Can the American Community Survey trust using respondent data to impute data for survey nonrespondents? Are nonrespondents to the ACS different from respondents?

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1. Introduction

Every 10 years the Census Bureau conducts a decennial census of population and housing. As part of the census, detailed demographic, socioeconomic, and housing data are collected from about one in six households to support hundreds of federal laws. As a consequence, these critical data are required by hundreds of federal laws every ten years. To meet the challenges of rapid demographic and technological changes and meet the needs of stakeholders, the Census Bureau developed the American Community Survey (ACS) as an alternative method of collecting these critical data. Data collection for the ACS will occur throughout the decade rather than just once in ten years. Eventually, the ACS will provide yearly estimates of the distribution of characteristics of the population and housing in small areas such as census tracts.

As the Census Bureau prepares to move into full implementation of the ACS, all sources of error in the ACS are being looked at to be certain that methods in place are sound and to identify areas of possible improvement. Survey response rates are calculated annually for the ACS to assess the potential for unit nonresponse error. The survey response rate for the ACS was 95.1 percent in 2000 and 96.7 percent in 2001. Despite excellent response rates, it is still possible to introduce bias if the respondent characteristics differ from characteristics for nonrespondents (Groves and Couper, 1998).

In this study we take advantage of 2000 decennial census data to study the characteristics of ACS nonrespondents and to look at the ACS noninterview adjustment procedures.

2. Background

2.1 The American Community Survey

The Census Bureau began examining a new approach for gathering decennial long form data over 10 years ago in response to congressional and other stakeholder demands for more timely and relevant data. Instead of a static, once-a-decade snapshot of the nation's population, the Census Bureau began researching the feasibility of an ongoing survey to collect and disseminate timely demographic and socioeconomic data. Since 1996, the Census Bureau has continued to test and develop methods for the ACS.

Since 1999, the ACS has been conducted in 36 diverse counties across the country. In addition, the Census 2000 Supplementary Survey (C2SS) was conducted as part of Census 2000 in 1,203 additional counties nationwide to demonstrate the operational feasibility of ACS methods. The C2SS and ACS test sites (1,239 counties) provide national and sub-national level data. The data for the 1,239 counties are used in this study and are referred to as ACS data.

A sample of about 70,000 addresses is selected each month for the ACS. Data collection for each ACS sample panel occurs over three months using three modes–mail, telephone, and personal visit. To explain this, let's look at the March 2000 sample panel. The address sample was mailed a survey questionnaire at the end of February. An advance letter, reminder card, and a targeted second mailing were used to improve mail response. In April, nonresponding addresses were followed up using computer-assisted telephone interviewing if a telephone number was available. Then, in May, about one in three remaining nonresponding addresses were visited by full-time Census Bureau interviewers to collect the sample data using a computer.

Following data collection, the ACS sample person and housing data are weighted to produce final estimates. Each sample address is assigned a base weight to account for its probability of selection. These base weights are adjusted by factors to account for the certain features of the ACS design. For example, a subsampling factor is assigned to all cases selected for personal visit follow-up to reflect the results of subsampling. After data collection, the weight assigned to each sample housing unit is adjusted to account for noninterviews at the housing unit level. Since the ACS does not know the characteristics of nonresponding households, known factors, such as sampling stratum, building type, month in sample, and geographic location are used to correct for nonresponse in the ACS. The noninterview factor adjusts the weight of all responding occupied housing units to account for both responding and nonresponding housing units within weighting classes. Additional adjustments are later made to adjust for mode bias, and to control to population estimates.

2.2 Studying Characteristics of Nonrespondents

Groves and Couper (1998) state that the biggest drawback in attempting to study nonresponse is that the people we are most interested in are precisely that –nonrespondents. Groves and Couper (1998) outline some common approaches used to studying nonresponse. These include:

This paper reports the results of research and analysis undertaken by Census Bureau staff. It has undergone a Census Bureau review more limited in scope than that given to official Census Bureau publications. This report is released to inform interested parties of ongoing research and to encourage discussion of work in progress. Emily M. Braker assisted in this research as a JPSM intern during Summer 2002. Emily is currently a senior at Baker College majoring in Business.

