



Empirical Bayes Shrinkage Estimates of State Supplemental Nutrition Assistance Program Participation Rates in Fiscal Year 2017 to Fiscal Year 2019 for All Eligible People and Working Poor People



February 2023

Non-Discrimination Statement

In accordance with Federal civil rights law and U.S. Department of Agriculture (USDA) civil rights regulations and policies, the USDA, its Agencies, offices, and employees, and institutions participating in or administering USDA programs are prohibited from discriminating based on race, color, national origin, religion, sex, gender identity (including gender expression), sexual orientation, disability, age, marital status, family/parental status, income derived from a public assistance program, political beliefs, or reprisal or retaliation for prior civil rights activity, in any program or activity conducted or funded by USDA (not all bases apply to all programs). Remedies and complaint filing deadlines vary by program or incident.

Persons with disabilities who require alternative means of communication for program information (e.g., Braille, large print, audiotape, American Sign Language, etc.) should contact the responsible Agency or USDA's TARGET Center at (202) 720-2600 (voice and TTY) or contact USDA through the Federal Relay Service at (800) 877-8339. Additionally, program information may be made available in languages other than English.

To file a program discrimination complaint, complete the USDA Program Discrimination Complaint Form, AD-3027, found online at [How to File a Program Discrimination Complaint](#) and at any USDA office or write a letter addressed to USDA and provide in the letter all of the information requested in the form. To request a copy of the complaint form, call (866) 632-9992. Submit your completed form or letter to USDA by: (1) mail: U.S. Department of Agriculture, Office of the Assistant Secretary for Civil Rights, 1400 Independence Avenue, SW, Washington, D.C. 20250-9410; (2) fax: (202) 690-7442; or (3) email: program.intake@usda.gov.

USDA is an equal opportunity provider, employer, and lender.



Empirical Bayes Shrinkage Estimates of State Supplemental Nutrition Assistance Program Participation Rates in Fiscal Year 2017 to Fiscal Year 2019 for All Eligible People and Working Poor People

February 2023

Karen Cunnynggham, Mathematica

Submitted to:

U.S. Department of Agriculture
Food Nutrition Service
1320 Braddock Place
Alexandria, VA 22314
Project Officer: Kameron Burt
Contract Number: 12-3198-21-F-0034

Submitted by:

Mathematica
1100 1st Street, NE, 12th Floor
Washington, DC 20002-4221
Telephone: (202) 484-9220
Project Director: Joshua Leftin
Reference Number: 51213.700

Suggested citation

Cunnynggham, Karen. "Empirical Bayes Shrinkage Estimates of State Supplemental Nutrition Assistance Program Participation Rates in Fiscal Year 2017 to Fiscal Year 2019 for All Eligible People and Working Poor People." Prepared by Mathematica, Contract No. 12-3198-21-F-0034. Alexandria, VA: U.S. Department of Agriculture, Food and Nutrition Service, Office of Policy Support, February 2023.

Disclaimer

The findings and conclusions in this report are those of the authors and should not be construed to represent any official USDA or U.S. Government determination or policy.

This page has been left blank for double-sided copying.

Acknowledgements

This report was prepared by Karen Cunnynggham of Mathematica for the U.S. Department of Agriculture's Food and Nutrition Service (FNS), Office of Policy Support. Allen Schirm, Laura Castner, and Amang Sukasih made substantial contributions to previous reports in this series. The author thanks Joshua Leftin, Francisco Yang, and Sharon Clark from Mathematica for their contributions to this report and Kameron Burt from FNS for providing guidance and review.

This page has been left blank for double-sided copying.

Contents

Executive Summary	ix
I. Introduction	1
II. A Step-by-Step Guide to Deriving State Estimates.....	7
A. From CPS ASEC data and SNAP administrative data, derive direct estimates of State SNAP participation rates	7
B. Using a regression model, predict State SNAP participation rates based on administrative, ACS, and other data	7
C. Using shrinkage methods, average the direct estimates and regression predictions to obtain preliminary shrinkage estimates of State SNAP participation rates.....	9
D. Adjust the preliminary shrinkage estimates to obtain final shrinkage estimates of State SNAP participation rates and numbers of eligible people	9
III. State Estimates of SNAP Participation Rates and Number of Eligible People	11
References	21
Appendix A The Estimation Procedure: Additional Technical Details	23
Appendix B Data for Figures in Cunningham 2022.....	65

Tables

III.1. Final shrinkage estimates of SNAP participation rates.....	12
III.2. Final shrinkage estimates of number of people eligible for SNAP	13
III.3. Approximate 90 percent confidence intervals for final shrinkage estimates for FY 2017, all eligible people	14
III.4. Approximate 90 percent confidence intervals for final shrinkage estimates for FY 2018, all eligible people	15
III.5. Approximate 90 percent confidence intervals for final shrinkage estimates for FY 2019, all eligible people	16
III.6. Approximate 90 percent confidence intervals for final shrinkage estimates for FY 2017, working poor people	17
III.7. Approximate 90 percent confidence intervals for final shrinkage estimates for FY 2018, working poor people	18
III.8. Approximate 90 percent confidence intervals for final shrinkage estimates for FY 2019, working poor people	19

A.1.	Number of people receiving SNAP benefits, monthly average	38
A.2.	Estimated percentage of participants who are correctly receiving benefits and eligible under federal SNAP rules	39
A.3.	Estimated number of participants who are correctly receiving benefits and income eligible under federal SNAP rules, monthly average.....	40
A.4.	Estimated number of working poor participants who are correctly receiving benefits and eligible under federal SNAP rules, monthly average.....	41
A.5.	Estimated percentage of people eligible for SNAP	42
A.6.	Directly estimated number of people eligible for SNAP	43
A.7.	Directly estimated number of working poor people eligible for SNAP.....	44
A.8.	CPS ASEC population estimate.....	45
A.9.	Population on July 1	46
A.10.	Percentage of working poor participants without reported earned income but with other indicators of earnings	47
A.11.	Direct estimates of SNAP participation rates	48
A.12.	Standard errors of direct estimates of SNAP participation rates.....	49
A.13.	Potential predictors.....	50
A.14.	Predictors in current model.....	51
A.15.	Values for FY 2017 predictors	52
A.16.	Values for FY 2018 predictors	53
A.17.	Values for FY 2019 predictors	54
A.18.	Regression estimates of SNAP participation rates.....	55
A.19.	Standard errors of regression estimates of SNAP participation rates.....	56
A.20.	Preliminary shrinkage estimates of SNAP participation rates.....	57
A.21.	Final shrinkage estimates of SNAP participation rates.....	58
A.22.	Standard errors of final shrinkage estimates of SNAP participation rates	59
A.23.	Final shrinkage estimates of number of people eligible for SNAP	60
A.24.	Final shrinkage estimates of number of working poor people eligible for SNAP.....	61
A.25.	Standard errors of final shrinkage estimates of number of people eligible for SNAP	62
A.26.	Standard errors of final shrinkage estimates of number of working poor people eligible for SNAP	63

B.1a.	How many people were eligible in 2019? What percentage participated? (States)	67
B.1b.	How many people were eligible in 2019? What percentage participated? (Regions and national)	68
B.2a.	How many working poor people were eligible in 2019? What percentage participated? (States)	69
B.2b.	How many working poor people were eligible in 2019? What percentage participated? (Regions and national)	70
B.3a.	Estimates of participation rates (State percentage)	71
B.3b.	Estimates of participation rates (Regional and national percentage).....	72
B.4.	How did your State rank in 2019?	73
B.5a.	How did your State compare with other States in 2019 for all eligible people? (Illinois to Ohio)	74
B.5b.	How did your State compare with other States in 2019 for all eligible people? (Michigan to New Jersey)	75
B.5c.	How did your State compare with other States in 2019 for all eligible people? (Minnesota to Wyoming).....	76
B.6.	Estimates of participation rates varied widely	77
B.7.	Supporting detail for Cunnyngnam (2022)	78

Exhibits

I.1.	An illustrative regression estimator	3
I.2.	Shrinkage estimation	5
II.1.	The estimation procedure	8
A.1.	Algorithm to identify working poor participants.....	26
A.2.	Direct estimates of national totals and adjustment factors	35
A.3.	Estimated participation rates over 100 percent	36

This page has been left blank for double-sided copying.

Executive Summary

The Supplemental Nutrition Assistance Program (SNAP) provides nutrition assistance to eligible, low-income individuals and households in need. SNAP is the largest of the domestic nutrition assistance programs administered by the Food and Nutrition Service (FNS) of the U.S. Department of Agriculture (USDA). During fiscal year 2021, the program served over 41 million people in an average month at a total annual cost of over \$108 billion in benefits.

This report presents estimates of the program's effectiveness at reaching its target population in each State and the District of Columbia for fiscal years 2017 to 2019. The program's effective reach is measured by estimated SNAP participation rates. In addition to estimates that pertain to all eligible people, we derived estimates for "working poor" people—that is, people who were eligible for SNAP and lived in households in which someone earned income from a job.

The estimates for all eligible people and for working poor people were derived jointly using empirical Bayes shrinkage estimation methods and data from the Current Population Survey Annual Social and Economic Supplement (CPS ASEC), the American Community Survey (ACS), and administrative records. The shrinkage estimator averaged direct estimates of participation rates in each State with predictions from a regression model. The regression predictions were based on observed indicators of socioeconomic conditions in the States, such as the percentage of the total State population receiving SNAP benefits. Shrinkage estimators improve precision by "borrowing strength," that is, by using data for multiple years from all the States to derive each State's estimates for a given year and by using data from multiple sources, including sample surveys and administrative data. On average, 90 percent shrinkage confidence intervals for fiscal year 2019 participation rates for all eligible people were 43 percent narrower than the corresponding direct confidence intervals. This report describes our shrinkage estimator in detail.

Final shrinkage estimates for fiscal year 2017 and fiscal year 2018 presented in this report differ slightly from the estimates presented in Cunyningham (2021a) and Cunyningham (2021b) because of annual data updates. As a result, the estimates presented in this report should not be compared to those published in earlier reports.

This page has been left blank for double-sided copying.

I. Introduction

The Supplemental Nutrition Assistance Program (SNAP) provides nutrition assistance to eligible, low-income individuals and households in need. SNAP is the largest of the domestic nutrition assistance programs administered by the Food and Nutrition Service (FNS) of the U.S. Department of Agriculture (USDA). During fiscal year (FY) 2021, the program served over 41 million people in an average month at a total annual cost of over \$108 billion in benefits.

This report presents estimates that measure the program’s effectiveness at reaching its target population in each State and the District of Columbia for FY 2017 to FY 2019. The estimates presented here are also reported and compared with one another in Cunyningham (2022). The program’s effective reach is measured by estimated SNAP participation rates—the percentage of eligible people who actually participate in the program. In addition to presenting estimates that pertain to all eligible people, we present estimates for “working poor” people, meaning people who are eligible for SNAP and live in households in which someone earned income from a job or self-employment.

We derived estimates for all eligible people and working poor people for each State in each of the three fiscal years using empirical Bayes shrinkage estimation methods. Specifically, we used a shrinkage estimator that optimally averaged direct estimates of SNAP participation rates with predictions from a regression model. We obtained the direct estimates by applying SNAP eligibility rules to households in the Current Population Survey Annual Social and Economic Supplement (CPS ASEC) to estimate numbers of eligible people and using SNAP Quality Control (QC) data to estimate numbers of participating people. The regression predictions drew on data from the American Community Survey (ACS), individual tax returns, population estimates, and administrative records. The remainder of this introductory chapter provides an overview of indirect estimation and our shrinkage estimator. Chapter II describes, step by step, how we derived the shrinkage estimates presented here, and Chapter III presents State estimates for all eligible people and working poor people. Technical details and additional information about our estimation methods are provided in Appendix A. Appendix B contains data for the figures presented in Cunyningham (2022).

U.S. Census Bureau Data

The **Current Population Survey** is conducted monthly for the Bureau of Labor Statistics and is the primary source of current information on the labor force characteristics of the U.S. population. The CPS Annual Social and Economic Supplement includes additional data on work experience, income, and noncash benefits, and has a sample size of just under 100,000 households.

The **American Community Survey** is conducted monthly in every county, American Indian and Alaska Native Area, Hawaiian Home Land, and in Puerto Rico. Designed to replace the decennial census long form, it collects economic, social, demographic, and housing information on about 3 million households annually.

The Census Bureau develops annual **population estimates** using decennial census population estimates along with administrative records and other data on births, deaths, net domestic migration, and net international migration.

More information on these data sources is available at <http://www.census.gov>. ▲

Direct estimates. The principal challenge in deriving State estimates like those presented in this report is the small sample size of the CPS ASEC. The optimal survey for estimating State SNAP eligibility would (1) have a large sample for all States, (2) be representative at the State level, and (3) contain the detail on

household relationships and income sources needed to estimate program eligibility. Among the three leading surveys, the CPS ASEC comes closest to meeting these standards despite its small sample sizes for most States. Another national household survey, the Survey of Income and Program Participation, contains more detail on relationships and income than the CPS ASEC but is not representative at the State level (and has even smaller State samples than the CPS ASEC). The third candidate, the ACS, is much larger than the CPS ASEC but has fewer details on relationships and income sources. Additionally, unlike the CPS ASEC's fixed reference period of the prior calendar year for all households, the ACS reference period is the prior 12 months and therefore varies across households by up to a year, depending on when respondents complete the survey. For these reasons, we use the CPS ASEC to estimate SNAP eligibility.

However, estimates of SNAP eligibility and participation rates based only on the CPS ASEC sample for the State and time period in question, or “direct” estimates, are imprecise for many States. For example, to directly estimate New Jersey's FY 2019 SNAP participation rate, we used only FY 2019 CPS ASEC data on households from New Jersey. Because of the potential errors introduced by the CPS ASEC surveying a small number of families in New Jersey, we can be confident—by a commonly used standard—only that New Jersey's SNAP participation rate in FY 2019 was between about 72 and 91 percent. This range is wide, although typical, reflecting our substantial uncertainty about what New Jersey's participation rate actually was.

Indirect estimators. To improve precision, statisticians have developed indirect estimators, which borrow strength by using data from additional States, time periods, or data sources. The assumption underlying indirect estimation is that what happened in other States and in other years is relevant to estimating what happened in a particular State in a particular year.

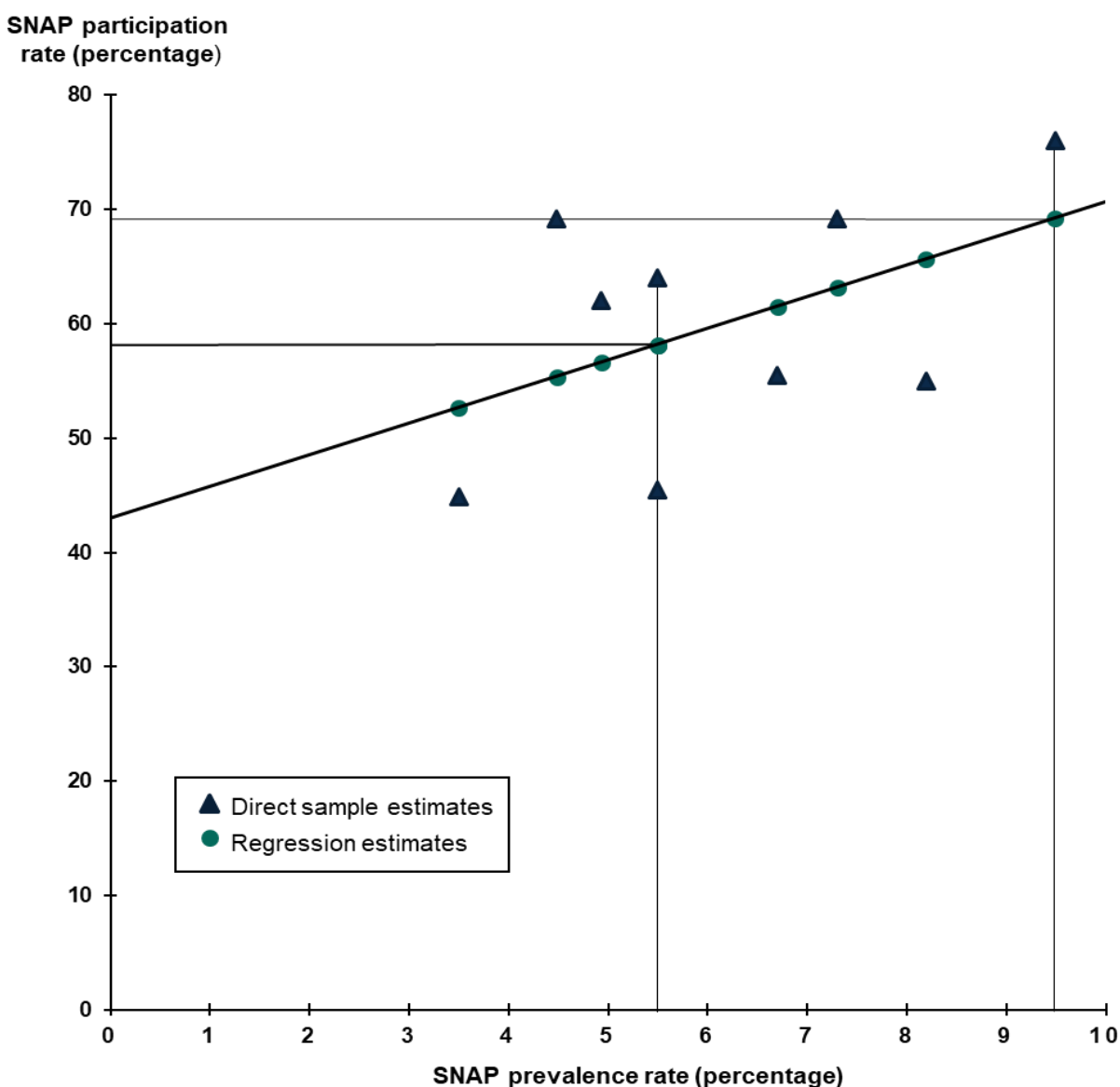
One type of indirect estimator is the shrinkage estimator, which averages estimates obtained from different methods. In an early application of shrinkage methods, Fay and Herriott (1979) developed a shrinkage estimator that combined direct sample and regression estimates of per capita income for small places that were used to allocate funds under the General Revenue Sharing Program. For FNS, Schirm and DiCarlo (1998) developed a shrinkage estimator to derive estimates of State participation rates for the Food Stamp Program (the previous name for SNAP) and found that the shrinkage estimates were substantially more precise than the corresponding direct estimates—the shrinkage 90 percent confidence intervals were, on average, about 64 percent as wide as (or 46 percent narrower than) the corresponding sample confidence intervals. FNS has been publishing annual estimates of State Food Stamp Program/SNAP participation rates since Schirm (2000) estimated rates for September 1997.

