The American Community Survey Design Issues And Initial Test Results

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The American Community Survey (ACS) will be a large continuing survey of the U.S. population using a "rolling sample" design of the type described in Kish (1990). It is a mail survey with follow-up by telephone and personal visit of a sample of nonrespondents. The Census bureau's ongoing Master Address File operation provides the frame. The ACS collects information about the same topics as the census "long form" content sample questionnaire. After a period of testing and comparison to the 2000 census long form, the ACS sample will increase to about three million mailouts each year starting 2003, leading to replacement of the content sample in the 2010 census. This paper describes the ACS survey design, objectives, and estimation procedures along with the considerations that led to them. The major methodological issues in conducting the survey and assessing the quality of the data are outlined. Initial results from the 1996 tests in four counties are presented, along with plans for future research and testing.

Key words: Rolling sample, small area, survey coverage

INTRODUCTION

The American Community Survey (ACS) is a rolling sample survey being developed by the U.S. Bureau of the Census as an eventual replacement for the decennial census "long form" survey that provides the detailed economic, social, and housing characteristics of communities throughout the U.S. The ACS will cover the same topics as the census long form, but instead of contacting about 17,000,000 addresses at one time, the ACS will mail to about 3,000,000 addresses each year throughout the decade.

The ACS design has two main estimation objectives:

a) provide descriptive profiles for communities of all sizes with mean squared error (MSE) generally similar to the census long form estimates, but updated throughout the decade;
b) provide a time series of annual estimates for communities well below the State level, to measure changing local conditions.

After Census 2000, the ACS will replace the census long form sample as the source of detailed estimates of the characteristics of small areas. There will still be a decennial census to get a population and housing "count."

There has been a long-standing interest in updating the census descriptive profiles (Melnick, 1991 or Sawyer, 1993) in part because of their role in allocating Federal funds to local areas. The interest in tracking changes for sub-state areas has increased because of recent political developments in the U.S. sometimes referred to as "devolution" of decision-making to state and local governments.

To meet these two objectives, the ACS uses a rolling sample design suggested by Kish (1990, 1981) with what Kish calls "asymmetrical cumulation" of the survey data, i.e. cumulating different numbers of years of data for different geographic levels or different uses. For the first objective, to produce estimates comparable in variance and bias to census long form estimates, 5 years of data would be cumulated to get sufficient sample sizes. For the second objective, to track changes for states and sub-state areas, single-

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year estimates would be used with the understanding that the larger sampling variance would mean that only very large changes could be detected for the smallest domains such as census tracts. The ACS questionnaire will initially cover the same topics as the 2000 census long form. After 2002, additional topics might be added. Participation in the ACS by sample households is required by law.

The Census Bureau views the ACS as part of a larger "continuous measurement" program, including benefits for the statistical programs of other Federal agencies. Besides the direct ACS data collection, this includes:

a. use of ACS information to improve the Bureau's intercensal demographic estimates, which are in turn used in weighting the ACS;

b. use of the ACS field staff to help update MAF/TIGER, keeping it complete enough for an intercensal survey frame;

c. use of the ACS data and sampling frame to improve the estimation from various household surveys conducted by the Census Bureau, such as the Current Population Survey (CPS), the Survey of Income and Program Participation (SIPP) or the National Health Interview Survey (NHIS);

d. development of model-based small-area estimates for specific characteristics using data from existing household surveys, administrative records and eventually the ACS; the Census Bureau's Small Area Income and Poverty Estimates (SAIPE) program is an example, as is the Bureau of Labor Statistics Local Area Unemployment Statistics (LAUS) program (Brown, 1997).

The ACS is being introduced in stages to allow review of the data, refinement of the operations, and a comparison with the Census 2000 long form before proceeding with a full introduction of the new survey. The stages are as follows:

1996-1998	Demonstration and Testing Period (four sites in 1996, eight in 1997, nine in 1998)
1999-2001	Thirty-seven "comparison sites" with 5% annual sample
2000-2002	National comparison sample with overall rate of 0.7% annually
2003-on	Full introduction (three million addresses per year, including all counties).

