UNITED STATES DEPARTMENT OF COMMERCE
Economics and Statistics Administration
U.S. Census Bureau
Washington, DC 20233-0001

9/20/11

2011 AMERICAN COMMUNITY SURVEY RESEARCH AND EVALUATION REPORT MEMORANDUM SERIES #ACS11-RER-07

DSSD 2011 AMERICAN COMMUNITY SURVEY RESEARCH MEMORANDUM SERIES ACS11-R-17

MEMORANDUM FOR ACS Research and Evaluation Steering Committee

From: David C. Whitford ***signed***
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Subject: Analysis of the Variances of American Community Survey Estimates of the Group Quarters Population

Attached is the final American Community Survey Research and Evaluation report for "Analysis of the Variances of American Community Survey Estimates of the Group Quarters Population". It has been noted that variances are higher for American Community Survey (ACS) estimates of the group quarters (GQ) population of substate geographies than they are for the housing unit (HU) population. The research described in this paper had two goals. The first was descriptive, to determine for which estimates the GQ variances are highest and what the effects of the higher GQ variances are on the estimates of the total resident population (people in GQs and HUs). The second was analytic, to assess the relative contribution of certain previously identified reasons why the GQ population estimates have higher variances.

If you have any questions about this report, please contact Mark Asiala (301-763-3605) or John Jordan (301-763-2938).

Attachment

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September 20, 2011

Analysis of the Variances of American Community Survey Estimates of the Group Quarters Population

FINAL REPORT

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United States™ Census Bureau

Analysis of the Variances of American Community Survey Estimates of the Group Quarters Population[1]

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1. Introduction

The Census Bureau's American Community Survey (ACS) provides detailed estimates of demographic, economic, and social characteristics of the United States population and housing for geographies as small as the tract and block group, effectively replacing the function of the decennial census long form sample. The ACS separates the United States population into two mutually exclusive categories, people living in group quarters (GQ) and the household population, applying differing sampling, data collection, and weighting methodologies to each. The population of the United States living in GQ facilities only makes up approximately 3 percent of the total population, but it can have a disproportionate impact on variances of the estimates of the total resident population (Beaghen and Stern, 2009; Navarro, 2010). At the heart of the matter is that the observed ACS sample design and weighting were designed to produce state-level estimates of characteristics of the GQ population, whereas estimates of the GQ population contribute to substate estimates of the characteristics of the total resident population. For example, Navarro (2010) shows the gaps in representation of the ACS GQ sample across tracts and counties.

A housing unit, HU, may be a house, an apartment, a mobile home, a group of rooms or a single room that is occupied (or, if vacant, intended for occupancy) as separate living quarters. Separate living quarters are those in which the occupants live separately from any other individuals in the building and which have direct access from outside the building or through a common hall. A GQ facility is a place where people live or stay that is normally owned or managed by an entity or organization providing housing and/or services for the residents. These services may include custodial or medical care as well as other types of assistance, and residency is commonly restricted to those receiving these services. GQ facilities include such places as college residence halls, residential treatment centers, skilled nursing facilities, group homes, military barracks, correctional facilities, and workers' dormitories. For a complete description of the types of GQ facilities included in the 2007 ACS see U.S. Census Bureau (2009a).

The Census Bureau has taken several steps to address these concerns about the estimates of the GQ population. Sommers and Hefter (2010) investigated the effect of the cluster size of the persons interviewed at GQ facilities for potentially more efficient sample designs. The Census Bureau has undertaken a research program aimed at improving the ACS estimates of characteristics of the GQ population for substate geographies such as counties and tracts (Navarro, 2010). The new methods the Census Bureau is investigating seek to use as auxiliary data the 2010 decennial Census GQ universe file and the ACS sampling frame itself, imputing GQ person data to GQ facilities which are not in sample (Navarro, 2010). The Census Bureau also has engaged a National Academy of Sciences Panel to investigate the larger issues of producing ACS GQ estimates including sample design, data collection, weighting, the target population, and ACS data products.

[1] Any views expressed on statistical, methodological, technical, or operational issues are those of the authors and not necessarily those of the U.S. Census Bureau.

