

Appendix B.

Sample Design, Weighting, and Telephone Experiments

SAMPLE DESIGN

This report is based on data from a sample of housing units interviewed between July and December 1993. The same basic sample of housing units is interviewed every 2 years until a new sample is selected. We update the sample adding newly constructed housing units and units discovered through coverage improvement efforts every enumeration.

For the 1993 American Housing Survey–National (AHS-N), we selected approximately 56,700 sample housing units for interview. About 3,300 of these units were ineligible because the unit no longer existed or because the unit did not meet our definition of a housing unit.

We classified about 2,300 of the remaining units (both occupied and vacant housing units), as “type A” noninterviews because (a) no one was at home after repeated visits, (b) the respondent refused to be interviewed, or (c) the interviewer was unable to find the unit.

SAMPLE SELECTION

We have interviewed the current sample of housing units since 1985. First, we divided the United States into areas made up of counties or groups of counties and independent cities, which we refer to as primary sampling units (PSU's). We selected a sample of these PSU's. Then we selected a sample of housing units within these PSU's.

Selection of sample areas. The sample for AHS is spread over 394 PSU's. These PSU's cover 878 counties and independent cities with coverage in all 50 States and the District of Columbia. If there were a sufficient number of housing units in a PSU, the PSU was known as a *self-representing* PSU and was in sample with certainty. The sample from the PSU represents only that PSU. There are 170 self-representing PSU's.

We grouped the remaining PSU's into strata and selected one PSU per stratum to represent all PSU's in the stratum. We refer to these PSU's as *nonself-representing PSU's*. The sample nonself-representing PSU's for AHS are a subsample of the Current Population Survey's (CPS) sample areas.

Selection of sample housing units. The AHS sample consists of the following types of housing units:

- Housing units selected from the 1980 census
- New construction in permit issuing areas
- Housing units missed in the 1980 census
- Other housing units added since the 1980 census

Housing units selected from the 1980 census. We selected a sample of housing units from the 1980 decennial census files using an overall sampling rate of about 1 in 2,148. We determined the within-PSU sampling rate so the overall probability of selection for each sample housing unit was the same (e.g., if the probability of selecting a NSR PSU was 1 in 10, then the within-PSU sampling rate would be 1 in 214.8).

We classified the areas within a PSU into two types based on (a) the completeness of the addresses in the areas that make up the PSU and (b) the presence of a system to monitor new construction through building permits.

The two types of areas were known as address enumeration districts (ED's) or area enumeration districts. We selected the sample of 1980 census units differently in the two types of areas.

In *address ED's*, most of the housing-unit addresses were complete, and the construction of new housing units was monitored by building permits. We selected a sample of housing units from the list of units that received long-form questionnaires in the 1980 census.

We also used the census files to select a sample of living quarters in address ED's that did not meet the definition of a housing unit (e.g., military barracks, college dorm). We use this sample to identify units that convert to housing units after the 1980 census.

In *area ED's*, 4 percent or more of the 1980 census addresses were either incomplete or inadequate or new construction was not governed by building permits (mostly rural areas).

We selected a sample of housing units from the list of units that received 1980 census long-form questionnaires in several steps. First, we grouped area ED's based on certain characteristics of interest. Then we selected a systematic sample of ED's. We selected a sample of land areas in these ED's. Finally, we selected a sample of housing units that received 1980 census long forms within the land areas.

New construction in permit issuing areas. The building permit frame covers only non-mobile home new construction. We selected the sample of permit new-construction housing units from permits that were expected to be completed after, April 1, 1980. In certain permit areas and for structures of certain sizes, we included permits issued as early as March 1979. But, for the most part, we included permits issued since July 1979. Within each PSU, we selected building permits monthly, based on certain geography characteristics. We created clusters of approximately four housing units and subsampled units within these clusters at the rate of 1 in 4, yielding clusters of size 1. The overall probability of selection of these units is about 1 in 2,148.

Housing units missed in the 1980 census. The Census Bureau conducted a special study, called the Housing Unit Coverage Study (HUCS), as part of the 1980 census. This study identified units at addresses missed or inadequately defined in the 1980 census. We included a sample of the units identified in the HUCS in the AHS sample.

Housing units added since the 1980 census. We pick up two other types of units added since the 1980 census: (a) units added within structures containing sample units and (b) whole structure additions that did not contain living quarters at the time of the 1980 census.

