Calculating Margins of Error the ACS Way
Using Replicate Methodology to Calculate Uncertainty

February 12, 2020

Sirius Fuller
Decennial Statistical Studies Division

Charles Gamble
American Community Survey Office

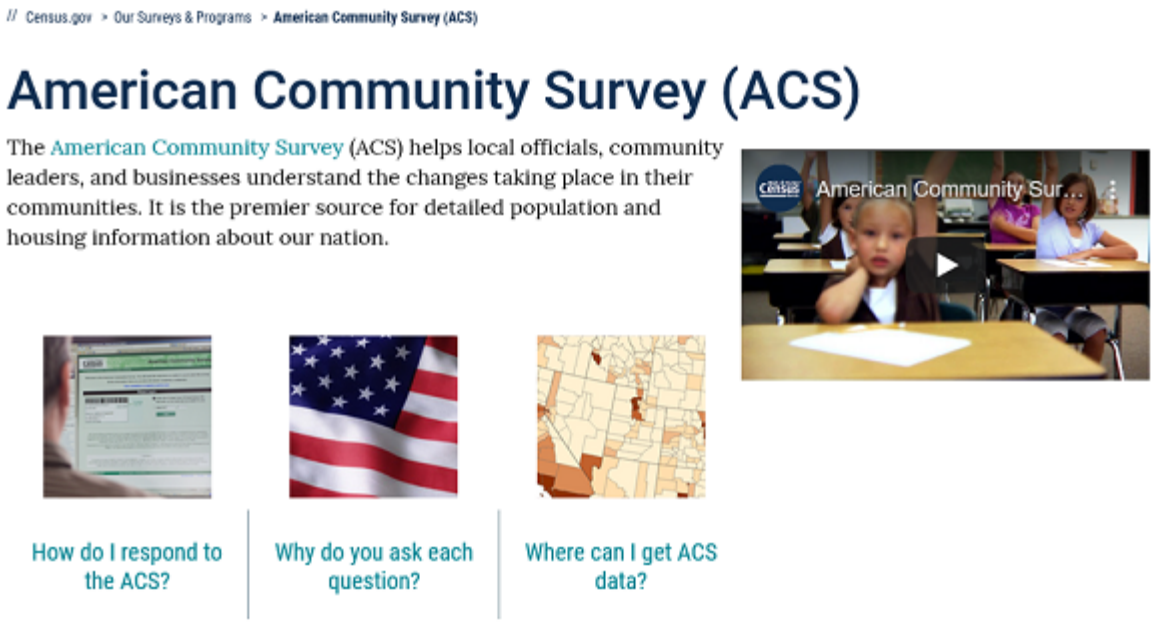
United States® Census Bureau

Outline

1. **Overview of the American Community Survey (ACS)**
2. Variance Replicate Estimates (VRE) Tables
    - Motivation for Using the VRE Tables
    - Comparison to Detailed Tables
    - Obtaining VRE Data
    - Worked Example
3. Public Use Microdata Sample (PUMS)
4. Questions

United States® Census Bureau

Overview of the ACS



- Survey that samples over 3.5 million housing unit addresses annually
- Provides estimates for detailed Social, Economic, Housing, and Demographic statistics
- Estimates published with 90% confidence level margin of error (MOE)

United States Census Bureau

Overview of the ACS

Type of Data	Description
1-year American Community Survey (ACS)	Combines 12 months of ACS survey responses Available for geographies with a population over 65,000 Supplemental tables are also published for geographies with a population of 20,000 or more
5-year American Community Survey (ACS)	Combines 60 months of ACS survey responses Released for all geographies down to block group geographies Variance Replicate Estimates (VRE) Tables available

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Overview of the ACS PUMS

	A	B	C	D	E	F	G
1	RT	SERIALNO	DIVISION	SPORDER	PUMA	REGION	ST
2	Record Type	Housing unit/GQ person serial number	Division code based on 2010 Census definitions	Person number	Public use microdata area code (PUMA) based on 2010 Census definition (areas with population of 100,000 or more, use with ST for unique code)	Region code based on 2010 Census definitions	State Code based on 2010 Census definitions
3	P	2018GQ0000030	9	1	00101	4	02
4	P	2018GQ0000055	9	1	00101	4	02
5	P	2018GQ0000488	9	1	00300	4	02
6	P	2018GQ0000840	9	1	00300	4	02
7	P	2018GQ0000867	9	1	00101	4	02
8	P	2018GQ0000927	9	1	00400	4	02
9	P	2018GQ0001015	9	1	00300	4	02
10	P	2018GQ0001640	9	1	00200	4	02
11	P	2018GQ0001755	9	1	00400	4	02
12	P	2018GQ0001990	9	1	00400	4	02

- Public Use Microdata Sample (PUMS) are a subset of the full ACS records
- Additional data disclosure avoidance measures are applied to protect respondents confidentiality
- Data users may calculate their own estimates
- VRE Tables and PUMS use the same methodology to calculate margins of error
- Both 1-year and 5-year PUMS data are available

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What Are the VRE Tables?

- Variance Replicate Estimates (VRE) Tables are equivalent to ACS detailed tables
- Published in comma-separated values (CSV) format on FTP site
- Allow data users to calculate the margin of error (MOE) using replicate methodology for combined ACS estimates

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Motivation for Using the VRE Tables

- Can combine estimates published on data.census.gov:
  - Sum within a table

	Census Tract 1, Aleutians East Borough, Alaska		Census Tract 1, Aleutians West Census Area, Alaska	
	Estimate	Margin of Error	Estimate	Margin of Error
Total:	3,338	*****	975	+/-128
Male:	2,049	+/-100	627	+/-102
Under 5 years	42	+/-12	28	+/-10
5 to 9 years	74	+/-16	33	+/-10

United States Census Bureau

Motivation for Using the VRE Tables

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United States Census Bureau

Motivation for Using the VRE Tables

- Can combine estimates published on data.census.gov:
  - Sum within a table
  - Sum across geographies
  - Sum both within a table and across geographies

	Census Tract 1, Aleutians East Borough, Alaska		Census Tract 1, Aleutians West Census Area, Alaska	
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United States Census Bureau

Motivation for Using the VRE Tables

- Must approximate the margin of error (MOE) if using published tables
  - MOE be large and diverge from MOE calculated from microdata
  - Approximation formulas differ depending on estimate type

Approximating count MOE:

$$\mathrm{MOE}(\mathrm{Est}_1 + \mathrm{Est}_2) = \sqrt{\mathrm{MOE}(\mathrm{Est}_1)^2 + \mathrm{MOE}(\mathrm{Est}_2)^2}$$

Approximating percent MOE:

$$\mathrm{MOE}(\mathrm{percent}) = \frac{1}{\mathrm{Denom}}\sqrt{\mathrm{MOE}(\mathrm{Num})^2 - \mathrm{p}^2 \times \mathrm{MOE}(\mathrm{Denom})^2}$$

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Motivation for Using the VRE Tables

- VRE Tables allow you to calculate the margin of error using the same methodology as the ACS uses

$$\text{Variance} = \frac{4}{80}\sum_{i=1}^{80}\left(\text{Var_Rep}_i - \text{Estimate}\right)^2$$

- Not an approximation formula
- May be used for different types of estimates
  - Counts, Means, Ratios, etc.