The purpose of this paper is to inform this larger discussion of the impact of the GQ population on the ACS estimates and the development of new GQ methodologies by investigating the variances of the GQ population. The research questions this paper will answer are: how much does the GQ population contribute to the variances of the total resident population; and what are the effects on the variances of several key steps in the GQ weighting process such as controlling. The research described in this paper can be broken down into descriptive and experimental. In the descriptive research, we determine what the effects of the GQ population are on the estimates of the variances of the estimates of the total resident population. The experimental research examines two possible causes of why the estimates of the GQ population have higher variances. Related topics have already been explored by Beaghen and Stern (2009), though this paper more systematically examines estimates of multiple characteristics.

2. Background

This section provides a general overview of the ACS with particular attention to elements such as GQ sampling and weighting which may impact the quality of estimates of the GQ population for substate areas.

2.1 The American Community Survey

The ACS takes a series of monthly samples to produce annual estimates of detailed demographic, social, economic, and household characteristics comparable to those previously produced once a decade by the decennial census long form sample. Starting in 2010 the ACS will produce its first 5-year estimates based on data collected from 2005 through 2009 and will release new 5-year estimates each year thereafter. The 5-year estimates will include estimates for tracts and block groups. The Census Bureau also produces 1-year and 3-year ACS data products for larger geographic areas that meet the threshold population sizes of 65,000 and 20,000. For details on ACS data releases see U.S. Census Bureau (2008a).

2.2 ACS Sampling

Due to the sparseness of distribution of GQ facilities across geographies and the clustering of people within facilities, the GQ population is sampled and weighted differently than the household population. The ACS HU sample includes about three million HU addresses each year. While the HU sampling rates vary by geography, they are roughly comparable to or lower than the sampling rates for people in GQ facilities.

On the GQ sampling frame, GQ facilities fall into either the large or small strata. The small stratum consists of GQ facilities with expected populations of 15 or fewer people. The large stratum is defined as GQ facilities with expected populations of 16 or more people. The primary sampling unit for large stratum GQ facilities is a group of ten people, not the facility itself. The expected sizes come from the sampling frame, which were obtained primarily from the 2000 Census.

There are two phases in GQ sampling for both large and small stratum GQ facilities. In the first phase, GQ facilities are selected to be interviewed, directly or indirectly, based on their expected populations. The second phase is done when we know the actual size of

the GQ population in the facility. In the second phase, residents are selected using an algorithm based on the observed number of residents in the facility.

For small stratum GQ facilities, the first phase is a systematic sample of 1 in 40 for most states and higher sample rates for selected smaller states. The second phase is completed once we have more information about the GQ facility. If less than 16 residents are living in the facility, then all residents are selected to be interviewed. If 16 or more live in the facility however, a sample of ten is randomly selected to be interviewed.

For large stratum GQ facilities, the sampling is done with probability proportional to estimated size. In the first phase, a systematic sample of 1-in-40 (or higher) groups of ten is selected to be interviewed. In the second phase of large GQ sampling, a field representative visits each facility that had at least one group selected. With the aide of a listing instrument, the field representative randomly selects a group or groups of 10 people to be interviewed. If the large GQ facility does not have an observed population of 10 or more, then all residents are selected to be interviewed.

2.3 Overview of ACS GQ Person Weighting

There are three stages of weighting for GQ sample people. The first stage calculates initial weights which reflect each sample persons' probability of selection. The initial weights also reflect adjustments due to differences in observed and expected GQ populations as well as a weight trimming procedure. The second stage adjusts the weights to account for non-interviewed people. The third stage adjusts these weights in a controlling or post-stratification procedure, so that the state-level sums of the weights equal independent population controls (see Section 2.4). It then rounds all of the weights to integers. These rounded weights are the final weights used in tabulating estimates. For additional information about the sampling and weighting methods described, see U.S. Census Bureau (2008b, 2009b).

2.4 Controls

The Census Bureau's Population Estimates Program (PEP) publishes total resident population estimates and demographic components of change (births, deaths, and migration) each year (U.S. Census Bureau, 2009c). PEP estimates of population are derived by combining administrative records data with data from most recent census (U.S. Census Bureau, 2009d). The program also publishes the estimates by demographic characteristics (age, sex, race, and Hispanic origin) and total HUs for the nation, states and counties. Further, it publishes population counts of GQ residents for each state by major types of GQ facilities and total population only for each county.