Regression estimates. The first step of our shrinkage estimator is to use data from outside the CPS ASEC to estimate a regression model and formulate a prediction for each group (all eligible people and working poor people) in each State in each year.

Regression estimates are predictions based either on nonsample or on highly precise sample data. Exhibit I.1 illustrates how a regression estimator works. The simple example in the exhibit has only nine States and data for just one year on one predictor—the SNAP “prevalence” rate—that will be used to predict each State's SNAP participation rate for eligible people. The SNAP prevalence rate is the percentage of all people (eligible and ineligible combined) who received SNAP benefits, in contrast to the SNAP participation rate, which is the percentage of eligible people who received SNAP benefits. The triangles in the exhibit correspond to direct sample estimates; a triangle shows the prevalence rate in a State (horizontal axis) and the sample estimate of the participation rate in that State (vertical axis).

Not surprisingly, the graph suggests that prevalence and participation rates are systematically associated. States with higher percentages of all people participating in the program tend to have higher percentages of eligible people participating, although the relationship is far from perfect. To measure this relationship between prevalence and participation rates and derive predictions, we can use a technique called “least squares regression” to draw a line through the triangles. Regression estimates of participation rates are points on that line, the circles in Exhibit I.1. The predicted participation rate for a particular State is obtained by moving up or down from the State’s direct sample estimate (the triangle) to the regression line (where there is a circle) and reading the value from the vertical axis. For example, the regression estimator predicts a participation rate of just under 60 percent for both States with prevalence rates of about 5.5 percent. In contrast, for the State with about 9.5 percent of people receiving SNAP benefits, the predicted participation rate is nearly 70 percent.

Exhibit I.1. An illustrative regression estimator



Comparison of direct and regression estimators. A comparison of how the direct and regression estimators use data illustrates how the regression estimator borrows strength to improve precision. Using New Jersey as an example again, we used only one year of CPS ASEC sample data from the State to estimate New Jersey's participation rate in that year. To derive regression estimates, we estimated a regression line from sample, administrative, and ACS data for multiple years and all the States and used the estimated line (with administrative and ACS data for New Jersey) to predict New Jersey's participation rate in a given year. In other words, the regression estimator not only uses the direct estimates from every State for multiple years to develop a regression estimate for a single State in a single year but also incorporates data from outside the sample—namely, data in administrative records systems and the ACS. To improve precision even further, the estimator borrows strength across groups—all eligible people and working poor people—by deriving estimates for the groups jointly.

The regression estimator can improve precision by using additional data to identify States with direct estimates that seem too high or too low because of sampling error (error from drawing a sample of the population that has a higher or lower participation rate than the entire State population has). For example, when a State has a low SNAP prevalence rate and values for other predictors that are consistent with a low SNAP participation rate, our regression estimator will predict a low participation rate for that State. If the direct estimate for that State is high, the regression estimate will be lower than the direct estimate. On the other hand, if the sample data for a State show a lower participation rate than expected in light of the SNAP prevalence rate and the other predictors, the regression estimate for that State will be higher than the direct estimate.

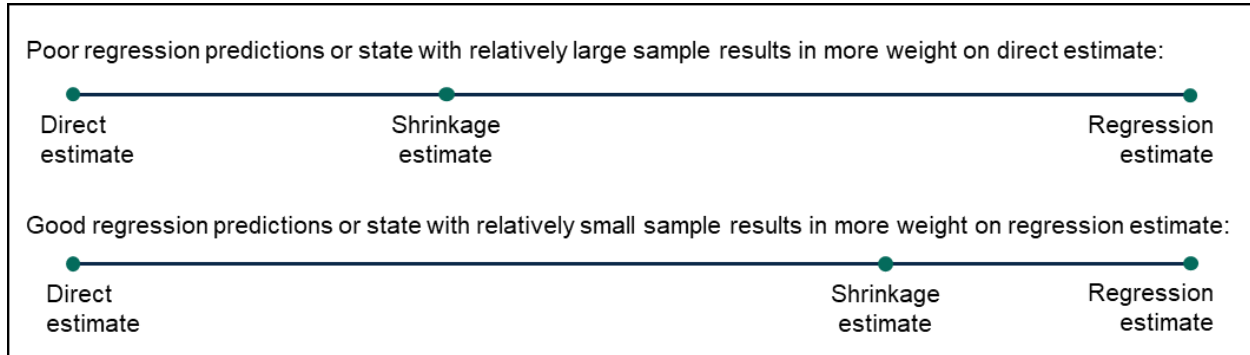
A limitation of the regression estimator is “bias.” Some States actually have higher or lower participation rates than predicted with the regression estimator. Such errors in regression estimates reflect bias. Although the regression estimator borrows strength, using data from all the States and multiple years as well as administrative and ACS data, it makes no further use of the sample data after estimating the regression line. It treats the entire difference between the sample and regression estimates as sampling error (that is, error in the direct estimate). No allowance is made for prediction error (that is, error in the regression estimate). Although not all, if any, true State participation rates lie on the regression line, the assumption underlying the regression estimator is that they do.

Shrinkage estimator. The shrinkage estimator strikes a compromise between the limitations of the direct estimator (imprecision) and the regression estimator (bias) by combining the two estimates. As illustrated in Exhibit I.2, the shrinkage estimator takes a weighted average of the direct and regression estimates, weighting them according to their relative precision. When the direct estimate is more precise than the regression estimate, the estimator gives more weight to the direct estimate. On the other hand, when the regression estimate is more precise than the direct estimate, the estimator gives more weight to the regression estimate. The larger samples drawn in large States support more-precise direct estimates, so shrinkage estimates tend to be closer to the direct estimates for large States. The weight given to the regression estimate depends on how well the regression line “fits.” If we find good predictors reflecting why some States have higher participation rates than other States, we say that the regression line “fits well.” The shrinkage estimate will be closer to the regression estimate when the regression line fits well than when the line fits poorly (See Appendix A for a description of the methods used to produce the estimates in this report.)

The direct and regression estimates are optimally weighted to improve accuracy by minimizing a measure of error that reflects both imprecision and bias. By accepting a little bias, the shrinkage estimator may be substantially more precise than the direct sample estimator. By sacrificing a little precision, the shrinkage

estimator may be substantially less biased than the regression estimator. The shrinkage estimator optimizes the trade-off between imprecision and bias.

Exhibit I.2. Shrinkage estimation



This page has been left blank for double-sided copying.

II. A Step-by-Step Guide to Deriving State Estimates

This chapter describes our procedure for estimating State SNAP participation rates for all eligible people and working poor people and the numbers of people eligible for SNAP benefits for FY 2017 to FY 2019. This procedure, summarized by the flowchart in Exhibit II.1, has the following four steps:

1. From CPS ASEC data, SNAP administrative data, and population estimates, derive direct estimates of State SNAP participation rates.
2. Using a regression model and the direct estimates derived in Step 1, predict State SNAP participation rates based on SNAP administrative, individual income tax, and ACS data and population estimates.
3. Using a shrinkage estimator, average the direct estimates from Step 1 and the regression predictions from Step 2 to obtain preliminary shrinkage estimates of State SNAP participation rates.
4. Adjust the preliminary shrinkage estimates from Step 3 using national estimates of eligible people derived from the CPS ASEC to obtain final shrinkage estimates of State SNAP participation rates.

Each step is described in the remainder of this chapter. Additional technical details are provided in Appendix A.

A. From CPS ASEC data and SNAP administrative data, derive direct estimates of State SNAP participation rates

A SNAP participation rate is obtained by dividing an estimate of the number of people participating in SNAP by an estimate of the number of people eligible for SNAP, with the resulting ratio expressed as a percentage. We used SNAP QC data to estimate numbers of participants in an average month in the fiscal year and CPS ASEC data to estimate numbers of eligible people in an average month. Because the CPS ASEC collects income data for the prior calendar year, we obtained estimates of eligible people in FY 2019 (October 2018 through September 2019) from the 2019 and 2020 CPS ASEC. To derive a participation rate for working poor people, we divided the number of working poor participants by the number of eligible working poor people. Appendix A presents direct estimates and their standard errors for each group (all eligible people and working poor people) in each State for each of the three fiscal years.

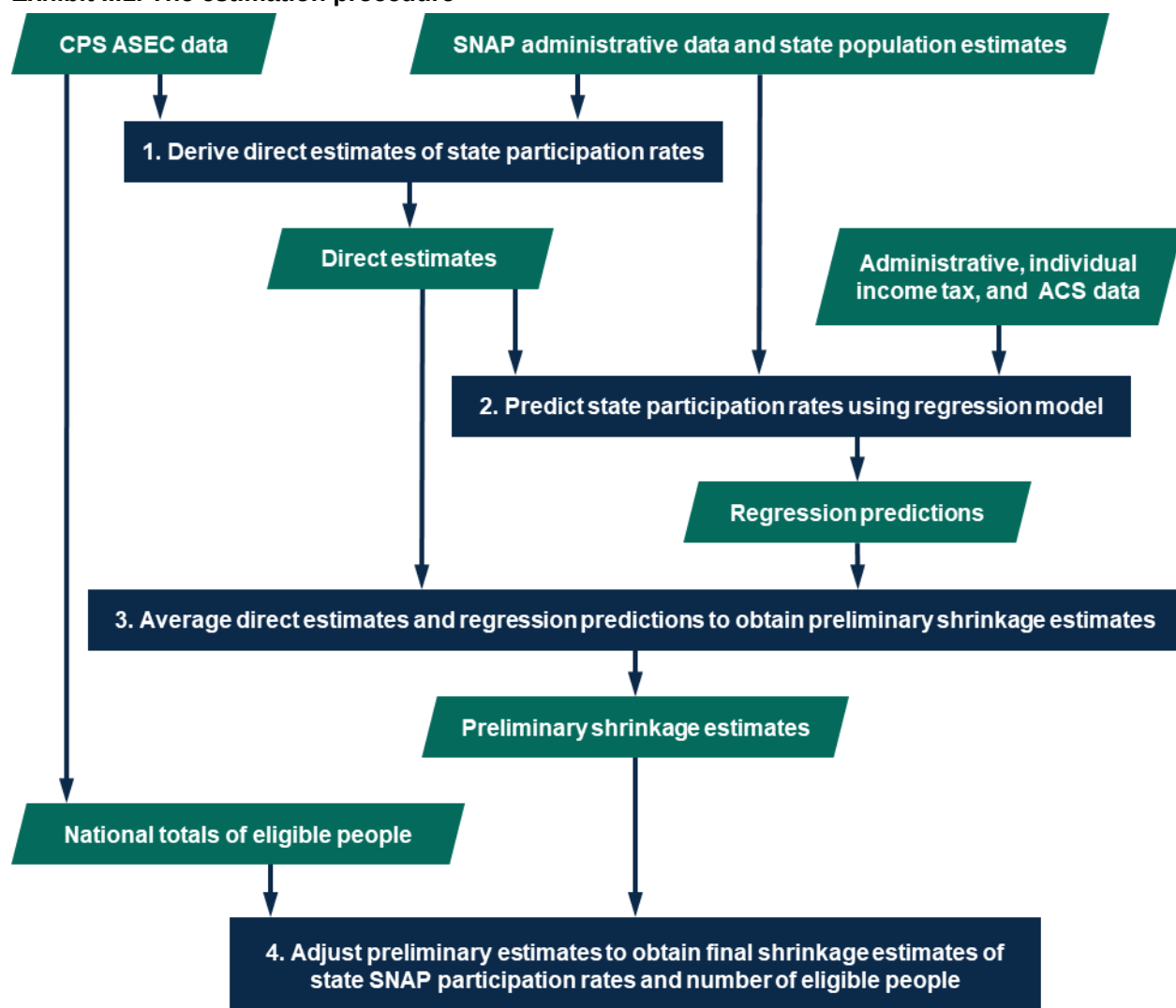
B. Using a regression model, predict State SNAP participation rates based on administrative, ACS, and other data

To derive regression estimates for the three fiscal years and for all eligible people and working poor people, we included all States, not just nine as in our illustrative example in Chapter 1, and we used seven predictors, not just one. The seven predictors used for the estimates in this report measure the following:

1. Percentage of the population receiving SNAP benefits according to administrative data and population estimates
2. Percentage of children under age 18 with household income under 50 percent of the federal poverty level according to American Community Survey (ACS) one-year estimates
3. Percentage of people age 25 and older who have completed a bachelor's degree according to ACS one-year estimates

4. Percentage of individuals age 18 to 64 with household income under 100 percent of the federal poverty level according to ACS one-year estimates
5. Percentage of individuals age 65 and older with household income under 125 percent of the federal poverty level according to ACS one-year estimates
6. Percentage of the civilian employed population over age 16 who are private wage and salary workers according to ACS one-year estimates
7. Percentage of all individuals not claimed on tax returns or claimed on tax returns with adjusted gross income under the federal poverty level according to individual income tax data and population estimates

Exhibit II.1. The estimation procedure



CPS ASEC = Current Population Survey Annual Social and Economic Supplement; ACS = American Community Survey; SNAP = Supplemental Nutrition Assistance Program.

These seven predictors were selected as the best from a longer list described in Table A.13, which provides complete definitions and sources for the predictors. All but the fourth predictor—the percentage

of individuals age 18 to 64 with household income under 100 percent of the federal poverty level according to ACS one-year estimates—were included in the previous model. The predictor used in the previous model but not the current one is the percentage of households with earnings according to ACS one-year estimates.

The regression equations do not express causal relationships. Rather, they imply only statistical associations. For this reason, predictors are often called “symptomatic indicators.” They are symptomatic of differences among States in conditions associated with having higher or lower participation rates.

Appendix A presents the regression estimates and their standard errors. The standard errors tend to be fairly equal across the States and much smaller than the largest standard errors for direct estimates, reflecting substantial gains in precision from regression for the States with the most error-prone direct estimates.

C. Using shrinkage methods, average the direct estimates and regression predictions to obtain preliminary shrinkage estimates of State SNAP participation rates

To derive preliminary estimates of State SNAP participation rates, we averaged the direct estimates calculated in Step 1 and the regression predictions from Step 2 using an empirical Bayes shrinkage estimator. (See Appendix A for a description of the empirical Bayes methods we used.) We call the estimates from this step “preliminary” because we make some adjustments to them in the next step. Appendix A presents the preliminary shrinkage estimates of State SNAP participation rates for all eligible people and working poor people for all three fiscal years.

D. Adjust the preliminary shrinkage estimates to obtain final shrinkage estimates of State SNAP participation rates and numbers of eligible people

We adjusted the preliminary shrinkage estimates of participation rates in two ways. First, we adjusted the rates so that the counts of eligible people implied by the rates sum to the national count of eligible people estimated directly from the CPS ASEC. Second, we adjusted the rates so that no State’s estimated rate was greater than 100 percent. These adjustments were carried out separately for each year and for the two groups (all eligible people and working poor people). The following description of the adjustments will focus on the FY 2019 estimates for all eligible people. In Appendix A, we describe the results of the adjustments for other years and for working poor people and discuss our adjustment method in more detail.

To implement the first adjustment, we calculated preliminary estimates of the numbers of eligible people from the preliminary estimates of participation rates derived in Step 3 and the administrative estimates of the numbers of SNAP participants obtained in Step 1. For FY 2019, the State estimates of eligible people summed to 42,593,713, whereas the national total estimated directly from the CPS ASEC was 41,073,677. To obtain estimated numbers of eligible people for States that sum (aside from rounding error) to the direct estimate of the national total, we multiplied each of the State preliminary estimates of eligible people by the ratio of 41,073,677 divided by 42,593,713, or 0.9643. Such benchmarking of estimates for smaller areas to a relatively precise estimated total for a larger area is common practice. (See, for example, Doppelt and Haley (2020) for a discussion of the Bureau of Labor Statistics benchmarking of the Current Employment Statistics.)

After carrying out this first adjustment, nine States—Delaware, Illinois, Massachusetts, New Mexico, Oregon, Pennsylvania, Rhode Island, Vermont, and Washington—had fewer estimated eligible people

than estimated eligible participants in FY 2019, incorrectly implying participation rates over 100 percent. To cap participation rates at 100 percent, we performed a second adjustment. Specifically, we increased the number of eligible people in Delaware, Illinois, Massachusetts, New Mexico, Oregon, Pennsylvania, Rhode Island, Vermont, and Washington so that the number of eligible people in those States equaled the number of participants. We reduced the number of eligible people in the other 41 States and the District of Columbia by an equivalent number and in proportion to their numbers of eligible people. This adjustment, which moved small numbers of eligible people among States, did not change the national total or State rankings. Moreover, except for the States with participation rates initially over 100 percent, this adjustment did not change any State's participation rate by more than one percentage point.