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ACS Detailed Tables

Detailed tables may be referred to by their Table ID

b01001 Search

SEX BY AGE

Survey/Program: American

TableID: B01001

Product: 2017: ACS 5-Year Estimates Detailed Tables

Universe: Total population

CUSTOMIZE TABLE

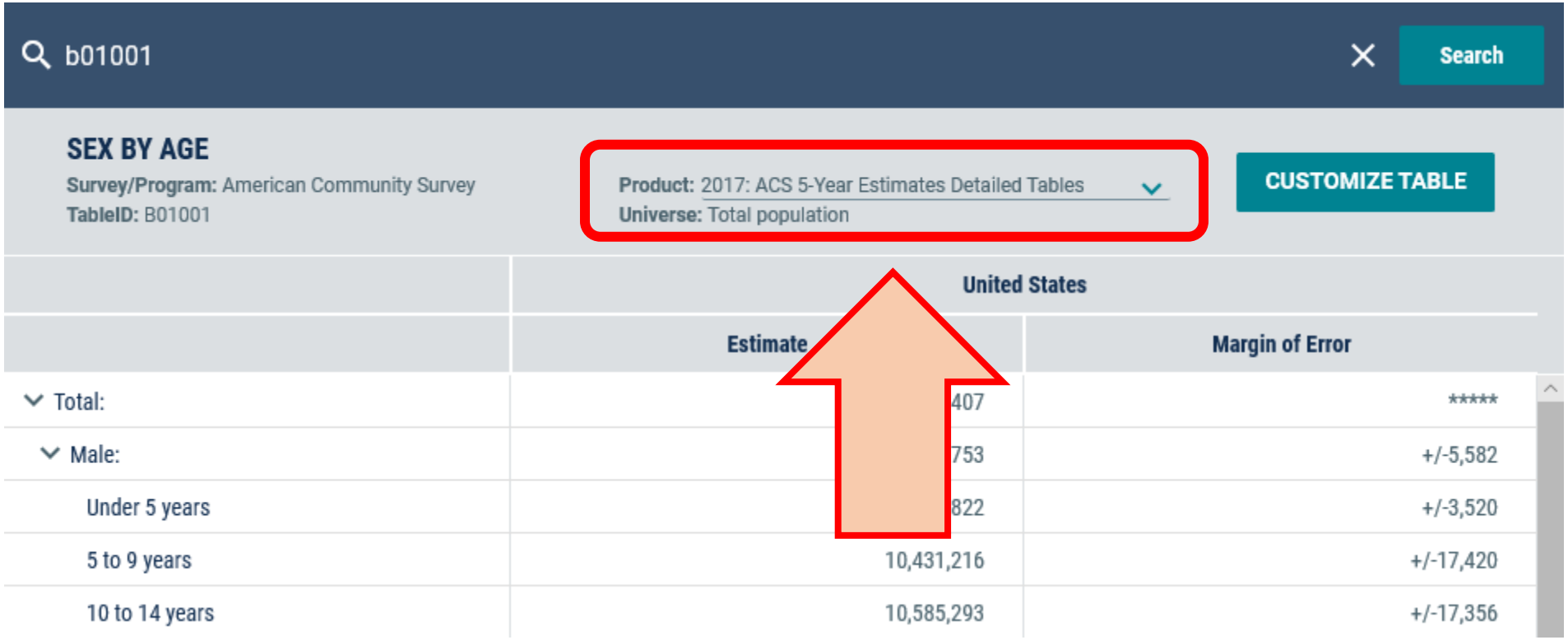
	United States	
	Estimate	Margin of Error
Total:	321,004,407	*****
Male:	158,018,753	+/-5,582
Under 5 years	10,151,822	+/-3,520
5 to 9 years	10,431,216	+/-17,420
10 to 14 years	10,585,293	+/-17,356

Source: https://data.census.gov/cedsci/table?q=b01001&g=&lastDisplayedRow=28&table=B01001&tid=ACSDT5Y2017.B01001

United States® Census Bureau

ACS Detailed Tables

Choose the relevant year and time period on data.census.gov



Source: https://data.census.gov/cedsci/table?q=b01001&g=&lastDisplayedRow=28&table=B01001&tid=ACSDT5Y2017.B01001

United States Census Bureau

ACS VRE Table vs. Detailed Table

	A	B	C	D	E	F	G	H	I	J	K	L	M
1	TBLID	GEOID	NAME	ORDER	TITLE	estimate	moe	CME	SE	Var_Rep1	Var_Rep2	Var_Rep3	Var_Rep4
2	B01001				SEX BY AGE								
3	B01001				Universe: Total population								
4	B01001	01000US	United States	1	Total:	321,004,407	0	*****	0	321,004,391	321,004,391	321,004,391	321,004,391
5	B01001	01000US	United States	2	Male:	158,018,753	5,582	+/-5,582	3,393	158,022,330	158,018,446	158,020,151	158,019,657
6	B01001	01000US	United States	3	Under 5 years	10,151,822	3,520	+/-3,520	2,140	10,154,087	10,152,109	10,153,832	10,151,106
7	B01001	01000US	United States	4	5 to 9 years	10,431,216	17,420	+/-17,420	10,590	10,434,084	10,431,448	10,434,956	10,431,501
8	B01001	01000US	United States	5	10 to 14 years	10,585,293	17,356	+/-17,356	10,550	10,581,975	10,586,227	10,580,133	10,585,131

SEX BY AGE

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Comparison of the Sex by Age table (table ID B01001) at the national level

Variance Replicate Estimates (VRE) data is above

ACS detailed table data is on the left

United States® Census Bureau

ACS VRE Table vs. Detailed Table

	A	B	C	D	E	F	G	H	I	J	K	L	M
1	TBLID	GEOID	NAME	ORDER	TITLE	estimate	moe	CME	SE	Var_Rep1	Var_Rep2	Var_Rep3	Var_Rep4
2	B01001				SEX BY AGE								
3	B01001				Universe: Total population								
4	B01001	01000US	United States	1	Total:	321,004,407	0	*****	0	321,004,391	321,004,391	321,004,391	321,004,391
5	B01001	01000US	United States	2	Male:	158,018,753	5,582	+/-5,582	3,393	158,022,330	158,018,446	158,020,151	158,019,657
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Estimates in VRE Table and Detailed Table are the same

Variable name is called “estimate”

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ACS VRE Table vs. Detailed Table

	A	B	C	D	E	F	G	H	I	J	K	L	M
1	TBLID	GEOID	NAME	ORDER	TITLE	estimate	moe	CME	SE	Var_Rep1	Var_Rep2	Var_Rep3	Var_Rep4
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Margin of Error has the same data

VRE refers to the Margin of Error as CME

CME stands for “Character Margin of Error”

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ACS VRE Table vs. Detailed Table

	A	B	C	D	E	F	G	H	I	J	K	L	M
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VRE also include a numeric version of the margin of error

It is called “MOE”

Data users do not need to remove the “+/-” to use the numeric version

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ACS VRE Table vs. Detailed Table

	A	B	C	D	E	F	G	H	I	J	K	L	M
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VRE data also includes 80 variance replicate estimates

They are used to calculate the margin of error

Only 4 are shown here

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Additional Variables in VRE Tables

Variable	Description
TBLID	Table ID (e.g. B01001)
GEOID	Geographic ID - uniquely identifies a specific geography
NAME	Name of Geography
ORDER	Order within a table (line number)
MOE	MOE is the numeric margin of error
CME	CME is the Character version of the margin of error NOTE: CME is how the margin of error appears on data.census.gov
SE	Standard Error (numeric)
Var_Rep1 – Var_Rep80	Variance Replicate estimates