The ACS controls its estimates to the PEP estimates. Controlling estimates reduces bias due to undercoverage or overcoverage of GQ facilities and HUs, and of people within HUs and GQ facilities, relative to the PEP estimates. It also reduces the variance of the HU, household, and population estimates. It is important to note that the GQ person final weights are used in the calculation of the household person weights. In other words, estimates of the total resident population depend on the estimates of the GQ population.

The process of controlling applies three sets of constraints to ACS estimates. (1) The GQ person weights are controlled to independent GQ population estimates obtained from the PEP at the state level by seven major GQ types (correctional institutions, juvenile

facilities, nursing homes, other long-term care facilities, college dormitories, military facilities, and other non-institutional facilities). (2) ACS estimates of HU counts are constrained to equal PEP estimates at the weighting area level. A weighting area is usually a county but can be two or more counties when a smaller county is grouped with others. (3) Estimates of the total resident population are constrained to equal PEP estimates of totals by demographic groups defined by sex, age, race and Hispanic origin at the weighting area level. Note that this third set of constraints implies that the ACS estimates of population in HUs are not directly controlled to PEP estimates. Rather, the controls for total persons in HUs are obtained by subtracting out ACS estimates of GQ population from the PEP estimates of total resident population.

2.5 ACS GQ Population Data Products

An extensive set of data products is available for detailed characteristics of the total resident population for all geographic areas that meet the respective 1- and 3-year population thresholds (for a description of the available data products, see U.S. Census Bureau, 2008a). Starting in 2010, data products on the total resident population will also be available for 5-year data. However, only limited products are available for the GQ population itself. ACS estimates for all published geographies include the size of the GQ population without characteristics. ACS 1-, 3-, and 5-year state estimates provide characteristics of the GQ population, though these are not broken down by type of GQ facility. ACS 1-, 3-, and 5-year region and division estimates provide some characteristics of the GQ population broken down by institutional versus non-institutional GQ facilities. Lastly, ACS 1-, 3-, and 5-year estimates for the nation provide some characteristics of the GQ population broken down by some major types of GQ facilities.

3. Methodology

We have done two types of analysis in our research of 2008 ACS 1-year data, descriptive and experimental. In the descriptive analysis we examined the effect the GQ population had on the estimates of variances of characteristics of the total resident population using only the production weighting. In the experimental analyses we made two independent alterations to the GQ weighting process and produced new weights and estimates for the GQ populations. We did this to study the effects of the adjustment for the second phase of GQ sampling and controlling GQ estimates at the state level on the estimates of the GQ population.

3.1 Variables Analyzed

In this paper we describe the analyses we conducted on ten characteristics. One variable of much interest has been the estimate of the total GQ population and its variance (Beaghen and Stern, 2009). It has received attention for two reasons. The first is because it is the only estimate of the GQ population published for geographies smaller than the state. The second is because of the relatively large variances which have been noticed by data users as large year-to-year fluctuations in the estimate of the GQ population for counties. The average standard error (SE) of the GQ population for counties large enough for 1-year estimates was 1,666, while on average these counties had only 8,744 estimated GQ persons. Note that while the ACS estimates in years before 2008 showed much smaller GQ variances, the variance estimator for the GQ population was improved starting with the 2008 estimates (see Keathley, 2010) and we consider these larger

estimates of variances to be more accurate. There has also been much interest in the effects of the GQ population on the estimates of poverty, as the GQ contribution has been attributed to large year-to-year fluctuations in county estimates of poverty for some counties. Thus in this study we chose to systematically study poverty estimates.

The other characteristics we studied were foreign born, high school graduate or higher, Hispanic origin, 65 or older, civilian veteran, civilian unemployment, Spanish speaking at home, and male. Male, Hispanic origin, and 65 or older were chosen to get a better understanding of how the experimental weightings affect variables to which we control the total resident population. We included those characteristics used in the county-level controls of the total resident population such as age and Hispanic origin, and those not controlled, nativity, educational attainment, civilian veteran, Spanish speaking at home, civilian unemployment, and poverty, because we wished to get a better understanding of how these kinds of variables were affected by the controlling. In the future, we plan to study more variables.

