7
5	13.5	3.2	1.4	3.1	2.0	2.0	1.7	6.1
10	19.1	4.5	1.9	4.3	2.8	2.8	2.4	8.5
25	30.0	7.1	3.0	6.8	4.4	4.4	3.8	13.5
50	41.9	10.0	4.1	9.3	6.1	6.1	5.3	18.9
100	57.7	14.0	5.5	12.5	8.4	8.3	7.3	26.3
300	88.7	23.0	6.7	15.6	12.6	12.7	10.7	42.7
500	97.9	28.1	0.4	6.3	13.4	13.6	10.6	51.0
700	92.1	31.2	(N/A)	(N/A)	11.5	12.1	7.2	55.2
900	67.4	32.9	(N/A)	(N/A)	3.8	6.5	(N/A)	56.1
1100	(N/A)	33.3	(N/A)	(N/A)	(N/A)	(N/A)	(N/A)	53.9
1300	(N/A)	32.7	(N/A)	(N/A)	(N/A)	(N/A)	(N/A)	48.2
1500	(N/A)	30.8	(N/A)	(N/A)	(N/A)	(N/A)	(N/A)	37.4
1700	(N/A)	27.4	(N/A)	(N/A)	(N/A)	(N/A)	(N/A)	(N/A)
1900	(N/A)	21.9	(N/A)	(N/A)	(N/A)	(N/A)	(N/A)	(N/A)
2100	(N/A)	11.6	(N/A)	(N/A)	(N/A)	(N/A)	(N/A)	(N/A)
2300	(N/A)	(N/A)	(N/A)	(N/A)	(N/A)	(N/A)	(N/A)	(N/A)
2500	(N/A)	(N/A)	(N/A)	(N/A)	(N/A)	(N/A)	(N/A)	(N/A)
3000	(N/A)	(N/A)	(N/A)	(N/A)	(N/A)	(N/A)	(N/A)	(N/A)
3450	(N/A)	(N/A)	(N/A)	(N/A)	(N/A)	(N/A)	(N/A)	(N/A)

Size of estimate	Denver, CO	Fort Worth, TX	Indianapolis, IN	Kansas City, MO	Los Angeles, CA	Memphis, TN	Milwaukee, WI	New Orleans, LA
0	0.7	17.4	0.5	0.5	2.4	0.4	3.2	0.4
1	0.9	4.5	0.7	0.8	1.7	0.7	1.9	0.7
5	2.1	10.1	1.7	1.8	3.7	1.5	4.3	1.5
10	2.9	14.3	2.3	2.5	5.3	2.1	6.1	2.2
25	4.5	22.4	3.7	3.9	8.4	3.2	9.5	3.4
50	6.4	31.2	5.1	5.5	11.8	4.5	13.1	4.7
100	8.8	42.7	6.9	7.5	16.8	6.0	17.8	6.3
300	13.5	63.4	10.0	11.2	29.3	7.8	24.9	8.0
500	15.0	65.2	9.8	11.8	38.1	4.6	21.8	4.4
700	14.2	50.4	5.7	9.7	45.4	(N/A)	(N/A)	(N/A)
900	10.8	(N/A)	(N/A)	(N/A)	51.9	(N/A)	(N/A)	(N/A)
1100	(N/A)	(N/A)	(N/A)	(N/A)	57.8	(N/A)	(N/A)	(N/A)
1300	(N/A)	(N/A)	(N/A)	(N/A)	63.2	(N/A)	(N/A)	(N/A)
1500	(N/A)	(N/A)	(N/A)	(N/A)	68.4	(N/A)	(N/A)	(N/A)
1700	(N/A)	(N/A)	(N/A)	(N/A)	73.3	(N/A)	(N/A)	(N/A)
1900	(N/A)	(N/A)	(N/A)	(N/A)	78.1	(N/A)	(N/A)	(N/A)
2100	(N/A)	(N/A)	(N/A)	(N/A)	82.6	(N/A)	(N/A)	(N/A)
2300	(N/A)	(N/A)	(N/A)	(N/A)	87.1	(N/A)	(N/A)	(N/A)
2500	(N/A)	(N/A)	(N/A)	(N/A)	91.4	(N/A)	(N/A)	(N/A)
3000	(N/A)	(N/A)	(N/A)	(N/A)	101.7	(N/A)	(N/A)	(N/A)
3450	(N/A)	(N/A)	(N/A)	(N/A)	110.6	(N/A)	(N/A)	(N/A)

Table D-3 Continued.