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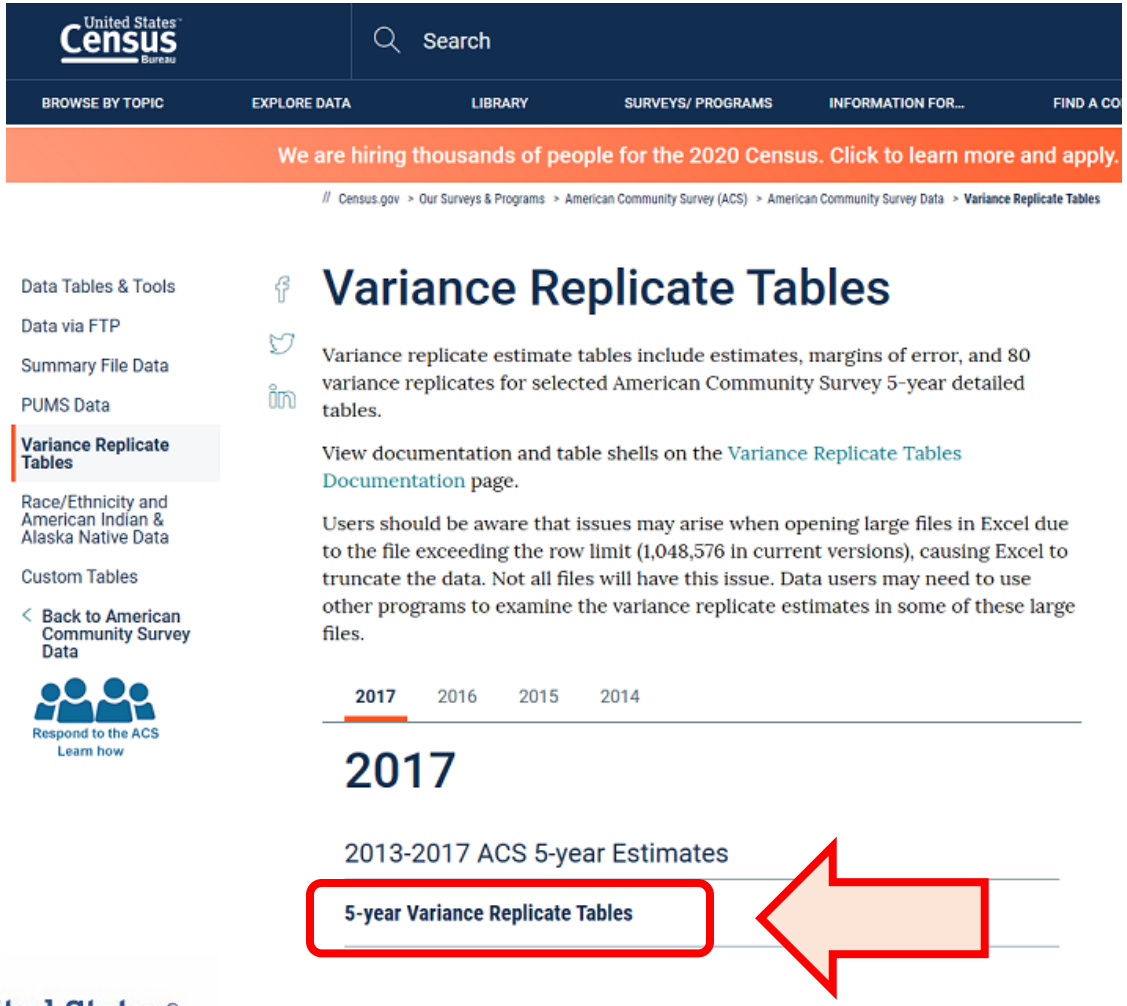
Obtaining VRE Table Data



Variance Replicate Estimates (VRE) tables available through the FTP site

https://www.census.gov/programs-surveys/acs/data/variance-tables.html

Click on “5-year Variance Replicate Tables”

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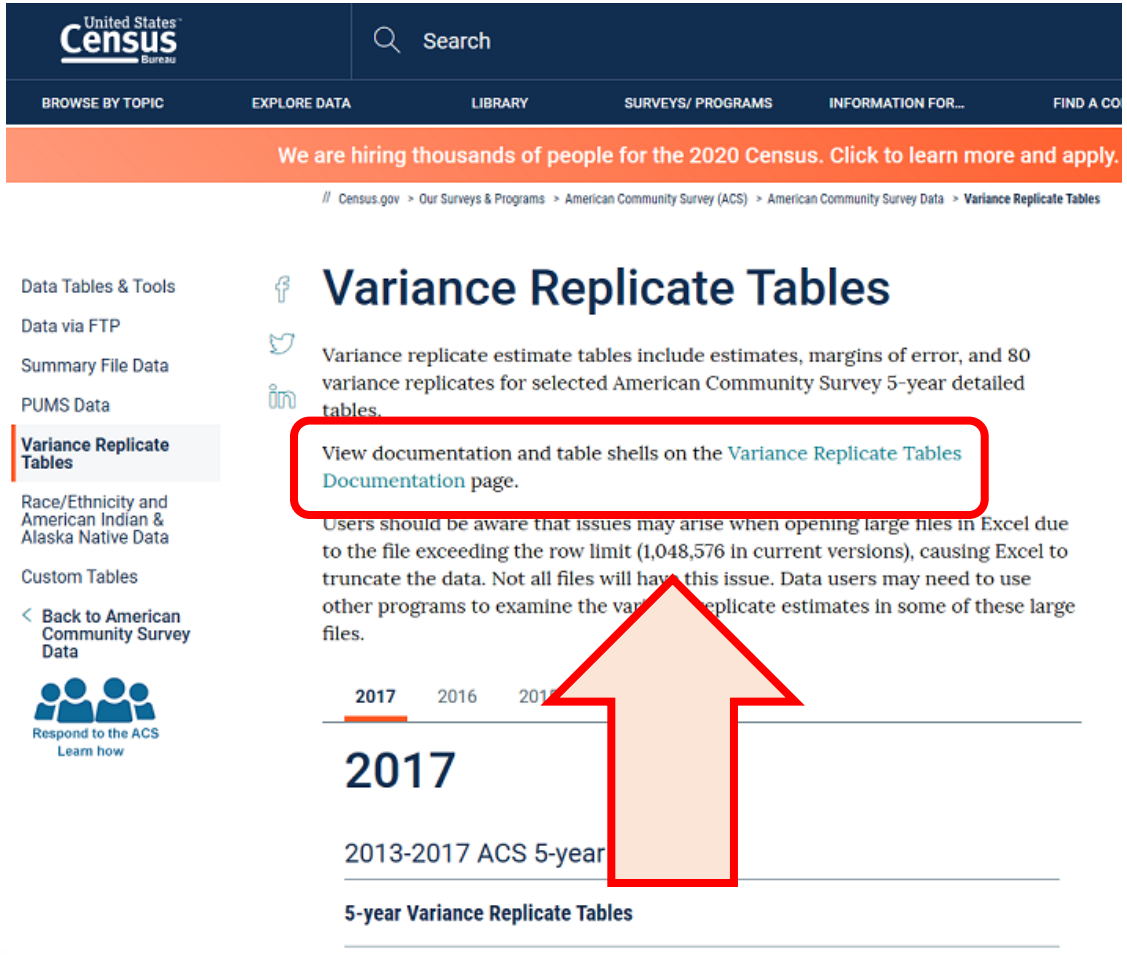
Obtaining VRE Table Data