Note also that the universes for several of the variables of interest are restricted. Poverty in the GQ population is only measured in other non-institutional facilities, such as workers dormitories and religious dwellings. Estimates of educational attainment are produced only for individuals 25 or older. Civilian employment is only measured in college dorms, military facilities, and other non-institutional facilities. Veteran status is only published for those individuals older than 18. Finally language spoken at home is only published for those individuals older than 5. On the other hand, citizenship, age, sex, and Hispanic origin are measured across the entire population.

3.2 Calculation of Variance, Standard Error, and Coefficient of Variation

To calculate variances of ACS estimates or functions of variances such as the SE and the coefficient of variation (CV) the method of successive differences is employed. This method is translated into 80 replicate weights for each person record via a Hadamard matrix (Fay and Train, 1995). It is these replicate weights which are used to produce variance of estimates in production ACS tabulations. In our study we used the original replicate weights for the descriptive analyses and we used the same Hadamard matrix to produce new replicate weights which reflected the altered weighting for the experimental analyses.

We calculated the variance by adding up the squared differences between each of the 80 replicate weights and the production weight. We then multiplied by 4/80, or 4 over the number of replicate weights. This provided the variance. By taking the square root, we were able to determine the SE. We calculated the CV by dividing the SE by the number of people and multiplying by 100.

$$\mathrm{Var} = \frac{4}{80} * \sum_{r=1}^{80} \left(\hat{\theta}_r - \hat{\theta}_0\right)^2 \quad \text{where } \hat{\theta}_r = \text{weights in Hadamard Matrix}$$

$$\hat{\theta}_0 = \text{replicate weight}$$

$$\mathrm{SE} = \sqrt{\mathrm{Var}}$$

When calculating SEs and CVs of totals, if no sample person exhibited a particular characteristic in a certain county, that county was not be used in the calculation of our statistics. When we were calculating the SE and CV of the percent of people who exhibit

that characteristic, however, that county was used in the calculation of our statistics if the characteristic's universe existed in that county.

3.3 Summary Statistics

For summarizing effects over the states or the counties with 1-year data we used the mean absolute difference and mean difference. These statistics are defined in Table 1.

Table 1: Definition of Summary Statistics

Mean Difference	$\frac{1}{\text{Number of States/Counties}} * \sum_{\text{States/Counties}} \text{Production CV} - \text{Experimental CV}$
Mean Absolute Difference	$\frac{1}{\text{Number of States/Counties}} * \sum_{\text{States/Counties}} \lvert\text{Prodution CV} - \text{Experimental CV}\rvert$

3.4 The Effects of the GQ Estimates on Estimates of the Total Resident Population

The greater interest is not in the estimates of characteristics of the GQ population in themselves, which are published for state or larger geographies and are viewed as sound, but in the effect of the GQ population on estimates of the total resident population, which might be problematic for estimates for small geographies. Thus we made direct comparisons between estimates of characteristics for the household population, the GQ population, and the total resident population itself for counties and states.

We also broke down the GQ population into the seven major GQ type groups and provided estimates of characteristics by each major GQ type to examine the homogeneity or heterogeneity between GQ populations. We describe the work in this section as descriptive because we did not manipulate the weights.

We chose to investigate totals with certain characteristics as opposed to percents in our study. We did this because of a complication which arose for variances of estimates of proportions in counties with a small number of GQ interviews.

3.5 Comparing Estimates with and without the Adjustment for the Second Phase of Sampling

The first experimental weighting method attempted to determine the effect of the adjustment for the second phase of GQ sampling on the variances of the estimates of GQ population. This adjustment, which is driven by the differences between the expected and observed populations in a GQ facility, is made in the first step of the GQ weighting process. If the omission of this step yields smaller variance estimates, then this would suggest that more accurate expected population values on the sampling frame would produce more reliable estimates. Furthermore, the differences we see would quantify how much they might have helped.

The two GQ sampling stratum, large and small GQ stratum, have different adjustments for the difference between a GQ facility's expected and observed populations. For both of these cases, we produced modified weights which omitted this adjustment. We included only the probability of selection from the first phase disregarding the probability of selection from the second phase. Note that by omitting the adjustment, we introduce a bias in estimates produced by the experimental weights. We continued the weighting

process with these altered weights, producing experimental final weights. We produced new biased estimates with these weights and used them to calculate experimental CV. We then compared these estimates to the published estimates to determine how much the adjustment changes the SE and CV for our characteristics. For our comparison, we used the summary statistics seen in Section 3.3 to compare the GQ production CVs to the GQ experimental CVs when we did not take into account the difference between the expected and observed population. These summary statistics determined the mean absolute difference and mean difference.