ACS DESIGN AND OPERATIONS

Sample Design: The ACS uses a "rolling" sample design with each address being interviewed at most once in a 5 year period. Each year's sample addresses will be spread evenly across the 12 months of the year and, starting in 2003, across the entire nation. The sample is in general not clustered, although there may be some exceptions in areas with unusually high travel costs and in group quarters.

The sampling frame will be the Census Bureau's Master Address File (MAF). The MAF is being created for the 2000 census, but is being created early for the ACS test sites. It starts with the 1990 census Address Control File, which is linked to the TIGER geographic database. This is updated using Postal Delivery Systems Files (DSF) in areas where the DSF addresses can be geocoded based on a "city-style" house number and street name. In other areas, the MAF must be created by physically listing each block. After Census 2000, the MAF will be kept up to date by regular matches to the DSF, at least every 6 months, by additional listing in rural areas of high growth as identified by administrative records systems.

The sample will be selected as a systematic sample from the MAF, including only addresses not selected in the previous four years.

Data Collection: For each monthly sample panel, the ACS starts by mailing a questionnaire to each address about 10 days before the start of the "mailout month." There is a "pre-notice" letter, an initial mail questionnaire, and a reminder card, one week apart. After about 3 weeks, a replacement questionnaire is mailed if no response has been received.

At the beginning of the following month, nonresponding addresses are assigned to telephone nonresponse follow-up. For addresses where the telephone number can be obtained from commercial directories, a telephone interview is attempted. Mail returns continue to come in during this second month; in 1996 about 19% of the telephone nonresponse follow-up group were removed from follow-up because of a late mail return.

The third month, any addresses still not interviewed are eligible for personal-visit follow-up. This includes addresses where no telephone number could be located, as well as addresses where there was a number but no interview could be obtained. One-third of these addresses are selected for follow-up by personal visit. Note that this includes most of the vacant addresses.

As an example, the March mailout panel has telephone follow-up in April, and personal-visit follow-up in May. In general, a new area introduced in a particular year starts with mailouts in November and December of the previous year, so that the normal pattern of follow-up work in January and February is in place by the time the year starts.

Roughly speaking, based on the results of the 1996 and 1997 tests, we expect a National average of about 70% of the sampled addresses to be completed by mail or telephone and about 1/3 of the remaining 30% to be selected for personal visit followup.

The mail returns undergo a clerical edit which includes determining

1) if the form is missing enough responses to require a callback;
2) if an initial write-in entry giving the number of persons at the address was inconsistent with the number actually included in the questionnaire;
3) if more than 5 people were listed as living at the address, since the form only collects characteristics for 5 people.

The first condition is referred to as the "content edit" and the last two as the "coverage edit." If the form fails either edit, then there is a telephone callback that attempts to fill in all missing data and straighten out any coverage problems. The exception is that if the content edit finds that the form is completely blank, the case continues to nonresponse follow-up as if no form had been returned. In 1996, about half of the mail returns failed one or more edits; of these 96% gave a telephone number, and 92% of these had some further resolution from telephone followup.

Residence Rule and Reference Period: The residents of any sample address, and their characteristics, will be determined as of the time of data collection. This refers either to when the mail form is filled out or when the nonresponse follow-up interview takes place. The ACS currently uses a "2-month" rule to determine who is a "current resident" of an address. Anyone staying at the address more than two months

is included as a current resident. People staying two months or less would also be included, unless they usually live somewhere else.

ACS ESTIMATION METHODS

ACS Weighting: The 1996 ACS estimates were weighted using fairly conventional survey methods combining features of the census long-form weighting and household surveys such as the Current Population Survey (CPS). The details are given in Alexander, Dahl, and Weidman (1997).

Edit and Imputation: The editing and imputation for the 1996 ACS was similar to that for the 1990 census long form, although there are minor improvements for specific data items, mainly associated with minor questionnaire changes that are also being considered for the 2000 census.