- Using frame data available for both respondents and nonrespondents
- Studying reluctant nonrespondents by using sample persons who required effort to interview as proxies for final nonrespondents
- Using observational data collected on the household or the interaction to supplement information on the sampling frame
- Studying panel nonrespondents using characteristics of those who responded the first panel but did not respond in later panels
- Conducting surveys of survey participation
- Using innovative experimental strategies such as measuring the effect of alternative design features, collecting information on social psychological dispositions prior to the survey request,
- Conducting match studies that could provide additional information on nonresponding households in ongoing surveys

2.3 Match Studies

For much of their research, Groves and Couper (1998) used data from a match study of survey respondent and nonrespondent cases from six surveys to the 1990 U.S. Decennial Census to study nonresponse. Given the ACS is a national survey fielded at the same time as the 2000 U.S. Decennial Census and given that the ACS uses the same sampling frame used for Census 2000, this provided a unique opportunity to conduct a match study to learn more about ACS nonrespondents. In this study we used identifying information for nonresponding ACS sample addresses to link to basic demographic data from the Census 2000 data files. Census 2000 results are used as a proxy for the characteristics of ACS nonrespondents. We will use this information to better understand who ACS nonrespondents are and also to assess if the noninterview adjustment methods used for ACS warrant revision.

3. Methodology

3.1 Study Design

This study uses ACS data from the March, April, and May 2000 sample panels. The ACS uses the Master Address File (MAF) also used during Census 2000, as the sampling frame. To get data for the ACS nonrespondents, the ACS nonresponding addresses were linked to Census 2000 response files using the MAF Identification numbers (MAFID), an address identifier common to both data collection efforts. If Census 2000 data were available for the nonresponding ACS address when the MAF IDs were matched, the person data available for that MAF ID were used as an estimate of the characteristics of the people living at the nonresponding ACS addresses.[1] Census 2000 long form sample addresses were not eligible for selection into the 2000 ACS sample; therefore, only basic demographic characteristics such as gender, age, race, Hispanic origin, relationship, household size, and whether the housing unit was owned or rented could be obtained from the Census 2000 files during the linking process.

For the March, April and May ACS samples, there were 144,556 responding housing units and 3,809 eligible ACS nonresponding housing units. Census person data were available for over 83 percent of the nonresponding addresses, representing 6,782 people. The estimated population of ACS respondents, adjusted to represent the whole year, was 253 million and it was 10 million for ACS nonrespodents. The estimated number of occupied housing units for ACS respondents, adjusted to represent the whole year, was 98 million and it was 4 million for ACS nonrespondents.

3.2 Measures

This report contains tables comparing distributions of characteristics. Distributions are produced for two distinct universes- respondents and nonrespondents. In this study "respondents" includes all data collected in the ACS from interviewed households; "nonrespondents" includes data collected in Census 2000 for households classified as noninterviews in the ACS. The distributions show the percent of each universe providing each response. For example, the two distributions of gender show the percentage of males and females in interviewed households (respondents) and in noninterviewed household (nonrespondents). The key measure is the difference between these two proportions. These comparisons were made for gender, age, relationship, race, Hispanic origin, whether the housing unit was owned or rented, and the average household size.

A second set of tables were created to answer the question of whether the ACS nonresponse adjustment procedures reflect differences observed? The census data for ACS noninterviews were combined with the ACS interview data to produce an estimate of the true combined distribution. This was compared to the ACS data for respondents, adjusted for nonresponse.

3.3 Hypothesis Testing

The data were weighted by their probabilities of selection and subsampling factors. The comparisons took into account the sampling variances. Standard errors were produced using replicates.

Several tests of statistical significance were conducted. First, chi-square testing was conducted to test the tables to determine if the two distributions were independent. A Rao-Scott adjustment was used to take into account the sampling error in both estimates (See Smith and Starsinic, 2002).