Size of estimate	Norfolk, VA	Phoenix, AZ	Pittsburgh, PA	Portland, Or	Providence, RI	Riverside - San Bernardino, CA	San Diego, CA	San Francisco, CA
0	0.4	18.2	0.7	0.6	0.3	12.8	33.3	0.5
1	0.7	4.6	0.9	0.8	0.6	3.9	6.3	0.7
5	1.6	10.3	2.1	1.8	1.4	8.7	14.1	1.7
10	2.2	14.6	2.9	2.6	1.9	12.2	19.9	2.3
25	3.5	23.0	4.6	4.0	3.0	19.3	31.2	3.7
50	4.8	32.3	6.5	5.6	4.1	27.0	43.6	5.1
100	6.5	45.0	8.9	7.7	5.6	37.5	60.3	6.9
300	9.2	73.4	13.8	11.6	7.3	60.3	94.1	10.1
500	8.3	88.4	15.5	12.4	4.8	71.1	106.4	9.8
700	(N/A)	96.5	14.9	10.8	(N/A)	75.4	105.2	5.8
900	(N/A)	99.4	12.0	4.5	(N/A)	74.4	89.9	(N/A)
1100	(N/A)	97.6	1.4	(N/A)	(N/A)	67.6	48.5	(N/A)
1300	(N/A)	90.7	(N/A)	(N/A)	(N/A)	53.2	(N/A)	(N/A)
1500	(N/A)	77.4	(N/A)	(N/A)	(N/A)	16.8	(N/A)	(N/A)
1700	(N/A)	53.3	(N/A)	(N/A)	(N/A)	(N/A)	(N/A)	(N/A)
1900	(N/A)	(N/A)	(N/A)	(N/A)	(N/A)	(N/A)	(N/A)	(N/A)
2100	(N/A)	(N/A)	(N/A)	(N/A)	(N/A)	(N/A)	(N/A)	(N/A)
2300	(N/A)	(N/A)	(N/A)	(N/A)	(N/A)	(N/A)	(N/A)	(N/A)
2500	(N/A)	(N/A)	(N/A)	(N/A)	(N/A)	(N/A)	(N/A)	(N/A)
3000	(N/A)	(N/A)	(N/A)	(N/A)	(N/A)	(N/A)	(N/A)	(N/A)
3450	(N/A)	(N/A)	(N/A)	(N/A)	(N/A)	(N/A)	(N/A)	(N/A)

Size of estimate	San Jose, CA	St. Louis, MO	Charlotte, NC	Oakland, CA	Sacramento, CA
0	0.6	0.9	0.5	0.6	0.6
1	0.9	1.0	0.7	0.9	0.8
5	1.9	2.3	1.7	1.9	1.8
10	2.7	3.2	2.4	2.7	2.6
25	4.2	5.1	3.7	4.2	4.1
50	5.8	7.1	5.1	5.9	5.7
100	7.9	9.9	7.0	8.1	7.8
300	10.9	15.5	10.0	12.4	11.6
500	9.3	17.8	9.6	13.4	12.1
700	(N/A)	18.0	4.8	12.2	9.8
900	(N/A)	16.2	(N/A)	7.7	(N/A)
1100	(N/A)	11.5	(N/A)	(N/A)	(N/A)
1300	(N/A)	(N/A)	(N/A)	(N/A)	(N/A)
1500	(N/A)	(N/A)	(N/A)	(N/A)	(N/A)
1700	(N/A)	(N/A)	(N/A)	(N/A)	(N/A)
1900	(N/A)	(N/A)	(N/A)	(N/A)	(N/A)
2100	(N/A)	(N/A)	(N/A)	(N/A)	(N/A)
2300	(N/A)	(N/A)	(N/A)	(N/A)	(N/A)
2500	(N/A)	(N/A)	(N/A)	(N/A)	(N/A)
3000	(N/A)	(N/A)	(N/A)	(N/A)	(N/A)
3450	(N/A)	(N/A)	(N/A)	(N/A)	(N/A)