Applying this adjustment, we obtained our final shrinkage estimates of the numbers of people eligible for SNAP. From those estimates and our administrative estimates of the numbers of SNAP participants, we derived final shrinkage estimates of participation rates. Our final shrinkage estimates are presented in the next chapter.

III. State Estimates of SNAP Participation Rates and Number of Eligible People

Tables III.1 and III.2 present our final shrinkage estimates of SNAP participation rates and the number of people eligible, respectively, in each State for FY 2017 to FY 2019 for all eligible people and for working poor people. These shrinkage estimates are relatively precise; they have much smaller standard errors and narrower confidence intervals than the CPS ASEC direct estimates. Tables III.3 to III.8 display approximate 90 percent confidence intervals showing the uncertainty remaining after using shrinkage estimation to derive the estimates in Tables III.1 and III.2. One interpretation of a 90 percent confidence interval is that there is a 90 percent chance that the true value—that is, the true participation rate or the true number of eligible people—falls within the estimated bounds. For example, although our best estimate is that New Jersey’s participation rate for all eligible people was 80 percent in FY 2019 (see Table III.1), the true rate may have been higher or lower. However, according to Table III.5, the chances are 90 in 100 that the true rate was between 74 and 85 percent, an interval that is 44 percent narrower than the interval (72 and 91 percent, as cited in Chapter I) around the direct estimate. A narrower interval means that we are less uncertain about the true value. On average, shrinkage confidence intervals for FY 2019 participation rates for all eligible people were 43 percent narrower than the corresponding direct confidence interval. Thus, shrinkage estimation substantially improves precision and reduces our uncertainty.

Despite the impressive gains in precision, substantial uncertainty about the true participation rates for some States remains even after the application of shrinkage methods. Nevertheless, as discussed in Cunyningham (2022), the shrinkage estimates are sufficiently precise to show, for example, whether a State’s SNAP participation rate was probably near the top, near the bottom, or in the middle of the distribution of rates in a given year. That is enough information for many important purposes, such as guiding an initiative to improve program performance.

Final shrinkage estimates for FY 2017 and FY 2018 presented in this report differ slightly from the estimates presented in Cunyningham (2021a) and Cunyningham (2021b) for two reasons:

1. **The shrinkage estimator uses data from three years to estimate participation rates for each year.** Annually, data for the most recent year are added and data for the oldest year are dropped. As a result, the estimates for 2017 and 2018 presented in this report are based on 2017 to 2019 data, while the corresponding estimates published in Cunyningham (2021a) and Cunyningham (2021b) are based on 2016 to 2018 data.
2. **The shrinkage estimator incorporates a regression model that is updated each year.** Each year we choose a regression model that best predicts participation rates for all three years and both groups (all eligible people and eligible working poor people.) Although we place a premium on maintaining consistency in regression predictors from year to year, differences between 2016 data (used in the previous estimates) and 2019 data (used in the current estimates) resulted in the use of a different regression model. Different regression models lead to slight differences in predicted participation rates, which in turn lead to slight differences in estimated participation rates.

Because of these updates, the estimates presented in this report should not be compared to those published in earlier reports.

Table III.1. Final shrinkage estimates of SNAP participation rates

	All eligible people			Working poor people		
	FY 2017	FY 2018	FY 2019	FY 2017	FY 2018	FY 2019
Alabama	80	78	80	79	77	75
Alaska	73	86	89	72	79	72
Arizona	78	77	76	74	70	66
Arkansas	68	66	64	64	63	59
California	71	70	70	57	59	56
Colorado	77	80	84	63	66	67
Connecticut	90	92	95	84	79	80
Delaware	100	100	100	95	99	89
District of Columbia	90	84	97	43	39	57
Florida	86	84	81	79	75	70
Georgia	86	84	78	74	70	61
Hawaii	78	85	88	71	74	72
Idaho	76	73	82	75	71	73
Illinois	99	100	100	90	92	96
Indiana	73	75	73	75	78	73
Iowa	89	88	92	91	86	85
Kansas	66	70	71	61	65	63
Kentucky	77	77	69	71	76	68
Louisiana	86	84	85	75	73	77
Maine	83	80	81	82	78	74
Maryland	86	89	91	71	69	65
Massachusetts	91	97	100	64	69	75
Michigan	89	89	90	87	86	84
Minnesota	76	76	80	75	75	79
Mississippi	74	71	65	64	66	64
Missouri	84	85	85	77	75	74
Montana	82	79	83	74	71	69
Nebraska	78	80	83	72	75	74
Nevada	90	91	94	88	84	83
New Hampshire	75	80	82	66	69	63
New Jersey	79	81	80	71	72	72
New Mexico	96	98	100	86	89	95
New York	86	87	89	73	74	78
North Carolina	71	69	76	65	66	69
North Dakota	61	64	70	49	62	65
Ohio	82	85	90	86	84	86
Oklahoma	85	86	90	77	77	74
Oregon	100	100	100	97	90	89
Pennsylvania	94	98	100	91	94	98
Rhode Island	99	93	100	86	80	92
South Carolina	79	78	74	74	70	63
South Dakota	76	79	84	71	78	78
Tennessee	92	91	88	80	79	71
Texas	74	75	73	67	72	70
Utah	74	79	79	66	72	68
Vermont	96	93	100	82	77	85
Virginia	74	73	78	65	61	61
Washington	95	100	100	81	85	85
West Virginia	87	89	96	86	89	87
Wisconsin	93	93	100	84	85	88
Wyoming	49	56	55	45	57	45
United States	82	82	82	73	74	72

Table III.2. Final shrinkage estimates of number of people eligible for SNAP

	All eligible people			Working poor people		
	FY 2017	FY 2018	FY 2019	FY 2017	FY 2018	FY 2019
Alabama	959	932	859	435	417	342
Alaska	118	105	89	55	49	46
Arizona	1,007	947	910	524	485	443
Arkansas	551	547	536	247	225	244
California	5,082	4,895	4,787	2,897	2,560	2,313
Colorado	551	523	489	280	271	238
Connecticut	387	358	327	162	140	142
Delaware	117	110	107	56	42	51
District of Columbia	124	120	104	47	42	30
Florida	3,313	3,240	3,109	1,502	1,449	1,350
Georgia	1,781	1,700	1,685	853	845	850
Hawaii	192	172	161	103	81	87
Idaho	208	199	167	114	110	93
Illinois	1,684	1,612	1,575	784	747	740
Indiana	891	779	722	403	363	340
Iowa	344	329	288	176	166	160
Kansas	348	303	276	184	158	144
Kentucky	798	740	716	301	271	287
Louisiana	1,069	1,016	940	477	448	388
Maine	176	177	150	79	68	54
Maryland	700	631	581	304	306	251
Massachusetts	737	680	651	284	246	230
Michigan	1,344	1,245	1,121	614	546	472
Minnesota	489	481	435	245	241	211
Mississippi	705	684	675	332	281	273
Missouri	854	825	785	410	353	371
Montana	130	124	111	59	65	53
Nebraska	209	194	179	119	106	100
Nevada	422	417	372	190	192	183
New Hampshire	106	92	81	49	33	33
New Jersey	923	829	798	441	397	370
New Mexico	441	423	404	222	226	215
New York	2,997	2,865	2,588	1,477	1,211	1,010
North Carolina	1,690	1,744	1,502	754	829	725
North Dakota	69	66	56	30	27	26
Ohio	1,668	1,520	1,386	734	688	613
Oklahoma	675	634	594	309	315	307
Oregon	563	519	514	232	211	216
Pennsylvania	1,705	1,595	1,550	729	729	707
Rhode Island	138	145	124	49	46	44
South Carolina	865	789	761	409	323	362
South Dakota	122	108	95	58	46	41
Tennessee	1,123	1,042	1,001	475	440	414
Texas	4,571	4,468	4,061	2,417	2,523	2,193
Utah	271	232	214	161	135	132
Vermont	69	66	58	30	30	22
Virginia	1,007	978	863	477	480	431
Washington	810	705	670	363	263	205
West Virginia	356	323	280	126	112	93
Wisconsin	630	583	521	350	299	255
Wyoming	66	51	48	30	25	24
United States	46,152	43,862	41,074	22,156	20,659	18,924

Table III.3. Approximate 90 percent confidence intervals for final shrinkage estimates for FY 2017, all eligible people

	Participation rate (percentage)		Number of eligible people (thousands)	
	Lower bound	Upper bound	Lower bound	Upper bound
Alabama	76	84	908	1,011
Alaska	66	81	106	130
Arizona	73	84	939	1,074
Arkansas	64	72	516	585
California	69	74	4,878	5,286
Colorado	72	83	511	591
Connecticut	84	96	362	412
Delaware	94	100	110	124
District of Columbia	84	97	115	134
Florida	82	90	3,163	3,463
Georgia	81	90	1,694	1,868
Hawaii	73	84	178	206
Idaho	71	81	194	221
Illinois	94	100	1,605	1,764
Indiana	68	78	833	949
Iowa	83	96	321	367
Kansas	62	71	324	372
Kentucky	72	82	743	852
Louisiana	83	90	1,025	1,112
Maine	77	89	164	188
Maryland	79	92	644	755
Massachusetts	85	97	689	785
Michigan	84	93	1,273	1,415
Minnesota	70	81	452	525
Mississippi	71	76	679	731
Missouri	79	90	800	908
Montana	77	88	121	138
Nebraska	73	83	195	223
Nevada	85	96	397	447
New Hampshire	70	81	98	114
New Jersey	74	84	864	981
New Mexico	89	100	411	471
New York	82	90	2,857	3,138
North Carolina	67	76	1,593	1,787
North Dakota	55	67	62	76
Ohio	78	87	1,581	1,754
Oklahoma	79	91	631	719
Oregon	93	100	531	595
Pennsylvania	89	98	1,624	1,787
Rhode Island	92	100	128	147
South Carolina	75	83	820	911
South Dakota	69	82	111	132
Tennessee	87	96	1,066	1,181
Texas	71	77	4,381	4,761
Utah	69	80	251	292
Vermont	90	100	64	73
Virginia	69	78	940	1,074
Washington	90	100	763	856
West Virginia	81	92	333	380
Wisconsin	87	99	591	668
Wyoming	45	54	60	72
United States	81	83	45,509	46,795

Table III.4. Approximate 90 percent confidence intervals for final shrinkage estimates for FY 2018, all eligible people

	Participation rate (percentage)		Number of eligible people (thousands)	
	Lower bound	Upper bound	Lower bound	Upper bound
Alabama	73	82	879	985
Alaska	79	93	96	113
Arizona	72	82	881	1,014
Arkansas	62	71	510	583
California	67	73	4,703	5,087
Colorado	74	86	486	559
Connecticut	86	98	335	380
Delaware	93	100	104	117
District of Columbia	77	91	111	130
Florida	80	89	3,074	3,405
Georgia	80	89	1,606	1,795
Hawaii	79	91	160	185
Idaho	68	78	185	212
Illinois	95	100	1,529	1,695
Indiana	70	80	726	832
Iowa	81	94	307	352
Kansas	65	75	281	325
Kentucky	72	82	690	789
Louisiana	81	88	971	1,062
Maine	73	86	163	191
Maryland	83	95	586	676
Massachusetts	91	100	637	724
Michigan	84	94	1,178	1,312
Minnesota	70	81	446	517
Mississippi	67	74	651	717
Missouri	79	90	771	880
Montana	74	85	116	133
Nebraska	75	86	181	208
Nevada	85	96	392	441
New Hampshire	74	87	85	100
New Jersey	76	86	776	882
New Mexico	90	100	391	455
New York	83	91	2,733	2,998
North Carolina	64	74	1,609	1,879
North Dakota	58	70	60	73
Ohio	80	89	1,434	1,607
Oklahoma	81	91	594	674
Oregon	94	100	490	548
Pennsylvania	93	100	1,513	1,678
Rhode Island	86	100	134	156
South Carolina	74	82	745	833
South Dakota	73	86	99	117
Tennessee	86	96	983	1,101
Texas	72	78	4,284	4,651
Utah	73	85	214	250
Vermont	87	99	61	70
Virginia	68	78	911	1,045
Washington	94	100	664	746
West Virginia	84	95	304	341
Wisconsin	87	99	547	619
Wyoming	51	62	46	56
United States	81	83	43,202	44,522

Table III.5. Approximate 90 percent confidence intervals for final shrinkage estimates for FY 2019, all eligible people

	Participation rate (percentage)		Number of eligible people (thousands)	
	Lower bound	Upper bound	Lower bound	Upper bound
Alabama	75	84	806	912
Alaska	82	96	82	96
Arizona	71	82	843	976
Arkansas	59	69	493	579
California	68	73	4,599	4,975
Colorado	78	90	453	524
Connecticut	89	100	306	349
Delaware	93	100	101	113
District of Columbia	89	100	95	113
Florida	77	85	2,951	3,266
Georgia	73	83	1,578	1,792
Hawaii	81	95	148	174
Idaho	77	87	157	177
Illinois	94	100	1,496	1,654
Indiana	69	78	676	768
Iowa	85	98	268	308
Kansas	65	76	255	297
Kentucky	64	74	660	773
Louisiana	80	89	890	991
Maine	75	88	138	161
Maryland	84	98	535	626
Massachusetts	94	100	609	693
Michigan	85	95	1,059	1,182
Minnesota	74	86	401	468
Mississippi	61	69	634	716
Missouri	79	90	732	839
Montana	78	89	103	119
Nebraska	78	88	167	191
Nevada	88	100	349	395
New Hampshire	76	88	75	87
New Jersey	75	86	743	853
New Mexico	93	100	379	430
New York	85	93	2,468	2,707
North Carolina	72	80	1,418	1,587
North Dakota	63	76	51	61
Ohio	85	95	1,308	1,465
Oklahoma	84	95	555	632
Oregon	93	100	484	544
Pennsylvania	94	100	1,471	1,629
Rhode Island	93	100	117	131
South Carolina	70	78	715	806
South Dakota	77	90	88	103
Tennessee	83	93	942	1,059
Texas	70	76	3,891	4,231
Utah	73	85	197	230
Vermont	93	100	54	62
Virginia	72	83	799	927
Washington	94	100	632	708
West Virginia	90	100	261	298
Wisconsin	94	100	489	553
Wyoming	48	62	42	53
United States	81	84	40,432	41,716

Table III.6. Approximate 90 percent confidence intervals for final shrinkage estimates for FY 2017, working poor people

	Participation rate (percentage)		Number of eligible people (thousands)	
	Lower bound	Upper bound	Lower bound	Upper bound
Alabama	73	85	403	468
Alaska	62	82	47	63
Arizona	68	81	477	571
Arkansas	58	71	222	273
California	53	62	2,663	3,130
Colorado	57	70	250	309
Connecticut	76	92	147	176
Delaware	87	100	52	60
District of Columbia	33	53	36	58
Florida	73	84	1,397	1,606
Georgia	68	80	787	919
Hawaii	63	79	91	115
Idaho	69	82	105	124
Illinois	84	97	727	841
Indiana	68	82	364	441
Iowa	84	98	162	190
Kansas	55	67	166	202
Kentucky	65	78	272	330
Louisiana	69	81	437	518
Maine	73	90	71	86
Maryland	62	80	267	341
Massachusetts	56	71	250	318
Michigan	81	94	568	660
Minnesota	68	83	221	269
Mississippi	58	71	299	364
Missouri	71	83	376	443
Montana	67	82	53	65
Nebraska	66	79	109	130
Nevada	80	95	174	205
New Hampshire	58	73	44	55
New Jersey	64	78	397	484
New Mexico	78	94	201	243
New York	66	79	1,346	1,608
North Carolina	60	71	692	816
North Dakota	41	57	25	35
Ohio	78	93	671	796
Oklahoma	71	84	282	335
Oregon	88	100	211	254
Pennsylvania	84	98	674	784
Rhode Island	76	95	43	54
South Carolina	68	80	374	444
South Dakota	63	79	51	64
Tennessee	74	86	439	511
Texas	62	72	2,241	2,592
Utah	59	72	145	176
Vermont	73	90	26	33
Virginia	58	72	428	527
Washington	74	89	330	397
West Virginia	79	94	114	137
Wisconsin	77	91	322	379
Wyoming	38	51	25	34
United States	71	75	21,582	22,730

Table III.7. Approximate 90 percent confidence intervals for final shrinkage estimates for FY 2018, working poor people