3.6 Comparing Estimates with and without GQ Controls

The ACS controls the GQ population to the PEP estimates at the state level by the seven major GQ types. In this section, we attempt to discern the effect of this controlling on the variances of the state and county estimates of characteristics of the GQ population. To calculate uncontrolled estimates, we used the non-interview adjusted weights, which include all steps up to but not including controlling. We then compared estimates based on non-interview adjusted weights to ACS production estimates to determine how much the controlling changed the CV for characteristics of interest in GQ populations. We used the same summary statistics as we did in Section 3.5.

4. Results and Discussion

In this section we present the results of our findings. In the experimental analyses we chose to use CVs as opposed to SEs because CVs are standardized and made the county and states estimates of totals comparable to each other, in addition to making comparisons between different characteristics easier to interpret. It is important to note, however, that SEs produced similar results.

4.1 National Estimates by Major Type of GQ Facility

Table 2 compares the total population, coverage rates, and characteristics of the household population with the GQ population broken down by the seven major GQ types at the national level. We see that the characteristics of the GQ population differ from that of the household population. However, the seven major GQ types also differ amongst themselves. For example, the percent of Hispanics in nursing homes is only 4.3 percent, compared to 19.7 percent in correctional facilities. Characteristics for which differences are greater between the household and GQ populations will yield greater differences between the household and total resident populations. The most extreme difference we see is for poverty, where 64 percent of the GQ poverty universe is estimated to be in poverty, compared to only 13 percent for households. Of the characteristics we are considering, one could surmise that the GQ population has the most impact on the estimates of poverty. The coverage rates will be relevant in the discussion of results in Section 4.3 which discusses the effects of controlling.

4.2 Contribution of the GQ Population to the Variance of the Total Resident Population

At the state level, we saw that the GQ population had a noticeable effect on the estimates of total persons exhibiting a characteristic in the total resident population. In contrast,

Table 2: ACS 2008 1-Year National Estimates in Percent for Characteristics of the GQ, Household, and Total Resident Populations[2]

Population	Number in Facility	Coverage Rate	Poverty	Foreign Born	High School Graduate or Higher	Speak Spanish Primarily	Civilian Veterans	Civilian Unemployed	Male	Hispanic	65 or Older
Correctional Facility	2,135,944	102.0	N/A	8.93	63.8	17.9	7.7	N/A	90.5	19.7	1.1
Juvenile Facility	124,031	140.9	N/A	3.36	73.8	10.8	0.0	N/A	71.8	18.1	0.0
Nursing Home	1,845,567	93.1	N/A	6.14	63.0	4.0	13.4	N/A	31.7	4.3	85.0
Other Long-Term Care Facility	97,026	28.3	N/A	10.49	59.1	11.8	12.2	N/A	61.8	13.0	11.6
College Dorm	2,380,556	63.6	N/A	7.83	97.9	4.7	0.6	15.4	46.6	6.4	0.0
Military Facility	366,617	77.4	N/A	6.38	96.2	8.4	7.3	3.3	86.2	13.4	0.0
Other Non-Institutional Facility	1,297,097	65.4	64.3	10.09	62.5	9.7	9.5	19.7	56.6	11.9	23.9
Total Group Quarters Population	8,246,838	80.8	N/A	7.99	64.2	9.1	7.3	N/A	58.5	10.8	23.2
Household Population	295,812,891	98.7	13.0	12.61	85.5	12.3	9.8	6.3	49.0	15.6	12.5
Total Resident Population	304,059,729	93.8	13.2	12.48	85.0	12.2	9.7	6.4	49.3	15.4	12.8

the GQ facilities did not have a large effect on the variances of the total resident population. When we included the GQ population, the SEs of state-level estimates generally stay the about the same for characteristics not controlled to in the weighting of the total resident population. In Table 3A these are poverty through civilian unemployed. The SEs are smaller for demographic characteristics that are controlled to, which in Table 3A are male, Hispanic, and age 65 or older. For example, the average difference between the SE of the household poverty and total poverty was close to zero averaged across the 51 state equivalents. The SE of male, however, decreased from 0.09 for the household population to 0.06 percent for the total resident population. Seeing smaller SEs for controlled variables for the total resident population was expected, as we control to them for the total resident population (and not the household population).