Within structure additions. These additions have a chance of being in sample, because there is at least one unit that existed at the time of the 1980 census that was eligible for selection. We identified these adds in structures with at least one unit selected from the 1980 census sample and the HUCS sample. We also pick up adds in permit new construction, e.g., units added since the structure was completed. The rules for identifying within structure additions differed in certain types of areas and frames.

In *area ED's*, all within-structure additions in structures containing at least one sample unit were interviewed for the AHS.

In *address ED's* and in the *HUCS* and *building permit frames*, we interviewed all within-structure additions in 1-15 unit structures containing at least one sample unit for AHS. In 16-or-more unit structures, we only interviewed a sample of units.

Whole structure additions. These types of additions are units in structures that contained no living quarters at the time of the 1980 census. We used area sampling methods to identify these in all types of areas. Under area sampling, we list all housing units within a land area and then select a systematic sample.

To identify whole structure additions in *address ED's*, we used land areas in sample for the National Health Interview Survey (NHIS). The NHIS uses an area sampling approach in all its sample *ED's*. We only used NHIS areas that were in AHS PSU's or in NHIS PSU's adjacent to AHS PSU's. Only units that were not already assigned to NHIS were eligible.

We matched these units to the 1980 census address registers. If the address matched to the census, the unit was ineligible. (Only the basic address, i.e., 801 Main Street, had to match. Apartment number, mobile home site number, etc., did not have to match.)

When we listed all the units in structure, we screened eligible units further to pick up units with no previous chance of selection. (The screening eliminated units such as non-mobile home new construction, which is covered by building permits, and census misses.) We updated these areas in 1991.

In *area ED's* where new construction is not governed by *building permits*, we used all land areas chosen for the area ED sample. We selected an expected four units, using area sampling methods, within these land areas to identify whole structure additions. However, we did not match this sample to the census. Instead, we screened this sample, using criteria similar to those used in address *ED's*. One important difference to note is that we did not eliminate new construction during the screening process. In 1989, we only updated one-third of all segments (2 of 6 panels). In 1991, we only updated one-sixth of the segments (1 of 6 panels) but we used twice as many units. In 1993, we updated half of the segments (3 of 6 panels).

In *area ED's* where new construction is governed by *building permits*, we only used one-third of the land areas chosen for the area ED sample. We selected an expected eight units using area sampling methods within these areas to identify whole structure additions. We screened this sample using the same criteria as for address *ED's*. Again, we did not match this sample to the census. The screening process eliminated non-mobile home new construction, because it is covered by the building permit frame. In 1991, we increased the expected number of units by 50 percent and updated one-half of the areas (1 of 2 panels). In 1993, we updated the other half.

WEIGHTING

We assigned each unit a weight to reflect the correct probability of selection. After applying this weight, the AHS-N weighting procedure consists of two phases.

1. First phase

In the first phase, we make a series of adjustments to account for units that could not be interviewed for a number of reasons. For each of these adjustments, we compute a factor and apply it to the appropriate units. The factors equal the following ratio:

$$\frac{\text{Interviewed housing units} + \text{Housing units not interviewed}}{\text{Interviewed housing units}}$$

The interviewed housing units have the above factor applied to them. The first of these adjustments, done only in permit segments, accounts for permits that could not be sampled and units that could not be

found. Records representing these two situations were treated as noninterviews. These noninterviews make up “housing units not interviewed.” The “interviewed housing units” for the first adjustment actually include both interviews and noninterviews (excluding unable to locate units).

The second of the adjustments accounts for units in structures built before the 1980 census that could not be found. The unlocatable units are represented by both interviews and noninterviews (excluding unable-to-locate units).

The last of these adjustments accounts for “type A” noninterviews (excluding unable-to-locate units). (See the section on Sample Design for a description of “type A” noninterviews.)

When prior year AHS-N or 1980 census data are available, we use this information to determine the noninterview adjustment cell. The cells include the following characteristics:

- Tenure (i.e., owner or renter)
- Geography
- Type of housing unit (i.e., mobile home or non-mobile home)
- Units in structure
- Number of rooms

When previous data are not available, we compute adjustment factors using more general characteristics such as type of area and type of housing unit (i.e., mobile home, non-mobile home).

