

Appendix D. 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.)
- Wrong answers (The U.S. Census Bureau does not adjust for wrong answers and does not estimate the size of the errors.)
- Sampling (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 1981 and 1991 (see Appendix C) corrected some of the error due to incomplete data; that one correction averaged 2.5 percent in 1991. 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 the Census Bureau’s sampling lists, the homes in the survey do not represent all homes in the country. The Census Bureau attempts to adjust for the deficiencies by raising the raw numbers from the survey proportionally so that the numbers published here match independent estimates of the total number of homes. The approximate housing unit undercoverage rates for the 2002 metropolitan areas range from less than 1 percent to 11.8 percent. Table D-1 lists units that have known coverage deficiencies.

Missing data. Some people refuse the interview or some of the questions, or do not know the answers. When the entire interview is missing, other similar interviews represent the missing ones (see Appendix B). For most missing answers, an answer from a similar household is copied.¹ The Census Bureau does not know how close the imputed values are to the actual values. For other items, “not

¹Hot deck allocation is used: an answer is copied from the most recently processed similar household before the household with the missing item.

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

Type of unit	Type of Deficiency
Manufactured/mobile homes, boats, and recreational vehicles (RVs)	1970-based metropolitan areas: Poor coverage of new mobile homes parks in permit-issuing areas. 1990-based metropolitan areas: No coverage of new mobile home parks, new marinas, and new RV parks since April 1990 in areas where addresses are complete and permits are required for new construction.
Conventional new construction	No coverage of permits issued fewer than 8 months before interviewing or homes 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 (for example, college campuses, prisons, etc.)	Not covered in either permit-issuing or 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	1970-based metropolitan areas: Nonresidential units at the time of the 1970 Census that converted to residential units were missed. 1990-based metropolitan areas: Nonresidential units at the time of the 1990 Census that converted to residential units were missed.
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	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.

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.

Incompleteness can cause large errors since, when even 10 percent of homes are missed by a particular question, they represent about 10 million homes that have to be estimated on little or no basis (there are about 100 million homes in the United States). The survey estimates them by

assuming that they are like some group of homes that did give data, an assumption that is never exactly true although it is usually better than ignoring the homes with the missing data. Thus, 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 homes for particular items. Again, readers should be wary of items with highly incomplete data.² Rates of completeness were not computed for 2002. Table 2 in Appendix D of *American Housing Survey for the United States in 1995* gives the completeness rates for 1995. Due to the change in data collection methodology, the rates for 2002 may be higher or lower than in the past. However, the items that were most incomplete in 1995 are probably still the most incomplete for 2002.

Effect on income. The nonsampling errors interact particularly badly for income. Income questions are inconsistently answered (Table D-3), incompletely answered, and the totals fall short of totals known from the National Income Accounts, especially for the elderly.³

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. Wording and question order for most questions changed. Also, the questionnaire now runs on interviewers' portable computers (as described in Appendix C), resulting in the following possible changes:

- The correct questions should be asked. Skip patterns will be followed more accurately.
- Inconsistent answers (such as reporting a move-in date before the date built) are probed during the interview, rather than just being changed in later computer processing, so these problems should be resolved more accurately.
- Some respondents may dislike the presence of the computer, though interviewers do not report many problems.

²Statistical 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: $1.645 X (.0012 X U + .0363 X (\text{lesser of } A \text{ or } U-A))$, where A is any count from the AHS and U is the total number of housing units in the United States 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 from HUD USER (see "Where to Get AHS Data").

³Data are in the *Codebook for the American Housing Survey Volume 1*, available from HUD USER. Newer comparisons, though for a different survey, are in *Money Income of Households Families, and Persons in the United States: 1992*, Series P60-184, pages C12-C14, available from the Superintendent of Documents (see "Where to Get AHS Data").

- It is now a little harder for interviewers to go back to a question much earlier in the questionnaire, if a respondent suddenly remembers something.
- For some questions, large changes from prior year data are probed during the interview, to reduce mistaken measurement of change.

In the future, the Census Bureau may try to estimate the net effects of these differences.

WRONG ANSWERS

Wrong answers happen because people misunderstand questions, cannot recall the correct answer, or do not want to give the right answer. Table D-3 shows which items have been measured for inconsistency when people are reinterviewed after a few weeks. The actual survey did not catch and reconcile these inconsistencies and continuously occurring errors are not measured at all. Thus, a high rate of wrong answers remains for some items. The Census Bureau categorizes these levels of inconsistency into three ranges:

1. Less than 20 is considered a low level of inconsistency.
2. Between 20 and 50 is considered a moderate level of inconsistency.
3. Greater than 50 is considered a high level of inconsistency indicating that responses are not reliable.

Not all questions have been checked for inconsistencies; the ones checked were the questions where inconsistencies seemed likely. Questions measuring opinions were likely to have high inconsistencies. For the 2002 AHS-MS, the wording for some questions changed. This change is expected to lower the level of inconsistency for the changed items. The numbers in Table D-3 are percents. They are nearly the same as 100 minus the correlation between answers in the original interview and the reinterview. For example, an inconsistency of 20 means a correlation of 80 percent, which is good. This is the correlation between answers to the same question, usually from the same respondents, a month apart. Wrong answers create wrong results and mean that data on groups (for example, income groups) are infected with data from people who really are not like the group at all. Errors are especially troublesome for rare items where even small errors overwhelm the true data. Readers should be wary of drawing firm conclusions from items with high inconsistency or from categories smaller than a few million homes.

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.

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 error from sampling. As with the other types of errors, readers should be wary of numbers with large errors from sampling.