Variance Estimation: The sampling variances for ACS estimates have been estimated using replication methods similar to those used for the CPS, with reweighting of each replicate to account for the effect of population and housing controls. For some items, the variance was also estimated using the random group method used for the 1990 census. The results of the two methods are still being compared, but an initial review showed the results to be generally similar. As with the 1990 census long form, the ACS variance estimates do not include variance due to imputation of missing data. This will be remedied as soon as possible. The ACS variances will mainly be reported to the users in the form of "generalized variance functions" (GVF), which approximate the variance as a "design factor" times the corresponding variance from a simple random sample. Different groups of characteristics have different design factors. Work on the 1996 GVFs is still underway.

RELATIONSHIP TO OTHER FEDERAL GOVERNMENT SURVEYS

The ACS will provide a valuable "statistical infrastructure" to improve the estimates and operations for other Federal government household surveys. The ACS data can be used in weighting and sampling for these surveys, as census long form data have traditionally been used, but the ACS will be more up-to-date. The sample for other surveys can be supplemented with housing units having specific demographic or economic characteristics taken from recently interviewed ACS sample units. When the survey samples are redesigned after the 2000 census, the MAF will provide more flexibility for drawing additional sample between censuses. The ACS will also provide auxiliary variables to improve small area models such as those used for the Local Area Unemployment Statistics (LAUS) or Small-Area Income and Poverty Estimates (SAIPE) programs.

However, the ACS will not replace the need for the CPS to measure unemployment, the SIPP to measure the dynamics of income and poverty, or other special-purpose surveys such as the NHIS or the National Crime Victimization Survey (NCVS). The subject matter of these surveys requires specialized questions that are too complicated for a self-response mail questionnaire. The ACS design is not suitable for measuring month-to-month changes as does the CPS, nor for following people over a period of time as does the SIPP.

There has been concern about possible confusion between the more accurate national and state labor force estimates from the CPS, which is designed especially to measure labor force status and the corresponding ACS estimates. The Census Bureau and Bureau of Labor Statistics are working together to avoid such confusion (Brown, 1997). The ACS will not produce monthly unemployment estimates. For annual estimates, the ACS will provide a set of "adjusted" unemployment and civilian labor force (CLF)

responses that will give unemployment and CLF estimates agreeing exactly with CPS at the national level, and conforming more closely to the CPS estimates at the state level.

The potential benefits of the ACS for other Federal government surveys, and its limitations, are discussed in more detail in Brown (1997).

WHY THIS DESIGN?

The Alternative of Expanding the CPS. An alternative to having a separate mail survey like the ACS to produce intercensal small-area data would be to expand the CPS sample and have one large personal-visit survey to produce both annual small-area data and estimates of short-term change in labor force characteristics. A rolling sample design with approximately 2 million addresses per year (without sampling for nonresponse followup) could in theory serve both objectives. This is about four times the current monthly CPS sample, but would not dramatically reduce the variance of monthly change estimates because the high correlation between monthly estimates with the current CPS rotating panel design would be lost.

The unit cost of this design would be substantially higher than the current CPS. The CPS now uses a cluster sample, conducts most interviews by telephone using the phone numbers obtained on the first of eight interviews at each address, and has a shorter interview than a combined ACS/CPS survey would require. We think that a survey of this design would cost several times as much as the combined cost of the current CPS plus the projected $75 million annual cost of the ACS operations.

To make a compromise CPS/ACS design affordable, it would be necessary to give up on some of the objectives, sacrificing either top-quality monthly measurement of unemployment, or "long form" data for small areas such as census tracts. A review of uses of census data (Edmonston and Schultze, 1995) showed that the long-form small-area estimates were necessary to meet legislative requirements, and the importance of the monthly unemployment estimates for economic decision-making is well established.

The Alternative of a Mid-Decade Census. With the failure of a mid-decade census to be funded for 1985 or 1995, this alternative was not extensively considered in the ACS development. For the purpose of updating census profiles for small areas, a mid-decade sample census is arguably as effective as the five-year averages proposed for the ACS. However, a quinquennial "snapshot" is not effective for monitoring year-to-year changes, the second major use of the ACS. This new use seems to have made the difference in obtaining support for the ACS.

Alternatives Relying Mainly on "Indirect" Estimation. Another alternative would have been to rely less on "direct" estimation from a large survey and more on "indirect" model-based methods combining information from administrative records and smaller surveys. The "smaller surveys" could be a modification of CPS and existing surveys, or they might include a smaller mail survey such as a much reduced ACS.