Note the link to the Technical Documentation

Includes:

- Technical documentation
- Parameter files
- Lists of published VRE tables and Geographies
- ACS Table Shells (layout for ACS detailed tables)

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Selecting a VRE Geographic Summary Level

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Name	Last modified	Size	Description
Parent Directory		-	
010/	10-Dec-2018 09:10	-	
040/	10-Dec-2018 09:15	-	
050/	10-Dec-2018 09:17	-	
060/	10-Dec-2018 09:35	-	
140/	10-Dec-2018 11:27	-	
150/	12-Dec-2018 11:38	-	
160/	10-Dec-2018 12:13	-	
250/	11-Dec-2018 09:52	-	
310/	11-Dec-2018 09:53	-	
500/	11-Dec-2018 09:55	-	
860/	11-Dec-2018 10:09	-	

Geographic Summary Level	Description
010	Nation
040	State
050	County
060	County Subdivision
140	Census Tract
150	Census Block Group
160	Place
250	American Indian Area Alaska Native Area Hawaiian Homeland
310	Metroplitan/Micropolitan Statistical Area
500	Congressional District
860	Zip Code Tabulation Area (ZCTA)

Geographic Summary Levels identified by 3-digit code

Only 11 Summary Levels published for VRE tables

Summary level is broad category for geographic level (e.g. Alabama contained in state summary level)

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Select VRE Table to Download

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Name	Last modified	Size	Description
Parent Directory		-	
B01001.csv.gz	10-Dec-2018 09:10	14K	
B01003.csv.gz	10-Dec-2018 09:10	349	
B02001.csv.gz	10-Dec-2018 09:10	3.2K	
B02008.csv.gz	10-Dec-2018 09:10	739	
B02009.csv.gz	10-Dec-2018 09:10	743	

Files identified by Table ID

Over 800 detailed tables published for ACS 5-year data on data.census.gov

About 100 tables available through VRE tables

All data used in data profiles available in VRE tables

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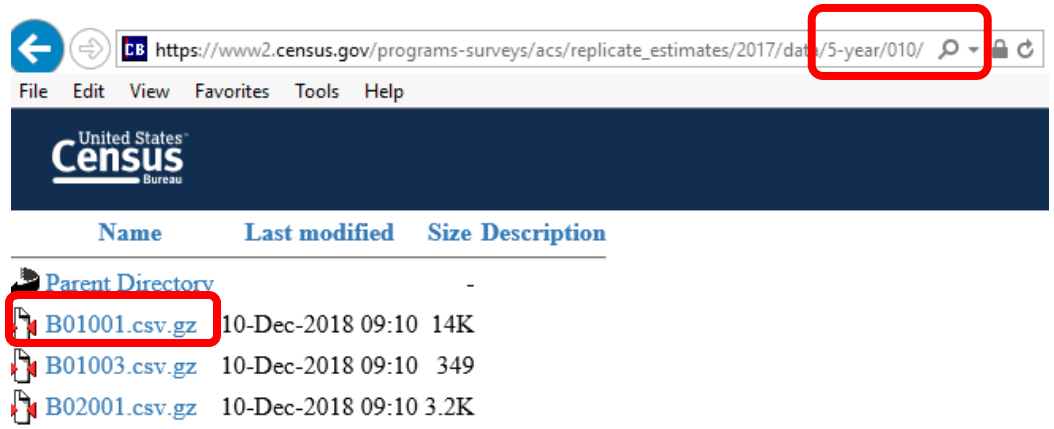
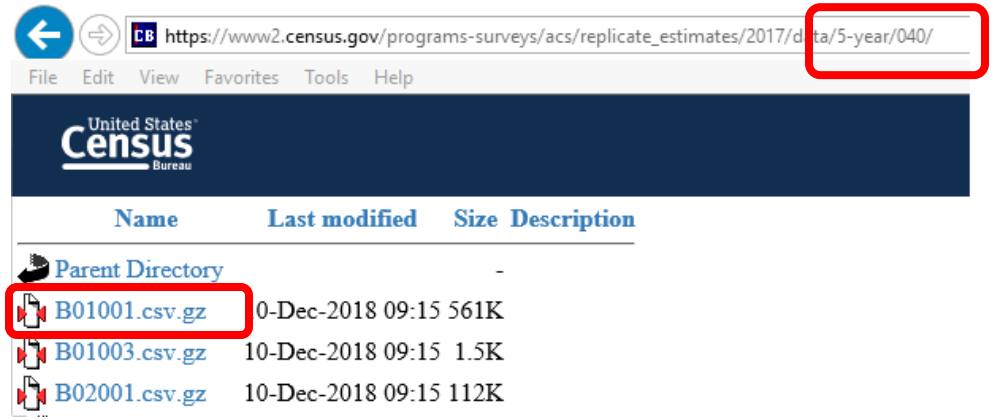
Select VRE Table to Download





Files at different geographies generally have the same name

Sex by Age table at the national (010) and state (040) summary levels both named B01001

Need to download to separate locations or rename files if downloading both

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Select VRE Table to Download

United States Census Bureau

Name	Last modified	Size	Description
Parent Directory		-	
B01001.csv.gz	10-Dec-2018 09:10	14K	
B01003.csv.gz	10-Dec-2018 09:10	349	
B02001.csv.gz	10-Dec-2018 09:10	3.2K	
B02008.csv.gz	10-Dec-2018 09:10	739	
B02009.csv.gz	10-Dec-2018 09:10	743	
B02010.csv.gz	10-Dec-2018 09:10	763	
B02011.csv.gz	10-Dec-2018 09:10	697	
B02012.csv.gz	10-Dec-2018 09:10	746	
B02013.csv.gz	10-Dec-2018 09:10	733	
B02014.csv.gz	10-Dec-2018 09:10	13K	
B02015.csv.gz	10-Dec-2018 09:10	7.0K	
B02016.csv.gz	10-Dec-2018 09:10	3.3K	
B03001.csv.gz	10-Dec-2018 09:10	8.8K	
B03002.csv.gz	10-Dec-2018 09:10	6.2K	
B03003.csv.gz	10-Dec-2018 09:10	886	
B04006.csv.gz	10-Dec-2018 09:10	30K	