The variances of the estimates of counties show a similar pattern to what we saw for states. The differences in the SEs and CVs between the household population and the total resident population are small or about unchanged for characteristics which are not controlled. For example, the differences in SE of poverty and foreign born are close to zero. However, for demographic characteristics which are controlled for total resident population, we see smaller variances for the estimates of the total resident population. Male, Hispanic, and 65 or older are all have noticeably smaller SEs and CVs for the total

[2] A zero estimate shown above means that there were either no sample cases with that characteristic or there were too few sample cases than could be shown due to disclosure limitations.

resident population. We can say that generally, the inclusion of the GQ population does not increase the variances of estimates at the county level. For controlled characteristics, as expected, it decreases them.

Table 3A: Differences in Percent Standard Errors and Coefficients of Variation of Characteristics of the Total Resident and the Household Populations at the State Level

Characteristic	Mean SE of the Total Resident Population	Mean SE of the Household Population	Difference of SE	Mean CV in Percent of the Total Resident Population	Mean CV in Percent of the Household Population	Difference of CV in Percent
Poverty	0.32	0.32	0.00	2.61	2.67	-0.06
Foreign Born	0.17	0.17	0.00	2.99	3.08	-0.09
High School Graduate or Higher	0.25	0.25	0.00	0.29	0.29	0.00
Spanish Speaking at Home	0.13	0.13	0.00	3.18	3.32	-0.14
Civilian Veterans	0.20	0.20	0.00	1.64	1.66	-0.02
Civilian Unemployed	0.13	0.13	0.00	3.68	3.70	-0.03
Male	0.06	0.09	-0.03	0.12	0.19	-0.06
Hispanic	0.03	0.05	-0.02	0.74	0.95	-0.21
65 or Older	0.02	0.04	-0.02	0.27	0.43	-0.17

Table 3B: Differences in Percent Standard Errors and Coefficients of Variation of Characteristics of the Total Resident and the Household Populations at the County Level

Characteristic	Mean SE of the Total Resident Population	Mean SE of the Household Population	Difference of SE	Mean CV in Percent of the Total Resident Population	Mean CV in Percent of the Household Population	Difference of CV in Percent
Poverty	1.23	1.20	0.03	10.20	10.27	-0.07
Foreign Born	0.57	0.58	-0.01	13.20	13.67	-0.47
High School Graduate or Higher	1.07	1.06	0.01	1.27	1.24	0.03
Spanish Speaking at Home	0.73	0.75	-0.02	14.09	15.08	-0.99
Civilian Veterans	0.83	0.82	0.01	6.70	6.81	-0.11
Civilian Unemployed	0.49	0.51	-0.02	15.04	15.21	-0.17
Male	0.28	0.44	-0.16	0.56	0.91	-0.35
Hispanic	0.16	0.39	-0.23	1.65	4.33	-2.68
65 or Older	0.02	0.12	-0.10	1.25	3.22	-1.97

We will use Nassau County, New York, to illustrate the contribution of including the GQ population in the total resident population on the variance of its estimates. In Nassau County the poverty rate for the household population was 4.4 percent, with a SE of 0.3. When we included the GQ population in the total resident population, we saw that the percent of those in poverty was larger at 4.5 percent, though the SE remained the same at 0.3 percent. This illustrates the point that the inclusion of the GQ population in the total resident population can produce noticeable changes to estimates of characteristics without similar changes to the SEs.

4.3 Effect of the Adjustment for the Second Phase of Sampling

When we did not adjust the weighting for the second phase of sampling, we saw reductions in the CV at the state level. We saw greater reductions at the county level. In Table 4A, we can see that the adjustment increases the CV of the estimates of all of our characteristics at both the state and county levels. We remind the reader that without this adjustment that the estimates are biased. The greatest reduction in CV is for civilian unemployment, which decreases from 26.3 to 22.4 percent for the state estimates. Notice

that the county-level CV of total GQ population decreases by 3.4 percentage points at the county level. Its CV is zero for state estimates because of state-level GQ population controls. These results suggest that better expected populations on the sampling frame would yield a more efficient sample design and less sampling variation.