[1] Census 2000 data were only obtained if they were collected as part of the Census 2000 mail or personal visit follow-up operations; that is, we did not use data imputed for addresses that did not respond in Census 2000.

Next, individual differences were tested. When comparing interviews and noninterviews, the hypotheses of % category Ir = % category I_n, were tested for each response category.

where r=data collected for ACS interviewed households after three phases of data collection
n=data collected in Census 2000 for households classified as noninterviews in the ACS after all three phases of data collection

When comparing the true combined distribution and the weighted ACS respondent data, adjusted for nonreseponse, the hypotheses of % category Iw = % category Ic.

where: w= data for ACS interviewed households, weighted to account for unit nonresponse only
c= census data for ACS noninterviews combined with the ACS interview data

Estimates of differences and margins of error of the differences were produced to represent 90 percent confidence intervals of the difference, the Census Bureau standard, and were adjusted by a Bonferroni multiple comparison factor. Whenever the difference in the estimates is statistically significant, it is flagged (*) as such.

3.4 Assumptions and Limitations

The address identification number (MAF ID) was used to obtain census data for ACS nonrespondents. The following assumptions were made:

-- The same address and household were visited for the ACS and Census 2000
-- The responses would be the same for the ACS and Census 2000

When comparing national distributions for race and Hispanic origin for the ACS and Census 2000, differences were found in reporting. Namely, there were more whites and few other races reported in the ACS. For Hispanic origin, the Census had more "other Hispanics" and the ACS had more "Mexicans" reported (Raglin and Leslie, 2002 and Leslie, Raglin and Schwede, 2002). Differences detected might be a byproduct of this finding.

Census data were obtained for 83 percent of the nonresponding ACS addresses. We did not get data for the remaining nonresponding addresses and therefore assume that the data obtained are representative of data for all nonrespondents.

4. Results

There are two sections in Results–Comparison of ACS Respondent and Nonrespondent Characteristics, and Comparison of Combined Responses to Weighted Responses.

4.1 Comparison of ACS Respondent and Nonrespondent Characteristics

The next seven tables show the results from testing the tables and the hypotheses that the distributions for respondents and nonrespondents were the same for gender, age, relationship, race, Hispanic origin, whether the housing unit was owned or rented, and the average household size. The tables show the distributions for respondents (Resp), nonrespondents (NR), the difference, that is, nonrespondents-respondents (Diff), and the margin of error of the difference (MofE of Diff). The MofE of Diff is the 90 percent confidence interval around the estimate, the Census Bureau standard. All numbers are shown as percentages. As the $\times^2$ and p values below each of the tables show, all tables had significantly different distributions. Separate testing showed that only some of the response categories in each table were statistically significant at the 90-percent confidence interval, as indicated by an (*) next to the MofE of Diff.

Gender

Table 1 shows the comparison of gender distributions for ACS respondents and nonrespondents. A demographic variable commonly examined in nonresponse studies is gender. Most studies have found either no gender effect on cooperation or the tendency for males to have lower cooperation rates (Groves and Couper, 19998) The chi square statistic shows the distributions are different. As the data in Table 1 show, the ACS nonrespondents were slightly more likely to be male. This is consistent with studies such as Smith (1983) and Lindström (1983) as cited in Groves and Couper (1998).

Table 1. Gender, Comparison of Distributions

Gender	Resp (%)	NR (%)	Diff (%)	MofE of Diff (%)
Male	48.5	49.9	1.4	± 1.1*
Female	51.5	50.1	-1.4	± 1.1*

* denotes statistical significance at the 90 percent confidence interval; $\times^2$=4.48, df=1, p=0.034.

Age

Table 2 shows the comparisons of age distributions between ACS respondents and nonrespondents. The chi square statistic shows the distributions differ. ACS nonrespondents have a higher proportion of younger adult household members (between 25 and 44 years of age) and a lower proportion of householder members ages 65 and older than ACS respondents. These findings seem intuitive as those in the 25 to 44 age groups are more likely to be in the workforce and therefore harder to contact to participate in the survey.