Recommended to use Chrome or Safari to download the data

If using Firefox, save the data before opening it

If using Internet Explorer or Edge the file extension may change

You will have to rename the file extension to unzip the data

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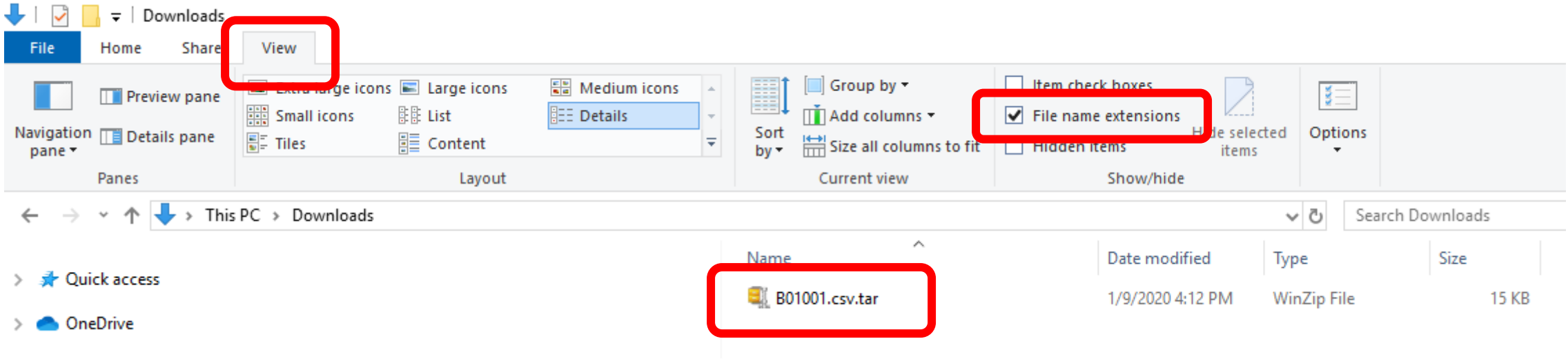
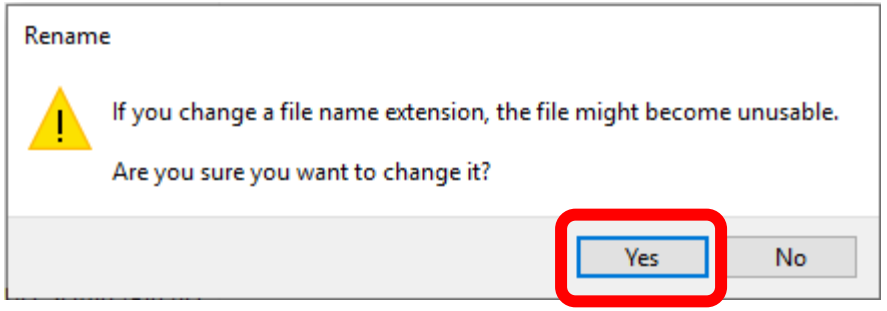
Changing File Extension Name



Rename the file extension from ".tar" to ".gz" before attempting to unzip the data

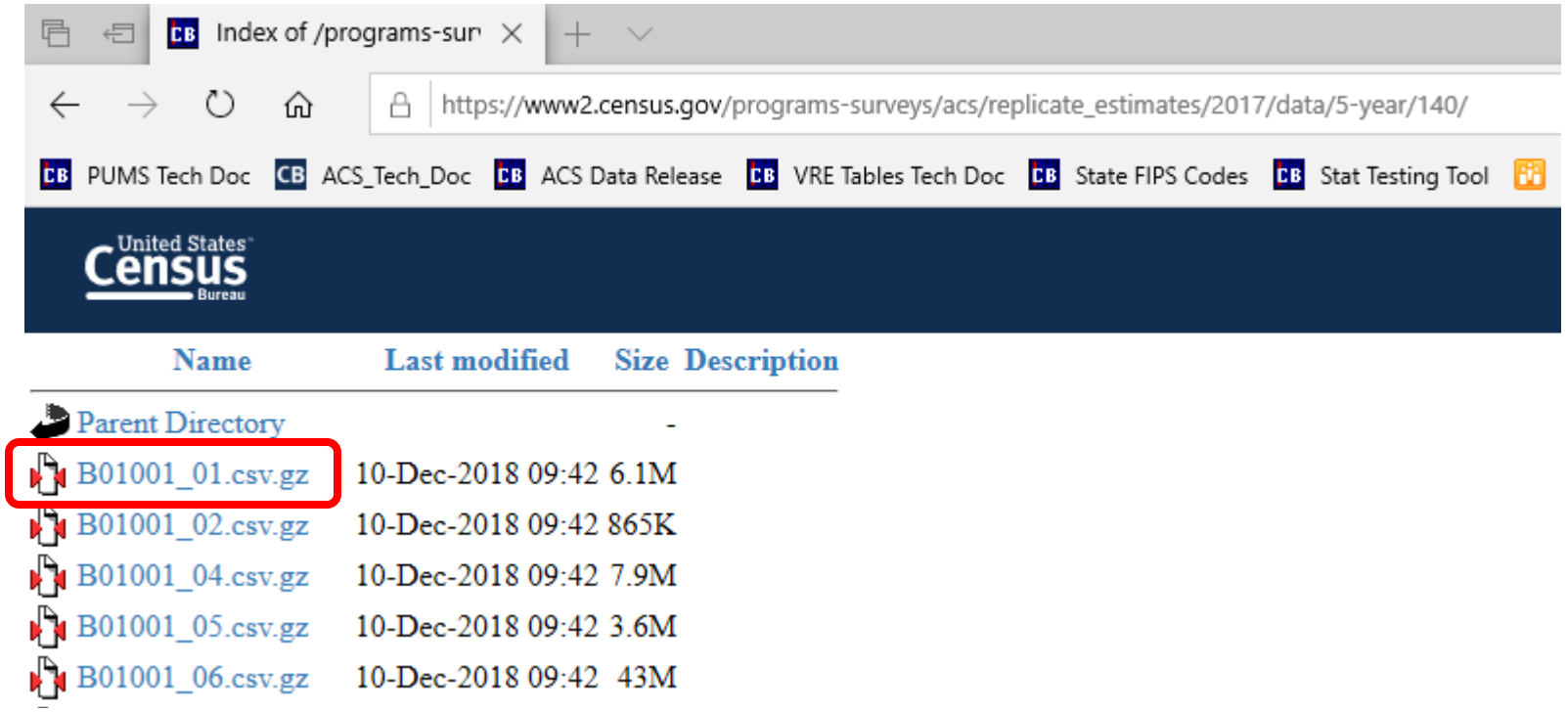
Click on "View" > "File name extensions" in the folder to see the file extension name

Click "Yes" on the Warning Message



United States Census Bureau

Tract and Block Group Tables



Tract and Block Group tables are divided by state

The format is: Table ID + "_" + State FIPS Code

For example, Alabama has a state FIPS code of 01

United States Census Bureau

State FIPS Codes

American National Standards Institute (ANSI) Codes for States

American National Standards Institute (ANSI) Codes for States, the District of Columbia, Puerto Rico, and the Insular Areas of the United States

EXPAND ALL | COLLAPSE ALL

National FIPS and GNIS Codes File

FIPS Codes for the States and District of Columbia

Name	FIPS State Numeric Code	Official USPS Code
Alabama	01	AL
Alaska	02	AK
Arizona	04	AZ
Arkansas	05	AR
California	06	CA
Colorado	08	CO
Connecticut	09	CT

State names are represented by a 2-digit state FIPS code

FIPS stands for Federal Information Processing Standards

https://www.census.gov/library/reference/code-lists/ansi/ansi-codes-for-states.html

Click on “FIPS Codes for the States and District of Columbia”

Puerto Rico has a FIPS state code of “72”

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Outline

1. Overview of the American Community Survey (ACS)
2. Variance Replicate Estimates (VRE) Tables
   - Motivation for Using the VRE Tables
   - Comparison to Detailed Tables
   - Obtaining VRE Data
   - **Worked Example**
3. Public Use Microdata Sample (PUMS)
4. Questions

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Background

- Margin of Error based on Successive Difference Replication (SDR) methodology
- Calculated using replicate estimates and is similar to Balanced Repeated Replication (BRR) and Jackknife methodology
- PUMS data uses replicate weights to calculate replicate estimates
- Can be used to calculate the variance for counts, aggregates, percentages, means, ratios, etc.