Table D-4 gives a list of errors for a range of numbers for the 2002 AHS-MS metropolitan areas. For numbers not found in this table, interpolate between the numbers in the table or use the appropriate formula from Table D-5 for the 2002 AHS-MS metropolitan areas. In each formula, A is a number (a count of units in thousands) from the AHS. Each formula is an overestimate for most items. Remember that the total error is larger than sampling error.

For example, suppose there are 320,000 owner-occupied housing units in the Charlotte, NC-SC MSA (that is, A = 320). The error from sampling for a 90-percent confidence interval for those 320,000 owner-occupied housing units is

$$1.645 \times \sqrt{(.150 \times 320) - (.000225 \times 320 \times 320)} = 8.2$$

The 90-percent confidence interval can then be formed by adding and subtracting this error to the survey estimate of 320 (that is, 320 ± 8.2). Statements such as “the actual value is in the range 320 plus or minus 8.2 (that is, 311.8 to 328.2)” are right 90 percent of the time and wrong 10 percent of the time.

Numbers in the book are printed in thousands, so 320 means 320,000. The formulas are designed to use numbers directly from the book; do not add zeros. The result is also in thousands, so 8.2 means 8,200.

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-6. In each formula, p is the percent and A is the denominator, or base of the percent in thousands.

For example, the error from sampling for a 90-percent confidence interval for 40 percent of 320 (meaning 320,000) is:

$$1.645 \times \sqrt{\frac{.150 \times 40 \times (100 - 40)}{(320)}} = 1.7$$

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

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.⁴

Medians. The steps in Table D-7 calculate the error from sampling for a 90-percent confidence interval for medians. This is an approximation to the error.

For small bases the confidence interval on medians cannot be estimated reliably. To estimate a median’s sampling error more accurately, find the sampling error on 50 percent as described in Table D-8 and compute the 90-percent confidence interval.

Differences. Two numbers from the AHS, like 34 and 40 or 40 percent and 45 percent have a “statistically significant difference” if their ranges of error from sampling for a 90-percent confidence interval do not overlap.⁵

Formulas for error from sampling. The letter “A” in the formulas in Tables D-5, D-6, D-7, and D-8 represents a number (a count of units in thousands) from AHS (see the “Counts” section for an example of how “A” is used).

For a 90-percent confidence interval on zero for the 2002 AHS-MS, refer to Table D-4, 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 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.

⁴The error from sampling for a 90-percent confidence interval for a ratio C/D is

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

where 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.

⁵When 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.

Table D-2. **Errors for Incomplete Data Bias: 2002 AHS-MS**

[Numbers in thousands]

Size of estimate	Anaheim-Santa Ana, CA	Buffalo, NY	Charlotte, NC-SC	Columbus, OH	Dallas, TX	Fort Worth-Arlington, TX	Kansas City, KS	Miami-Fort Lauderdale, FL	Milwaukee, WI	Phoenix, AZ	Portland, OR-WA	Riverside-San Bernardino-Ontario, CA	San Diego, CA
0	2.0	1.0	1.3	1.3	2.7	1.3	1.5	3.2	1.2	2.6	1.6	2.4	2.1
10	2.6	1.6	1.9	1.9	3.3	1.9	2.1	3.8	1.8	3.2	2.2	3.0	2.7
100	7.9	7.0	7.3	7.3	8.7	7.2	7.5	9.2	7.2	8.6	7.6	8.4	8.1
250	16.9	15.9	16.2	16.3	17.6	16.2	16.4	18.2	16.2	17.6	16.5	17.4	17.0
500	31.6	1.9	11.3	12.3	32.6	9.6	17.4	33.1	8.8	32.5	20.2	32.3	32.0
750	16.6	NA	NA	NA	39.4	NA	2.5	48.0	NA	37.9	5.3	31.1	21.3
1,000	1.7	NA	NA	NA	24.5	NA	NA	41.4	NA	23.0	NA	16.1	6.4
1,250	NA	NA	NA	NA	9.6	NA	NA	26.4	NA	8.0	NA	1.2	NA
1,500	NA	NA	NA	NA	NA	NA	NA	11.5	NA	NA	NA	NA	NA
1,600	NA	NA	NA	NA	NA	NA	NA	5.5	NA	NA	NA	NA	NA

NA means no error estimates are provided because the estimate is larger than the estimated total number of housing units in the MSA.