	Participation rate (percentage)		Number of eligible people (thousands)	
	Lower bound	Upper bound	Lower bound	Upper bound
Alabama	70	83	382	452
Alaska	69	90	43	56
Arizona	63	77	437	532
Arkansas	56	69	201	248
California	54	63	2,353	2,766
Colorado	59	72	243	299
Connecticut	72	87	127	153
Delaware	89	100	38	46
District of Columbia	30	49	32	52
Florida	69	81	1,331	1,567
Georgia	64	76	770	920
Hawaii	64	83	71	91
Idaho	65	77	100	120
Illinois	84	99	686	808
Indiana	70	85	328	398
Iowa	79	93	152	179
Kansas	59	72	143	174
Kentucky	69	83	246	296
Louisiana	67	80	411	485
Maine	70	87	61	75
Maryland	60	78	267	344
Massachusetts	61	78	217	275
Michigan	79	93	500	593
Minnesota	68	83	216	265
Mississippi	59	72	253	308
Missouri	69	82	323	384
Montana	63	78	58	71
Nebraska	69	82	97	116
Nevada	77	92	175	208
New Hampshire	59	78	28	38
New Jersey	65	80	356	439
New Mexico	79	99	201	252
New York	67	80	1,107	1,315
North Carolina	59	73	745	912
North Dakota	53	70	23	31
Ohio	77	91	631	745
Oklahoma	70	85	286	344
Oregon	81	98	191	230
Pennsylvania	86	100	669	789
Rhode Island	70	89	41	52
South Carolina	64	75	297	350
South Dakota	70	87	41	52
Tennessee	72	86	402	477
Texas	66	77	2,334	2,712
Utah	64	79	121	148
Vermont	69	85	27	33
Virginia	54	67	429	531
Washington	77	93	238	288
West Virginia	81	98	101	122
Wisconsin	78	92	274	325
Wyoming	49	64	21	28
United States	71	76	20,067	21,252

Table III.8. Approximate 90 percent confidence intervals for final shrinkage estimates for FY 2019, working poor people

	Participation rate (percentage)		Number of eligible people (thousands)	
	Lower bound	Upper bound	Lower bound	Upper bound
Alabama	68	82	310	374
Alaska	62	82	40	53
Arizona	59	73	397	490
Arkansas	52	67	212	276
California	51	61	2,112	2,514
Colorado	60	74	213	262
Connecticut	72	88	128	156
Delaware	80	98	46	56
District of Columbia	44	70	23	37
Florida	64	76	1,234	1,467
Georgia	54	68	749	951
Hawaii	61	82	75	99
Idaho	66	79	85	102
Illinois	87	100	676	804
Indiana	66	80	308	373
Iowa	78	93	145	174
Kansas	56	69	129	159
Kentucky	61	76	256	318
Louisiana	70	84	353	423
Maine	66	83	47	60
Maryland	55	74	214	288
Massachusetts	66	84	204	256
Michigan	77	91	431	513
Minnesota	71	87	190	232
Mississippi	56	71	240	306
Missouri	67	81	335	406
Montana	59	78	46	60
Nebraska	67	81	91	109
Nevada	75	91	166	201
New Hampshire	56	71	29	37
New Jersey	64	80	328	411
New Mexico	84	100	190	240
New York	72	85	921	1,100
North Carolina	64	75	665	786
North Dakota	57	74	23	30
Ohio	79	93	562	664
Oklahoma	67	82	275	338
Oregon	79	98	193	239
Pennsylvania	90	100	647	766
Rhode Island	83	100	40	48
South Carolina	57	70	327	398
South Dakota	70	86	37	45
Tennessee	65	77	378	450
Texas	65	75	2,023	2,363
Utah	61	75	118	145
Vermont	75	95	19	25
Virginia	54	68	379	483
Washington	77	93	185	224
West Virginia	78	96	83	103
Wisconsin	81	96	233	277
Wyoming	37	54	20	29
United States	70	75	18,347	19,500

This page has been left blank for double-sided copying.

References

- Cronquist, Kathryn, Sarah Lauffer, and Alma Vigil. “Technical Documentation for the Fiscal Year 2019 Supplemental Nutrition Assistance Program Quality Control Database and QC Minimodel.” Final report submitted to the U.S. Department of Agriculture, Food and Nutrition Service. Washington, DC: Mathematica Policy Research, December 2020.
- Cunyngham, Karen “Reaching Those in Need: State Supplemental Nutrition Assistance Program Participation Rates in 2019.” Final report submitted to the U.S. Department of Agriculture, Food and Nutrition Service. Washington, DC: Mathematica, November 2022.
- Cunyngham, Karen. “Empirical Bayes Shrinkage Estimates of State Supplemental Nutrition Assistance Program Participation Rates in Fiscal Year 2016 to Fiscal Year 2018 for All Eligible People and Working Poor People.” Final report submitted to the U.S. Department of Agriculture, Food and Nutrition Service. Washington, DC: Mathematica Policy Research, May 2021a.
- Cunyngham, Karen. “Reaching Those in Need: State Supplemental Nutrition Assistance Program Participation Rates in 2018.” Final report submitted to the U.S. Department of Agriculture, Food and Nutrition Service. Washington, DC: Mathematica Policy Research, May 2021b.
- Doppelt, Lawrence, and Shane Haley. “CES National Benchmark Article: BLS Establishment Survey National Estimates Revised to Incorporate March 2019 Benchmarks.” 2020. Available at <https://www.bls.gov/web/empsit/cesbmart.htm>.
- Fay, Robert E., and Roger Herriott. “Estimates of Incomes for Small-Places: An Application of James-Stein Procedures to Census Data.” *Journal of the American Statistical Association*, vol. 74, no. 366, June 1979, pp. 269–277.
- Schirm, Allen L. “Reaching Those in Need: Food Stamp Participation Rates in the States.” Final report submitted to the U.S. Department of Agriculture, Food and Nutrition Service. Washington, DC: Mathematica Policy Research, July 2000.
- Schirm, Allen L., and John V. DiCarlo. “Using Bayesian Shrinkage Methods to Derive State Estimates of Poverty, Food Stamp Program Eligibility, and Food Stamp Program Participation.” Final report submitted to the U.S. Department of Agriculture, Food and Nutrition Service. Washington, DC: Mathematica Policy Research, March 1998.
- U.S. Census Bureau. “Current Population Survey: Design and Methodology, Technical Paper 66”. October 2006. Available at <https://www2.census.gov/programs-surveys/cps/methodology/tp-66.pdf>.
- Vigil, Alma. “Trends in Supplemental Nutrition Assistance Program Participation Rates: Fiscal Year 2016 to Fiscal Year 2019.” Final report submitted to the U.S. Department of Agriculture, Food and Nutrition Service. Washington, DC: Mathematica, March 2022.

This page has been left blank for double-sided copying.

Appendix A

The Estimation Procedure: Additional Technical Details

This appendix provides additional information and technical details about our four-step procedure to estimate State SNAP participation rates for all eligible people and working poor people. Each step is discussed in turn.

1. From CPS ASEC data and SNAP administrative data, derive direct estimates of State SNAP participation rates for each of the three fiscal years 2017 to 2019

We derived direct estimates of participation rates for all eligible people for a given fiscal year according to the following formula:

$$(1) \quad Y_{1,i} = 100 \frac{P_i(\mathcal{E}_{1,i} / 100)}{(E_{1,i} / 100)T_i},$$

where $Y_{1,i}$ is the estimated participation rate for all eligible people for State i ($i = 1, \dots, 51$); P_i is the number of people participating in SNAP according to adjusted SNAP Program Operations data; $\mathcal{E}_{1,i}$ is the percentage of participating people who are correctly receiving benefits and eligible under federal SNAP rules according to SNAP Quality Control (SNAP QC) data; $E_{1,i}$ is the estimated number of people who are eligible for SNAP according to a microsimulation model based on CPS ASEC data, expressed as a percentage of the CPS ASEC population; and T_i is the estimated resident population according to decennial census and administrative records (mainly vital statistics) data.

We estimated P_i by adjusting SNAP program operations data to exclude people who received SNAP benefits only because of a natural disaster. Participant figures, including counts of participants eligible only through disaster assistance, were provided by USDA's Food and Nutrition Service. SNAP Program Operations data include the full population of SNAP cases, so participant counts are not subject to sampling error.

We estimated $\mathcal{E}_{1,i}$ (the correctly eligible rate) from the SNAP QC sample data as follows:

$$(2) \quad \mathcal{E}_{1,i} = 100 \frac{\sum_h m_{i,h} \mathcal{E}_{1,i,h}}{\sum_h m_{i,h}},$$

where h indexes households in a State's SNAP QC sample; $m_{i,h}$ equals the number of people in household h times the weight for household h ; and $\mathcal{E}_{1,i,h}$ is an indicator that household h is eligible to receive SNAP benefits. We excluded from our estimates of participants two groups that are not included in our estimates of eligible people: (1) ineligible participants who received SNAP benefits in error and (2) participants who were eligible through State expanded categorical eligibility policies but would not meet federal SNAP income and resource criteria.

We estimated the percentage of people who were eligible for SNAP using the following formula:

$$(3) \quad E_{1,i} = 100 \frac{Z_{1,i}}{N_i},$$

where $Z_{1,i}$ is the CPS ASEC estimate of the number of eligible people and N_i is the CPS ASEC estimate of the population. Estimated percentages are more precise than estimated counts because the

sampling errors in the numerators and denominators of percentages tend to be positively correlated and, therefore, partially cancel each other out.

We derived SNAP eligibility estimates ($Z_{1,i}$) by applying SNAP rules to CPS ASEC households. However, some key information needed to determine whether a household is eligible for SNAP is not collected in the CPS ASEC. For example, there are no data on resources or expenses deductible from gross income. Also, it is not possible to ascertain directly which members of a dwelling unit purchase and prepare food together or which members may be categorically ineligible for SNAP. Yet another limitation is that only annual, rather than monthly, income amounts are recorded.

We have developed methods, described Vigil (2022), to address these data limitations. These methods include procedures for identifying the members of the SNAP household within the (potentially) larger CPS ASEC household, taking account of the restrictions on participation by noncitizens, distributing annual amounts across months, and imputing net income. Vigil (2022) also describes how we applied SNAP gross and net income tests and calculated the benefits for which an eligible household would qualify.

Because our focus in this document is on participation among people who were eligible for SNAP, these estimates of SNAP eligibility counts and participation rates do not include people who were not legally entitled to receive SNAP benefits, such as Supplemental Security Income recipients in California who received cash in lieu of SNAP benefits prior to June 2019. It might be useful in other contexts, however, to consider participation rates among those eligible for SNAP or a cash substitute.

To derive fiscal year estimates of eligibility, we combined two years of the CPS ASEC. For example, to estimate $Z_{1,i}$ for FY 2019, we used data from the 2019 CPS ASEC (simulating October through December 2018) and the 2020 CPS ASEC (simulating January through September 2019). To estimate N_i , we used a weighted average of population estimates from the two CPS ASEC files.

The Census Bureau derives population estimates () by subtracting from decennial census counts people “exiting” the population (due to death or net out-migration) and adding people “entering” the population (due to birth or net in-migration).

SNAP participation rates for working poor people. We derived sample estimates of participation rates for working poor people for a given year according to the following formulas:

$$(4) \quad Y_{2,i} = 100 \frac{P_i(\varepsilon_{2,i} / 100)}{(E_{2,i} / 100)T_i},$$

$$(5) \quad \varepsilon_{2,i} = 100 \frac{\sum_h m_{i,h} \varepsilon_{2,i,h}}{\sum_h m_{i,h}},$$

and

$$(6) \quad E_{2,i} = 100 \frac{Z_{2,i}}{N_i},$$

where $Y_{2,i}$ is the estimated participation rate for working poor people for State i ; $\varepsilon_{2,i}$ is the percentage of SNAP participants who are working poor, correctly receiving SNAP benefits, and eligible under

federal SNAP rules according to SNAP QC data; $E_{2,i}$ is the percentage of people who are working poor and eligible for SNAP according to the CPS ASEC; $Z_{2,i}$ is the CPS ASEC estimate of the number of eligible working poor people, and P_i , h , $m_{i,h}$ and N_i are as defined above.

We defined as working poor any person who was eligible for SNAP and lived in a household in which a member earned money from a job. Working poor people were identified slightly differently in the SNAP QC data than in the CPS ASEC. Specifically, a participant household was identified as working poor if the household had earnings according to the edited SNAP QC data file or, prior to editing, had multiple indicators of earnings that suggested a household was likely to have a member who worked. Exhibit A.1 describes the algorithm that identified working poor participants, and Cronquist et al. (2020) describe the procedure for editing the SNAP QC data. An eligible household was identified as working poor only on the basis of earnings.

Exhibit A.1. Algorithm to identify working poor participants

Working poor participants are defined as those in households with one of the following criteria:

- 1) Earnings in the edited SNAP QC data
- 2) Multiple indicators of earnings in the unedited SNAP QC data
 - a) At least one person with earned income AND
 - i) An earned income deduction or a workforce participation variable indicating employment OR
 - ii) Earned and unearned income that sum to total income, or earned income with the earned income deduction already subtracted and unearned income that sum to the total income (some States subtract the earned income deduction from income deemed by an ineligible member before recording it on the file)
 - b) An earned income deduction AND
 - i) At least one person with a workforce participation variable indicating employment OR
 - ii) Earnings implied by the earned income deduction and unearned income that sum to total income OR
 - iii) Gross income that is more than the earned income implied by the earned income deduction and both unearned and earned income equal zero (to account for household records that have no recorded individual income amounts but do have what appear to be consistent household-level indicators)

Sampling variances. In addition to our point estimates of participation rates, we need estimates of their sampling variability. We estimated the variances of $Y_{1,i}$ and $Y_{2,i}$ as follows:

$$(7) \quad \text{var}(Y_{1,i}) = \text{variance due to } E_{1,i} \text{ when } \varepsilon_{1,i} \text{ is fixed} + \text{variance due to } \varepsilon_{1,i} \text{ when } E_{1,i} \text{ is fixed} \\ = \text{var}_{E_1|\varepsilon_1}(Y_{1,i}) + \text{var}_{\varepsilon_1|E_1}(Y_{1,i})$$

and

$$(8) \quad \text{var}(Y_{2,i}) = \text{variance due to } E_{2,i} \text{ when } \varepsilon_{2,i} \text{ is fixed} + \text{variance due to } \varepsilon_{2,i} \text{ when } E_{2,i} \text{ is fixed} \\ = \text{var}_{E_2|\varepsilon_2}(Y_{2,i}) + \text{var}_{\varepsilon_2|E_2}(Y_{2,i}).$$

When a variable is held fixed, we fix it at its point estimate. Note that covariance terms are not needed because the estimates of $E_{1,i}$ and $\varepsilon_{1,i}$, and the estimates of $E_{2,i}$ and $\varepsilon_{2,i}$, are based on independent samples.

For a given year, we estimated $\text{var}_{E_1|\varepsilon_1}(Y_{1,i})$ and $\text{var}_{E_2|\varepsilon_2}(Y_{2,i})$ using a replication method called the Successive Difference Replication Method (SDRM) with 160 replicate weights developed by the U.S. Census Bureau for the CPS ASEC (U.S. Census Bureau 2006), resulting in the following formulas:

$$(9) \quad \text{var}_{E_1|\varepsilon_1}(Y_{1,i}) = \frac{4}{160} \sum_{r=1}^{160} (Y_{1,i(r)} - Y_{1,i})^2$$

and

$$(10) \quad \text{var}_{E_2|\varepsilon_2}(Y_{2,i}) = \frac{4}{160} \sum_{r=1}^{160} (Y_{2,i(r)} - Y_{2,i})^2,$$

where is the r^{th} ($r = 1, \dots, 160$) replicate estimate with the same form as $Y_{1,i}$ and $Y_{2,i}$, respectively, and calculated using the r^{th} set of replicate weights. The replicate estimates $Y_{1,i(r)}$ are obtained by replicating $E_{1,i}$:

$$(11) \quad E_{1,i(r)} = 100 \frac{Z_{1,i(r)}}{N_{i(r)}}$$

and

$$(12) \quad Y_{1,i(r)} = 100 \frac{P_i(\varepsilon_{1,i} / 100)}{(E_{1,i(r)} / 100)T_i}.$$

Similarly, the replicate estimates $Y_{2,i(r)}$ are obtained by replicating $E_{2,i}$:

$$(13) \quad E_{2,i(r)} = 100 \frac{Z_{2,i(r)}}{N_{i(r)}}$$

and

$$(14) \quad Y_{2,i(r)} = 100 \frac{P_i(\varepsilon_{2,i} / 100)}{(E_{2,i(r)} / 100)T_i}.$$

Correctly eligible rates for all eligible participants and eligible working poor participants are also subject to sampling error, although this sampling error is small relative to other sources of error in the estimated participation rates. Based on Equation (1) and Equation (4), respectively, we can estimate $\text{var}_{\varepsilon_1|E_1}(Y_{1,i})$ and $\text{var}_{\varepsilon_2|E_2}(Y_{2,i})$ according to these formulas:

$$(15) \quad \text{var}_{\varepsilon_1|E_1}(Y_{1,i}) = \left(100 \frac{P_i}{T_i E_{1,i}} \right)^2 \text{var}(\varepsilon_{1,i})$$

and

$$(16) \quad \text{var}_{\varepsilon_2|E_2}(Y_{2,i}) = \left(100 \frac{P_i}{T_i E_{2,i}}\right)^2 \text{var}(\varepsilon_{2,i}),$$

because $P_{1,i}$ and T_i are constants (or, at least, subject to negligible sampling variability) and $E_{1,i}$ and $E_{2,i}$ are held fixed at their point estimates.