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Background

- Successive Difference Replicate Formula:

$$\text{Variance} = \frac{4}{80}\sum_{i=1}^{80}\left(\text{Var_Rep}_i - \text{Estimate}\right)^2$$

- Standard Error = $\sqrt{\text{Variance}}$
- Margin of Error = 1.645 x Standard Error

  Note: 90% two-sided confidence level margin of error

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Steps to Calculate the Margin of Error

$$\text{Variance} = \frac{4}{80}\sum_{i=1}^{80}\left(\text{Var_Rep}_i - \text{Estimate}\right)^2$$

1a. Calculate 80 Differences

1b. Square each difference

1c. Sum all of the squared differences

1d. Multiply the sum by 4/80

2. Take the square root to find the standard error (SE)

3. Multiply the SE by 1.645 to obtain the margin of error (MOE)

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Worked Example

// Search / Tables / B01001

SEX BY AGE

Survey/Program: American Community Survey **Universe:** Total population **TableID:** B01001 **Product:** 2017: ACS 5-Year Estimates Detailed Tables

Data Notes | Selections | 1 Geography | Years | Topic | Survey | Code | Hide | Filter | Sort | Transpose Table | Margin of Error | Restore Layout | Download | Print | Share

	Census Tract 1, Aleutians East Borough, Alaska	
	Estimate	Margin of Error
Total:	3,338	*****
Male:	2,049	+/-100
Under 5 years	42	+/-12
5 to 9 years	74	+/-16
10 to 14 years	88	+/-19
15 to 17 years	45	+/-14

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Worked Example

Data from VRE Table B01001_02 opened in Excel:

	A	B	C	D	E	F	G	H	I	J	K	L	M
1	TBLID	GEOID	NAME	ORDER	TITLE	estimate	moe	CME	SE	Var_Rep1	Var_Rep2	Var_Rep3	Var_Rep4
2	B01001				SEX BY AGE								
3	B01001				Universe: Total population								
9	**B01001**	**14000US02013000100**	**Census Tract 1, Aleutians East Borough, Alaska**	**6**	**15 to 17 years**	**45**	**14**	**+/-14**	**9**	**44**	**40**	**47**	**41**

Table	Sex by Age (Table ID: B01001)
Geography	Census Tract 1, Aleutians East Borough, Alaska
Characteristic	Males, age 15 to 17
Time Period	2013-2017 ACS 5-year data

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Worked Example

Step 1a: Subtract the estimate from each replicate estimate

Note: Only 4 replicate estimates shown for simplicity. You must use all 80 replicate estimates to calculate the variance.

$$\text{Variance} = \frac{4}{80}\sum_{i=1}^{80}(\mathbf{Var_Rep_i} - \mathbf{Estimate})^2$$

Steps	Estimate	Variance Replicate Estimate 1	Variance Replicate Estimate 2	Variance Replicate Estimate 3	…	Variance Replicate Estimate 80
-	45	44	40	47	…	40
Difference:	-					
Squared Difference:	-					

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Worked Example

Step 1a: Subtract the estimate from each replicate estimate

Difference for Replicate Estimate 1 = 44 – 45 = -1

$$\text{Variance} = \frac{4}{80}\sum_{i=1}^{80}(\mathbf{Var_Rep_i} - \mathbf{Estimate})^2$$

Steps	Estimate	Variance Replicate Estimate 1	Variance Replicate Estimate 2	Variance Replicate Estimate 3	…	Variance Replicate Estimate 80
-	45	44	40	47	…	40
Difference:	-	-1	-5	2	…	-5
Squared Difference:	-					

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Worked Example

Step 1b: Square Each Difference

Squared Difference for Replicate Estimate 1 = $(-1)^2 = 1$

$$Variance = \frac{4}{80}\sum_{i=1}^{80}(Var_Rep_i - Estimate)^2$$

Steps	Estimate	Variance Replicate Estimate 1	Variance Replicate Estimate 2	Variance Replicate Estimate 3	…	Variance Replicate Estimate 80
-	45	44	40	47	…	40
Difference:	-	-1	-5	2	…	-5
Squared Difference:	-	1	25	4	…	25

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Worked Example

Step 1c: Sum the squared differences

Sum 80 Squared Differences = 1 + 25 + 4 + … + 25 = 1,458

$$Variance = \frac{4}{80} \sum_{i=1}^{80} Var_Rep_i - Estimate)^2$$

Steps	Estimate	Variance Replicate Estimate 1	Variance Replicate Estimate 2	Variance Replicate Estimate 3	…	Variance Replicate Estimate 80
-	45	44	40	47	…	40
Difference:	-	-1	-5	2	…	-5
Squared Difference:	-	1	25	4	…	25

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Worked Example

Step 1d: Multiply the sum by 4/80

Variance = 4/80 x 1,458 = 72.9

$$Variance = \frac{\mathbf{4}}{\mathbf{80}} \sum_{i=1}^{80} (Var_Rep_i - Estimate)^2$$

Steps	Estimate	Variance Replicate Estimate 1	Variance Replicate Estimate 2	Variance Replicate Estimate 3	…	Variance Replicate Estimate 80
-	45	44	40	47	…	40
Difference:	-	-1	-5	2	…	-5
Squared Difference:	-	1	25	4	…	25

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Worked Example

- Step 2: Standard Error = $\sqrt{Variance}$

$$\boxed{Standard\ Error = \sqrt{72.9} = 8.538}$$

- Step 3: Margin of Error (90% confidence level) = 1.645 x Standard Error

$$Margin\ of\ Error = 1.645 \times SE = 1.645 \times \sqrt{72.9} = 14.045$$

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Worked Example

- Step 2: Standard Error = $\sqrt{Variance}$

$$Standard\ Error = \sqrt{72.9} = 8.538$$

- Step 3: Margin of Error (90% confidence level) = 1.645 x Standard Error

$$\boxed{Margin\ of\ Error = 1.645 \times SE = 1.645 \times \sqrt{72.9} = 14.045}$$

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Worked Example

$$Standard\ Error = \sqrt{72.9} = 8.538$$

$$Margin\ of\ Error = 1.645 \times \sqrt{72.9} = 14.045$$

The standard error and the margin of error match the values in the VRE table after rounding to whole numbers

	A	B	C	D	E	F	G	H	I	J	K	L	M
1	TBLID	GEOID	NAME	ORDER	TITLE	estimate	moe	CME	SE	Var_Rep1	Var_Rep2	Var_Rep3	Var_Rep4
2	B01001				SEX BY AGE								
3	B01001				Universe: Total population								
9	**B01001**	**14000US02013000100**	**Census Tract 1, Aleutians East Borough, Alaska**	**6**	**15 to 17 years**	**45**	**14**	**+/-14**	**9**	**44**	**40**	**47**	**41**

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Worked Example

- This method may be used for counts, means, ratios, percents, etc.
- You may encounter special cases (e.g. estimate is zero)
- Special cases are covered in the Technical Documentation:
  https://www.census.gov/programs-surveys/acs/technical-documentation/variance-tables.html

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Combining Multiple Estimates

1. First sum the relevant estimates and replicate estimates
2. Then use the formula and steps to calculate the margin of error