Tables D-4. **Formulas for 90 Percent Confidence Intervals: 2011 AHS-MS**

1970-Design Areas

MSA and Estimate Type	Counts	Percents
Anaheim – Santa Ana, CA		
Owner Occupied	$1.645 \times \sqrt{(8.227 \times A) - (0.01434 \times A^2)}$	$1.645 \times \sqrt{(8.227 \times p \times (100 - p)\,)/A}$
Renter Occupied	$1.645 \times \sqrt{(9.695 \times A) - (0.02393 \times A^2)}$	$1.645 \times \sqrt{(9.695 \times p \times (100 - p)\,)/A}$
Combined Owner, Renter, and Vacant	$1.645 \times \sqrt{(13.61 \times A) - (0.01305 \times A^2)}$	$1.645 \times \sqrt{(13.61 \times p \times (100 - p)\,)/A}$
New Construction	$1.645 \times \sqrt{(0.364 \times A) + (0.75889 \times A^2)}$	$1.645 \times \sqrt{(0.364 \times p \times (100 - p)\,)/A}$
Buffalo-Niagara Falls, NY		
Owner Occupied	$1.645 \times \sqrt{(0.767 \times A) - (0.00205 \times A^2)}$	$1.645 \times \sqrt{(0.767 \times p \times (100 - p)\,)/A}$
Renter Occupied	$1.645 \times \sqrt{(0.353 \times A) - (0.00022 \times A^2)}$	$1.645 \times \sqrt{(0.353 \times p \times (100 - p)\,)/A}$
Combined Owner, Renter, and Vacant	$1.645 \times \sqrt{(0.710 \times A) - (0.00136 \times A^2)}$	$1.645 \times \sqrt{(0.710 \times p \times (100 - p)\,)/A}$
New Construction	$1.645 \times \sqrt{(0.360 \times A) + (0.17990 \times A^2)}$	$1.645 \times \sqrt{(0.360 \times p \times (100 - p)\,)/A}$
Dallas-Plano-Irving, TX		
Owner Occupied	$1.645 \times \sqrt{(2.650 \times A) - (0.00193 \times A^2)}$	$1.645 \times \sqrt{(2.650 \times p \times (100 - p)\,)/A}$
Renter Occupied	$1.645 \times \sqrt{(2.410 \times A) - (0.00107 \times A^2)}$	$1.645 \times \sqrt{(2.410 \times p \times (100 - p)\,)/A}$
Combined Owner, Renter, and Vacant	$1.645 \times \sqrt{(2.715 \times A) - (0.00309 \times A^2)}$	$1.645 \times \sqrt{(2.715 \times p \times (100 - p)\,)/A}$
New Construction	$1.645 \times \sqrt{(0.893 \times A) + (0.07849 \times A^2)}$	$1.645 \times \sqrt{(0.893 \times p \times (100 - p)\,)/A}$
Fort Worth-Arlington, TX		
Owner Occupied	$1.645 \times \sqrt{(6.015 \times A) - (0.00781 \times A^2)}$	$1.645 \times \sqrt{(6.015 \times p \times (100 - p)\,)/A}$
Renter Occupied	$1.645 \times \sqrt{(1.317 \times A) + (0.00311 \times A^2)}$	$1.645 \times \sqrt{(1.317 \times p \times (100 - p)\,)/A}$
Combined Owner, Renter, and Vacant	$1.645 \times \sqrt{(7.654 \times A) - (0.00902 \times A^2)}$	$1.645 \times \sqrt{(7.654 \times p \times (100 - p)\,)/A}$
New Construction	$1.645 \times \sqrt{(0.279 \times A) + (0.26455 \times A^2)}$	$1.645 \times \sqrt{(0.279 \times p \times (100 - p)\,)/A}$
Milwaukee-Waukesha-West Allis, WI		
Owner Occupied	$1.645 \times \sqrt{(0.986 \times A) - (0.00012 \times A^2)}$	$1.645 \times \sqrt{(0.986 \times p \times (100 - p)\,)/A}$
Renter Occupied	$1.645 \times \sqrt{(0.565 \times A) + (0.00258 \times A^2)}$	$1.645 \times \sqrt{(0.565 \times p \times (100 - p)\,)/A}$
Combined Owner, Renter, and Vacant	$1.645 \times \sqrt{(1.378 \times A) - (0.00205 \times A^2)}$	$1.645 \times \sqrt{(1.378 \times p \times (100 - p)\,)/A}$
New Construction	$1.645 \times \sqrt{(0.174 \times A) + (0.10962 \times A^2)}$	$1.645 \times \sqrt{(0.174 \times p \times (100 - p)\,)/A}$
Phoenix-Mesa-Scottsdale, AZ		
Owner Occupied	$1.645 \times \sqrt{(4.823 \times A) - (0.00455 \times A^2)}$	$1.645 \times \sqrt{(4.823 \times p \times (100 - p)\,)/A}$
Renter Occupied	$1.645 \times \sqrt{(4.232 \times A) - (0.00563 \times A^2)}$	$1.645 \times \sqrt{(4.232 \times p \times (100 - p)\,)/A}$
Combined Owner, Renter, and Vacant	$1.645 \times \sqrt{(7.927 \times A) - (0.00430 \times A^2)}$	$1.645 \times \sqrt{(7.927 \times p \times (100 - p)\,)/A}$
New Construction	$1.645 \times \sqrt{(0.700 \times A) + (0.14398 \times A^2)}$	$1.645 \times \sqrt{(0.700 \times p \times (100 - p)\,)/A}$
Riverside-San Bernardino-Ontario, CA		
Owner Occupied	$1.645 \times \sqrt{(2.825 \times A) - (0.00251 \times A^2)}$	$1.645 \times \sqrt{(2.825 \times p \times (100 - p)\,)/A}$
Renter Occupied	$1.645 \times \sqrt{(4.424 \times A) - (0.00722 \times A^2)}$	$1.645 \times \sqrt{(4.424 \times p \times (100 - p)\,)/A}$
Combined Owner, Renter, and Vacant	$1.645 \times \sqrt{(5.574 \times A) - (0.00367 \times A^2)}$	$1.645 \times \sqrt{(5.574 \times p \times (100 - p)\,)/A}$
New Construction	$1.645 \times \sqrt{(0.539 \times A) + (0.07958 \times A^2)}$	$1.645 \times \sqrt{(0.539 \times p \times (100 - p)\,)/A}$

1970-Design Areas (Cont.)