To calculate $\text{var}(\varepsilon_{1,i})$ and $\text{var}(\varepsilon_{2,i})$, we constructed 500 bootstrap replicate weights for the SNAP QC sample. The estimates $\varepsilon_{1,i}$ and $\varepsilon_{2,i}$ are then replicated 500 times, each using a set of bootstrap replicate weights:

$$(17) \quad \varepsilon_{1,i(r)} = 100 \frac{\sum_h m_{i,h(r)} \varepsilon_{1,i,h}}{\sum_h m_{i,h(r)}}, (r = 1, 2, \dots, 500)$$

and

$$(18) \quad \varepsilon_{2,i(r)} = 100 \frac{\sum_h m_{i,h(r)} \varepsilon_{2,i,h}}{\sum_h m_{i,h(r)}}, (r = 1, 2, \dots, 500),$$

where $m_{i,h(r)}$ is the number of people in household h times the r^{th} replicate weight for household h . Then:

$$(19) \quad \text{var}(\varepsilon_{1,i}) = \frac{1}{499} \sum_{r=1}^{500} (\varepsilon_{1,i(r)} - \bar{\varepsilon}_{1,i}^*)^2,$$

where

$$(20) \quad \bar{\varepsilon}_{1,i}^* = \frac{1}{500} \sum_{r=1}^{500} \varepsilon_{1,i(r)}$$

and

$$(21) \quad \text{var}(\varepsilon_{2,i}) = \frac{1}{499} \sum_{r=1}^{500} (\varepsilon_{2,i(r)} - \bar{\varepsilon}_{2,i}^*)^2,$$

where

$$(22) \quad \bar{\varepsilon}_{2,i}^* = \frac{1}{500} \sum_{r=1}^{500} \varepsilon_{2,i(r)}.$$

Summing the estimates from Equations (9) and (15)—as indicated by Equation (7)—and taking the square root of the sum provides an estimated standard error of the participation rate for all eligible people. Similarly, summing the estimates from Equations (10) and (16)—as indicated by Equation (8)—and taking the square root of the sum provides an estimated standard error of the participation rate for working poor people.

Covariances. We estimated the covariance between the estimates of participation rates for all eligible people and working poor people, for a given year, according to:

$$(23) \quad \text{cov}(Y_{1,i}, Y_{2,i}) = \text{covariance due to } E_{1,i} \text{ and } E_{2,i} \text{ when } \varepsilon_{1,i} \text{ and } \varepsilon_{2,i} \text{ are fixed} \\ + \text{covariance due to } \varepsilon_{1,i} \text{ and } \varepsilon_{2,i} \text{ when } E_{1,i} \text{ and } E_{2,i} \text{ are fixed} \\ = \text{cov}_{E_1 E_2 | \varepsilon_1 \varepsilon_2}(Y_{1,i}, Y_{2,i}) + \text{cov}_{\varepsilon_1 \varepsilon_2 | E_1 E_2}(Y_{1,i}, Y_{2,i}).$$

Note that we do not need to include additional terms because the CPS ASEC and SNAP QC samples are independent. To derive an estimate of the first term in this expression, we obtained an SDRM estimate of the covariance due to $E_{1,i}$ and $E_{2,i}$ according to:

$$(24) \quad \text{cov}_{E_1 E_2 | \varepsilon_1 \varepsilon_2}(Y_{1,i}, Y_{2,i}) = \frac{4}{160} \sum_{r=1}^{160} (Y_{1,i(r)} - Y_{1,i})(Y_{2,i(r)} - Y_{2,i}).$$

For the second term, we estimated the covariance due to $\varepsilon_{1,i}$ and $\varepsilon_{2,i}$ according to:

$$(25) \quad \text{cov}_{\varepsilon_1 \varepsilon_2 | E_1 E_2}(Y_{1,i}, Y_{2,i}) = \left(100 \frac{P_i}{T_i E_{1,i}}\right) \left(100 \frac{P_i}{T_i E_{2,i}}\right) \text{cov}(\varepsilon_{1,i}, \varepsilon_{2,i})$$

where

$$(26) \quad \text{cov}(\varepsilon_{1,i}, \varepsilon_{2,i}) = \frac{1}{\left(\sum_h m_{i,h}\right)^2} \left(\frac{n_i}{n_i - 1}\right) \sum_h m_{i,h}^2 (\varepsilon_{1,i,h} - \varepsilon_{1,i})(\varepsilon_{2,i,h} - \varepsilon_{2,i}).$$

CPS ASEC samples from different years are not independent, so participation rates for different years are correlated. (SNAP QC samples from different years are independent, so sampling variability in estimates from the CPS ASEC is the only source of intertemporal covariation between participation rates.) We derived a preliminary SDRM estimate of the correlation between $Y_{1,i,t}$ and $Y_{2,i,t-g}$, the sample estimate for all eligible people for one year (year t) and the sample estimate for working poor people for g years earlier, as follows:

$$(27) \quad \text{cov}(Y_{1,i,t}, Y_{2,i,t-g}) = \frac{4}{160} \sum_{r=1}^{160} (Y_{1,i(r),t} - Y_{1,i,t})(Y_{2,i(r),t-g} - Y_{2,i,t-g}).$$

The correlation between $Y_{1,i,t}$ and $Y_{2,i,t-g}$ is

$$(28) \quad \text{corr}(Y_{1,i,t}, Y_{2,i,t-g}) = \frac{\text{cov}(Y_{1,i,t}, Y_{2,i,t-g})}{\sqrt{\text{var}(Y_{1,i,t}) \text{var}(Y_{2,i,t-g})}}.$$

To improve the precision of estimated correlations (and covariances), we used a simple smoothing technique in which we “replaced” the State-specific correlation from Equation (28) by the average correlation between $Y_{1,i,t}$ and $Y_{2,i,t-g}$ across States:

$$(29) \quad \overline{\text{corr}(Y_{1,t}, Y_{2,t-g})} = \frac{\sum_{i=1}^{51} (n_{i,t} + n_{i,t-g}) \text{corr}(Y_{1,i,t}, Y_{2,i,t-g})}{\sum_{i=1}^{51} (n_{i,t} + n_{i,t-g})},$$

where $n_{i,t}$ and $n_{i,t-g}$ are the (unweighted) number of households in the CPS ASEC samples for one year and g years earlier, respectively. Using this average correlation, we obtained as our final estimate of the covariance between $Y_{1,i,t}$ and $Y_{2,i,t-g}$:

$$(30) \quad \text{cov}(Y_{1,i,t}, Y_{2,i,t-g}) = \overline{\text{corr}(Y_{1,t}, Y_{2,t-g})} \sqrt{\text{var}(Y_{1,i,t}) \text{var}(Y_{2,i,t-g})}.$$

Other intertemporal covariances—such as the covariance between the participation rates for working poor people in two different years—are similarly estimated. All interstate covariances equal zero because State samples are independent in both the CPS ASEC and the SNAP QC. As described under Step 3, the variances and covariances obtained in this step are the elements of a variance-covariance matrix used in deriving shrinkage estimates of participation rates.

Table A.1 presents estimates of the number of people participating in SNAP (values of P_i); Table A.2 presents the percentages of all and working poor participants who are income eligible and correctly receiving SNAP benefits (values of $\mathcal{E}_{1,i}$ and $\mathcal{E}_{2,i}$); and Tables A.3 and A.4 show payment error-adjusted numbers of, respectively, all people and working poor people receiving SNAP benefits under normal program eligibility rules (values of $P_i(\mathcal{E}_{1,i}/100)$ and $P_i(\mathcal{E}_{2,i}/100)$). Tables A.5, A.6, A.7, and A.8 present CPS ASEC estimates of SNAP eligibility percentages for all eligible people and working poor people (values of $E_{1,i}$ and $E_{2,i}$), the number of eligible people (values of $Z_{1,i}$), the number of eligible working poor people (values of $Z_{2,i}$), and the population (values of N_i), respectively, and Table A.9 presents the population totals (values of T_i). Table A.10 shows the percentage of working poor participants in Table A.4 that are in households without reported earned income but are identified as working poor through the other indicators described in Exhibit A.1. Table A.11 displays direct estimates of participation rates for all eligible people and working poor people (values of $Y_{1,i}$ and $Y_{2,i}$), and Table A.12 presents standard errors for the direct estimates.

2. Using a regression model, predict State SNAP participation rates based on administrative, ACS, and other data

Our regression model consisted of six equations, with three predicting SNAP participation rates for all eligible people in fiscal years 2017, 2018, and 2019, and three predicting SNAP participation rates for working poor people in fiscal years 2017, 2018, and 2019. The six equations were estimated jointly, and the values of the regression coefficients could vary from equation to equation. The predictors used were (in addition to an intercept):

1. Percentage of the population receiving SNAP benefits according to administrative data and population estimates
2. Percentage of children under age 18 with household income under 50 percent of the federal poverty level according to American Community Survey (ACS) one-year estimates

3. Percentage of people age 25 and older who have completed a bachelor's degree according to ACS one-year estimates
4. Percentage of individuals age 18 to 64 with household income under 100 percent of the federal poverty level according to ACS one-year estimates
5. Percentage of individuals age 65 and older with household income under 125 percent of the federal poverty level according to ACS one-year estimates
6. Percentage of the civilian employed population over age 16 who are private wage and salary workers according to ACS one-year estimates
7. Percentage of all individuals not claimed on tax returns or claimed on tax returns with adjusted gross income under the federal poverty level according to individual income tax data and population estimates

For all the predictors, we used 2017 values in both equations for predicting FY 2017 rates, 2018 values in both equations for predicting FY 2018 rates, and 2019 values in both equations for predicting FY 2019 rates. Because prediction errors were allowed to be correlated and intergroup and intertemporal correlations among direct estimates were taken into account as specified in the next step, the shrinkage estimates for a group (all eligible people or working poor people) in any one year were determined by the predictions and sample estimates for all three years and both groups.

In addition to the predictors that we selected for our model, we considered many other potential predictors, including the percentage of households with earnings according to ACS one-year estimates, which was used to produce the estimates in Cunyningham (2021a). All of the predictors considered had three characteristics: (1) it is plausible that they are good indicators of differences among States in SNAP participation rates; (2) they could be defined and measured uniformly across States; and (3) they could be obtained from nonsample or highly precise sample data—such as the ACS or administrative records data—and, thus, measured with little or no sampling error. In addition, all but the fourth predictor listed above—the percentage of individuals age 18 to 64 with household income under 100 percent of the federal poverty level according to ACS one-year estimates were used to produce the estimates in Cunyningham (2021a).

The regression equations do not express causal relationships. Rather, they imply only statistical associations. For this reason, predictors are often called “symptomatic indicators.” They are symptomatic of differences among States in conditions associated with having higher or lower participation rates.

As shown in the next step, where we describe the regression estimation procedure in more detail, we do not have to calculate regression estimates as a separate step, although we do have to select a best regression model before we can calculate shrinkage estimates. We selected our best model on the basis of its strong relative performance in predicting participation rates. We judged performance by examining functions of the regression residuals, such as mean squared error. In addition to assessing the predictive fit of alternative specifications, we checked for potential biases as part of our extensive model evaluation. To check for biases, we looked for a persistent tendency to under- or overpredict the number of eligible people for certain types of States categorized by, for example, population size, region, and percentage of the population that is black or Hispanic. We found no evidence of correctable bias.

Predictors considered are listed in Table A.13 and definitions, and data sources for the predictors in our chosen regression model are given in Table A.14. The values for the predictors listed above are displayed in Tables A.15, A.16, and A.17.

3. Using shrinkage methods, average the direct estimates and regression predictions to obtain preliminary shrinkage estimates of State SNAP participation rates

To average the direct estimates and the regression predictions, we used an empirical Bayes shrinkage estimator. A State's shrinkage estimate for either all eligible people or working poor people in a given year does not have to be between the direct and regression estimates for the group and year in question. It may be above both of those estimates if, for example, they seem too low based on data from other years. However, in most cases, the shrinkage estimates presented in this report are between the direct and regression estimates. In the remaining cases, the shrinkage estimate is usually close to either the direct or regression estimate, and it is often close to both because the sample and regression estimates are close to each other.

The shrinkage estimator does not have a closed-form expression from which we can calculate shrinkage estimates. Instead, we must numerically integrate over six scalar parameters for which we do not have an exact value— σ_1 , σ_2 , ρ , η_1 , η_2 , and $\eta_{1,2}$. The parameters σ_1 and σ_2 capture intertemporal (between-year) correlations among regression prediction errors for all eligible people and for working poor people, respectively; σ_1 and σ_2 capture additional within-year variance across States. Correlations between all eligible people and working poor people are parameterized by ρ and $\eta_{1,2}$, with ρ capturing the between-year portion and $\eta_{1,2}$ capturing the additional within-year portion. To perform the numerical integration, we specified a grid that resulted in 7,469,280 equally spaced points, starting with $\sigma_1 = 0.001$, $\sigma_2 = 0.001$, $\rho = -0.999$, $\eta_1 = 0.000$, $\eta_2 = 0.000$, and $\eta_{1,2} = -0.999$ and incrementing σ_1 , σ_2 , ρ , η_1 , η_2 , and $\eta_{1,2}$ by 0.350, 0.600, 0.111, 0.400, 0.700, and 0.222, respectively, up to $\sigma_1 = 4.551$, $\sigma_2 = 6.601$, $\rho = 0.999$, $\eta_1 = 6.800$, $\eta_2 = 8.400$, and $\eta_{1,2} = 0.999$. For combination k of σ_1 , σ_2 , ρ , η_1 , η_2 , and $\eta_{1,2}$ ($k = 1, \dots, 7,469,280$), we calculated a vector of shrinkage estimates:

$$(31) \quad \theta_k = (\Sigma_k^{-1} + V^{-1})^{-1} (\Sigma_k^{-1} X \hat{B}_k + V^{-1} Y),$$

a variance-covariance matrix:

$$(32) \quad U_k = (\Sigma_k^{-1} + V^{-1})^{-1} + (\Sigma_k^{-1} + V^{-1})^{-1} \Sigma_k^{-1} X (X' (\Sigma_k + V)^{-1} X)^{-1} X' \Sigma_k^{-1} (\Sigma_k^{-1} + V^{-1})^{-1},$$

and a probability:

$$(33) \quad p_k^* = |\Sigma_k + V|^{-1/2} |X' (\Sigma_k + V)^{-1} X|^{-1/2} \exp \left(-1/2 (Y - X \hat{B}_k)' (\Sigma_k + V)^{-1} (Y - X \hat{B}_k) \right).$$

In these expressions, Y is a column vector of direct estimates (from Step 1) with 306 elements—six sample estimates for each of the 50 States and the District of Columbia. The first six elements of Y pertain to the first State, the next six to the second State, and so forth. For a given State, the first two elements are the FY 2017 sample estimates for all eligible people and working poor people, respectively; the second two elements are the FY 2018 estimates; and the final two elements are the FY 2019 estimates. The vector of shrinkage estimates, θ_k , has the same structure as the vector of sample estimates, Y . V is the (306×306) variance-covariance matrix for the sample estimates. Because State samples are independent in the CPS ASEC, V is block-diagonal with 51 (6×6) blocks. We described under Step 1 how we derived estimates for the variance and covariance elements of V (Equations (21) and (30), respectively). X is a (306×48) matrix containing values for each of the seven predictors (plus an intercept) for every State,

every fiscal year (2017, 2018, and 2019), and both groups (all eligible people and working poor people). The first six rows of X pertain to the first State, the next six rows pertain to the second State, and so forth. The six rows for State i are given by

$$(34) \quad X_i = \begin{pmatrix} x'_{i,1,1} & \underline{0} & \underline{0} & \underline{0} & \underline{0} & \underline{0} \\ \underline{0} & x'_{i,1,2} & \underline{0} & \underline{0} & \underline{0} & \underline{0} \\ \underline{0} & \underline{0} & x'_{i,2,1} & \underline{0} & \underline{0} & \underline{0} \\ \underline{0} & \underline{0} & \underline{0} & x'_{i,2,2} & \underline{0} & \underline{0} \\ \underline{0} & \underline{0} & \underline{0} & \underline{0} & x'_{i,3,1} & \underline{0} \\ \underline{0} & \underline{0} & \underline{0} & \underline{0} & \underline{0} & x'_{i,3,2} \end{pmatrix},$$

where $x'_{i,t,1}$ is a row vector for fiscal year t ($t=1$ for 2017, $t=2$ for 2018, and $t=3$ for 2019) with eight elements (an intercept plus the seven predictors listed under Step 2) to predict participation rates for all eligible people, $x'_{i,t,2}$ is a row vector for year t with eight elements (an intercept plus the seven predictors) to predict participation rates for working poor people, and $\underline{0}$ is a row vector with eight zeros. In a given year, the values of the predictors are the same for the equations for all eligible people and for working poor people. Thus, $x'_{i,t,1} = x'_{i,t,2}$. $\hat{B}_k$ is a (48×1) vector of regression coefficients, and is

$$(35) \quad \hat{B}_k = (X'(\Sigma_k + V)^{-1}X)^{-1}X'(\Sigma_k + V)^{-1}Y.$$

Finally, Σ_k is a block-diagonal matrix with 51 (6×6) blocks, and every block equals

$$(36) \quad \Sigma_k^* = \begin{pmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{pmatrix} \otimes \begin{pmatrix} \sigma_{1,k}^2 & \sigma_{1,k}\sigma_{2,k}\rho_k \\ \sigma_{1,k}\sigma_{2,k}\rho_k & \sigma_{2,k}^2 \end{pmatrix} + \begin{pmatrix} 1 & 1 & 1 \\ 1 & 1 & 1 \\ 1 & 1 & 1 \end{pmatrix} \otimes \begin{pmatrix} \eta_{1,k}^2 & \eta_{1,k}\eta_{2,k}\eta_{1,2,k} \\ \eta_{1,k}\eta_{2,k}\eta_{1,2,k} & \eta_{2,k}^2 \end{pmatrix}.$$

After calculating U_k , and p_k^* 7,469,280 times (once for each combination of σ_1 , σ_2 , ρ , η_1 , η_2 , and $\eta_{1,2}$), we calculated the probability of $(\sigma_{1,k}, \sigma_{2,k}, \rho_k, \eta_{1,k}, \eta_{2,k}, \eta_{1,2,k})$:

$$(37) \quad p_k = \frac{p_k^*}{\sum_{k=1}^{7,469,280} p_k^*},$$

which is also an estimate of the probability that the shrinkage estimates θ_k are the true values. As Equation (37) suggests, the θ_k are obtained by normalizing the p_k^* to sum to one.