Table D-3. **Different Answers a Month Apart**

Item	Level of inconsistency ¹	Confidence interval ²	When measured ³
HIGH LEVEL OF INCONSISTENCY			
Other kinds of heating equipment (central warm-air)	91	(73 - 100)	89-MS
Mortgage payment includes anything else (first mortgage)	90	(72 - 111)	90-MS
Water came in from other places	81	(64 - 100)	89-MS
Moved for other, financial/employment	80	(62 - 104)	85-MS
Moved for other, housing related	79	(65 - 97)	85-MS
Poor city/county service in neighborhood	78	(63 - 95)	89-MS
Police protection problem in neighborhood	78	(63 - 95)	89-MS
Number of business rooms with direct access to outside	76	(63 - 91)	95-N
Moved for other reason	73	(64 - 85)	85-MS
Number of other rooms	73	(64 - 83)	95-N
Difficulty hearing with or without a hearing aid	72	(59 - 88)	95-N
Rooms used both as business space and for something else	70	(62 - 80)	95-N
Cost for routine repairs and maintenance	70	(65 - 75)	95-N
Moved for better quality house	69	(58 - 82)	85-MS
Move for other family/personal related	68	(54 - 86)	85-MS
Cost for water supply and sewage disposal	68	(61 - 76)	81-N
Lower cost State or local mortgage	67	(54 - 83)	95-N
Other problem in neighborhood	67	(61 - 74)	89-MS
Number of living rooms	66	(53 - 82)	95-N
Shed, detached garage, or other building added or replaced in last 2 years	66	(49 - 88)	95-N
Water safe for drinking	66	(56 - 77)	95-N
Undesirable industries/businesses in neighborhood	66	(54 - 82)	89-MS
Difficulty reaching kitchen facilities	65	(49 - 87)	95-N
Number of family rooms, dens, recreation rooms and/or libraries	65	(57 - 75)	95-N
Rats	65	(54 - 69)	89-MS
Difficulty opening, closing, or going through any doors of home	64	(46 - 87)	95-N
Noise in neighborhood	64	(57 - 72)	89-MS
Difficulty moving between rooms	64	(49 - 84)	95-N
Number of business rooms without direct access to outside	64	(54 - 76)	95-N
Peeling paint on the ceiling	63	(49 - 80)	81-N
Other kinds of heating equipment (none)	63	(60 - 67)	89-MS
How LIKELY to move to place prefer to live in 5 years	62	(54 - 71)	85-MS
Difficulty reaching bathroom facilities	62	(47 - 82)	95-N
Other kinds of heating equipment (unvented room)	62	(45 - 86)	89-MS
Difficulty seeing with or without glasses or contact lenses	60	(49 - 72)	95-N
How LIKELY to still be living in this unit in 5 years	60	(49 - 74)	85-MS
Gross income	59	not available	82-MS
Number of days worked at home	59	(49 - 72)	95-N
Patio, terrace, or detached deck added or replaced in last 2 years	58	(42 - 81)	95-N
Electric fuses or breaker switches blown	58	(50 - 68)	81-N
Open cracks or holes in building	58	(47 - 72)	81-N
People in neighborhood	57	(52 - 62)	89-MS
Other major repairs over \$500 each - repair done	57	(50 - 64)	85-MS
Work done in last 2 years to attic, basement, garage, or unfinished area of home	56	(44 - 71)	95-N
Difficulty going up and down steps	56	(46 - 69)	95-N
Central air conditioning/dehumidifier	56	not available	80-N
Satisfactory police protection	55	(49 - 62)	77-N
Moved for lower rent or less expensive house to maintain	55	(43 - 70)	85-MS
Broken plaster or peeling paint	55	(46 - 65)	89-MS
Water came in from walls, doors, windows	55	(45 - 67)	89-MS
A working electric wall outlet	55	(42 - 71)	77-N
Home equity loans	55	(48 - 64)	95-N
Other kinds of heating equipment (fireplace with no insert)	54	(49 - 59)	89-MS
Shopping	54	(47 - 61)	77-N
Special modifications, equipment, or assistance needed because of physical limitation	54	(44 - 66)	95-N
Difficulty entering and exiting home	54	(43 - 67)	95-N
Broken plaster on the ceiling	53	(40 - 70)	81-N
Water came in from roof	53	(46 - 60)	89-MS
Driveways or walkways added or replaced in last 2 years	53	(42 - 67)	95-N

Table D-3. **Different Answers a Month Apart**—Con.

Item	Level of inconsistency ¹	Confidence interval ²	When measured ³
HIGH LEVEL OF INCONSISTENCY—Con.			
Difficulty with personal activities- bathing/showering	53	(42 - 66)	95-N
Payments the same during whole length of the mortgage	52	(46 - 59)	85-MS
Difficulty with personal activities - cooking and preparing food	52	(41 - 66)	95-N
Other major repairs over \$500 each - someone in household do work	51	(36 - 72)	85-MS
Number of hours worked at home as self-employed,contract worker, or business owner	51	(43 - 61)	95-N
Litter in neighborhood	51	(44 - 60)	89-MS
Which best describes place at that time	51	(46 - 55)	85-MS
Rate the place (10 categories)	51	(49 - 53)	89-MS
Main reason moved	51	(47 - 55)	85-MS
Yearly cost for garbage	51	(43 - 62)	81-N
MODERATE LEVEL OF INCONSISTENCY			
Holes in the floors	50	(33 - 74)	81-N
Type of vacant	50	(38 - 65)	81-N
Cookstove or range with oven	50	(39 - 64)	85-N
Public transportation	50	(44 - 56)	77-N
Oil, coal, kerosene, wood and any other fuel cost	50	(40 - 64)	81-N
Other kinds of heating equipment (other built-in electric)	50	(38 - 66)	89-MS
Central air fuel	50	(40 - 63)	85-N
At age 16, live in this area/different place	50	(44 - 57)	85-MS
Difficulty with personal activities - housework/laundry	50	(41 - 61)	95-N
Do work at home	50	(43 - 58)	95-N
Traffic in neighborhood	49	(43 - 54)	89-MS
Moved to establish own household	48	(38 - 59)	85-MS
Rate the place (categories 1-6 combined)	48	(46 - 51)	89-MS
Fencing or walls added or replaced in last 2 years	48	(37 - 61)	95-N
Drive to work alone or with others	48	(38 - 59)	95-N
Real estate taxes	47	(33 - 67)	81-N
Other kinds of heating equipment (portable electric)	47	(41 - 54)	89-MS
Central air conditioning/none	47	not available	80-N
Crime in neighborhood	47	(41 - 53)	89-MS
Bathroom or kitchen remodeled in last 2 years	46	(39 - 54)	95-N
Fixed place of work	46	(37 - 57)	95-N
Any additions built - repair done	46	(35 - 61)	85-MS
Water came in from basement	45	(38 - 55)	89-MS
Any other rooms	45	(42 - 49)	95-N
Moved to change from owner to renter/renter to owner	44	(36 - 55)	85-MS
Five years from now, would you prefer living in this area or someplace else	44	(32 - 60)	80-N
Major equipment, such as furnace or central air replaced or added - repair done	44	(35 - 55)	85-MS
Major disaster in last 2 years required repairs	44	(31 - 60)	95-N
Water leaked into home from outdoors	43	(39 - 47)	89-MS
Concealed wiring	43	(33 - 57)	89-MS
Other kinds of heating equipment (fireplace with insert)	43	(35 - 52)	89-MS
Rate the place (4 combined categories)	43	(41 - 46)	89-MS
Difficulty with personal activities - grooming/dressing	43	(30 - 60)	95-N
Siding replaced or added in last 2 years - repair done	42	(32 - 56)	85-MS
Moved to be closer to school/work	41	(32 - 53)	85-MS
Yearly cost of insurance (reported in \$100 increments to\$1,000)	41	(38 - 44)	89-MS
Heat breakdown	41	(30 - 56)	89-MS
Heating equipment broke down for 6 hours or more	41	(30 - 56)	89-MS
Public elementary school satisfactory	40	(34 - 47)	89-MS
Cost for real estate taxes	40	(35 - 46)	81-N
Mice or rats or signs of	40	not available	76-N
House/apartment cold for 24 hours	40	(36 - 45)	89-MS
Central air conditioning/portable fan	40	not available	80-N
Current mortgage same year as bought home	39	27 - 56)	85-MS
Mode of transportation to work last week	38	(31 - 46)	95-N
Anything about the neighborhood that bothers you	38	(35 - 41)	89-MS
Prefer to be living in another home in this area in 5 years	38	(31 - 48)	85-MS
Change in taxes/insurance/principal balance	37	(28 - 51)	85-MS