MSA and Estimate Type	Counts	Percents
San Diego-Carlsbad-San Marcos, CA		
Owner Occupied	$1.645 \times \sqrt{(7.873 \times A) - (0.01276 \times A^2)}$	$1.645 \times \sqrt{(7.873 \times p \times (100 - p))/A}$
Renter Occupied	$1.645 \times \sqrt{(11.03 \times A) - (0.02200 \times A^2)}$	$1.645 \times \sqrt{(11.03 \times p \times (100 - p))/A}$
Combined Owner, Renter, and Vacant	$1.645 \times \sqrt{(14.69 \times A) - (0.01264 \times A^2)}$	$1.645 \times \sqrt{(14.69 \times p \times (100 - p))/A}$
New Construction	$1.645 \times \sqrt{(0.498 \times A) + (0.51145 \times A^2)}$	$1.645 \times \sqrt{(0.498 \times p \times (100 - p))/A}$

1980-Design Area

MSA and Estimate Type	Counts	Percents
Los Angeles-Long Beach, CA		
Owner Occupied	$1.645 \times \sqrt{(1.055 \times A) - (0.00028 \times A^2)}$	$1.645 \times \sqrt{(1.055 \times p \times (100 - p))/A}$
Renter Occupied	$1.645 \times \sqrt{(0.942 \times A) + (0.00049 \times A^2)}$	$1.645 \times \sqrt{(0.942 \times p \times (100 - p))/A}$
Combined Owner, Renter, and Vacant	$1.645 \times \sqrt{(1.032 \times A) + (0.00008 \times A^2)}$	$1.645 \times \sqrt{(1.032 \times p \times (100 - p))/A}$
New Construction	$1.645 \times \sqrt{(1.687 \times A) + (0.00201 \times A^2)}$	$1.645 \times \sqrt{(1.687 \times p \times (100 - p))/A}$

1990-Design Areas

MSA and Estimate Type	Counts	Percents
Atlanta-Sandy Springs-Marietta, GA		
Owner Occupied	$1.645 \times \sqrt{(0.793 \times A) - (0.00041 \times A^2)}$	$1.645 \times \sqrt{(0.793 \times p \times (100 - p))/A}$
Renter Occupied	$1.645 \times \sqrt{(0.784 \times A) - (0.00033 \times A^2)}$	$1.645 \times \sqrt{(0.784 \times p \times (100 - p))/A}$
Combined Owner, Renter, and Vacant	$1.645 \times \sqrt{(0.759 \times A) - (0.00035 \times A^2)}$	$1.645 \times \sqrt{(0.759 \times p \times (100 - p))/A}$
New Construction	$1.645 \times \sqrt{(0.845 \times A) - (0.00557 \times A^2)}$	$1.645 \times \sqrt{(0.845 \times p \times (100 - p))/A}$
Birmingham-Hoover, AL		
Owner Occupied	$1.645 \times \sqrt{(0.143 \times A) - (0.00026 \times A^2)}$	$1.645 \times \sqrt{(0.143 \times p \times (100 - p))/A}$
Renter Occupied	$1.645 \times \sqrt{(0.150 \times A) - (0.00022 \times A^2)}$	$1.645 \times \sqrt{(0.150 \times p \times (100 - p))/A}$
Combined Owner, Renter, and Vacant	$1.645 \times \sqrt{(0.139 \times A) - (0.00028 \times A^2)}$	$1.645 \times \sqrt{(0.139 \times p \times (100 - p))/A}$
New Construction	$1.645 \times \sqrt{(0.158 \times A) - (0.00222 \times A^2)}$	$1.645 \times \sqrt{(0.158 \times p \times (100 - p))/A}$
Cincinnati-Middletown, OH-KY-IN		
Owner Occupied	$1.645 \times \sqrt{(0.300 \times A) - (0.00034 \times A^2)}$	$1.645 \times \sqrt{(0.300 \times p \times (100 - p))/A}$
Renter Occupied	$1.645 \times \sqrt{(0.271 \times A) - (0.00033 \times A^2)}$	$1.645 \times \sqrt{(0.271 \times p \times (100 - p))/A}$
Combined Owner, Renter, and Vacant	$1.645 \times \sqrt{(0.292 \times A) - (0.00032 \times A^2)}$	$1.645 \times \sqrt{(0.292 \times p \times (100 - p))/A}$
New Construction	$1.645 \times \sqrt{(0.344 \times A) + (0.00437 \times A^2)}$	$1.645 \times \sqrt{(0.344 \times p \times (100 - p))/A}$
Cleveland-Elyria-Mentor, OH		
Owner Occupied	$1.645 \times \sqrt{(0.319 \times A) - (0.00041 \times A^2)}$	$1.645 \times \sqrt{(0.319 \times p \times (100 - p))/A}$
Renter Occupied	$1.645 \times \sqrt{(0.271 \times A) - (0.00037 \times A^2)}$	$1.645 \times \sqrt{(0.271 \times p \times (100 - p))/A}$
Combined Owner, Renter, and Vacant	$1.645 \times \sqrt{(0.287 \times A) - (0.00030 \times A^2)}$	$1.645 \times \sqrt{(0.287 \times p \times (100 - p))/A}$
New Construction	$1.645 \times \sqrt{(0.301 \times A) - (0.00947 \times A^2)}$	$1.645 \times \sqrt{(0.301 \times p \times (100 - p))/A}$
Columbus, OH		
Owner Occupied	$1.645 \times \sqrt{(0.232 \times A) - (0.00032 \times A^2)}$	$1.645 \times \sqrt{(0.232 \times p \times (100 - p))/A}$
Renter Occupied	$1.645 \times \sqrt{(0.246 \times A) - (0.00040 \times A^2)}$	$1.645 \times \sqrt{(0.246 \times p \times (100 - p))/A}$

