

An Introduction to ACS Statistical Methods and Lessons Learned

Alfredo Navarro
US Census Bureau

Measuring People in Place
Boulder, Colorado
October 5, 2012

Outline

- Motivation
- Early Decisions
- Statistical Methodology
- Reliability of ACS estimates, specifically for small areas and population groups
 - Sample Size
 - Mail/CATI Response Rates
 - Population Controls
- Successes, Challenges, Lessons Learned

Motivating Goals

- Produce more timely social, economic, and housing data for all geographic areas, particularly for small areas.
- Simplify decennial census operations to collect only the most basic data.

Basic Tenets of the ACS

- ACS Program serves as the replacement to the Census long form
- Selected sample is spread over the years throughout the decade
- Accumulate data over time to generate more reliable estimates

Design Origins and Early Proposals

Concept of “rolling sample design”

Mid-decade census

Proposed “Decade Census Program”

Continuous measurement alternatives to the
Census 2000 long form

Early Decisions - Data Collection

- Methodology based on best practices from decennial census and demographic surveys
- Monthly samples using overlapping multi-mode data collection methods
 - Mail
 - Telephone
 - Personal Visit

Early Decisions

Data Collection Strategy

	Calendar Month						
Sample Panel	February 2005	March 2005	April 2005	May 2005	June 2005	July 2005	August 2005
Feb 2005	Mail	Phone	Personal Visit				
March 2005		Mail	Phone	Personal Visit			
April 2005			Mail	Phone	Personal Visit		
May 2005				Mail	Phone	Personal Visit	
June 2005					Mail	Phone	Personal Visit

Early Decisions Residence Rules

Should the residence rule in the ACS be based on current residence or should be made to be more consistent with a more usual residence based rule?

Residence Rules - Options

1. Current residence at time of interview.
2. Usual residence at time of interview.
3. Usual residence with a constant reference date .
4. Delay decision, conduct experimental research and consult with data users.

Residence Rules-Decision Criteria

1. Simplicity of implementation
2. Complete coverage of the population
3. Completeness of data collection
4. Meeting data users' needs

Sample Design

USCENSUSBUREAU

Sample Design

- Survey designed to include
 - U.S. Stateside and Puerto Rico
 - Population in both housing units and group quarters (group quarters started in 2006)
- Survey designed to produce annually updated single-year and multi-year estimates

Sample Design Frame

- Sample cases selected from an updated Master Address File (MAF)
- MAF updated through the use of...
 - Postal Service updates in most areas
 - Special field updating in more rural areas and presence of non-city style addresses

Sample Design

- Un-clustered one-stage systematic sample of housing units selected as initial sample each month
- Sub-sample of nonrespondents selected after mail and phone attempts for personal visit follow-up

ACS Initial Sample Design

Governmental Unit Size: Estimate of Occupied Housing Units	ACS 1-year Sampling Rates
0 - 200	10.0%
201 - 800	~7.0%
801 - 1200	~3.5%
Census Tract Size	
2000 or less	~2.4%
Over 2000	~1.7%

ACS Sample Design

- Rate Definitions 2005 to 2010
- Sampling rates function of base rate (BR)
- One fixed rate stratum

Stratum	Block MOS Criteria	Sampling Rates
5	$0 < \text{GUMOS} \leq 200$	10% (fixed)
2	$200 < \text{GUMOS} \leq 800$	$3 \times \text{BR}$
3	$800 < \text{GUMOS} \leq 1,200$	$1.5 \times \text{BR}$
1	$\text{TRACTMOS} \leq 2,000$	BR
4	$2,000 < \text{TRACTMOS}$	$0.735 \times \text{BR}$

Reallocation of the HU Address Sample - Improvement

- Increase the number of sampling strata
 - Smaller stratum intervals allows smoother transitions between rates
- Increase sampling rates for blocks in the very smallest governmental units
 - Increase reliability of the estimates

Reallocation of the HU Address Sample – 2011 Stratification

- New Stratification (small GUs)
 - increased number of fixed rate strata
 - increased the rates

Stratum	Block MOS Criteria	Sampling Rates
1	$0 < \text{GUMOS} \leq 200$	15% (fixed)
2	$200 < \text{GUMOS} \leq 400$	10% (fixed)
3	$400 < \text{GUMOS} \leq 800$	7% (fixed)
4	$800 < \text{GUMOS} \leq 1,200$	$2.8 \times \text{BR} \sim 5\%$