Table D-3. **Different Answers a Month Apart**—Con.

Item	Level of inconsistency ¹	Confidence interval ²	When measured ³
MODERATE LEVEL OF INCONSISTENCY —Con.			
Number of mortgages on home/property	36	(28 - 47)	95-N
Other kinds of heating equipment (stove)	36	(28 - 47)	89-MS
Costs for gas for the month of August	35	(24 - 54)	89-N
Bathrooms remodeled or added - repair done	35	(28 - 45)	85-MS
All or part of roof replaced in last 2 years - repair done	35	(29 - 42)	85-MS
Married, widowed, divorced, or separated	35	not available	85-MS
Number of dining rooms	35	(32 - 38)	95-N
Highest level of school/degree	34	(32 - 35)	95-N
New storm doors or storm windows bought and installed - repair done	33	(27 - 41)	85-MS
Moved because needed larger house or apartment	33	(26 - 41)	85-MS
Number of homes source of water serving	33	(22 - 49)	95-N
Insulation added - repair done	32	(25 - 44)	85-MS
Kitchen remodeled or added - repair done	32	(25 - 41)	85-MS
House and lot sell on today's market	31	(29 - 34)	90-MS
Moved for new job or job transfer	30	(22 - 39)	85-MS
Average monthly cost for gas	29	(23 - 37)	89-N
Average monthly cost for electricity	28	(24 - 34)	89-N
Type of mortgage (for the first mortgage/loan) (non-CATI) ⁴	27	(21 - 36)	89-N
Change based on interest rates	26	(18 - 38)	85-MS
Year the building was built	25	not available	85-MS
All or part of roof replaced in last 2 years - someone in household do work	25	(15 - 44)	85-MS
Number of family rooms	25	(21 - 30)	85-N
Mortgage payment include homeowner's insurance (first mortgage)	24	(21 - 27)	90-MS
Prefer to be living in this house/apartment/somewhere else	24	(20 - 29)	85-MS
Number of half bathrooms	24	(20 - 27)	95-N
Clothes washer age	22	(19 - 25)	85-N
How many years for mortgage	22	(17 - 29)	85-MS
LOW LEVEL OF INCONSISTENCY			
Attend a public school or a private school	19	(15 - 25)	89-MS
New storm doors or storm windows bought and installed - someone in household do work	19	(11 - 35)	85-MS
Garbage disposal age	18	(15 - 22)	85-N
Refrigerator age	18	(16 - 20)	85-N
Heating equipment broke	18	(9 - 34)	89-MS
Clothes dryer age	18	(15 - 21)	85-N
Oven/cooking burner age	18	(16 - 21)	85-N
Monthly payment (first mortgage)	16	(14 - 18)	90-MS
Insulation added - someone in household do work	16	(8 - 33)	85-MS
New storm doors or storm windows bought and installed - job cost	15	(8 - 32)	85-MS
Mortgage payment include property tax (first mortgage)	15	(12 - 18)	90-MS
New/assumed mortgage	15	(11 - 22)	85-MS
How much was borrowed	14	(11 - 18)	85-MS
Monthly payment (for first mortgage/loan) (non-CATI) ⁴	14	(11 - 19)	89-N
Mortgage, home equity loan or other loan on this house/apartment	14	(11 - 17)	95-N
Dishwasher age	14	(11 - 17)	85-N
Number of full bathrooms	13	(11 - 15)	95-N
Where was mortgage borrowed (non-CATI) ⁴	13	(7 - 28)	89-N
How much was borrowed (for the first mortgage/loan)(non-CATI) ⁴	13	(10 - 17)	89-N
Number of bedrooms	12	(11 - 14)	95-N
Clothes dryer fuel	12	(9 - 14)	85-N
Have property insurance	12	(10 - 14)	89-MS
Number of room air conditioners	11	(9 - 15)	85-N
Room air conditioners	10	(8 - 12)	85-N
Interest rate on the mortgage (for the first mortgage/loan) (non-CATI) ⁴	10	(7 - 15)	89-N
Source of water serving 15 or more homes	10	(8 - 13)	95-N
Kitchen remodeled or added - someone in household do work	9	(3 - 26)	85-MS
Number of units in building	8	(6 - 9)	85-N
Clothes washer	8	(6 - 9)	85-N
Living quarters	8	(6 - 9)	85-N

Table D-3. **Different Answers a Month Apart**—Con.