To complete the numerical integration over σ_1 , σ_2 , ρ , η_1 , η_2 , and $\eta_{1,2}$ and obtain a single set of shrinkage estimates, we calculated a weighted sum of the 7,469,280 sets of shrinkage estimates, weighting each set θ_k by its associated probability p_k . Thus, our shrinkage estimates are:

$$(38) \quad \theta = \sum_{k=1}^{7,469,280} p_k \theta_k.$$

We call these estimates “preliminary” because we make some fairly small adjustments to them in the next step to derive our “final” estimates. The variance-covariance matrix for our preliminary shrinkage estimates is

$$(39) \quad U = \sum_{k=1}^{7,469,280} p_k U_k + \sum_{k=1}^{7,469,280} p_k (\theta_k - \theta)(\theta_k - \theta)'.$$

The first term on the right side of this expression reflects the error from sampling variability and the lack of fit of the regression model. The second term captures how the shrinkage estimates vary as σ_1 , σ_2 , ρ , η_1 , η_2 , and $\eta_{1,2}$ vary. Thus, the second term accounts for the variability from not knowing and, thus, having to estimate σ_1 , σ_2 , ρ , η_1 , η_2 , and $\eta_{1,2}$. As described later, standard errors of the final shrinkage estimates for States are calculated as functions of the square roots of the diagonal elements of U .

Regression estimates can be similarly obtained. They are

$$(40) \quad R = \sum_{k=1}^{7,469,280} p_k R_k,$$

where $R_k = X\hat{B}_k$ is the vector of regression estimates obtained when $\sigma_1 = \sigma_{1,k}$; $\sigma_2 = \sigma_{2,k}$; $\rho = \rho_k$; $\eta_1 = \eta_{1,k}$; $\eta_2 = \eta_{2,k}$; and $\eta_{1,2} = \eta_{1,2,k}$. The variance-covariance matrix is

$$(41) \quad G = \sum_{k=1}^{7,469,280} p_k G_k + \sum_{k=1}^{7,469,280} p_k (R_k - R)(R_k - R)',$$

where $G_k = X(X'(\Sigma_k + V)^{-1}X + \Sigma_k)^{-1}X' + \Sigma_k$. We can estimate the regression coefficient vector by

$$(42) \quad \hat{B} = \sum_{k=1}^{7,469,280} p_k \hat{B}_k.$$

Regression estimates of participation rates for all eligible people and working poor people are in Table A.18, and the standard errors for the regression estimates are in Table A.19. Preliminary shrinkage estimates of SNAP participation rates are displayed in Table A.20.

4. Adjust the preliminary shrinkage estimates to obtain final shrinkage estimates of State SNAP participation rates and numbers of eligible people

We adjusted the preliminary shrinkage estimates of participation rates in two ways. First, we adjusted the rates so that the number of eligible people implied by the rates sum to the national number of eligible people estimated directly from the CPS ASEC. Second, we adjusted the rates so that no State’s estimated rate was greater than 100 percent. These adjustments were carried out separately for each year and for the two groups of eligible people (all eligible people and working poor people).

To implement the first adjustment, we calculated preliminary estimates of counts for all eligible people according to

$$(43) \quad \psi_{1,i} = \frac{P_i(\varepsilon_{1,i} / 100)}{(\theta_{1,i} / 100)},$$

where $\psi_{1,i}$ is the preliminary count of all eligible people for State i , P_i and $\varepsilon_{1,i}$ are the participant count and correctly-eligible rate figures used in Equation (1), and $\theta_{1,i}$ is the preliminary participation rate derived in Equation (38). Using the FY 2019 estimates for all eligible people as an example, the State eligible people counts from Equation (43) summed to 42,593,713, and the national total estimated directly from the CPS ASEC was 41,073,677. To obtain estimated eligible people counts for States that sum (aside from rounding error) to the direct estimate of the national total, we multiplied each of the eligible people counts from Equation (43) by the ratio of 41,073,677 divided by 42,593,713, or 0.9643. Exhibit A.2 shows the direct estimates of national totals and adjustment factors for all three years and both groups.

Exhibit A.2. Direct estimates of national totals and adjustment factors

	All eligible people		Eligible working poor people	
	Direct estimate	Adjustment factor	Direct estimate	Adjustment factor
FY 2017	46,151,754	0.9811	22,156,168	0.9764
FY 2018	43,862,367	0.9767	20,659,346	0.9570
FY 2019	41,073,677	0.9643	18,923,637	0.9541

From the final shrinkage estimates of the numbers of eligible people, we calculated final shrinkage estimates of participation rates according to

$$(44) \quad \theta_{F,1,i} = 100 \frac{P_i(\varepsilon_{1,i} / 100)}{\psi_{F,1,i}},$$

where $\theta_{F,1,i}$ is the final shrinkage estimate of the participation rate for all eligible people in State i and $\psi_{F,1,i}$ is the final shrinkage estimate of the number of all eligible people. P_i and $\varepsilon_{1,i}$ are the participant count and correctly eligible rate figures used in Equations (1) and (38). We derived final shrinkage participation rates for eligible working poor people in the same way.

After calculating the final shrinkage participation rates, there were 9 instances where a State had an implied participation rate over 100 percent because the estimated number of eligible people was less than the number of participants. Exhibit A.3 shows the estimated participation rates over 100 percent by State, year, and group. (There were no estimated participation rates for working poor people over 100 percent in FY 2017 to FY 2019.) To cap participation rates at 100 percent, we increased the number of eligible people in States with estimated participation rates of over 100 percent so that the number of eligible people in that State equaled the number of participants each year. We reduced the number of eligible people in the other States and the District of Columbia by an equivalent number and in proportion to their numbers of eligible people. These adjustments, which were carried out separately for the three years and two groups, moved small numbers of eligible people among States but did not change the national totals or State rankings. Except for the States with participation rates initially over 100 percent, the adjustments did not change any State's participation rate by more than one percentage point.

Exhibit A.3. Estimated participation rates over 100 percent

	All eligible people		
	FY 2017	FY 2018	FY 2019
Delaware	100.1	107.0	106.5
Illinois		102.8	108.7
Massachusetts			100.1
New Mexico			105.5
Oregon	107.5	104.5	108.6
Pennsylvania			104.0
Rhode Island			107.2
Vermont			105.3
Washington		101.4	105.3

In Tables III.3 to III.8 of Chapter III, we reported approximate 90 percent confidence intervals for our final shrinkage estimates for all eligible people and eligible working poor people. The upper and lower bounds of the confidence intervals were calculated according to

$$(45) \quad \text{Upper Bound}_i = F_i + 1.645 e_i$$

and:

$$(46) \quad \text{Lower Bound}_i = F_i - 1.645 e_i,$$

where F_i is the final shrinkage estimate for State i and e_i is the standard error of that estimate. For participation rates and eligible people counts, the standard errors are, respectively

$$(47) \quad e_i = \frac{1}{r} \sqrt{U(6i-1, 6i-1)}$$

and

$$(48) \quad e_i = \frac{\psi_{F,1,i}}{\theta_{F,1,i}} r \sqrt{U(6i-1, 6i-1)},$$

where r is the ratio used to adjust preliminary estimates of State eligible people counts to the direct estimate of the national total (approximately 0.9643 for all eligible people for FY 2019), and $U(6i-1, 6i-1)$ is the $(6i-1, 6i-1)$ diagonal element of U for all eligible people for FY 2019, which was derived according to Equation (39). To derive standard error estimates for all eligible people for 2017 and 2018, we used the $(6i-5, 6i-5)$ and $(6i-3, 6i-3)$ diagonal elements of U , respectively. To derive estimates for working poor people for FY 2017, FY 2018, and FY 2019, we used the $(6i-4, 6i-4)$, $(6i-2, 6i-2)$, and $(6i, 6i)$ diagonal elements of U , respectively. Our estimate of e_i does not take account of the correlation between r and our preliminary shrinkage estimates for States, which were summed to obtain the denominator of r . Instead, r is treated as a constant.

Table A.21 presents final shrinkage estimates of participation rates for all eligible people and working poor people (values of $\theta_{F,1,i}$ and $\theta_{F,2,i}$), and Table A.22 presents standard errors for the rates. Tables A.23 and A.24 display final shrinkage estimates of the numbers of all eligible people and eligible working

poor people (values of $\psi_{F,1,i}$ and $\psi_{F,2,i}$), respectively, and Tables A.25 and A.26 present the standard errors for those estimated counts. (The rates in Table A.21 and counts in Tables A.23 and A.24 are the same as those in Table III.1 and Table III.2 except for the number of digits displayed.)

Table A.1. Number of people receiving SNAP benefits, monthly average

	FY 2017	FY 2018	FY 2019
Alabama	804,336	766,681	727,453
Alaska	89,113	91,995	84,900
Arizona	918,728	845,733	798,169
Arkansas	388,362	372,451	354,894
California	4,112,066	3,948,658	3,787,317
Colorado	459,247	449,824	450,596
Connecticut	410,344	387,329	367,918
Delaware	146,805	140,298	130,162
District of Columbia	123,289	112,282	110,033
Florida	3,184,409	3,080,213	2,836,821
Georgia	1,625,415	1,556,452	1,415,705
Hawaii	169,045	163,604	157,427
Idaho	171,251	157,858	146,641
Illinois	1,878,519	1,826,011	1,776,902
Indiana	671,986	617,032	576,302
Iowa	365,893	345,406	320,214
Kansas	233,778	217,420	201,164
Kentucky	654,873	615,305	542,044
Louisiana	928,616	867,342	809,106
Maine	179,734	167,858	156,623
Maryland	684,282	646,483	619,684
Massachusetts	765,714	770,566	759,669
Michigan	1,375,434	1,281,862	1,179,611
Minnesota	453,564	428,986	409,575
Mississippi	537,370	505,308	454,946
Missouri	758,855	736,590	693,955
Montana	120,889	115,223	107,439
Nebraska	175,849	169,811	160,946
Nevada	440,614	439,941	423,233
New Hampshire	92,457	86,502	76,420
New Jersey	817,979	760,303	706,216
New Mexico	460,534	456,251	448,706
New York	2,910,894	2,796,620	2,661,700
North Carolina	1,345,612	1,086,802	1,293,181
North Dakota	53,748	52,621	48,769
Ohio	1,501,795	1,421,366	1,383,876
Oklahoma	603,896	585,064	574,029
Oregon	680,671	633,970	599,143
Pennsylvania	1,842,945	1,818,589	1,757,826
Rhode Island	159,187	157,050	152,331
South Carolina	719,977	658,119	600,961
South Dakota	93,259	87,410	81,164
Tennessee	1,047,049	970,875	905,226
Texas	3,868,117	3,808,084	3,418,518
Utah	206,299	189,093	172,174
Vermont	76,558	73,058	69,301
Virginia	775,548	736,221	705,289
Washington	929,486	877,244	824,897
West Virginia	340,300	321,009	306,486
Wisconsin	691,635	652,885	618,225
Wyoming	32,839	29,330	26,429
United States	42,079,165	40,082,988	37,990,316

Source: USDA, Food and Nutrition Service.

Table A.2. Estimated percentage of participants who are correctly receiving benefits and eligible under federal SNAP rules

	All participants			Working poor participants		
	FY 2017	FY 2018	FY 2019	FY 2017	FY 2018	FY 2019
Alabama	95.56	94.58	94.04	42.76	41.75	35.32
Alaska	96.77	97.90	93.95	44.62	42.25	39.33
Arizona	85.94	86.23	86.89	42.37	40.04	36.49
Arkansas	96.52	97.49	96.98	41.05	37.92	40.76
California	88.25	87.01	88.82	40.23	37.96	34.29
Colorado	92.94	92.85	90.83	38.48	39.55	35.26
Connecticut	85.18	85.06	84.74	33.03	28.60	30.81
Delaware	79.70	78.68	82.08	36.04	29.69	34.94
District of Columbia	91.33	89.99	91.67	16.34	14.69	15.64
Florida	89.83	88.70	88.77	37.22	35.18	33.23
Georgia	93.79	92.19	92.56	38.90	38.11	36.74
Hawaii	89.00	89.73	90.14	43.21	36.26	39.62
Idaho	92.56	92.09	93.31	50.34	49.50	46.26
Illinois	88.69	88.27	88.64	37.65	37.62	39.81
Indiana	96.81	94.65	91.95	44.97	45.60	43.15
Iowa	84.08	83.46	82.47	43.76	41.30	42.63
Kansas	98.75	97.24	96.94	48.08	47.60	45.03
Kentucky	93.54	92.59	91.05	32.87	33.30	36.21
Louisiana	99.34	98.99	98.69	38.56	37.93	36.81
Maine	81.29	83.86	77.72	35.63	31.67	25.31
Maryland	87.48	86.90	85.18	31.56	32.63	26.11
Massachusetts	87.38	85.92	85.67	23.64	22.16	22.73
Michigan	86.59	86.33	85.69	38.87	36.63	33.68
Minnesota	81.59	85.03	85.13	40.80	42.18	40.64
Mississippi	96.39	95.81	96.19	39.66	36.57	38.12
Missouri	94.85	94.91	95.91	41.48	36.05	39.51
Montana	88.08	85.40	86.17	36.13	39.68	34.05
Nebraska	92.33	92.04	92.28	49.21	47.10	46.02
Nevada	86.46	85.87	82.63	37.76	36.82	35.91
New Hampshire	86.14	85.91	86.67	35.04	26.34	27.52
New Jersey	88.76	88.18	90.84	38.16	37.77	37.79
New Mexico	91.67	90.43	90.12	41.54	44.37	45.72
New York	88.60	88.93	86.75	36.81	31.90	29.80
North Carolina	89.73	110.51	87.93	36.62	50.29	38.86
North Dakota	79.08	80.98	79.87	27.42	31.98	35.26
Ohio	91.38	90.43	90.38	41.80	40.79	37.99
Oklahoma	95.02	93.09	92.65	39.50	41.77	39.75
Oregon	82.74	81.87	85.82	32.98	29.85	31.94
Pennsylvania	86.71	86.02	88.19	36.01	37.57	39.28
Rhode Island	85.86	85.81	81.56	26.24	23.34	26.68
South Carolina	95.12	93.36	93.77	42.05	34.15	38.24
South Dakota	98.81	97.72	98.26	43.83	41.48	39.68
Tennessee	98.26	97.98	97.18	36.30	35.84	32.32
Texas	87.74	87.74	87.25	42.02	47.55	44.90
Utah	97.47	97.18	98.46	51.15	50.96	52.05
Vermont	86.20	83.45	83.41	31.59	31.78	27.05
Virginia	95.53	96.70	94.84	39.94	39.69	37.31
Washington	83.01	80.41	81.23	31.75	25.37	21.10
West Virginia	90.73	89.89	87.84	31.91	31.03	26.40
Wisconsin	84.83	83.19	84.31	42.65	39.07	36.38
Wyoming	98.16	98.01	99.08	40.14	47.99	41.78

Source: SNAP QC database.

Table A.3. Estimated number of participants who are correctly receiving benefits and income eligible under federal SNAP rules, monthly average

	FY 2017	FY 2018	FY 2019
Alabama	768,583	725,158	684,097
Alaska	86,233	90,067	79,761
Arizona	789,573	729,267	693,553
Arkansas	374,863	363,095	344,176
California	3,628,816	3,435,609	3,363,933
Colorado	426,820	417,657	409,276
Connecticut	349,519	329,466	311,777
Delaware	117,005	110,384	106,833
District of Columbia	112,604	101,041	100,865
Florida	2,860,523	2,732,180	2,518,359
Georgia	1,524,460	1,434,831	1,310,405
Hawaii	150,455	146,800	141,908
Idaho	158,517	145,375	136,832
Illinois	1,666,077	1,611,765	1,575,135
Indiana	650,563	584,033	529,915
Iowa	307,654	288,276	264,068
Kansas	230,846	211,428	195,016
Kentucky	612,568	569,699	493,509
Louisiana	922,459	858,556	798,499
Maine	146,097	140,761	121,720
Maryland	598,596	561,800	527,822
Massachusetts	669,104	662,039	650,816
Michigan	1,190,961	1,106,619	1,010,797
Minnesota	370,058	364,784	348,655
Mississippi	517,992	484,151	437,594
Missouri	719,774	699,090	665,600
Montana	106,477	98,405	92,579
Nebraska	162,368	156,297	148,527
Nevada	380,955	377,760	349,717
New Hampshire	79,638	74,314	66,237
New Jersey	726,030	670,443	641,548
New Mexico	422,172	412,574	404,351
New York	2,578,994	2,486,894	2,308,972
North Carolina	1,207,431	1,200,981	1,137,094
North Dakota	42,504	42,615	38,951
Ohio	1,372,265	1,285,398	1,250,706
Oklahoma	573,798	544,619	531,855
Oregon	563,160	519,012	514,197
Pennsylvania	1,598,036	1,564,423	1,550,192
Rhode Island	136,680	134,758	124,247
South Carolina	684,813	614,426	563,533
South Dakota	92,152	85,417	79,752
Tennessee	1,028,820	951,215	879,681
Texas	3,393,770	3,341,137	2,982,760
Utah	201,076	183,764	169,519
Vermont	65,992	60,965	57,806
Virginia	740,865	711,940	668,917
Washington	771,538	705,374	670,023
West Virginia	308,747	288,558	269,223
Wisconsin	586,707	543,115	521,225
Wyoming	32,236	28,747	26,186
United States	37,807,944	35,987,083	33,868,720

Source: SNAP QC database.