Combined Owner, Renter, and Vacant…	$1.645 \times \sqrt{(0.224 \times A) - (0.00028 \times A^2)}$	$1.645 \times \sqrt{(0.224 \times p \times (100 - p)\,)/A}$
New Construction……	$1.645 \times \sqrt{(0.261 \times A) - (0.01034 \times A^2)}$	$1.645 \times \sqrt{(0.261 \times p \times (100 - p)\,)/A}$

1990-Design Areas (Cont.)

Denver-Aurora, CO		
Owner Occupied……	$1.645 \times \sqrt{(0.335 \times A) - (0.00035 \times A^2)}$	$1.645 \times \sqrt{(0.335 \times p \times (100 - p)\,)/A}$
Renter Occupied……	$1.645 \times \sqrt{(0.315 \times A) - (0.00035 \times A^2)}$	$1.645 \times \sqrt{(0.315 \times p \times (100 - p)\,)/A}$
Combined Owner, Renter, and Vacant…	$1.645 \times \sqrt{(0.313 \times A) - (0.00029 \times A^2)}$	$1.645 \times \sqrt{(0.313 \times p \times (100 - p)\,)/A}$
New Construction……	$1.645 \times \sqrt{(0.348 \times A) - (0.00692 \times A^2)}$	$1.645 \times \sqrt{(0.348 \times p \times (100 - p)\,)/A}$
Indianapolis-Carmel, IN		
Owner Occupied……	$1.645 \times \sqrt{(0.217 \times A) - (0.00028 \times A^2)}$	$1.645 \times \sqrt{(0.217 \times p \times (100 - p)\,)/A}$
Renter Occupied……	$1.645 \times \sqrt{(0.221 \times A) - (0.00036 \times A^2)}$	$1.645 \times \sqrt{(0.221 \times p \times (100 - p)\,)/A}$
Combined Owner, Renter, and Vacant…	$1.645 \times \sqrt{(0.204 \times A) - (0.00027 \times A^2)}$	$1.645 \times \sqrt{(0.204 \times p \times (100 - p)\,)/A}$
New Construction……	$1.645 \times \sqrt{(0.228 \times A) - (0.00585 \times A^2)}$	$1.645 \times \sqrt{(0.228 \times p \times (100 - p)\,)/A}$
Kansas City, MO-KS		
Owner Occupied……	$1.645 \times \sqrt{(0.253 \times A) - (0.00034 \times A^2)}$	$1.645 \times \sqrt{(0.253 \times p \times (100 - p)\,)/A}$
Renter Occupied……	$1.645 \times \sqrt{(0.261 \times A) - (0.00053 \times A^2)}$	$1.645 \times \sqrt{(0.261 \times p \times (100 - p)\,)/A}$
Combined Owner, Renter, and Vacant…	$1.645 \times \sqrt{(0.235 \times A) - (0.00026 \times A^2)}$	$1.645 \times \sqrt{(0.235 \times p \times (100 - p)\,)/A}$
New Construction……	$1.645 \times \sqrt{(0.304 \times A) - (0.00214 \times A^2)}$	$1.645 \times \sqrt{(0.304 \times p \times (100 - p)\,)/A}$
Memphis, TN-MS-AR		
Owner Occupied……	$1.645 \times \sqrt{(0.156 \times A) - (0.00029 \times A^2)}$	$1.645 \times \sqrt{(0.156 \times p \times (100 - p)\,)/A}$
Renter Occupied……	$1.645 \times \sqrt{(0.190 \times A) - (0.00042 \times A^2)}$	$1.645 \times \sqrt{(0.190 \times p \times (100 - p)\,)/A}$
Combined Owner, Renter, and Vacant…	$1.645 \times \sqrt{(0.163 \times A) - (0.00030 \times A^2)}$	$1.645 \times \sqrt{(0.163 \times p \times (100 - p)\,)/A}$