Item	Level of inconsistency ¹	Confidence interval ²	When measured ³
LOW LEVEL OF INSISTENCY —Con.			
Source of water	8	(6 - 11)	95-N
Dishwasher	6	(5 - 7)	85-N
Garbage disposal	5	(4 - 7)	85-N
Number of apartments	5	(4 - 8)	85-N
Central air conditioning	5	(4 - 6)	85-N
Clothes dryer	5	(4 - 7)	85-N
Cooking fuel	5	(4 - 6)	85-N

¹Levels are in percents. They are nearly the same as 100 minus the correlation between answers in the original interview and the reinterview a month later. For example, an inconsistency of 80 means a correlation of 20 percent, which is not good.

²Square brackets show 90-percent confidence intervals. Parentheses show 95-percent confidence intervals (used in 1988 and before).

³Measured in national surveys (N) or metropolitan surveys (MS).

⁴CATI is computer-assisted telephone interviewing; where shown, inconsistency was measured separately for CATI and non-CATI interviews.

Table D-4. **Errors from Sampling to Compute a 90-Percent Confidence Interval: 2002 AHS-MS**

[Numbers in thousands]

Size of estimate	Ana-heim-Santa Ana, CA	Buffalo, NY	Char-lotte, NC-SC	Colum-bus, OH	Dallas, TX	Fort Worth-Arling-ton, TX	Kansas City, KS	Miami-Fort Lauderdale, FL	Milwau-kee, WI	Phoenix, AZ	Portland, OR-WA	River-side-San Bern-ardino-Ontario, CA	San Diego, CA
0	0.7	0.4	0.3	0.4	1.0	0.5	0.4	0.9	0.5	1.1	0.4	0.9	0.7
1	0.9	0.7	0.6	0.7	1.1	0.7	0.7	1.0	0.7	1.1	0.7	1.0	0.9
5	2.1	1.5	1.4	1.5	2.4	1.6	1.6	2.3	1.6	2.6	1.6	2.2	2.1
10	2.9	2.1	2.0	2.1	3.4	2.3	2.3	3.3	2.3	3.6	2.2	3.2	2.9
25	4.6	3.3	3.1	3.3	5.4	3.6	3.6	5.2	3.6	5.7	3.5	5.0	4.6
50	6.4	4.6	4.3	4.5	7.6	5.0	5.0	7.3	5.0	7.9	4.8	7.0	6.4
100	8.8	6.1	5.9	6.2	10.5	6.8	6.8	10.1	6.7	11.0	6.6	9.7	8.8
300	13.5	7.6	8.2	8.7	16.7	9.3	9.8	16.4	9.2	17.5	9.7	15.2	13.6
500	14.7	2.6	7.1	7.7	19.4	7.7	9.6	19.5	7.4	20.3	9.8	17.4	15.1
600	14.4	NA	4.9	5.7	20.0	4.5	8.3	20.4	3.7	20.9	8.8	17.7	15.0
700	13.4	NA	NA	NA	20.2	NA	5.7	21.0	NA	20.9	6.9	17.5	14.4
900	8.7	NA	NA	NA	19.1	NA	NA	21.1	NA	19.7	NA	15.6	11.1
1000 ...	NA	NA	NA	NA	17.9	NA	NA	20.7	NA	18.2	NA	13.8	7.5
1200 ...	NA	NA	NA	NA	13.2	NA	NA	18.8	NA	12.8	NA	5.4	NA
1300 ...	NA	NA	NA	NA	8.7	NA	NA	17.2	NA	7.1	NA	NA	NA
1400 ...	NA	NA	NA	NA	NA	NA	NA	15.0	NA	NA	NA	NA	NA
1600 ...	NA	NA	NA	NA	NA	NA	NA	6.5	NA	NA	NA	NA	NA
1800 ...	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

NA means no error estimates are provided because the estimate is larger than the estimated total number of housing units in the MSA.