Table A.4. Estimated number of working poor participants who are correctly receiving benefits and eligible under federal SNAP rules, monthly average

	FY 2017	FY 2018	FY 2019
Alabama	343,966	320,112	256,951
Alaska	39,762	38,870	33,388
Arizona	389,274	338,631	291,260
Arkansas	159,407	141,241	144,644
California	1,654,120	1,499,029	1,298,747
Colorado	176,737	177,914	158,858
Connecticut	135,541	110,788	113,352
Delaware	52,914	41,661	45,473
District of Columbia	20,152	16,491	17,210
Florida	1,185,364	1,083,619	942,619
Georgia	632,270	593,211	520,144
Hawaii	73,043	59,316	62,369
Idaho	86,204	78,137	67,832
Illinois	707,338	686,945	707,331
Indiana	302,165	281,342	248,663
Iowa	160,118	142,653	136,494
Kansas	112,403	103,501	90,578
Kentucky	215,250	204,878	196,252
Louisiana	358,056	329,000	297,824
Maine	64,032	53,156	39,646
Maryland	215,973	210,928	161,781
Massachusetts	181,007	170,781	172,635
Michigan	534,576	469,508	397,246
Minnesota	185,063	180,942	166,451
Mississippi	213,110	184,796	173,421
Missouri	314,781	265,511	274,147
Montana	43,675	45,722	36,588
Nebraska	86,534	79,986	74,069
Nevada	166,376	161,969	151,979
New Hampshire	32,393	22,785	21,030
New Jersey	312,141	287,144	266,914
New Mexico	191,324	202,443	205,130
New York	1,071,471	892,262	793,054
North Carolina	492,790	546,498	502,556
North Dakota	14,738	16,826	17,194
Ohio	627,675	579,804	525,776
Oklahoma	238,551	244,358	228,159
Oregon	224,492	189,259	191,348
Pennsylvania	663,589	683,280	690,439
Rhode Island	41,777	36,654	40,645
South Carolina	302,758	224,781	229,777
South Dakota	40,872	36,259	32,203
Tennessee	380,026	347,952	292,542
Texas	1,625,460	1,810,782	1,534,983
Utah	105,516	96,352	89,613
Vermont	24,183	23,216	18,747
Virginia	309,762	292,199	263,108
Washington	295,140	222,566	174,045
West Virginia	108,583	99,609	80,928
Wisconsin	294,989	255,089	224,886
Wyoming	13,183	14,074	11,041
United States	16,220,624	15,194,827	13,712,070

Source: SNAP QC database.

Table A.5. Estimated percentage of people eligible for SNAP

	All eligible people			Working poor people		
	FY 2017	FY 2018	FY 2019	FY 2017	FY 2018	FY 2019
Alabama	19.54	19.52	17.26	8.69	8.09	6.31
Alaska	15.60	14.26	13.23	7.07	6.62	6.68
Arizona	15.10	14.47	12.43	7.90	7.37	6.20
Arkansas	18.38	18.09	16.78	7.69	8.05	7.07
California	13.21	12.74	12.70	7.34	6.73	6.59
Colorado	10.38	9.87	9.35	5.49	5.09	4.43
Connecticut	11.51	10.94	7.62	4.50	4.40	2.84
Delaware	11.98	10.17	9.34	5.48	4.13	3.65
District of Columbia	17.74	17.75	15.25	6.16	6.51	4.46
Florida	16.01	15.66	15.22	7.31	6.87	6.76
Georgia	17.43	16.70	16.62	8.64	8.50	8.32
Hawaii	14.10	12.91	11.28	7.67	6.55	5.57
Idaho	11.75	11.49	9.40	6.29	6.35	5.24
Illinois	13.13	11.64	10.96	6.22	5.23	5.04
Indiana	13.37	11.82	11.44	5.98	5.53	5.31
Iowa	9.08	7.98	9.79	4.51	4.48	5.13
Kansas	12.85	10.34	10.07	6.84	5.44	5.27
Kentucky	17.63	16.55	16.46	7.26	5.85	5.98
Louisiana	23.91	22.81	20.74	10.91	10.83	9.12
Maine	14.65	13.12	12.06	6.00	4.98	4.04
Maryland	10.29	9.54	9.57	4.74	3.93	4.01
Massachusetts	11.70	10.45	9.00	5.21	4.84	3.46
Michigan	13.58	12.55	11.71	6.53	5.48	4.40
Minnesota	9.74	10.32	8.27	4.60	5.21	3.93
Mississippi	23.86	23.94	23.86	10.88	10.34	9.76
Missouri	13.01	13.08	11.05	6.21	5.94	4.06
Montana	10.93	10.67	10.63	5.09	5.02	4.41
Nebraska	10.99	10.84	9.76	6.19	5.93	5.66
Nevada	14.19	14.38	12.60	6.43	7.18	6.62
New Hampshire	8.17	6.48	5.72	3.38	2.90	3.08
New Jersey	10.57	9.45	8.85	4.77	4.12	3.46
New Mexico	22.31	20.72	19.29	11.78	10.89	9.73
New York	15.02	14.76	14.18	6.43	6.38	5.72
North Carolina	17.14	16.21	16.24	8.22	7.59	7.88
North Dakota	9.58	8.74	7.17	4.50	3.56	3.14
Ohio	14.36	13.44	13.46	5.95	6.05	6.30
Oklahoma	16.53	15.30	13.68	8.13	7.05	6.35
Oregon	12.77	11.57	9.36	5.66	5.20	4.06
Pennsylvania	13.57	12.42	11.46	5.67	5.09	5.21
Rhode Island	12.46	12.09	11.88	4.79	4.22	4.44
South Carolina	17.24	15.16	14.98	7.15	6.90	7.25
South Dakota	13.69	12.10	10.44	5.95	5.30	4.44
Tennessee	16.58	14.38	15.49	7.19	6.51	7.01
Texas	16.36	15.93	14.62	9.13	8.45	7.53
Utah	8.86	8.00	7.12	5.74	4.95	4.12
Vermont	10.46	9.82	9.53	4.53	4.01	4.16
Virginia	11.88	11.38	11.08	5.48	5.39	5.31
Washington	11.23	9.01	7.32	5.25	3.74	3.06
West Virginia	21.21	19.01	16.89	6.86	6.56	7.11
Wisconsin	9.98	10.30	9.09	5.87	5.59	4.49
Wyoming	11.98	10.19	9.78	5.70	5.21	5.41

Source: CPS ASEC.

Table A.6. Directly estimated number of people eligible for SNAP

	FY 2017	FY 2018	FY 2019
Alabama	941,919	949,204	841,764
Alaska	111,932	102,889	93,663
Arizona	1,052,025	1,040,232	906,154
Arkansas	539,225	528,307	489,603
California	5,191,389	4,997,272	5,000,373
Colorado	574,019	561,565	538,478
Connecticut	409,885	377,792	264,749
Delaware	115,432	99,178	90,951
District of Columbia	122,450	122,907	107,007
Florida	3,337,231	3,306,026	3,252,404
Georgia	1,790,847	1,735,768	1,728,094
Hawaii	197,871	180,438	155,180
Idaho	201,964	201,948	168,158
Illinois	1,656,275	1,466,107	1,374,213
Indiana	874,041	777,888	764,325
Iowa	278,535	247,438	306,903
Kansas	369,163	294,733	284,268
Kentucky	775,394	734,709	727,253
Louisiana	1,087,835	1,031,448	944,830
Maine	193,172	173,591	161,307
Maryland	615,162	575,676	581,223
Massachusetts	795,257	718,461	621,105
Michigan	1,345,760	1,246,940	1,161,602
Minnesota	542,889	590,047	471,679
Mississippi	704,242	698,279	695,134
Missouri	777,279	787,786	669,875
Montana	113,682	111,169	111,749
Nebraska	206,479	205,078	185,008
Nevada	421,969	432,825	388,333
New Hampshire	108,704	87,286	77,257
New Jersey	949,499	836,133	774,574
New Mexico	455,298	425,748	397,514
New York	2,957,614	2,874,174	2,718,230
North Carolina	1,756,837	1,679,494	1,699,340
North Dakota	71,212	65,019	53,944
Ohio	1,653,328	1,542,342	1,549,029
Oklahoma	636,815	590,841	533,485
Oregon	536,120	485,315	389,047
Pennsylvania	1,708,482	1,559,471	1,439,200
Rhode Island	130,686	125,710	124,276
South Carolina	853,252	761,734	767,566
South Dakota	118,609	103,735	89,749
Tennessee	1,110,135	963,229	1,041,731
Texas	4,582,636	4,528,506	4,193,312
Utah	276,314	253,252	229,271
Vermont	64,466	60,551	58,702
Virginia	977,528	951,631	926,396
Washington	830,905	678,728	553,121
West Virginia	382,205	337,513	296,238
Wisconsin	580,252	598,726	523,347
Wyoming	67,532	57,526	55,304
United States	46,151,753	43,862,365	41,576,026

Source: CPS ASEC.

Table A.7. Directly estimated number of working poor people eligible for SNAP

	FY 2017	FY 2018	FY 2019
Alabama	419,123	393,643	307,661
Alaska	50,699	47,736	47,331
Arizona	550,559	530,028	451,788
Arkansas	225,522	235,108	206,278
California	2,883,349	2,640,608	2,595,943
Colorado	303,297	289,505	255,077
Connecticut	160,296	151,714	98,691
Delaware	52,805	40,241	35,574
District of Columbia	42,546	45,096	31,293
Florida	1,523,646	1,450,672	1,443,641
Georgia	886,992	883,824	864,890
Hawaii	107,537	91,551	76,666
Idaho	108,038	111,644	93,663
Illinois	784,987	659,207	631,341
Indiana	391,302	363,820	354,967
Iowa	138,421	138,854	160,952
Kansas	196,580	155,142	148,690
Kentucky	319,268	259,732	264,057
Louisiana	496,497	489,808	415,711
Maine	79,136	65,825	54,093
Maryland	283,094	236,973	243,502
Massachusetts	353,791	332,508	239,087
Michigan	647,427	544,205	436,703
Minnesota	256,364	297,573	224,104
Mississippi	321,098	301,588	284,477
Missouri	371,281	357,997	246,230
Montana	52,956	52,264	46,363
Nebraska	116,342	112,070	107,172
Nevada	191,373	215,967	204,205
New Hampshire	44,994	38,991	41,589
New Jersey	428,228	364,320	303,001
New Mexico	240,463	223,817	200,396
New York	1,265,355	1,242,573	1,096,005
North Carolina	842,202	786,063	824,585
North Dakota	33,411	26,472	23,588
Ohio	685,432	694,643	725,639
Oklahoma	313,167	272,409	247,572
Oregon	237,655	218,211	168,590
Pennsylvania	713,929	639,135	654,586
Rhode Island	50,214	43,861	46,446
South Carolina	353,790	346,606	371,551
South Dakota	51,588	45,450	38,139
Tennessee	481,809	436,193	471,569
Texas	2,555,688	2,401,015	2,160,029
Utah	179,142	156,645	132,587
Vermont	27,904	24,712	25,657
Virginia	451,116	451,109	443,698
Washington	388,778	281,616	231,447
West Virginia	123,596	116,512	124,786
Wisconsin	341,226	324,666	258,712
Wyoming	32,156	29,425	30,582
United States	22,156,167	20,659,345	19,190,902

Source: CPS ASEC.

Table A.8. CPS ASEC population estimate

	FY 2017	FY 2018	FY 2019
Alabama	4,820,815	4,863,571	4,876,418
Alaska	717,431	721,566	708,085
Arizona	6,966,095	7,187,373	7,290,801
Arkansas	2,934,369	2,920,062	2,917,800
California	39,292,653	39,240,144	39,368,072
Colorado	5,529,211	5,688,751	5,760,986
Connecticut	3,560,181	3,451,880	3,474,732
Delaware	963,946	975,502	973,695
District of Columbia	690,406	692,544	701,815
Florida	20,851,024	21,107,389	21,370,984
Georgia	10,271,931	10,395,999	10,399,034
Hawaii	1,402,848	1,397,484	1,376,072
Idaho	1,718,632	1,757,875	1,788,228
Illinois	12,610,953	12,600,165	12,533,483
Indiana	6,538,271	6,580,035	6,681,973
Iowa	3,066,069	3,100,009	3,134,551
Kansas	2,872,684	2,851,686	2,822,952
Kentucky	4,397,309	4,439,959	4,419,357
Louisiana	4,550,227	4,522,566	4,555,918
Maine	1,318,447	1,322,891	1,337,742
Maryland	5,977,534	6,031,940	6,073,686
Massachusetts	6,794,543	6,872,921	6,901,611
Michigan	9,908,214	9,936,957	9,921,148
Minnesota	5,572,938	5,716,201	5,700,269
Mississippi	2,951,480	2,916,597	2,913,781
Missouri	5,975,751	6,024,479	6,062,882
Montana	1,040,196	1,041,842	1,051,255
Nebraska	1,878,638	1,891,310	1,895,026
Nevada	2,974,613	3,009,090	3,083,048
New Hampshire	1,330,906	1,346,133	1,350,912
New Jersey	8,984,709	8,849,297	8,752,953
New Mexico	2,040,738	2,054,871	2,060,455
New York	19,686,401	19,475,315	19,172,861
North Carolina	10,248,861	10,360,068	10,461,528
North Dakota	743,160	744,104	752,338
Ohio	11,511,577	11,479,167	11,509,548
Oklahoma	3,852,593	3,862,179	3,898,392
Oregon	4,196,850	4,194,068	4,157,405
Pennsylvania	12,588,405	12,556,499	12,555,889
Rhode Island	1,049,130	1,039,996	1,045,886
South Carolina	4,949,317	5,024,763	5,124,836
South Dakota	866,370	857,574	859,604
Tennessee	6,697,490	6,697,665	6,725,083
Texas	28,004,737	28,425,458	28,682,740
Utah	3,119,746	3,166,083	3,220,214
Vermont	616,141	616,871	616,132
Virginia	8,231,330	8,363,593	8,362,221
Washington	7,401,572	7,530,083	7,556,122
West Virginia	1,801,743	1,775,598	1,754,139
Wisconsin	5,814,257	5,810,465	5,759,722
Wyoming	563,881	564,261	565,625
United States	322,447,323	324,052,896	325,040,009

Source: CPS ASEC.

Table A.9. Population on July 1

	FY 2017	FY 2018	FY 2019
Alabama	4,875,120	4,887,681	4,907,965
Alaska	739,786	735,139	733,603
Arizona	7,048,876	7,158,024	7,291,843
Arkansas	3,002,997	3,009,733	3,020,985
California	39,399,349	39,461,588	39,437,610
Colorado	5,615,902	5,691,287	5,758,486
Connecticut	3,573,880	3,571,520	3,566,022
Delaware	957,078	965,479	976,668
District of Columbia	695,691	701,547	708,253
Florida	20,976,812	21,244,317	21,492,056
Georgia	10,413,055	10,511,131	10,628,020
Hawaii	1,424,203	1,420,593	1,415,615
Idaho	1,718,904	1,750,536	1,789,060
Illinois	12,786,196	12,723,071	12,667,017
Indiana	6,660,082	6,695,497	6,731,010
Iowa	3,143,637	3,148,618	3,159,596
Kansas	2,910,689	2,911,359	2,912,635
Kentucky	4,453,874	4,461,153	4,472,345
Louisiana	4,670,818	4,659,690	4,658,285
Maine	1,335,063	1,339,057	1,345,770
Maryland	6,024,891	6,035,802	6,054,954
Massachusetts	6,863,246	6,882,635	6,894,883
Michigan	9,976,447	9,984,072	9,984,795
Minnesota	5,568,155	5,606,249	5,640,053
Mississippi	2,989,663	2,981,020	2,978,227
Missouri	6,108,612	6,121,623	6,140,475
Montana	1,053,090	1,060,665	1,070,123
Nebraska	1,917,575	1,925,614	1,932,571
Nevada	2,972,405	3,027,341	3,090,771
New Hampshire	1,349,767	1,353,465	1,360,783
New Jersey	8,888,543	8,886,025	8,891,258
New Mexico	2,093,395	2,092,741	2,099,634
New York	19,590,719	19,530,351	19,463,131
North Carolina	10,270,800	10,381,615	10,501,384
North Dakota	755,176	758,080	763,724
Ohio	11,664,129	11,676,341	11,696,507
Oklahoma	3,932,640	3,940,235	3,960,676
Oregon	4,146,592	4,181,886	4,216,116
Pennsylvania	12,790,447	12,800,922	12,798,883
Rhode Island	1,056,486	1,058,287	1,058,158
South Carolina	5,021,219	5,084,156	5,157,702
South Dakota	873,286	878,698	887,127
Tennessee	6,708,794	6,771,631	6,830,325
Texas	28,322,717	28,628,666	28,986,794
Utah	3,103,118	3,153,550	3,203,383
Vermont	624,525	624,358	624,046
Virginia	8,465,207	8,501,286	8,556,642
Washington	7,425,432	7,523,869	7,614,024
West Virginia	1,817,048	1,804,291	1,795,263
Wisconsin	5,792,051	5,807,406	5,824,581
Wyoming	578,934	577,601	580,116
United States	325,147,121	326,687,501	328,329,953

Source: U.S. Census Bureau, Population Division.