Table 2. Age, Comparison of Distributions

Age	Resp (%)	NR (%)	Diff (%)	MoE of Diff (%)
< 5	6.7	6.7	-0.0	± 1.0
5 to 9	7.4	7.8	0.3	± 1.0
10 to 14	7.6	7.9	0.3	± 1.0
15 to 19	6.8	6.9	0.1	± 0.9
20 to 24	6.0	6.7	0.7	± 1.2
25 to 34	14.0	15.7	1.7	± 1.5*
35 to 44	16.4	18.4	2.0	± 1.7*
45 to 54	13.9	14.2	0.3	± 1.6
55 to 59	4.9	4.1	-0.8	± 0.8
60 to 64	4.0	3.9	-0.1	± 0.7
65 to 74	6.8	4.6	-2.2	± 0.9*
75 to 84	4.4	2.5	-1.8	± 0.7*
85+	1.2	0.7	-0.5	± 0.3*

* denotes statistical significance at the 90 percent confidence interval; $\times^2$= 101.30; df=12, p=0.000.

Relationship

Table 3 shows the comparisons between ACS respondents and nonrespondents for relationship. The chi square statistic shows that the distributions differ. In particular, ACS nonrespondents have a lower proportion of spouses than ACS respondents and a higher proportion of other relatives than the ACS respondents. These data could be telling us something about household size. The greater percentage of ACS nonrespondents who were householders is likely an indicator of one-person households. Additional analysis is needed to explore this in greater detail.

Table 3. Relationship, Comparison of Distributions

Relationship	Resp (%)	NR (%)	Diff (%)	MoE of Diff (%)
Householder	38.9	39.6	0.7	± 1.3
Spouse	20.0	16.4	-3.6	± 1.0*
Child	29.9	30.4	0.5	± 1.7
Other relative	6.3	7.8	1.6	± 1.3*
Nonrelative	5.0	5.7	0.8	± 1.1

* denotes statistical significance at the 90 percent confidence interval; $\times^2$= 83.35; df=4, p= 0.000.

Hispanic Origin

Table 4 shows the distribution of Hispanic origin for ACS respondents and nonrespondents. While the chi square statistic shows that the distributions differ, the only significant difference is that ACS nonrespondents have a higher proportion of "Other Hispanics" than the ACS respondents. This difference may be more a function of differences in census and ACS methods since we saw this difference when we compared the ACS and Census 2000 distributions at the national level (see Raglin and Leslie, 2002.)

Table 4. Hispanic Origin, Comparison of Distributions

Hispanic Origin	Resp (%)	NR (%)	Diff (%)	MofE of Diff (%)
Non-Hispanic	87.6	86.5	-1.2	± 1.6
Hispanic	12.4	13.5	1.2	± 1.6
Mexican	7.7	6.9	-0.9	± 1.8
Puerto Rican	1.2	1.8	0.6	± 0.8
Cuban	0.5	0.3	-0.2	± 0.2
Other	2.9	4.5	1.6	± 1.4*

* denotes statistical significance at the 90 percent confidence interval; $\times^2$= 23.26, df=5, p= 0.000.

Race

Table 5 shows the distribution of race for ACS respondents and nonrespondents and the chi square statistic shows they differ. The categories show race reporting for each category alone. These data suggest that a greater proportion of Blacks alone are in the nonresponse universe. These data are similar to differences found when comparing the ACS and census data in the aggregate. Leslie, Raglin, and Schwede (2002) found that more persons in Census 2000 were classified as "Some Other Race" while in the ACS more persons were classified as "White". The differences in reporting of White alone and Some Other Race alone may be a result of this difference.

Table 5. Race, Comparison of Distributions

Race	Resp (%)	NR (%)	Diff (%)	MoE of Diff (%)
White alone	77.8	65.2	-12.6	± 3.2*
Black alone	11.5	19.2	7.7	± 2.5*
AIAN alone	0.8	1.3	0.5	± 0.8
Asian alone	3.8	4.7	0.9	± 1.5
NHOPI alone	0.2	0.1	-0.0	± 0.2
Other alone	3.7	6.3	2.6	± 1.6*
2+	2.2	3.1	0.9	± 1.0

* denotes statistical significance at the 90 percent confidence interval; $\times^2$= 146.53; df=6, p= 0.000.
Key:AIAN=American Indian and Alaska Native; NHOPI=Native Hawaiian and Other Pacific Islander; Other=Race other than 5 listed; 2+=2 or more races specified for person.