New Construction……	$1.645 \times \sqrt{(0.174 \times A) - (0.00607 \times A^2)}$	$1.645 \times \sqrt{(0.174 \times p \times (100 - p)\,)/A}$
New Orleans-Metairie-Kenner, LA		
Owner Occupied……	$1.645 \times \sqrt{(0.208 \times A) - (0.00047 \times A^2)}$	$1.645 \times \sqrt{(0.208 \times p \times (100 - p)\,)/A}$
Renter Occupied……	$1.645 \times \sqrt{(0.168 \times A) - (0.00051 \times A^2)}$	$1.645 \times \sqrt{(0.168 \times p \times (100 - p)\,)/A}$
Combined Owner, Renter, and Vacant…	$1.645 \times \sqrt{(0.177 \times A) - (0.00032 \times A^2)}$	$1.645 \times \sqrt{(0.177 \times p \times (100 - p)\,)/A}$
New Construction……	$1.645 \times \sqrt{(0.177 \times A) - (0.00404 \times A^2)}$	$1.645 \times \sqrt{(0.177 \times p \times (100 - p)\,)/A}$
Virginia Beach-Norfolk-Newport News, VA-NC		
Owner Occupied……	$1.645 \times \sqrt{(0.204 \times A) - (0.00038 \times A^2)}$	$1.645 \times \sqrt{(0.204 \times p \times (100 - p)\,)/A}$
Renter Occupied……	$1.645 \times \sqrt{(0.194 \times A) - (0.00044 \times A^2)}$	$1.645 \times \sqrt{(0.194 \times p \times (100 - p)\,)/A}$
Combined Owner, Renter, and Vacant…	$1.645 \times \sqrt{(0.183 \times A) - (0.00026 \times A^2)}$	$1.645 \times \sqrt{(0.183 \times p \times (100 - p)\,)/A}$
New Construction……	$1.645 \times \sqrt{(0.219 \times A) - (0.00572 \times A^2)}$	$1.645 \times \sqrt{(0.219 \times p \times (100 - p)\,)/A}$
Pittsburgh, PA		
Owner Occupied……	$1.645 \times \sqrt{(0.350 \times A) - (0.00037 \times A^2)}$	$1.645 \times \sqrt{(0.350 \times p \times (100 - p)\,)/A}$
Renter Occupied……	$1.645 \times \sqrt{(0.326 \times A) - (0.00044 \times A^2)}$	$1.645 \times \sqrt{(0.326 \times p \times (100 - p)\,)/A}$
Combined Owner, Renter, and Vacant…	$1.645 \times \sqrt{(0.323 \times A) - (0.00029 \times A^2)}$	$1.645 \times \sqrt{(0.323 \times p \times (100 - p)\,)/A}$
New Construction……	$1.645 \times \sqrt{(0.367 \times A) - (0.01004 \times A^2)}$	$1.645 \times \sqrt{(0.367 \times p \times (100 - p)\,)/A}$
Portland-Vancouver-Beaverton, OR-WA		
Owner Occupied……	$1.645 \times \sqrt{(0.260 \times A) - (0.00032 \times A^2)}$	$1.645 \times \sqrt{(0.260 \times p \times (100 - p)\,)/A}$
Renter Occupied……	$1.645 \times \sqrt{(0.264 \times A) - (0.00038 \times A^2)}$	$1.645 \times \sqrt{(0.264 \times p \times (100 - p)\,)/A}$

Combined Owner, Renter, and Vacant…	$1.645 \times \sqrt{(0.245 \times A) - (0.00026 \times A^2)}$	$1.645 \times \sqrt{(0.245 \times p \times (100 - p)\,)/A}$
New Construction……	$1.645 \times \sqrt{(0.286 \times A) - (0.00408 \times A^2)}$	$1.645 \times \sqrt{(0.286 \times p \times (100 - p)\,)/A}$

1990-Design Areas (Cont.)