2. Second phase

The second phase involves a three-stage ratio-estimation procedure that adjusts for the following: (a) sampling of nonself representing PSU's, (b) known sampling deficiencies in new construction, and (c) differences between sample estimates and estimates derived from independent sources for key characteristics.

The *first stage* of this procedure reduces the portion of the variance due to the sampling of nonself-representing PSU's. The procedure accounts for differences that existed at the time of the 1980 census between housing units estimated from the nonself representing sample PSU's and the 1980 census count of housing units from all nonself-representing strata.

We compute factors accounting for these differences separately for the following characteristics: (a) region, (b) tenure, (c) metropolitan area status, and (d) urban or rural status. In addition, we use ethnicity (i.e., Hispanic, non-Hispanic) in the South and West regions and race in the South region.

The first stage factor equals the following ratio:

$$\frac{\text{1980 census housing units for all nonself-representing strata in a cell}}{\text{Number of 1980 housing units in the same cell estimated from the sample nonself-representing PSU's}}$$

We calculate the numerators of the ratios by summing the 1980 census housing-unit counts for each cell across all nonself-representing strata. We compute the denominators by weighting the 1980 census housing-unit counts from each nonself-representing sample PSU by the inverse of the probability of selection for that PSU. Then we sum the weighted counts across all nonself-representing sample PSU's.

The *second stage* of the ratio estimation procedure adjusts the AHS sample estimate of new construction (i.e., units built since the 1980 census) to account for known deficiencies (see the section on nonsampling error in appendix D).

For non-mobile homes, we control the sample estimates to independently derived estimates from the Survey of Construction. For mobile homes we control the most current sample estimates to independently derived estimates from the Survey of Mobile Home Placements. These estimates are the best estimates available for these types of units.

We compute factors separately for each region. The second stage factor equals the following ratio:

$$\frac{\text{Independently derived estimate for a cell}}{\text{AHS sample estimate in that cell}}$$

We compute the denominators of the above ratio by summing the existing weight on each record after the first stage of ratio estimation over all records for each cell in each region. The numerators come from either the Survey of Construction or the Survey of Mobile Home Placements.

The *third stage* of the ratio estimation procedure adjusts the AHS sample estimate of housing units to independently derived current estimates for key characteristics. We believe these characteristics are highly correlated with other characteristics of interest for AHS.

The third stage is done in two steps for occupied units. First, we control the sample estimate of occupied housing units to independently derived estimates for the following characteristics:

- Region
- Tenure
- Ethnicity (i.e., Hispanic head of household and non-Hispanic head of household)
- Household status (husband-wife, other male, or other female)
- Age of household head

Then we apply the factor from this step to the interviewed occupied units. Next, we control the new sample estimate of occupied housing units to independently derived estimates for similar characteristics. We substitute race for ethnicity in this step but all other characteristics are the same. We control the sample estimate of vacant housing units to an independently derived estimate for four type-of-vacant cells for each region.

We calculate all third stage factors similarly using the following ratio:

$$\frac{\text{Independently derived estimate of housing units in a cell}}{\text{AHS sample estimate of housing units in that cell}}$$

For occupied units, we derive the numerators of the factors in three steps. First we compute an independent intercensal estimate of total housing units for 1993 based on 1990 census counts. Then we determine the occupied portion of this independent control based on the sample proportion. Finally, we allocate the occupied portion of the independent control based on the Current Population Survey distribution for the third stage occupied cells.

For vacant units, we allocate the vacant portion of the independent control based on the distribution of vacant units from the Housing Vacancy Survey. This survey is a quarterly vacancy survey conducted by the Bureau of the Census.

We compute the denominators of the factors by summing the weights, with all previous factors applied, on all records in a cell. For the Hispanic/non-Hispanic and vacant cells, we use the weight after the second-stage of the ratio estimation procedure. For the Black/non-Black cells, we use the weight after the Hispanic/non-Hispanic portion of the third stage of the ratio estimation procedure.

We repeat the second stage and third stage of the ratio estimation procedure to bring the AHS sample estimate into closer agreement with the independent estimates. We used the final weight resulting from all iterations for the tabulations in this report.

As a result of the estimation procedure, the sampling error for most statistics is less than if the sample were simply weighted by the inverse of the probability of selection.

This is the second year we're using controls based on the 1990 census. The method for computing the controls also changed in 1991. We believe this method is better than the previous one because, using 1980 census data, it predicted the 1990 census count of housing units better than the previous method. As a result, the 1990-based control is about 2.5 percent lower than the 1980-based control.