Table D-5. **Formulas for 90-percent Confidence Intervals:¹ 2002 AHS-MS**

MSA and estimates type	The formula is:
1970-BASED METROPOLITAN AREAS	
Anaheim-Santa Ana, CA	
Owner housing unit estimates ²	$1.645 \times \sqrt{(.320 \times A) - (.000321 \times A^2)}$
Renter housing unit estimates ²	$1.645 \times \sqrt{(.280 \times A) - (.000281 \times A^2)}$
Combined owner, renter, and vacant housing unit estimates ²	$1.645 \times \sqrt{(.295 \times A) - (.000296 \times A^2)}$
Mobile home estimates	$1.645 \times \sqrt{(.310 \times A) - (.008632 \times A^2)}$
New construction estimates ³	$1.645 \times \sqrt{(.275 \times A) - (.000276 \times A^2)}$
Buffalo, NY	
Owner housing unit estimates ²	$1.645 \times \sqrt{(.170 \times A) - (.000330 \times A^2)}$
Renter housing unit estimates ²	$1.645 \times \sqrt{(.155 \times A) - (.000301 \times A^2)}$
Combined owner, renter, and vacant housing unit estimates ²	$1.645 \times \sqrt{(.160 \times A) - (.000310 \times A^2)}$
Mobile home estimates	$1.645 \times \sqrt{(.210 \times A) - (.023699 \times A^2)}$
New construction estimates ³	$1.645 \times \sqrt{(.200 \times A) - (.000388 \times A^2)}$
Dallas, TX	
Owner housing unit estimates ²	$1.645 \times \sqrt{(.380 \times A) - (.000278 \times A^2)}$
Renter housing unit estimates ²	$1.645 \times \sqrt{(.440 \times A) - (.000322 \times A^2)}$
Combined owner, renter, and vacant housing unit estimates ²	$1.645 \times \sqrt{(.395 \times A) - (.000289 \times A^2)}$
Mobile home estimates	$1.645 \times \sqrt{(.750 \times A) - (.013288 \times A^2)}$
New construction estimates ³	$1.645 \times \sqrt{(.495 \times A) - (.000363 \times A^2)}$
Fort Worth-Arlington, TX	
Owner housing unit estimates ²	$1.645 \times \sqrt{(.200 \times A) - (.000313 \times A^2)}$
Renter housing unit estimates ²	$1.645 \times \sqrt{(.180 \times A) - (.000282 \times A^2)}$
Combined owner, renter, and vacant housing unit estimates ²	$1.645 \times \sqrt{(.195 \times A) - (.000305 \times A^2)}$
Mobile home estimates	$1.645 \times \sqrt{(.205 \times A) - (.007087 \times A^2)}$
New construction estimates ³	$1.645 \times \sqrt{(.180 \times A) - (.000282 \times A^2)}$
Milwaukee, WI	
Owner housing unit estimates ²	$1.645 \times \sqrt{(.200 \times A) - (.000319 \times A^2)}$
Renter housing unit estimates ²	$1.645 \times \sqrt{(.185 \times A) - (.000295 \times A^2)}$
Combined owner, renter, and vacant housing unit estimates ²	$1.645 \times \sqrt{(.195 \times A) - (.000311 \times A^2)}$
Mobile home estimates	$1.645 \times \sqrt{(.275 \times A) - (.077750 \times A^2)}$
New construction estimates ³	$1.645 \times \sqrt{(.180 \times A) - (.000287 \times A^2)}$
Phoenix, AZ	
Owner housing unit estimates ²	$1.645 \times \sqrt{(.485 \times A) - (.000362 \times A^2)}$
Renter housing unit estimates ²	$1.645 \times \sqrt{(.405 \times A) - (.000302 \times A^2)}$
Combined owner, renter, and vacant housing unit estimates ²	$1.645 \times \sqrt{(.420 \times A) - (.000313 \times A^2)}$
Mobile home estimates	$1.645 \times \sqrt{(.780 \times A) - (.007645 \times A^2)}$
New construction estimates ³	$1.645 \times \sqrt{(.375 \times A) - (.000280 \times A^2)}$
Riverside-San Bernardino, CA	
Owner housing unit estimates ²	$1.645 \times \sqrt{(.375 \times A) - (.000305 \times A^2)}$
Renter housing unit estimates ²	$1.645 \times \sqrt{(.285 \times A) - (.000232 \times A^2)}$
Combined owner, renter, and vacant housing unit estimates ²	$1.645 \times \sqrt{(.325 \times A) - (.000264 \times A^2)}$
Mobile home estimates	$1.645 \times \sqrt{(.590 \times A) - (.004786 \times A^2)}$
New construction estimates ³	$1.645 \times \sqrt{(.315 \times A) - (.000256 \times A^2)}$

Table D-5. **Formulas for 90-percent Confidence Intervals:**¹ 2002 AHS-MS—Con.

MSA and estimates type	The formula is:
1970-BASED METROPOLITAN AREAS—Con.	
San Diego, CA	
Owner housing unit estimates ²	$1.645 \times \sqrt{(.315 \times A) - (.000294 \times A^2)}$
Renter housing unit estimates ²	$1.645 \times \sqrt{(.295 \times A) - (.000275 \times A^2)}$
Combined owner, renter, and vacant housing unit estimates ²	$1.645 \times \sqrt{(.295 \times A) - (.000275 \times A^2)}$
Mobile home estimates	$1.645 \times \sqrt{(.440 \times A) - (.008662 \times A^2)}$
New construction estimates ³	$1.645 \times \sqrt{(.280 \times A) - (.000261 \times A^2)}$
1990-BASED METROPOLITAN AREAS	
Charlotte, NC-SC	
Mobile home estimates	$1.645 \times \sqrt{(.240 \times A) - (.004105 \times A^2)}$
All other estimates ²	$1.645 \times \sqrt{(.150 \times A) - (.000225 \times A^2)}$
Columbus, OH	
Mobile home estimates	$1.645 \times \sqrt{(.230 \times A) - (.012154 \times A^2)}$
All other estimates ²	$1.645 \times \sqrt{(.165 \times A) - (.000242 \times A^2)}$
Kansas City, KS	
Mobile home estimates	$1.645 \times \sqrt{(.320 \times A) - (.015757 \times A^2)}$
All other estimates ²	$1.645 \times \sqrt{(.195 \times A) - (.000254 \times A^2)}$
Miami-Fort Lauderdale, FL	
Mobile home estimates	$1.645 \times \sqrt{(.485 \times A) - (.009145 \times A^2)}$
All other estimates ²	$1.645 \times \sqrt{(.405 \times A) - (.000247 \times A^2)}$
Portland, OR-WA	
Mobile home estimates	$1.645 \times \sqrt{(.255 \times A) - (.006538 \times A^2)}$
All other estimates ²	$1.645 \times \sqrt{(.185 \times A) - (.000228 \times A^2)}$

¹The formulas in the text are based on 1.645 times the errors 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 2.58 instead of 1.645.