	A	B	C	D	E	F	G	H	I	J	K	L	M
1	TBLID	GEOID	NAME	ORDI	TITLE	estimate	moe	CME	SE	Var_Rep1	Var_Rep2	Var_Rep3	Var_Rep4
2	B01001				SEX BY AGE								
3	B01001				Universe: Total population								
4	B01001	14000US02013000100	Census Tract 1, Aleutians East Borough, Alaska	1	Total:	3338	0	*****	0	3338	3338	3338	3338
5	B01001	14000US02013000100	Census Tract 1, Aleutians East Borough, Alaska	2	Male:	2049	100	+/-100	61	2015	2002	2028	2087
6	B01001	14000US02013000100	Census Tract 1, Aleutians East Borough, Alaska	3	Under 5 years	42	12	+/-12	8	44	43	40	38
7	B01001	14000US02013000100	Census Tract 1, Aleutians East Borough, Alaska	4	5 to 9 years	74	16	+/-16	10	80	82	73	73
8	B01001	14000US02013000100	Census Tract 1, Aleutians East Borough, Alaska	5	10 to 14 years	88	19	+/-19	12	96	82	81	94
9	B01001	14000US02013000100	Census Tract 1, Aleutians East Borough, Alaska	6	15 to 17 years	45	14	+/-14	9	44	40	47	41

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Combining Multiple Estimates

1. Sum the relevant estimates and replicate estimates

For example:

Estimate = 42 + 74 + 88 + 45 = 249

Characteristic	Estimate	Variance Replicate Estimate 1	…	Variance Replicate Estimate 80
Under 5 years	42	44	…	40
5 to 9 years	74	80	…	80
10 to 14 years	88	96	…	84
15 to 17 years	45	44	…	40
TOTAL	**249**	**264**	**…**	**244**

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Combining Multiple Estimates

1. Sum the relevant estimates and replicate estimates

For example:

1st Replicate Estimate = 44 + 80 + 96 + 44 = 264

Characteristic	Estimate	Variance Replicate Estimate 1	…	Variance Replicate Estimate 80
Under 5 years	42	44	…	40
5 to 9 years	74	80	…	80
10 to 14 years	88	96	…	84
15 to 17 years	45	44	…	40
TOTAL	**249**	**264**	**…**	**244**

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Combining Multiple Estimates

2. Use the formula and steps to calculate the margin of error

$$\text{Variance} = \frac{4}{80}\sum_{i=1}^{80}\left(\text{Var_Rep}_i - \text{Estimate}\right)^2$$

Steps	Estimate	Variance Replicate Estimate 1	…	Variance Replicate Estimate 80
-	249	264	…	244
Difference:	-	15	…	-5
Squared Difference:	-	225	…	25

Variance = 654.4 Margin of Error = 42.1

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Combining Multiple Estimates

Use the same method when combining estimates across geographies or combining both within tables and between geographies

Example: Combine estimates for males, aged 15 to 17 from 3 tracts in Alaska

	A	B	C	D	E	F	G	H	I	J	K	L	M
1	TBLID	GEOID	NAME	ORDI	TITLE	estimate	moe	CME	SE	Var_Rep1	Var_Rep2	Var_Rep3	Var_Rep4
9	B01001	14000US02013000100	Census Tract 1, Aleutians East Borough, Alaska	6	15 to 17 years	45	14	+/-14	9	44	40	47	41
58	B01001	14000US02016000100	Census Tract 1, Aleutians West Census Area, Alaska	6	15 to 17 years	3	3	+/-3	2	3	2	3	4
07	B01001	14000US02016000200	Census Tract 2, Aleutians West Census Area, Alaska	6	15 to 17 years	62	9	+/-9	5	64	60	57	60

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2. Variance Replicate Estimates (VRE) Tables
   - Motivation for Using the VRE Tables
   - Comparison to Detailed Tables
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   - Worked Example
3. **Public Use Microdata Sample (PUMS)**
4. Questions

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Overview of PUMS

- PUMS stands for the Public Use Microdata Sample
  - Microdata file is a subsample of the full ACS records
  - Additional data disclosure measures are applied to PUMS to protect confidentiality
- PUMS allows data users to create their own estimates which may not be published on data.census.gov
- Statistical programs, such as SAS, R, or STATA are recommended to calculate PUMS estimates and MOEs

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Overview of PUMS

PUMS Data

Supporting documentation for the data below is available on the PUMS Documentation page.

Available on the FTP site	PUMS on data.census.gov
PUMS files back to 2005 are available in CSV and SAS formats	Microdata access from 2005-current is now available on data.census.gov in beta.
2018 ACS PUMS	**2014-2018 ACS 5-year PUMS**
2017 ACS PUMS	**2018 ACS 1-year PUMS**
2016 ACS PUMS	**2013-2017 ACS 5-year PUMS**

https://www.census.gov/programs-surveys/acs/data/pums.html

Data users must aggregate PUMS records to create weighted estimates

PUMS weights and replicate weights are provided

Use the replicate weights to create replicate estimates

Use the Variance formula and steps to calculate the MOE

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Overview of PUMS

PUMS Training:
https://www.census.gov/programs-surveys/acs/guidance/training-presentations/acs-intro-pums.html

PUMS Technical Documentation:
https://www.census.gov/programs-surveys/acs/technical-documentation/pums/documentation.html

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Upcoming Intro To PUMS Webinar

Introduction to the American Community Survey Public Use Microdata Sample (PUMS) Files Webinar

MARCH 11, 2020

In this webinar, we will discuss foundational aspects of working with the ACS PUMS files, including the organization of the files, the confidentiality of the files, accessing the data, geographic availability, and the PUMS documentation. We will also explore how to use new features on data.census.gov to create custom PUMS tables.

Date and Time: Wednesday, March 11th from 2:00-3:00 PM EST

Join: (Link and Dial-in information to come)

Presenter: Amanda Klimek, American Community Survey Office

Wednesday,
March 11th, 2020

2 – 3 p.m.

https://www.census.gov/programs-surveys/acs/news/events/pums-2020.html

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Calculating PUMS Percent Estimate

ST	PUMA	AGEP	PWGTP	PWGTP1
02	00400	30	5	3
02	00400	15	34	34
02	00400	9	34	33
02	00400	60	25	28
02	00200	91	79	84
02	00200	66	71	72
02	00200	45	84	147
02	00200	43	135	227

Numerator = Records for people 18 years or older

Characteristic: Percent of people who are 18 years or older

Numerator: Age >= 18
Denominator: All records

Variable	Description
ST	State
PUMA	Public Use Microdata Area
AGEP	Age
PWGTP	PUMS Person Weight
PWGTP1	First Replicate Weight

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Calculating PUMS Percent Estimate

ST	PUMA	AGEP	PWGTP	PWGTP1
02	00400	30	5	3
02	00400	15	34	34
02	00400	9	34	33
02	00400	60	25	28
02	00200	91	79	84
02	00200	66	71	72
02	00200	45	84	147
02	00200	43	135	227

Numerator: 399

Numerator = Sum the relevant PUMS Weights

Only sum records where age >= 18

AGEP = Age
PWGTP = PUMS Weight

Numerator =
5 + 25 + 79 + 71 + 84 + 135 =
399

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Calculating PUMS Percent Estimate

ST	PUMA	AGEP	PWGTP	PWGTP1
02	00400	30	5	3
02	00400	15	34	34
02	00400	9	34	33
02	00400	60	25	28
02	00200	91	79	84
02	00200	66	71	72
02	00200	45	84	147
02	00200	43	135	227

Denominator: 467

Denominator = Sum the relevant PUMS Weights

Sum all records

AGEP = Age
PWGTP = PUMS Weight

Denominator =
5 + 34 + 34 + 25 + 79 +
71 + 84 + 135 =
467

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Calculating PUMS Percent Estimate

	Estimate	Replicate Estimate 1	Replicate Estimate 2	…	Replicate Estimate 80
Numerator	399				
Denominator	467				
Percent	**85.439**				

Percent = (numerator / denominator) x 100 = (399 / 467) x 100 = 85.4%

Calculate margin of error:

1 Calculate 80 replicate percents
2 Use variance formula to calculate the MOE

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Calculating PUMS Replicate Percent Estimates

ST	PUMA	AGEP	PWGTP	PWGTP1
02	00400	30	5	3
02	00400	15	34	34
02	00400	9	34	33
02	00400	60	25	28
02	00200	91	79	84
02	00200	66	71	72
02	00200	45	84	147
02	00200	43	135	227

1st Replicate Numerator: 561

Calculate the replicate numerator and replicate denominator

Use the 1st replicate weight, PWGTP1

First replicate numerator =
3 + 28 + 84 + 72 + 147 + 227 = 561

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Calculating PUMS Replicate Percent Estimates

ST	PUMA	AGEP	PWGTP	PWGTP1
02	00400	30	5	3
02	00400	15	34	34
02	00400	9	34	33
02	00400	60	25	28
02	00200	91	79	84
02	00200	66	71	72
02	00200	45	84	147
02	00200	43	135	227

1st Replicate Denominator: 628

For the 1st replicate denominator, sum all records

Use the 1st replicate weight, PWGT1

First replicate denominator =
3 + 34 + 33 + 28 + 84 + 72 + 147 + 227 =
628

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Calculating PUMS Replicate Percent Estimates

	Estimate	Replicate Estimate 1	Replicate Estimate 2	…	Replicate Estimate 80
Numerator	399	561			
Denominator	467	628			
Percent	**85.439**	**89.331**			

Calculate the replicate percent using the replicate numerator and denominator.

Replicate Percent = (replicate numerator / replicate denominator) * 100
First replicate percent = (561 / 628) x 100 = 89.3%

Calculate 80 replicate percents and use SDR formula to calculate the MOE

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Calculating PUMS Replicate Percent Estimates

	Estimate	Replicate Estimate 1	Replicate Estimate 2	…	Replicate Estimate 80
Numerator	399	561	271	…	210
Denominator	467	628	366	…	230
Percent	**85.439**	**89.331**	**74.044**	**…**	**91.304**

Calculate the margin of error (MOE):

1a. Calculate 80 Differences
1b. Square each difference
1c. Sum all of the squared differences
1d. Multiply the sum by 4/80 to get the variance
2. Take the square root of the variance
3. Multiply by 1.645 to obtain the 90% confidence level MOE

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Calculating the Percent Margin of Error

Step	Estimate	Variance Replicate Estimate 1	Variance Replicate Estimate 2	…	Variance Replicate Estimate 80
Estimate	85.439	89.331	74.044	…	91.304
Difference:	-	3.892	-11.395	…	5.865
Squared Difference:	-	15.150	129.852	…	34.403

SUM	= 15.150 + 129.852 + … + 34.403	=	5,019.220
Variance	= 4/80 x 5019.220	=	250.961
SE	= $\sqrt{250.961}$	=	15.842
MOE	= 1.645 x 15.842	=	26.060

Percent = 85.4 +/- 26.1

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Calculating Other Types of Estimates

- You can use the variance formula to calculate other types of estimates using the PUMS microdata
- For example: means, medians, ratios, etc.
- For a ratio
  - Calculate the ratio estimate
  - Calculate 80 replicate ratios
  - Use the variance formula
  - Calculate the margin of error for the ratio

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References

- Design and Methodology document

  See Chapter 12 on Variance Estimation

  https://www.census.gov/programs-surveys/acs/methodology/design-and-methodology.html

- Fay and Train Paper

  "Aspects of Survey and Model-Based Postcensal Estimation of Income and Poverty Characteristics for States and Counties"

  https://www.census.gov/content/dam/Census/library/working-papers/1995/demo/faytrain95.pdf

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References

- ACS Handbook

Understanding and Using American Community Survey Data: What All Data Users Need to Know

See Chapter 7 for more information on sampling error

https://www.census.gov/programs-surveys/acs/guidance/handbooks/general.html

- Other ACS Handbooks

https://www.census.gov/programs-surveys/acs/guidance/handbooks.html

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References

- PUMS Training

  Introduction to the Public Use Microdata Sample (PUMS) File

  https://www.census.gov/programs-surveys/acs/guidance/training-presentations/acs-intro-pums.html

- PUMS Technical Documentation page

  https://www.census.gov/programs-surveys/acs/technical-documentation/pums/documentation.html

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AMERICAN COMMUNITY SURVEY DATA USERS GROUP

- Purpose:
  - Improve understanding of the value and utility of ACS data.
  - Promote information sharing among data users about key ACS data issues and applications
- Membership is free and open to all interested ACS data users
- Presentations and recordings from past conferences available
- Webinars and special sessions at professional meetings planned
- Users group website and online community

https://acsdatacommunity.prb.org/

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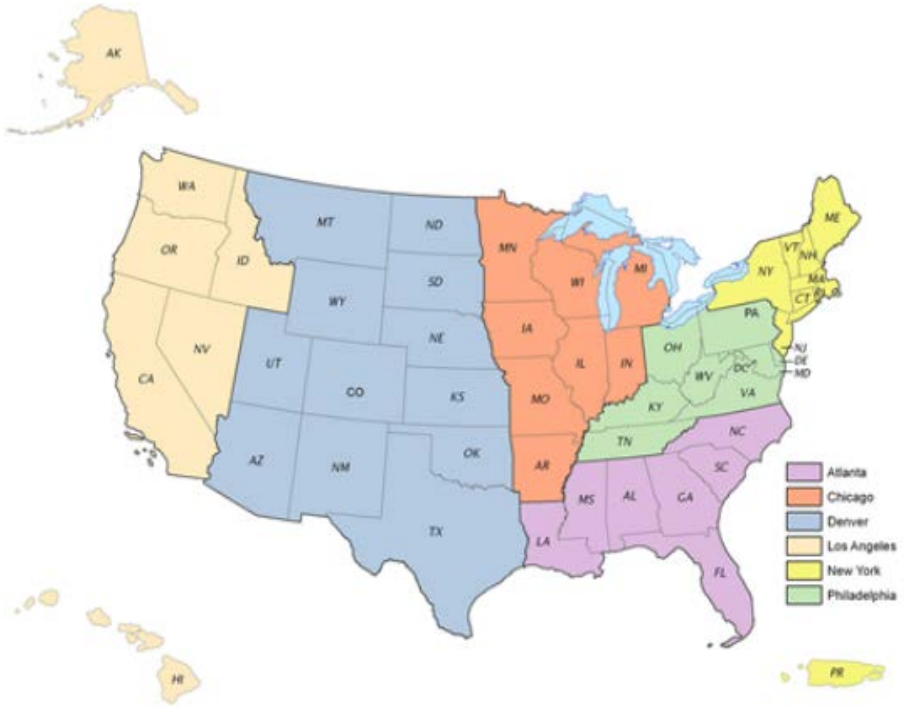
Need Local Stats or Training?

- Assistance Near You!
  Our regional data staff can help you access local statistics from the ACS or offer training to help build your skills.
- Contact us at:

  1-844-ASK-DATA

  (1-844-275-3282)

  census.askdata@census.gov



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https://public.govdelivery.com/accounts/USCENSUS/subscriber/new

Social media: @uscensusbureau
#ACSdata

More information online:
census.gov/acs/

acso.users.support@census.gov

Census Customer Service Center
800-923-8282

Source Us:

U.S. Census Bureau's [YYYY – YYYY] American Community Survey
[1/3/5]-year [estimates/statistics/data release]

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Questions?

Email: acso.users.support@census.gov

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