Owner/Renter

Table 6 shows the distribution of housing units owned or rented for ACS respondents and nonrespondents. As the data in Table 6 show, the ACS nonrespondents have a higher proportion of rentals and a lower proportion of owned units than ACS respondents. Groves and Couper (1998) looked at cooperation for owner versus renters and found no statistical difference. They did, however, find significantly higher rates of nonresponse for residents of large multi-unit structures (10 or more units). They hypothesize that these differences were largely due to lower contact rates because it's harder to gain access to these structures and finding their residents at home. Once contacted, however, such persons were no less likely to cooperate with the survey request than other households.

Table 6. Owner/renter, Comparison of Distributions

Tenure	Resp (%)	NR (%)	Diff (%)	Mo E of Diff (%)
Own	66.4	54.6	-11.8	±1.1*
Rent	33.6	45.4	11.8	±1.1*

* denotes statistical significance at the 90 percent confidence interval; $\times^2$= 85.65, df=1, p=0.000.

Size of Household

Table 7 shows the distribution of household size for ACS respondents and nonrespondents. The ACS nonrespondents have a higher proportion of one-person households than the ACS respondents. The average household size for nonrespondents is also smaller than for respondents. This seems reasonable and in line with the Groves and Couper (1998) hypothesis about ability to contact one-person households.

Table 7. Size of Household, Comparison of Distributions

Number of People	Resp (%)	NR (%)	Diff (%)	MoE of Diff
1	25.5	30.6	5.1	±0.9*
2	33.1	29.3	-3.7	±1.0*
3	16.8	16.7	-0.1	±0.9
4	14.4	13.6	-0.8	±0.8
5	6.7	5.1	-1.6	±1.1*
6	2.1	2.6	0.5	±1.4
7	1.4	2.0	0.6	±1.5
Avg hhld size	2.6	2.5	-0.1	±0.01*

* denotes statistical significance at the 90 percent confidence interval; $\times^2$= 44.20, df-6, p=0.000.

4.2 Comparison of Combined Responses to Weighted Responses

In the ACS, nonresponding sample cases are represented in the survey estimates by adjusting the weights of responding cases at the sample address level. One way to check the effectiveness of this adjustment is to compare the distributions of key demographic variables from the following two datasets:

- Persons in responding ACS sample addresses only. These data were weighted at the address level by the initial sampling weight, times an adjustment factor to account for nonresponding units. This adjustment occurs after data collection is complete and is done at the sample address level.
- A combination of persons in ACS responding sample addresses and persons in nonresponding ACS sample addresses. The demographic characteristic data for persons in nonresponding ACS sample addresses comes from the Census 2000 data files. All data in this set were weighted only by their sampling weight; that is, the weights were not adjusted for nonresponse.

Theoretically if the weighting procedures currently used for ACS to adjust for nonresponse work correctly, there would be no differences in the distributions when comparisons of key demographic characteristics are made.

Of the five population characteristics studied, chi square testing of the tables showed that only age and relationship had statistically significant different distributions in this phase of the analysis. For both of these characteristics, there was only one category that was statistically different. As Table 8 below shows, the 35-44 year old age category was the only age group that was statistically significant. The weighted distribution appears to understate this age group. As shown in Table 9, the only statistically significant difference was for householders. Householders are represented at a higher proportion in the weighted distribution than the combined distribution.

When we look at average household size and whether the unit was owned or rented (Tables 10 and 11), we still see statistically significant differences which seem logical given the differences found between ACS respondents and nonrespondents. It appears that the weighting procedure to adjust for nonresponse produces more smaller households (1 and 2 person households) and therefore a smaller average household size, compared to the results when respondent and nonrespondent data were combined. The weighting also seems to produce a higher proportion of renters than owners.