As mentioned in Section I, research on such methods is part of the Continuous Measurement program. As these methods develop and become accepted by data users, we hope some of the ACS sample will gradually be replaced by information from statistical models. However, the development of these methods is not far enough along to eliminate the need for large samples to produce estimates of a variety of characteristics for very small areas.

Why This Data Collection Design? The uniform spread of the sample was needed to provide comparable estimates for all levels of geography each year. A precursor of the ACS with different areas in different years was previously explored (Herriot, Bateman and McCarthy, 1989), but was rejected because of the difficulty in making comparisons across areas.

The choice of a mail survey with followup was based on experience with this design in the census. The particular multiple-mailings approach was selected based on research following the 1990 census. The limitations of the questions that can be asked by mail are not a barrier since the ACS objectives involve the topics covered by the census long form survey, which is also done by mail.

We decided not to have any clustering of the sample, rather than to use small "ultimate clusters" of, say, four adjacent addresses as does CPS. The unclustered design is more efficient for the mail survey. The relatively high mail response rate means that a large initial cluster would be needed to have an expected four, or even two, in a cluster for followup. We are still considering clustering of followup cases in remote areas by reassigning the followup cases in a particular area to the same month of interview.

The data collection procedures for the telephone and personal-visit followup interviews were adapted from those used for CPS and other Census Bureau household surveys. The subsampling rates were chosen considering the relative costs per interview for the mail, telephone, and personal-visit modes using the rule that the allocation should be inversely proportional to the square root of cost but rounding to whole-number sub-sampling rates (no subsampling for telephone and 1 in 3 for personal visit).

VARIANCE AND BIAS OF THE ACS ESTIMATES

The ACS was designed with certain tradeoffs in mind between sampling error, frequency of updating the data, various sources of measurement error, and issues of interpreting and using the data.

The intended tradeoffs for the smallest communities are as follows:

1) Sampling error: standard errors 1.25 times as large as the long form design for "typical" estimates for small areas;
2) Frequency of updating: annual rather than decennial;
3) Issues of interpreting and using the data: 5-year average rather than point-in-time;
4) Other nonsampling errors: roughly equivalent, with each design having relative strengths and weaknesses.

For larger domains, where 5 years of ACS sample is more than enough for many purposes, annual estimates or shorter averages can be used. In this case, sampling error and the interpretation issues concerning the multi-year averages are less important, and other nonsampling errors are relatively more important.

In presentations of the ACS plans, these intended quality tradeoffs have been described to potential ACS data users. Now that the preliminary 1996 data are available, we can begin to verify the first statement about the standard errors and the fourth about nonsampling errors. The remainder of this section gives a first look at the preliminary results. All these conclusions must be regarded as very tentative, since they are based on preliminary data, and a small non-probability sample of test areas.

Sampling Error: ACS Compared to 1990 Long Form. A preliminary comparison of the ACS standard errors for tracts, to the corresponding "1990 census standard errors" computed using the 1990 generalized variance function (GVF) assuming a 1-in-6 sampling rate, is generally consistent with the anticipated 1.25 ratio. However, the results show that a simplistic rule like "1.25 times as large" is only a general guide. The ratio is higher for items that are concentrated in the "nonresponse universe"--that portion of the population that would not respond by mail or telephone--because of the ACS's use of sampling for nonresponse followup. The extreme case is for vacant units, which are almost all collected by personal visit. We are still working on summarizing this variance comparison and extrapolating to what can be expected from the 2003 ACS.

Evidence From the 1996 Test About Nonsampling Errors. Rather than attempt to quantify the net bias in ACS estimates in a "total error" analysis, we adopt the less ambitious approach of looking for evidence of specific quality problems and quantifying them separately, in some cases with only indirect measures.