We have included 1990-based estimates of the occupied and vacant housing inventory for 1985, 1987, and 1989 for selected items in table H of appendix C of this report. Estimates of change between

1993 and previous years using data from this table are reliable. However, estimates of change between 1993 and previous years for items involving old construction in the United States will be understated by about 2.5 percent.

TELEPHONE EXPERIMENTS

In 1993, we used three different methods of interviewing: personal visit, decentralized telephone interviewing, and computer assisted telephone interviewing (CATI). Seventeen percent of the interviews (10,486) were completed using CATI and thirty-one percent by decentralized telephone interviewing (18,958). However, most interviews were conducted by personal visits (31,482).

CATI was generally assigned to areas where it is difficult to hire and retain field representatives. These areas are typically large urban PSU's.

1. Decentralized telephone interviewing

Possible effects of decentralized telephone interviewing on the data—We conducted a large scale decentralized telephone interviewing experiment for the 1983 AHS-National. Prior to 1983 all interviews were done by personal visits. The experiment provided more detailed information about the effects of decentralized telephone interviewing on the data. We concluded telephone interviewing had the following effect on the data: (a) Telephone interviewing increased the item nonresponse rate for income items although this effect did not appear to cause changes in the published estimates. (b) Problems with neighborhood quality were underreported, although this effect was minimal.

2. Computer assisted telephone interviewing (CATI)

We conducted large-scale Computer Assisted Telephone Interviewing (CATI) experiments as part of the 1987 (6,400 CATI interviews), 1989 (5,800 CATI interviews), and 1991 (6,142 CATI interviews) enumerations for AHS-N. Although there were differences between CATI and non-CATI data in 1987, 1989, and 1991, we recommended continuing CATI for the 1993 AHS-N. We identified many positive aspects of CATI. One positive aspect is that with CATI supervisors have the ability to monitor and observe inexperienced CATI interviewers while they collect data. Another benefit of CATI is if we use CATI in geographic areas with interviewer retention problems, we could hire fewer new interviewers. Therefore, the CATI data we obtain would be at least as good as the non-CATI data we would settle for otherwise. We will continue to use CATI in these areas to reconcile questionable results from previous enumerations and to improve AHS data quality.

Possible effects of computer assisted telephone interviewing (CATI) on the data—There is strong evidence differences exist in data collected by CATI versus non-CATI. We do not know for sure, however, which method produces better data. Analysis of the CATI experiment conducted in 1987 indicated CATI had a substantial effect on some AHS-N characteristics.

Based on the results from the 1987 and 1989 analyses, we made the following changes to the CATI interview in 1991:

- We moved the heating equipment reconciliation from the end of the interview to right after the question. We also changed the response based on the reconciliation answer.
- We added a probe and reconciliation to the question on the presence of a mortgage. We also changed the response based on the reconciliation answer.
- We added a probe for lot size, units-in-structure, and the age of household appliances (e.g., refrigerator) if the respondent initially replied they did not know.
- We improved the training for CATI interviewers, putting more emphasis on probing and dealing with “don’t know” responses, and CATI supervisors.

Use of the probes resulted in substantial reductions in “don’t know” answers. Most of the items where probes were added showed at least 50 percent fewer “don’t know” responses in 1991 compared to 1989. Other information from the 1991 experiment confirmed the results of the experiments conducted in 1987 and 1989.

We used the same method of analysis for the 1987, 1989, and 1991 experiments. We weighted data from the CATI and non-CATI treatment panels separately using the AHS-N estimation procedure described in the section on estimation. We produced estimates from the two treatments in data tables for characteristics provided in chapter 2 of the AHS-National publication. We used t-statistics to test differences between estimates from the CATI and non-CATI treatments.

The 1987 and 1989 analyses of the t-tests yielded similar results. The percents of significant differences observed at the 10 percent, 5 percent, and 1 percent significance levels were higher than what we expected by chance (e.g., we expected 10 percent of the tests to yield significant results, by chance, when tested at the $\alpha = .10$ significance level). For 1991, results show fewer significant differences than in 1987 and 1989, although the proportion is still higher than expected. It appears the changes introduced in 1991 had some effect on the CATI responses.