²Some items (for example, characteristic of total housing units) may involve housing units from both the mobile home and nonmobile home universe. The formulas for all other estimates should be used for these items. The formulas for mobile home estimates should be used for items that only involve housing units from the mobile home universe (all mobile homes including owner, renter, and new construction mobile homes).

³Use the new construction formulas for all conventional housing units built in the last 4 years.

Table D-6. **Formulas for 90-percent Confidence Intervals Associated With a Percentage**

MSA and estimates type	The formula is: ¹
1970 AHS-MS-BASED METROPOLITAN AREAS	
Anaheim-Santa Ana, CA	
Owner housing unit estimates ²	$1.645 \times \sqrt{(.320 \times p \times (100 - p))}/A$
Renter housing unit estimates ²	$1.645 \times \sqrt{(.280 \times p \times (100 - p))}/A$
Combined owner, renter, and vacant housing unit estimates ²	$1.645 \times \sqrt{(.295 \times p \times (100 - p))}/A$
Mobile home estimates	$1.645 \times \sqrt{(.310 \times p \times (100 - p))}/A$
New construction estimates ³	$1.645 \times \sqrt{(.275 \times p \times (100 - p))}/A$
Buffalo, NY	
Owner housing unit estimates ²	$1.645 \times \sqrt{(.170 \times p \times (100 - p))}/A$
Renter housing unit estimates ²	$1.645 \times \sqrt{(.155 \times p \times (100 - p))}/A$
Combined owner, renter, and vacant housing unit estimates ²	$1.645 \times \sqrt{(.160 \times p \times (100 - p))}/A$
Mobile home estimates	$1.645 \times \sqrt{(.210 \times p \times (100 - p))}/A$
New construction estimates ³	$1.645 \times \sqrt{(.200 \times p \times (100 - p))}/A$
Dallas, TX	
Owner housing unit estimates ²	$1.645 \times \sqrt{(.380 \times p \times (100 - p))}/A$
Renter housing unit estimates ²	$1.645 \times \sqrt{(.440 \times p \times (100 - p))}/A$
Combined owner, renter, and vacant housing unit estimates ²	$1.645 \times \sqrt{(.395 \times p \times (100 - p))}/A$
Mobile home estimates	$1.645 \times \sqrt{(.750 \times p \times (100 - p))}/A$
New construction estimates ³	$1.645 \times \sqrt{(.495 \times p \times (100 - p))}/A$
Fort Worth-Arlington, TX	
Owner housing unit estimates ²	$1.645 \times \sqrt{(.200 \times p \times (100 - p))}/A$
Renter housing unit estimates ²	$1.645 \times \sqrt{(.180 \times p \times (100 - p))}/A$
Combined owner, renter, and vacant housing unit estimates ²	$1.645 \times \sqrt{(.195 \times p \times (100 - p))}/A$
Mobile home estimates	$1.645 \times \sqrt{(.295 \times p \times (100 - p))}/A$
New construction estimates ³	$1.645 \times \sqrt{(.180 \times p \times (100 - p))}/A$
Milwaukee, WI	
Owner housing unit estimates ²	$1.645 \times \sqrt{(.200 \times p \times (100 - p))}/A$
Renter housing unit estimates ²	$1.645 \times \sqrt{(.185 \times p \times (100 - p))}/A$
Combined owner, renter, and vacant housing unit estimates ²	$1.645 \times \sqrt{(.195 \times p \times (100 - p))}/A$
Mobile home estimates	$1.645 \times \sqrt{(.275 \times p \times (100 - p))}/A$
New construction estimates ³	$1.645 \times \sqrt{(.180 \times p \times (100 - p))}/A$
Phoenix, AZ	
Owner housing unit estimates ²	$1.645 \times \sqrt{(.485 \times p \times (100 - p))}/A$
Renter housing unit estimates ²	$1.645 \times \sqrt{(.405 \times p \times (100 - p))}/A$
Combined owner, renter, and vacant housing unit estimates ²	$1.645 \times \sqrt{(.420 \times p \times (100 - p))}/A$
Mobile home estimates	$1.645 \times \sqrt{(.780 \times p \times (100 - p))}/A$
New construction estimates ³	$1.645 \times \sqrt{(.375 \times p \times (100 - p))}/A$
Riverside-San Bernardino, CA	
Owner housing unit estimates ²	$1.645 \times \sqrt{(.375 \times p \times (100 - p))}/A$
Renter housing unit estimates ²	$1.645 \times \sqrt{(.285 \times p \times (100 - p))}/A$
Combined owner, renter, and vacant housing unit estimates ²	$1.645 \times \sqrt{(.325 \times p \times (100 - p))}/A$
Mobile home estimates	$1.645 \times \sqrt{(.590 \times p \times (100 - p))}/A$
New construction estimates ³	$1.645 \times \sqrt{(.315 \times p \times (100 - p))}/A$

Table D-6. **Formulas for 90-percent Confidence Intervals Associated With a Percentage**—Con.