Providence-New Bedford-Fall River, RI-MA		
Owner Occupied……	$1.645 \times \sqrt{(0.153 \times A) - (0.00036 \times A^2)}$	$1.645 \times \sqrt{(0.153 \times p \times (100 - p)\,)/A}$
Renter Occupied……	$1.645 \times \sqrt{(0.146 \times A) - (0.00046 \times A^2)}$	$1.645 \times \sqrt{(0.146 \times p \times (100 - p)\,)/A}$
Combined Owner, Renter, and Vacant…	$1.645 \times \sqrt{(0.139 \times A) - (0.00024 \times A^2)}$	$1.645 \times \sqrt{(0.139 \times p \times (100 - p)\,)/A}$
New Construction……	$1.645 \times \sqrt{(0.131 \times A) - (0.00686 \times A^2)}$	$1.645 \times \sqrt{(0.131 \times p \times (100 - p)\,)/A}$
San Francisco, CA		
Owner Occupied……	$1.645 \times \sqrt{(0.231 \times A) - (0.00041 \times A^2)}$	$1.645 \times \sqrt{(0.231 \times p \times (100 - p)\,)/A}$
Renter Occupied……	$1.645 \times \sqrt{(0.228 \times A) - (0.00041 \times A^2)}$	$1.645 \times \sqrt{(0.228 \times p \times (100 - p)\,)/A}$
Combined Owner, Renter, and Vacant…	$1.645 \times \sqrt{(0.205 \times A) - (0.00027 \times A^2)}$	$1.645 \times \sqrt{(0.205 \times p \times (100 - p)\,)/A}$
New Construction……	$1.645 \times \sqrt{(0.222 \times A) - (0.01435 \times A^2)}$	$1.645 \times \sqrt{(0.222 \times p \times (100 - p)\,)/A}$
San Jose-Sunnyvale-Santa Clara, CA		
Owner Occupied……	$1.645 \times \sqrt{(0.175 \times A) - (0.00011 \times A^2)}$	$1.645 \times \sqrt{(0.175 \times p \times (100 - p)\,)/A}$
Renter Occupied……	$1.645 \times \sqrt{(0.316 \times A) - (0.0062 \times A^2)}$	$1.645 \times \sqrt{(0.316 \times p \times (100 - p)\,)/A}$
Combined Owner, Renter, and Vacant…	$1.645 \times \sqrt{(0.271 \times A) - (0.00042 \times A^2)}$	$1.645 \times \sqrt{(0.271 \times p \times (100 - p)\,)/A}$
New Construction……	$1.645 \times \sqrt{(0.824 \times A) + (0.03101 \times A^2)}$	$1.645 \times \sqrt{(0.824 \times p \times (100 - p)\,)/A}$
St. Louis, MO-IL		
Owner Occupied……	$1.645 \times \sqrt{(0.413 \times A) - (0.00036 \times A^2)}$	$1.645 \times \sqrt{(0.413 \times p \times (100 - p)\,)/A}$
Renter Occupied……	$1.645 \times \sqrt{(0.382 \times A) - (0.00040 \times A^2)}$	$1.645 \times \sqrt{(0.382 \times p \times (100 - p)\,)/A}$
Combined Owner, Renter, and Vacant…	$1.645 \times \sqrt{(0.392 \times A) - (0.00032 \times A^2)}$	$1.645 \times \sqrt{(0.392 \times p \times (100 - p)\,)/A}$
New Construction……	$1.645 \times \sqrt{(0.371 \times A) - (0.00433 \times A^2)}$	$1.645 \times \sqrt{(0.371 \times p \times (100 - p)\,)/A}$
Charlotte-Gastonia-Concord, NC-SC		
Owner Occupied……	$1.645 \times \sqrt{(0.219 \times A) - (0.00029 \times A^2)}$	$1.645 \times \sqrt{(0.219 \times p \times (100 - p)\,)/A}$
Renter Occupied……	$1.645 \times \sqrt{(0.214 \times A) - (0.00033 \times A^2)}$	$1.645 \times \sqrt{(0.214 \times p \times (100 - p)\,)/A}$
Combined Owner, Renter, and Vacant…	$1.645 \times \sqrt{(0.207 \times A) - (0.00028 \times A^2)}$	$1.645 \times \sqrt{(0.207 \times p \times (100 - p)\,)/A}$
New Construction……	$1.645 \times \sqrt{(0.210 \times A) - (0.00214 \times A^2)}$	$1.645 \times \sqrt{(0.210 \times p \times (100 - p)\,)/A}$
Oakland-Fremont-Hayward, CA		
Owner Occupied……	$1.645 \times \sqrt{(0.300 \times A) - (0.00037 \times A^2)}$	$1.645 \times \sqrt{(0.300 \times p \times (100 - p)\,)/A}$
Renter Occupied……	$1.645 \times \sqrt{(0.301 \times A) - (0.00040 \times A^2)}$	$1.645 \times \sqrt{(0.301 \times p \times (100 - p)\,)/A}$
Combined Owner, Renter, and Vacant…	$1.645 \times \sqrt{(0.270 \times A) - (0.00027 \times A^2)}$	$1.645 \times \sqrt{(0.270 \times p \times (100 - p)\,)/A}$
New Construction……	$1.645 \times \sqrt{(0.323 \times A) - (0.00686 \times A^2)}$	$1.645 \times \sqrt{(0.323 \times p \times (100 - p)\,)/A}$
Sacramento--Arden-Arcade--Roseville, CA		
Owner Occupied……	$1.645 \times \sqrt{(0.261 \times A) - (0.00030 \times A^2)}$	$1.645 \times \sqrt{(0.261 \times p \times (100 - p)\,)/A}$
Renter Occupied……	$1.645 \times \sqrt{(0.259 \times A) - (0.00031 \times A^2)}$	$1.645 \times \sqrt{(0.259 \times p \times (100 - p)\,)/A}$
Combined Owner, Renter, and Vacant…	$1.645 \times \sqrt{(0.254 \times A) - (0.00029 \times A^2)}$	$1.645 \times \sqrt{(0.254 \times p \times (100 - p)\,)/A}$
New Construction……	$1.645 \times \sqrt{(0.292 \times A) - (0.00561 \times A^2)}$	$1.645 \times \sqrt{(0.292 \times p \times (100 - p)\,)/A}$