Reallocation of the HU Address Sample – 2011 Stratification

Stratum	Block MOS Criteria	Sampling Rates
5	$0 < \text{TRACTMOS} \leq 400$	$3.5 \times \text{BR}$
6	$0 < \text{TRACTMOS} \leq 400$ H.R.	$0.92 \times 3.5 \times \text{BR}$
7	$400 < \text{TRACTMOS} \leq 1,000$	$2.8 \times \text{BR}$
8	$400 < \text{TRACTMOS} \leq 1,000$ H.R.	$0.92 \times 2.8 \times \text{BR}$
9	$1,000 < \text{TRACTMOS} \leq 2,000$	$1.7 \times \text{BR}$
10	$1,000 < \text{TRACTMOS} \leq 2,000$ H.R.	$0.92 \times 1.7 \times \text{BR}$
11	$2,000 < \text{TRACTMOS} \leq 4,000$	BR
12	$2,000 < \text{TRACTMOS} \leq 4,000$ H.R.	$0.92 \times \text{BR}$
13	$4,000 < \text{TRACTMOS} \leq 6,000$	$0.6 \times \text{BR}$
14	$4,000 < \text{TRACTMOS} \leq 6,000$ H.R.	$0.92 \times 0.6 \times \text{BR}$
15	$6,000 < \text{TRACTMOS}$	$0.35 \times \text{BR}$
16	$6,000 < \text{TRACTMOS}$ H.R.	$0.92 \times 0.35 \times \text{BR}$

Sub-sampling Rates

Nonresponse Follow-up

Address and Tract Characteristics	Sub-sampling Rate
Unmailable Addresses	2 – in – 3
Mailable addresses with the lowest mail/CATI rates	1 – in – 2
Mailable addresses in tracts with average mail/CATI rates	2 – in – 5
Other mailable addresses	1 – in – 3

Weighting and Estimation

Annual Weighting Process

3 Major Components

- Initial weights to reflect the probability of selection
- Adjust weights of interviewed households to account for noninterviews
- Adjust weights to independent housing unit and population estimates (controls)

Initial Weight

Probabilities of Selection

- Initial probability of selection is assigned as a function of the sample design
- Nonresponse follow-up (Personal Visit – CAPI) sample design

Nonresponse Adjustment

- The weight of the nonrespondents is transferred to the respondents
- Nonresponse adjustment is carried out at the census tract level for groups of households with characteristics correlated with nonresponse:
 - Census tract
 - Type of building (single vs. multi-unit)
 - Month of data collection

Ratio Adjustments to Housing Unit and Population Controls

- Post-censal estimates are produced by updating the previous census results using various administrative records data
- In a multi-stage process, housing unit and population adjustment ratios are applied to the weights
- Applied at the county (or group of counties) level by sub-county areas and race/ethnicity and age/sex groups.

Ratio Adjustments to Controls - Why?

- Reduce variability of the estimates
- Reduce bias
 - Undercoverage of housing units
 - Undercoverage of people within housing units

Reliability of ACS Estimates

Have we learned anything?

ACS Sample Design

- Sample size – about 3.54 M addresses on an annual basis
- Stratification and sample allocation – Similar to census long form
- Unlike census long form, only a sample is selected for personal visit during non-response follow-up

Sample Size Effect on Reliability

Census 2000 LF Sampling Rate = 1-in-6

Planned ACS Sampling Rate = 1-in-8

Reliability of ACS estimates relative to LF

1.25

Non-response Follow up Sampling

Differential Response Rates

- Mail/CATI response rates continue to decline below the levels assumed during the planning phase of the survey
- Substantial variation exists in mail response rates by geography
- Census tracts with high proportions of African American and Hispanic origin populations tend to have lower mail and telephone response rates (Griffin 2005)

Mail/CATI Response Rates Census Tracts

Source: 2008 and 2009 ACS

Size (Occ. HU's)	Median (%)	Range (Q3 – Q1)
0 - 399	31.8	35.8
400 - 999	45.8	31.1
1000 – 1999	57.2	26.3
2000 – 3999	59.6	21.8
4000 – 5999	58.3	18.0
Over 6000	61.0	15.4

Effect of Non-response Follow up Sampling (CAPI)

- Estimated from the 2005 -2009 ACS preliminary weighted files
- The range of the median effect is