MSA and estimates type	The formula is: ¹
1970 AHS-MS-BASED METROPOLITAN AREAS —Con.	
San Diego, CA	
Owner housing unit estimates ²	$1.645 \times \sqrt{(.315 \times p \times (100 - p))/A}$
Renter housing unit estimates ²	$1.645 \times \sqrt{(.295 \times p \times (100 - p))/A}$
Combined owner, renter, and vacant housing unit estimates ²	$1.645 \times \sqrt{(.295 \times p \times (100 - p))/A}$
Mobile home estimates	$1.645 \times \sqrt{(.440 \times p \times (100 - p))/A}$
New construction estimates ³	$1.645 \times \sqrt{(.280 \times p \times (100 - p))/A}$
1990-BASED METROPOLITAN AREAS	
Charlotte, NC-SC	
Mobile home estimates	$1.645 \times \sqrt{(.240 \times p \times (100 - p))/A}$
All other estimates ²	$1.645 \times \sqrt{(.150 \times p \times (100 - p))/A}$
Columbus, OH	
Mobile home estimates	$1.645 \times \sqrt{(.230 \times p \times (100 - p))/A}$
All other estimates ²	$1.645 \times \sqrt{(.165 \times p \times (100 - p))/A}$
Kansas City, KS	
Mobile home estimates	$1.645 \times \sqrt{(.320 \times p \times (100 - p))/A}$
All other estimates ²	$1.645 \times \sqrt{(.195 \times p \times (100 - p))/A}$
Miami-Fort Lauderdale, FL	
Mobile home estimates	$1.645 \times \sqrt{(.485 \times p \times (100 - p))/A}$
All other estimates ²	$1.645 \times \sqrt{(.405 \times p \times (100 - p))/A}$
Portland, OR-WA	
Mobile home estimates	$1.645 \times \sqrt{(.255 \times p \times (100 - p))/A}$
All other estimates ²	$1.645 \times \sqrt{(.185 \times p \times (100 - p))/A}$

¹These formulas are equivalent to $1.645 \times \sqrt{p \times (100 - p)/A}$. For example, for all other estimates in the Charlotte, NC-SC, metropolitan area, $.240/A$ adjusts the data to the effective sample size.

²Some items (for example, characteristic of total housing units) may involve housing units from both the mobile home and nonmobile home universe. The formulas for all other estimates should be used for these items. The formulas for mobile home estimates should be used for items that only involve housing units from the mobile home universe (all mobile homes including owner, renter, and new construction mobile homes).

³Use the new construction formulas for all conventional housing units built in the last 4 years.

Table D-7. **How to Compute a 90-Percent Confidence Interval for a Median**

Steps for calculations	The formula	An example	Your data
How many total units is the median based on (in thousands, exclude "not reported" and "don't know")?	A	297.3	_____
What are the end-points of the category the median is in?	X - Y	\$600-699	_____
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	21.6	_____
Then the error from sampling for the median is approximately: ¹	$\frac{K \times W \times \sqrt{A}}{B}$	$\frac{.319 \times 100 \times \sqrt{297.3}}{21.6} = \25	_____
The 90-percent confidence interval for the median is:.....	median $\pm \frac{K \times W \times \sqrt{A}}{B}$	median \pm \$25	_____

¹Note: To obtain an appropriate value for K, multiply the **numerator** of the formula for computing the error from sampling for 50 percent by a factor of .01. Refer to Table D-6 for the appropriate formula for AHS-MS metropolitan areas. For example, for estimates consisting of only mobile homes in the Charlotte, NC, MSA, $K = .01 \times (1.645 \times \sqrt{.240 \times 50 \times 50}) = .403$ and for all other estimates in Charlotte, $K = .319$.

Table D-8. Calculation of the 90-Percent Confidence Interval for Medians

The following steps calculate the 90-percent confidence interval for medians. First we give some example cost data in which to work (all numbers are in thousands):

		Cumulative number of housing units
Total housing units	321.6	-
Less than \$500	109.3	109.3
\$500 to \$599	24.7	134.0
\$600 to \$699	21.6	155.6
\$700 to \$799	28.9	184.5
\$800 or more	112.8	297.3
Not reported	24.4	-
<i>Median</i>	\$668	-

Item	Formula	Bottom limit		Top limit	
		Example	Your data	Example	Your data
How many total units is the median based on (in thousands, exclude "not reported" and "no cash rent")?	A	297.3	_____		
Half the total, for the median (in thousands).....	A/2	148.65	_____		
Error from sampling for 50 percent of the base of this median (first line) ¹	$31.9/\sqrt{A}$	1.85	_____		
Multiply this percentage error by .01 to turn it into a fraction and by total units to give the error in housing units.	$.319\sqrt{A}$	5.5	_____		
Bottom of error range (second line minus fourth line, in thousands).....	B _{bottom}	*143.15	_____		
Top of error range (second line plus fourth line, in thousands)	B _{top}			*154.15	_____
* Start adding up the housing units in the 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?		\$600-699	_____	\$600-699	_____
How many housing units are in all the categories before this one (in thousands)?.....	C	134.0	_____	134.0	_____
How many housing units are in this category (in thousands)?	D	21.6	_____	21.6	_____
What is the bottom limit of this category (in dollars, rooms, or whatever the item measures)?	E	\$600	_____	\$600	_____
What is the bottom limit of the next category (in dollars, rooms, etc)?	F	\$700	_____	\$700	_____
Formula to calculate limits of confidence interval	$\frac{(B-C)}{D}(F-E)+E$	$\frac{(143.15 - 134.0)}{21.6}(100)+600$		$\frac{(154.15 - 134.0)}{21.6}(100)+600$	
Limits of confidence interval (in dollars, rooms, etc.)		\$642		\$693	

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

¹Statistical note: This formula is based on the error from sampling for 50 percent (using the appropriate formula, $1.645 \times \sqrt{.240 \times 50 \times (100 - 50)/A} = 40.3/\sqrt{A}$) for medians involving estimates of only mobile homes in Charlotte, NC, metropolitan area. For medians involving all other estimates in the Charlotte, NC, metropolitan area, use $31.9/\sqrt{A}$. Refer to Table D-6 for the appropriate formula for AHS-MS.