In tables D-5 and D-6, housing cost data are used to calculate the 90 percent confidence interval for medians using grouped data (all numbers are in thousands), in this case All Occupied Units Housing Costs. The examples use the Combined Owner, Renter, and Vacant universe for Cleveland, OH.

	Total Housing Units	Cumulative number of housing units
Total	846	-
Less than $700	353	353
$700 to $799	73	426
$800 to $999	109	535
$1,000 to $1,249	99	634
$1,250 or more	212	846
Median (dollars)	$798	-

Table D-5. **How to Compute the Error From Sampling for a 90 Percent Confidence Interval for a Median**

Steps for Calculations	The formula	An example
How many total units is the median based on (in thousands, exclude "not reported" and "don't know")?	A	846
What is the estimated standard error of a 50% characteristic with a base equaling the total units?	$\sigma = \sqrt{\frac{0.287(0.5)(1-0.5)}{A}}$	$\sqrt{\frac{0.287(0.5)(1-0.5)}{846}} = 0.009$
What are the end points of the category the median is in?	X – Y	$700 – 799
What is the width of this category (in dollars, rooms, or whatever the item measures)?	W	$100
How many housing units are in this median category (in thousands)?	B	73
What is the estimated proportion of the total units falling in the category containing the sample median?	$P = \frac{B}{A}$	$\frac{73}{479} = 0.09$
Then the standard error from sampling for the median is approximately:	$se_{median} = \frac{\sigma \times W}{P}$	$\frac{0.009 \times \$100}{0.09} = \$10.67 \approx \$11$
The 90 percent confidence interval for the median is:	$Median \pm 1.645 \times se_{median}$	$\$798 \pm \$18$

Table D-6: **Calculation of the 90 Percent Confidence Interval for Medians**

Item	Formula	Bottom limit example	Top limit example
How many total units is the median based on (in thousands, exclude "not reported")?	A	846	
Half the total, for the median (in thousands)	A/2	423	
Error from sampling for 50 percent of the base of this median (first line)	$1.645 \times \sqrt{\frac{0.287(0.5)(1-0.5)}{\mathrm{A}}} = \frac{0.441}{\sqrt{\mathrm{A}}}$	$\frac{0.441}{\sqrt{846}} = 0.015$	
Multiply this percentage by total units to give the error in housing units.	$\frac{0.441}{\sqrt{\mathrm{A}}} \times \mathrm{A} = 0.441\sqrt{\mathrm{A}}$	$0.015 \times 846 = 12.8$	
Bottom of error range (second line minus fourth line, in thousands)	$\mathrm{B}_{\mathrm{bottom}}$	410.2*	
Top of error range (second line plus fourth line, in thousands)	$\mathrm{B}_{\mathrm{top}}$		435.8*
*Start adding up the housing units in this table, category by category, cumulatively from the beginning of the table, until you exceed the starred number above. What interval does the starred number fall in?		$700 – 799	$800 – 999
How many housing units are in all the categories before this one (in thousands)?	C	353	426
How many housing units are in this category (in thousands)?	D	73	109
What is the bottom limit of this category (in dollars, rooms, or whatever the item measures)?	E	$700	$800
What is the bottom limit of the next category (in dollars, rooms, etc.)?	F	$800	$1,000
Formula to calculate limits of confidence interval	$\frac{\mathrm{B}-\mathrm{C}}{\mathrm{D}}(\mathrm{F}-\mathrm{E}) + \mathrm{E}$	$\frac{410.2 - 353}{73}(100) + 700$	$\frac{435.8 - 426}{109}(200) + 800$
Limits of confidence interval (in dollars, rooms, etc.)		$778	$818

*Starting with the starred step, this worksheet is equivalent to interpolation, for those who are familiar with this term.