T-Test Results

Survey year	Proportion of significant tests (percent)		
	$\alpha = .10$	$\alpha = .05$	$\alpha = .01$
1987	11.1	6.2	1.9
1989	11.7	6.8	2.3
1991	10.2	5.9	1.7

For characteristics of total occupied units, the significant differences for estimates for panels assigned to CATI versus panels assigned to non-CATI treatment ranged from about 6 to 40 percent.

The following table shows which groups had the most significant differences between CATI and non-CATI estimates for 1987, 1989, and 1991.

Groups With Differences Between CATI and Non-CATI Estimates

Groups	1987	1989	1991
Owner occupied housing units	Y	Y	Y
Urban housing units	Y	Y	Y
Housing units with moderate physical problems	Y	Y	Y
Total occupied housing units		Y	Y
Housing units in the suburbs (in MSA's)		Y	Y
Housing units which moved in the past year		Y	Y

For both 1987 and 1989, the analyses also revealed CATI had an effect on certain items within the groups. The following table contains those items and indicates whether CATI (C) or non-CATI (N) estimates were higher. If neither estimates were higher, the results were termed inconclusive (I).

Items Within Groups Showing Differences Between CATI and Non-CATI Estimates

Items	1987	1989	1991
Lot size	I	I	I
Water leakage	N	N	N
Income	I	I	I
Monthly housing costs as percent of income	N	N	N
Housing ownership shared by person not living at the unit	C	C	C
Utilities paid separately from rent	C	C	C
Owners with a mortgage	N	N	N
Routine maintenance costs	I	I	I
Heating equipment	I	I	I
Other (additional) heating fuels	N	N	N

We used data from both CATI and non-CATI treatments to produce the data presented in the 1987, 1989, and 1991 publications. The 1987, 1989, and 1991 published estimates for the groups and items mentioned previously are different than if we used maximum decentralized telephone interviewing for all units. You can get detailed information

on which specific characteristics are affected and the extent of the effect by writing to:

Demographic Statistical Methods Division
Bureau of the Census
Washington, DC 20233

Conclusions. The 1991 results confirmed the findings from both the 1987 and 1989 studies. There is strong evidence there are differences in data collected using CATI versus non-CATI methods. We do not know which method provides better data. However, we speculate that CATI income estimates are probably better than non-CATI, but that some other estimates are probably worse.

For income, CATI ensures all questions are asked. The computer will not allow the interviewer to skip any questions. For other items, we believe non-CATI estimates are more accurate because it is unlikely people would over-report things like water leaks.

These findings affect various types of estimates and comparisons. In particular, change estimates across 1985, 1987, 1989, and 1991 are biased and longitudinal analysis is adversely affected since we used CATI in 1987, 1989, and 1991. Personal visits were the only type of data collection done for 1985. The extent to which we use CATI in the future will determine the impact on longitudinal analyses involving data from 1985.

Reconciliation experiment. As part of the CATI, we conducted reconciliation studies in 1987, 1989, 1991, and 1993. If the responses for a particular year differed from the previous year, we asked the respondent to explain the difference. Our goal was to determine if there was a change since the previous year or if one of the responses was wrong.

1987 reconciliation study. The 1987 reconciliation study indicated respondents had difficulty reporting items such as the following: (a) presence of basement, (b) heating equipment, and (c) heating fuel.

The number of respondents who said their 1985 response was wrong was about the same as the number who said their 1987 response was wrong. Since we interviewed all households by personal visit in 1985, this indicates an effect due to certain questions rather than the mode of interview.

1989 and 1991 Reconciliation Studies. We conducted reconciliation studies in 1989 and 1991 with some of the questions from the 1987 study. The results were similar to the 1987 study. Results indicate problems reporting the presence of a basement, and type of heating equipment. More respondents indicated the prior year response, rather than the current year response, was wrong.

1991 moderate physical problems (MPP's) study. In 1991, an experiment was done to determine why CATI reported fewer moderate physical problems (MPP's) than non-CATI. The low estimates of MPP's found by CATI, relative to non-CATI in 1987 and 1989 AHS-N were likely caused by CATI underestimating MPP's and non-CATI overestimating MPP's. Thirty-seven percent of the differences between CATI and non-CATI were attributed to CATI missing a true MPP. And forty-two percent of the differences were attributed to non-CATI recording MPP's which reconciliation showed did not exist.