1.25 – 1.28

Effect of Population Controls

Source: Small Area Estimates Research

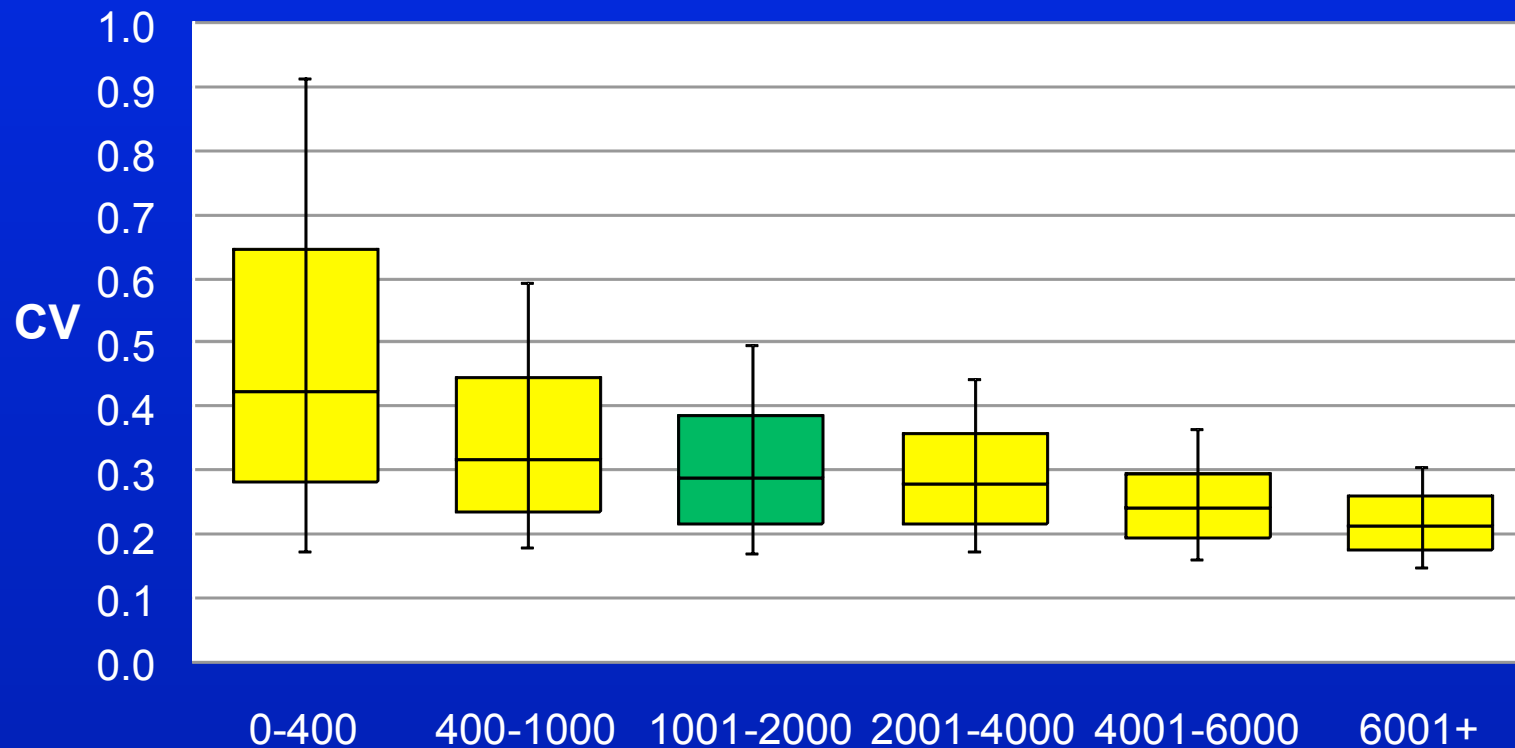
- Research on 1999-2005 ACS data showed that standard errors for small areas – census tracts and places - were much higher than anticipated.
- Lack of tract-level controls identified as a leading cause contributing to an increase of between **15 – 25** percent.
(Starsinic – 2006)