Table 4A: Effect of Adjustment for the Second Phase of Sampling at the State and County Level

Geography	Characteristic	Mean Production CV in Percent	Mean CV in Percent of Estimate without the Adjustment for the Second Phase	Mean Difference	Mean Absolute Difference
State	Foreign Born	16.3	14.6	1.7	2.7
	Poverty	12.7	11.8	0.9	2.5
	High School Degree	4.8	4.0	0.8	1.0
	Speak Spanish	16.0	13.6	2.4	2.8
	Civilian Veteran	14.7	12.8	1.9	2.0
	Civilian Unemployment	26.3	22.4	3.9	4.5
	Total GQ Population	0.0	0.0	0.0	0.0
	Male	4.2	3.7	0.5	0.6
	Hispanic Origin	15.1	12.7	2.4	2.7
	65 or older	6.5	5.8	0.7	1.3
County	Foreign Born	62.7	60.6	2.1	3.6
	Poverty	77.5	75.0	2.5	3.7
	High School Degree	44.3	41.1	3.2	4.2
	Speak Spanish	59.1	56.6	2.5	3.6
	Civilian Veteran	60.2	57.9	2.3	4.0
	Civilian Unemployment	71.8	69.4	2.4	3.9
	Total GQ Population	36.4	33.0	3.4	3.9
	Male	41.9	38.9	3.0	3.9
	Hispanic Origin	58.2	55.2	3.0	3.9
	65 or Older	58.4	55.8	2.6	3.8

In order to get a better understanding of the results summarized in Tables 4A, we looked at the estimates of Arlington County, Virginia. When we looked at the estimates of foreign born in Arlington County, Virginia, we saw that the CV under the production weighting was 42.4 percent. When we used the experimental weighting where we did not account for the second phase adjustment, we saw that the CV dropped to 36.2 percent. We saw similar results in poverty, high school graduate or higher, Hispanic origin, and 65 or older, sex, civilian veterans, and civilian unemployment.

Table 4B: Case Study: Effect of the Adjustment for the Second Phase of Sampling in Arlington County, VA

Variable in GQ Population	CV in Percent under Production weighting	CV in Percent without the Adjustment for the Second Phase of Sampling	Difference
Foreign Born	42.4	36.2	6.2
Poverty	91.3	85.8	5.5
High School Graduate or Higher	49.7	36.7	13.0
Spanish Speaking	53.0	53.3	-0.3
Civilian Veteran	69.6	59.4	10.2
Civilian Unemployment	84.1	76.5	7.6
Male	41.0	29.4	11.6
Hispanic Origin	57.9	46.2	11.7
65 or Older	55.8	47.4	8.4

4.4 Effect of GQ Controls

We calculated the CVs of the GQ population without the controls in place and compared them to the production results, as seen in Table 5. At the state level, we saw that the controls reduce the CVs. These reductions were expected, as we control at the state level by major GQ type. To the extent that a characteristic is related to GQ type, the SE and CV of its state-level estimate will be reduced. Some of the reductions in CV were dramatic, such as that for foreign born, which was 4.8 percent controlled but 9.0 percent without the controls.

However, when we look at the county-level estimates, we see the controls tended to increase the CVs, if only modestly. These increases are a result of the fact that the

Table 5: Effect of GQ Controls at the State and County Level

Geography	Characteristic	Mean Production CV in Percent	Mean Uncontrolled CV in Percent	Mean Difference	Mean Absolute Difference
State	Foreign Born	16.3	17.7	-1.7	2.3
	Poverty	12.7	27.4	-14.7	14.9
	High School Degree	4.8	9.0	-4.2	4.3
	Speak Spanish	16.0	18.5	-2.5	3.9
	Civilian Veteran	14.7	15.8	-1.1	2.3
	Civilian Unemployment	26.3	29.1	-2.8	4.1
	Total GQ Population	0.0	6.8	-6.8	6.8
	Male	4.2	7.7	-3.5	3.8
	Hispanic Origin	15.1	16.6	-1.5	2.9
	65 or Older	6.5	11.5	-5.0	5.3
County	Foreign Born	62.7	62.2	0.5	2.5
	Poverty	77.5	77.4	0.1	3.2
	High School Degree	44.3	44.2	0.1	2.8
	Speak Spanish	59.1	58.9	0.2	2.7
	Civilian Veteran	60.2	59.5	0.7	2.6
	Civilian Unemployment	71.8	71.6	0.2	2.4
	Total GQ Population	36.4	36.5	-0.1	2.7
	Male	41.9	38.9	3.0	3.1
	Hispanic Origin	58.2	57.9	0.3	3.4
	65 or Older	58.4	58.2	0.2	3.4