The final weighted unit response rates were quite high, running at 98.2% in the 1996 test areas and 98.7% in the 1997 areas except Houston, from January through July 1977, and 97.2% in Houston, TX, which has many hard-to-enumerate areas. By contrast, long-form data were collected for only 91.5% of sample units in the 1990 census, although all the rest had the basic census count information collected. The ACS final response rates in Rockland, NY were uniformly high for all tracts although mail return rates varied dramatically. (See Salvo and Lobo, 1997.)

Salvo and Lobo (1997) argue that a more valid comparison is to look at what proportion of households complete a specific questionnaire item, i.e., they look at the combined effect of "unit" and "item" nonresponse. In the Rockland, NY test site, they found that item response rates for cases assigned to follow-up were uniformly at least as high for the ACS as for the 1990 long form and were substantially higher for some items. This was expected, as a product of having a permanent field staff.

We are not prepared to draw a conclusion about whether the ACS suffers from the same kinds of overall undercoverage of persons relative to census-based intercensal demographic estimates that is seen for the CPS and many other household surveys. Comparisons of ACS weighted population estimates prior to post-stratification come within a few percent of the intercensal population estimates for the test counties. The population estimates include an adjustment for undercount in the 1990 census (Table 1, row 1). However, it is possible that these results are overly favorable if the vacancy rate is under-estimated, as discussed below.

There is still reason for concern about differential undercoverage of non-white persons and persons of Hispanic origin. Results were mixed on this, with some sites showing undercoverage of these groups and others showing good coverage and in one case overcoverage (Table 1). The latter anomaly suggests that the race/Hispanic-origin breakdown in the population controls may not have fully captured changes since the census. (Alexander, Dahl, and Weidman, 1997). If so, this demonstrated a situation where the ACS can provide information useful in improving the population controls. This analysis is complicated by differences in the race/origin categories between the ACS and the 1990 census, another reason that we are not prepared to draw conclusions without further study.

Table 1
Ratio of "Before PPSF" Estimate
Divided by "After PPSF" Estimate

Site				
	Rockland County	Multnomah County	Brevard County	Fulton County
Total Persons	.975	.987	.958	.941
Race = "Black"	1.044	.781	.861	*
Race = "Other"	.974	.985	.898	*
Hispanic Origin	.930	1.162	.849	*

* Sample too small for a reliable estimate

Comparisons of the 1996 ACS estimates with 1990 census estimates at the county level showed few differences that suggested methodological problems. The most salient concern is that the ACS had noticeably lower vacancy rates. Somewhat lower rates are expected because the residence rules reduce the number of "vacant-usual residence- elsewhere" situations, but there is a possibility that the vacancy rate could be underestimated because of the long period allowed for ACS follow-up, with units that are vacant at the time of mailout becoming occupied by the time of follow-up. This is being studied further.

Income, poverty, and other economic data were not ready in time for this anaylsis. There is concern that asking the income questions "for the last 12 months" throughout the year may give less accurate recall than asking for "the last calendar year" in April. A small test comparing "last 12 months" and "last calendar year" is being conducted at the end of 1997, and may give some insights about this issue.

Examination of changes for individual tracts has just begun. One dramatic error was found in a small tract in the Rockland test site where a geocoding error on the MAF caused the number of addresses to drop dramatically between1990 and 1996. This illustrates the need to feed information about address problems from the ACS data collection process back to the MAF updating process. The ability to detect such MAF errors is a potential benefit of the ACS, but we do not yet have this system in place.

A fundamental question is how funds can be allocated equitably based on the most recent data when the best estimate for large cities may be for the previous year while for small places it may be for the previous 5 years. Two solutions have been suggested. The first is to use the longest average (5 years in most cases) for all areas. The second is to allocate funds to large areas using one year data and then within the large areas based on multi-year averages. The large areas could include collections of small rural counties in addition to large cities or metropolitan areas. This question also needs to be widely discussed.

Annual Average Data. The differences between the ACS and the long form survey associated with collecting data all year with a moving reference date, rather than in the few months after the census using a fixed reference date, may actually be more important than the use of multi-year averages. However, these differences have generated less concern among users, perhaps because annual averages are more familiar from other household surveys such as CPS. The 1999-2001 comparison sites have been selected to represent areas in which various sources of differences are expected to be especially important and we expect our understanding of these differences to grow as time goes on.

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