Table 8. Age, Combined verses Weighted Responses

Age	Comb (%)	Wght (%)	Diff (%)	MoE of Diff (%)
Under 5	6.7	6.8	0.1	± 0.2
5 to 9	7.4	7.4	- 0.1	± 0.2
10 to 14	7.6	7.5	-0.0	± 0.2
15 to 19	6.8	6.8	0.1	± 0.2
20 to 24	6.0	6.1	0.1	± 0.2
25 to 34	14.1	13.9	-0.2	± 0.3
35 to 44	16.4	16.1	-0.3	± 0.3*
45 to 54	13.9	13.9	-0.0	± 0.3
55 to 59	4.9	4.9	0.1	± 0.2
60 to 64	4.0	4.0	0.0	± 0.2
65 to 74	6.7	6.8	0.1	± 0.2
75 to 84	4.3	4.4	0.1	± 0.2
85+	1.2	1.2	0.0	± 0.1

* denotes statistical significance at the 90 percent confidence interval; $\times^2$=23.45, df=12, p=0.024.

Table 9. Relationship, Combined verses Weighted Responses

Relationship	Comb (%)	Wght (%)	Diff (%)	MoE of Diff (%)
Householder	38.9	39.3	0.5	± 0.2*
Spouse	19.9	19.9	0.1	±0.2
Child	29.9	29.6	-0.3	±0.4
Other relative	6.3	6.1	-0.2	±0.3
Nonrelative	5.0	5.0	0.0	±0.2

* denotes statistical significance at the 90 percent confidence interval; $\times^2$=8.45, df=4, p=0.077.

Table 10. Owner/Renter, Combined verses Weighted Responses

Tenure	Comb (%)	Wght (%)	Diff (%)	MoE of Diff (%)
Own	65.9	65.4	-0.6	±0.4*
Rent	34.1	34.6	0.6	±0.4*

denotes statistical significance at the 90 percent confidence interval; $\times^2$=4.89, df=1, p=0.027.

Table 11. Household Size, Combined versus Weighted Responses

Number of People	Comb (%)	Wght (%)	Diff (%)	MoE of Diff (%)
1	25.7	26.4	0.7	±0.4*
2	32.9	33.0	0.1	±1.4
3	16.8	16.3	-0.5	±0.4*
4	14.3	14.1	-0.3	±0.3
5	6.7	6.6	-0.1	±0.3
6	2.1	2.2	0.0	±0.2
7	1.5	1.5	0.0	±0.2
Avg hhld size	2.6	2.5	0.0	±0.0*

* denotes statistical significance at the 90 percent confidence interval; $\times^2$=23.791, df=6, p=0.001

5. Discussion

This study is a first look at the characteristics of nonrespondents to the ACS. Even though the overall ACS survey nonresponse rate is low (less than five percentage points), it is still important to study the nonrespondents to ensure that the bias in the estimates is as minimal as possible. Conducting the ACS at the same time as Census 2000 provided a unique opportunity to study the characteristics of nonrespondents by using Census 2000 data as proxies for nonrespondents. Although the study was limited to examining basic demographic characteristics, the results show that ACS nonrespondents are different from the ACS respondents. The ACS nonrespondents are more likely to be male, Black, and between the ages of 25 and 44. They are also more likely to be in one-person households, households that have other relatives, and rented units at sample addresses. This is very consistent with other research on nonresponse (see Goves and Couper, 1998).

We take a first stab at looking at the ACS nonresponse adjustment procedures by comparing national distributions for the ACS respondents combined with the census data pulled for the ACS nonrespondents to the distributions for the ACS respondents weighted to adjust for nonresponse. This study shows that the ACS weighting used to adjust for nonresponse is correcting many of the differences detected. Of the five population characteristics examined, the only two differences that remained were for those aged 35-44 and for householders, meaning one-person households. These differences are not large. Differences still remain for household size and tenure of the housing unit. More research is needed to understand these differences–including multivariate analysis to determine if there are interaction effects.

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