controlling increases the weights when there coverage rates lower than 100. See Table 2 for the national coverage rates by major GQ type group. For certain major GQ types, the coverage rates tended to be much lower than 100, such as other long-term care facilities with a coverage rate of 28.3 percent, and college dorms with a coverage rate of 63.6 percent. This result suggests better coverage for certain major GQ types would reduce the variance of GQ estimates for substate geographies.

5. Limitations

There are two important limitations regarding the scope of the research. First, we examined only ten variables in our study, only six of which were uncontrolled estimates of characteristics. These variables may not be typical and the study would benefit from looking at more characteristic variables. Second, we did not study the effects on estimates of areas smaller than the county. In late 2010 the first 5-year ACS estimates are scheduled to be released, including detailed estimates of characteristics for geographies as small as the tract and block group. The variances of these estimates for smaller geographies can be expected to benefit little from the state- and county-level controls. Thus it is possible that any negative impact of the GQ population on the total resident population will be more severe at these smaller areas.

Another limitation is that we only looked at mean differences, not median differences, for our summary statistics. Using means as summary statistics gives heavier weight to less typical observations.

6. Conclusions

The goals of the research described in this paper were to investigate and better understand the effects of GQ population on the variances of estimates of the total resident population and the mechanisms driving these estimates of variances. To accomplish these goals we examined the direct effects of GQ estimates in our descriptive analyses. We also examined two alternative weightings to understand how certain steps of the GQ weighting affect the variances of the GQ estimates.

Since the GQ population differs from the household population, the inclusion of the GQ population has noticeable effects on the estimates of total persons exhibiting given characteristics and estimates of proportions of the total resident population. The reasons for this effect are clear and expected. Of greater interest were the effects on the variances of the estimates of the total resident population, which are not as well understood, and, we suspect, will be larger for certain characteristics for small geographies, such as tracts and block groups.

We found that for state-level estimates for all nine of the characteristics we studied that the variances of estimates of the total resident population were close to those of the household population. This result is not surprising because the GQ sample design and weighting are designed to produce state-level estimates. For the county-level estimates, we found that for characteristics to which we do not control, the SEs and CVs change little. In contrast, for the characteristics to which we do control, we saw that the SEs and CVs of the total resident population were less than those of the household population. Controlling the total resident population at the county level prevented the variances of

their estimates from being adversely affected when the GQ population was included in the total resident population. This suggests pursuing future research for tract-level estimates when the 2005-2009 5-year estimates are ready.

The experimental results examined the effects of two key weighting steps in the GQ weighting. When we did not account for the difference between the expected and observed populations, we saw that the experimental weighting generally produced lower CVs at the state and county level. This indicates that the second phase adjustment increases the variances and suggests that a better frame will produce more accurate results.

When we omitted the GQ controls, we saw that the experimental weighting had higher CVs at the state level but tended to produce lower CVs at the county level. These better state level estimates are consistent with our design goals. The lower CVs at the county level are likely attributable to the low coverage rates within certain major GQ types. We speculate that if we oversample those GQ facilities with low coverage rates, such as other long-term care facilities and other non-institutional facilities, and undersample those with higher coverage rates, such as juvenile facilities, we can expect to reduce the variances while maintaining the overall GQ sample sizes and costs.

Lastly, we note that prior research had shown large variances for the estimates of total GQ population for counties (Beaghen and Stern, 2009). This phenomena arises because typically all sample persons in a given GQ yield the same GQ population and thus instead of a sample of ten the effective sample is one. Another way of looking at it is that the intracluster correlation is one. Estimates of characteristics do not face this limitation.

7. Future Research

There are several avenues we believe would be beneficial to explore, which relate to the generalizability of the results. We would like to look at more characteristics in our discussion, and expand the analyses to tracts when the 2005-2009 5-year estimates are released in late 2010. At the state and county level, there are controls in place which keep the SE and CV low. By examining tracts in the 5-year data, we will see how much effect the GQ population has on tract estimates, which are not controlled.

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