ACS Reliability

Source: 2005 – 2009 ACS

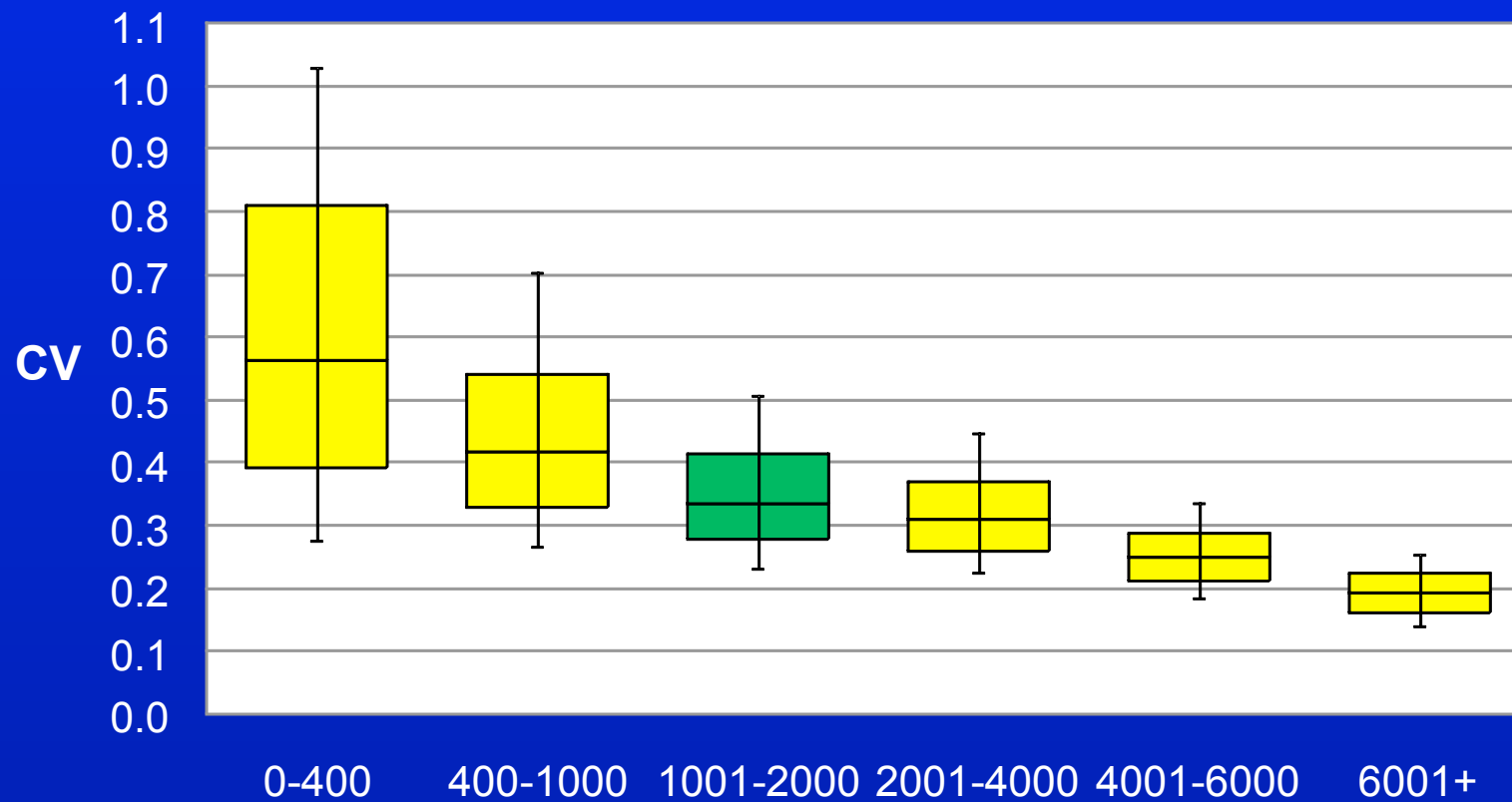
- The survey was designed to produce estimates with CV about **1.33** the CV of corresponding long form estimates
- The most current results show that the CV is about **1.75** the CV of corresponding long form estimates

Preliminary Tract CV Distribution for % Persons in Poverty



Source: 2005 – 2009 ACS 5-year Data

Preliminary Tract CV Distribution for % Unemployed



Size of Tract (Occupied Housing Units)

Source : 2005 – 2009 ACS 5-year Data

ACS Today – Successes and Challenges

- Developed and implemented a sampling plan that over-samples census tracts with lower than average response by mail and phone.
- Developed a model-assisted estimation application that relies on auxiliary information to reduce variance for census tracts and medium-sized places.
- Use of experienced interviewers (including bilingual) facilitate high levels of survey response.

Group Quarters Small Area Estimation Research

- Improving the GQ estimation process, specifically for small areas such as census tracts
- NAS Panel on measuring GQ population

Additional Improvements for FY11

- The ACS sample was expanded from 2.9 M to 3.54 M housing unit addresses
- Improved stratification to produce a more equitable distribution of tract level estimates with respect to reliability
- Updated population controls based on the 2010 Census

Additional Improvements ... 2

- 100 Percent Follow up of non mailable addresses in American Indian areas with high concentrations of Native Population
- Enhanced Variance Estimates will reduce margins of error by 3- 5 %.

Lessons Learned and Summary Thoughts

- Do not overpromise
- Emphasis on Research and Evaluation
- Secure resources with specific knowledge and skills set to accomplish broad spectrum of objectives

Contact Information



U.S. DEPARTMENT OF COMMERCE
U.S. Census Bureau
Washington, DC 20233

Alfredo Navarro

Room 4K071

Phone: 301-763-3600

Email: Alfredo.Navarro@census.gov

U S C E N S U S B U R E A U