Table A.10. Percentage of working poor participants without reported earned income but with other indicators of earnings

	FY 2017	FY 2018	FY 2019
Alabama	0.0	0.0	0.0
Alaska	0.0	0.0	0.0
Arizona	0.0	0.0	0.0
Arkansas	0.0	0.0	0.0
California	0.7	0.0	0.0
Colorado	0.0	0.0	0.0
Connecticut	0.0	0.0	0.0
Delaware	0.0	0.0	0.0
District of Columbia	0.0	0.0	0.0
Florida	0.0	0.6	0.0
Georgia	0.0	0.0	0.0
Hawaii	0.0	0.0	0.6
Idaho	0.0	0.0	0.0
Illinois	0.0	0.0	0.0
Indiana	0.0	0.0	0.0
Iowa	0.4	0.3	0.2
Kansas	0.0	0.0	0.0
Kentucky	0.0	0.2	0.3
Louisiana	0.0	0.0	0.0
Maine	0.0	0.0	0.0
Maryland	0.0	0.0	0.0
Massachusetts	0.0	0.0	0.0
Michigan	0.0	0.0	0.0
Minnesota	0.4	0.7	0.0
Mississippi	0.0	0.0	0.0
Missouri	0.0	0.0	0.0
Montana	0.0	0.0	0.0
Nebraska	0.0	0.0	0.0
Nevada	0.0	0.0	0.0
New Hampshire	0.0	0.0	0.0
New Jersey	0.0	0.0	0.0
New Mexico	0.0	0.0	0.0
New York	0.0	0.0	0.0
North Carolina	0.0	0.0	0.0
North Dakota	0.0	0.0	0.4
Ohio	0.0	0.5	0.0
Oklahoma	0.0	0.0	0.0
Oregon	0.0	0.0	0.0
Pennsylvania	0.0	0.0	0.0
Rhode Island	0.0	0.0	0.0
South Carolina	0.0	0.0	0.0
South Dakota	0.0	0.0	0.2
Tennessee	0.0	0.0	0.0
Texas	0.0	0.0	0.1
Utah	0.0	0.0	0.0
Vermont	0.0	0.0	0.0
Virginia	0.0	0.0	0.0
Washington	0.0	0.0	0.0
West Virginia	0.0	0.0	0.0
Wisconsin	0.0	0.0	0.0
Wyoming	0.0	0.0	0.0

Source: SNAP QC database.

Table A.11. Direct estimates of SNAP participation rates

	All eligible people			Working poor people		
	FY 2017	FY 2018	FY 2019	FY 2017	FY 2018	FY 2019
Alabama	80.69	76.02	80.75	81.16	80.92	82.98
Alaska	74.71	85.92	82.20	76.06	79.92	68.09
Arizona	74.17	70.39	76.53	69.87	64.15	64.46
Arkansas	67.93	66.68	67.90	69.07	58.29	67.73
California	69.71	68.36	67.16	57.21	56.45	49.94
Colorado	73.21	74.34	76.04	57.37	61.43	62.31
Connecticut	84.95	84.29	114.75	84.23	70.58	111.91
Delaware	102.09	112.45	117.11	100.92	104.60	127.44
District of Columbia	91.26	81.15	93.40	47.00	36.10	54.50
Florida	85.20	82.11	76.99	77.33	74.22	64.93
Georgia	83.97	81.76	74.20	70.32	66.38	58.85
Hawaii	74.90	80.03	88.89	66.91	63.74	79.08
Idaho	78.48	72.29	81.33	79.78	70.28	72.39
Illinois	99.21	108.87	113.41	88.87	103.20	110.86
Indiana	73.07	73.79	68.83	75.81	76.00	69.54
Iowa	107.73	114.71	85.36	112.82	101.15	84.13
Kansas	61.72	70.27	66.49	56.43	65.35	59.04
Kentucky	78.00	77.17	67.06	66.56	78.51	73.44
Louisiana	82.61	80.79	82.66	70.25	65.19	70.07
Maine	74.69	80.11	75.01	79.91	79.78	72.85
Maryland	96.54	97.53	91.09	75.69	88.95	66.65
Massachusetts	83.29	92.02	104.89	50.65	51.29	72.28
Michigan	87.89	88.33	86.46	82.01	85.87	90.39
Minnesota	68.22	63.04	74.71	72.25	62.00	75.07
Mississippi	72.61	67.84	61.59	65.52	59.95	59.64
Missouri	90.59	87.33	98.11	82.94	72.99	109.93
Montana	92.52	86.95	81.38	81.47	85.93	77.52
Nebraska	77.04	74.86	78.72	72.87	70.10	67.77
Nevada	90.35	86.75	89.83	87.00	74.55	74.24
New Hampshire	72.24	84.68	85.11	70.99	58.12	50.20
New Jersey	77.29	79.85	81.54	73.68	78.49	86.72
New Mexico	90.39	95.15	99.82	77.56	88.81	100.45
New York	87.63	86.28	83.68	85.09	71.61	71.28
North Carolina	68.58	71.36	66.66	58.39	69.38	60.72
North Dakota	58.74	64.33	71.13	43.41	62.39	71.80
Ohio	81.92	81.93	79.45	90.38	82.06	71.30
Oklahoma	88.27	90.35	98.13	74.62	87.93	90.71
Oregon	106.32	107.26	130.33	95.61	86.99	111.92
Pennsylvania	92.06	98.40	105.67	91.48	104.87	103.47
Rhode Island	103.86	105.35	98.82	82.62	82.13	86.49
South Carolina	79.11	79.72	72.95	84.35	64.09	61.45
South Dakota	77.08	80.36	86.10	78.60	77.86	81.82
Tennessee	92.52	97.67	83.14	78.74	78.90	61.08
Texas	73.23	73.26	70.39	62.89	74.88	70.32
Utah	73.16	72.85	74.33	59.22	61.76	67.94
Vermont	100.99	99.48	97.22	85.50	92.82	72.14
Virginia	73.70	73.60	70.57	66.77	63.73	57.95
Washington	92.56	104.01	120.21	75.67	79.10	74.63
West Virginia	80.10	84.14	88.80	87.11	84.13	63.37
Wisconsin	101.50	90.76	98.49	86.78	78.61	85.96
Wyoming	46.49	48.82	46.17	39.93	46.73	35.20

Table A.12. Standard errors of direct estimates of SNAP participation rates

	All eligible people			Working poor people		
	FY 2017	FY 2018	FY 2019	FY 2017	FY 2018	FY 2019
Alabama	3.952	4.101	5.332	5.466	7.537	8.930
Alaska	8.718	6.071	6.017	12.933	10.637	8.852
Arizona	5.761	5.172	5.794	7.779	7.033	7.041
Arkansas	3.417	3.456	4.477	6.138	5.314	6.927
California	2.032	1.936	1.806	3.510	3.958	3.567
Colorado	6.151	6.223	7.901	6.852	7.772	7.882
Connecticut	7.443	7.329	11.992	12.157	11.408	21.686
Delaware	7.513	8.277	10.507	13.523	15.800	24.374
District of Columbia	4.436	4.403	5.570	6.866	5.914	9.324
Florida	3.290	3.802	3.220	5.247	5.851	5.345
Georgia	3.587	4.248	4.244	5.459	5.544	6.947
Hawaii	4.842	5.471	7.097	7.675	8.006	10.606
Idaho	5.338	5.172	4.663	7.052	7.576	7.255
Illinois	4.313	6.492	7.118	7.294	10.126	11.158
Indiana	4.768	5.377	4.130	9.120	8.692	7.405
Iowa	8.905	11.837	8.620	10.961	11.027	10.489
Kansas	4.134	5.390	6.209	5.881	6.260	7.416
Kentucky	6.244	5.744	6.069	8.857	9.528	9.544
Louisiana	2.455	2.718	3.485	5.103	4.778	5.384
Maine	5.513	9.376	8.470	11.470	18.564	15.433
Maryland	8.235	7.423	7.456	10.566	13.272	11.052
Massachusetts	5.610	6.225	7.620	7.261	7.461	9.344
Michigan	4.762	4.309	4.829	7.509	8.315	9.817
Minnesota	5.995	4.664	6.119	10.129	7.714	8.786
Mississippi	1.924	2.464	2.959	5.747	5.184	7.332
Missouri	6.017	7.035	9.922	8.639	9.248	24.854
Montana	6.679	8.315	5.171	11.264	12.820	11.215
Nebraska	7.943	6.894	5.793	9.619	7.821	7.829
Nevada	6.313	5.048	5.761	10.007	7.981	8.694
New Hampshire	6.031	7.587	8.994	10.470	11.228	8.969
New Jersey	5.237	5.389	5.932	8.493	9.466	11.097
New Mexico	5.667	7.576	6.176	6.344	9.400	10.898
New York	3.521	3.346	3.118	6.859	6.806	6.462
North Carolina	3.325	3.725	3.171	4.428	4.998	4.711
North Dakota	5.690	5.717	6.651	7.298	8.189	10.784
Ohio	3.603	5.049	5.413	8.035	8.327	7.867
Oklahoma	6.469	6.209	7.039	7.746	11.351	12.939
Oregon	8.720	6.667	11.193	14.934	10.343	17.338
Pennsylvania	4.115	5.306	6.013	8.619	10.687	10.955
Rhode Island	9.729	9.232	10.342	14.775	16.164	14.271
South Carolina	4.164	4.509	4.296	8.989	6.109	7.586
South Dakota	11.478	8.092	8.952	13.172	13.841	9.509
Tennessee	4.361	4.770	5.253	6.751	7.196	6.105
Texas	2.261	2.197	2.184	3.750	4.359	4.625
Utah	6.587	7.918	8.828	7.401	8.418	9.175
Vermont	7.180	7.305	9.815	11.748	13.325	13.191
Virginia	4.563	5.155	6.121	7.239	7.231	7.625
Washington	5.377	7.584	9.722	9.707	11.625	11.530
West Virginia	5.427	4.151	6.047	8.258	10.114	9.144
Wisconsin	6.191	6.049	8.275	8.145	9.059	11.367
Wyoming	3.134	4.683	6.027	4.967	6.375	6.966

Table A.13. Potential predictors

Predictor	Data source(s)
Number of people who received SNAP benefits	Administrative data
Estimated population on July 1; Change in July 1 estimated population	Census Bureau
Percentages of population that (1) received SNAP benefits, (2) correctly received regular SNAP benefits, and (3) correctly received regular SNAP benefits under federal eligibility rules	Administrative data; population estimates
Percentage of children ages 5 to 17 approved to receive free lunches under the National School Lunch Program	
Percentage of elderly people that received Supplemental Security Income	
Percentage of population that received unemployment	
Per capita personal income	Commerce Bureau; population estimates
Mean adjusted gross income; Median adjusted gross income	Individual income tax data
Percentages of exemptions for (1) people, (2) elderly people, and (3) children claimed on tax returns with adjusted gross income below the federal poverty level (FPL)	
Percentages of (1) people, (2) elderly people, and (3) nonelderly people not claimed on tax returns	Individual income tax data; population estimates
Percentages of (1) people; (2) elderly people; and (3) non-elderly people, not claimed on tax returns or claimed on returns with adjusted gross income below the FPL	
Percentages of population that were (1) foreign-born and entered the U.S. in 2000 or later and (2) noncitizens	American Community Survey one-year estimates
Percentage of foreign-born people who entered the U.S. in 2000 or later	
Percentages of households that (1) were married-couple families, (2) were nonfamily households, and (3) had one or more children under age 18	
Percentages of households and families that had a female householder, no husband present, and related children under age 18	
Percentages of adults age 25 and older who had (1) completed high school or equivalent and (2) completed a bachelor's degree	
Employment/population ratio and labor force participation rate for the civilian population age 16 and older	
Employment rate for the civilian population ages 16 to 64 in the labor force	
Disability rate the civilian population ages 16 to 64 not in the labor force	
Percentages of civilian employed population age 16 and older who were (1) in service occupations and (2) private wage and salary workers	
Percentage of households that had earnings	
Percentage of occupied housing units that were owner occupied	
Percentages of renter-occupied housing units that spent (1) 30 percent or more and (2) 50 percent or more of household income on rent and utilities	
Lower rent quartile among renter-occupied housing units paying cash rent	
Median monthly housing costs among occupied housing units with cost	
Median household income; median family income	
Percentages of population with household income under (1) 100 percent and (2) 200 percent of the FPL	
Percentages of children with household income under (1) 50 percent and (2) 100 percent of the FPL	
Percentages of adults ages 18 to 64 with household income under (1) 100 percent and (2) 125 percent of the FPL	
Percentage of adults age 65 and older with household income under (1) 125 percent and (2) 200 percent of the FPL	
Percentage of families with income under 130 percent of the FPL	

Table A.14. Predictors in current model

Predictor	Rate numerator	Rate denominator
SNAP prevalence rate	People receiving SNAP benefits according to SNAP Program Operations data	Resident population ^a
Rate of children with income under 50 percent of poverty	Children under age 18 with income under 50 percent of the poverty level according to ACS one-year estimates ^c	Total children under age 18 according to ACS one-year estimates ^c
Bachelor's degree rate	People age 25 and older who have completed a bachelor's degree according to ACS one-year estimates ^c	People age 25 and older according to ACS one-year estimates ^c
Rate of individuals age 18 to 64 with income under 100 percent of poverty	Individuals age 18 to 64 with income under 100 percent of the poverty level according to ACS one-year estimates ^c	Total individuals age 18 to 64 according to ACS one-year estimates ^c
Rate of elderly people with income under 125 percent of poverty	Adults age 65 and older with income under 125 percent of the poverty level according to ACS one-year estimates ^c	Total adults age 65 and older according to ACS one-year estimates ^c
Private sector employment rate	Civilians age 16 and older employed in the private sector according to ACS one-year estimates ^c	Total employed civilians age 16 and older according to ACS one-year estimates ^c
Combined poverty and tax return non-filer rate	People not claimed on tax returns or claimed on tax returns with adjusted gross income under the federal poverty level ^b	Resident population ^a

Note: All rates expressed as percentages.

^aEstimates of the resident population are from the annual July 1 population estimates released in June 2021, available at <http://www.census.gov/popest/>.

^bCounts of people claimed on tax returns are from individual income tax data provided by the Census Bureau Small Area Estimates Branch.

^cACS one-year estimates available at <https://data.census.gov/cedsci/>.

ACS = American Community Survey.

Table A.15. Values for FY 2017 predictors

	SNAP prevalence rate	Combined poverty and non- filer rate	Bachelor's degree rate	Private sector employment rate	Child 50 percent of poverty rate	Non-elderly adult poverty rate	Elderly 125 percent of poverty rate
Alabama	16.501	38.631	25.5	80.0	11.3	15.9	16.1
Alaska	12.047	27.286	28.8	68.7	7.1	10.3	11.8
Arizona	13.043	36.111	29.4	80.8	8.9	14.2	13.4
Arkansas	12.940	38.942	23.4	78.8	9.6	15.7	16.1
California	10.448	30.661	33.6	78.4	7.2	12.2	15.2
Colorado	8.183	25.598	41.2	80.4	5.2	10.2	11.7
Connecticut	11.484	25.678	38.7	80.6	5.9	9.2	10.3
Delaware	15.343	29.108	31.5	81.7	7.4	13.4	12.8
District of Columbia	17.742	38.098	57.3	70.3	14.1	14.6	19.5
Florida	15.190	35.891	29.7	82.6	8.8	13.2	15.2
Georgia	15.613	37.517	30.9	80.2	9.2	13.6	15.7
Hawaii	11.868	27.353	32.9	73.2	6.1	8.9	12.5
Idaho	9.970	26.831	26.8	78.2	6.4	13.0	11.9
Illinois	14.700	27.963	34.4	83.7	7.6	11.9	13.0
Indiana	10.093	28.728	26.8	85.0	8.2	13.0	12.2
Iowa	11.647	24.855	28.9	80.4	4.8	11.2	11.2
Kansas	8.037	27.211	33.7	77.6	6.5	11.8	11.6
Kentucky	14.709	35.621	24.0	80.5	11.1	17.1	16.2
Louisiana	19.882	40.621	23.8	78.9	14.3	18.4	18.3
Maine	13.467	28.832	32.1	78.5	5.7	11.4	13.9
Maryland	11.360	26.533	39.7	73.4	6.4	8.6	11.0
Massachusetts	11.162	25.038	43.4	82.4	7.0	9.8	13.5
Michigan	13.791	31.137	29.1	84.7	8.7	13.7	12.6
Minnesota	8.148	21.184	36.1	83.0	4.7	9.3	10.9
Mississippi	17.981	42.254	21.9	76.3	13.1	18.4	20.0
Missouri	12.427	31.651	29.1	82.4	8.0	12.8	13.4
Montana	11.486	29.634	32.3	75.3	6.8	13.3	12.2
Nebraska	9.178	23.288	31.7	80.5	5.6	10.3	11.8
Nevada	14.836	31.455	24.9	83.1	7.8	12.1	13.7
New Hampshire	6.855	20.851	36.9	80.0	4.8	7.4	9.8
New Jersey	9.206	23.894	39.7	82.1	6.0	9.0	11.8
New Mexico	22.016	38.748	27.1	71.0	12.3	18.8	18.0
New York	14.859	31.526	36.0	78.8	9.0	12.9	16.3
North Carolina	13.105	34.421	31.3	80.1	9.4	13.7	14.7
North Dakota	7.120	22.523	30.7	77.2	5.8	10.2	14.5
Ohio	12.880	29.579	28.0	83.2	9.2	13.4	11.8
Oklahoma	15.361	36.533	25.5	76.7	9.3	15.2	14.6
Oregon	16.427	29.934	33.7	79.6	6.5	13.4	13.0
Pennsylvania	14.412	28.223	31.4	84.5	7.9	12.1	12.9
Rhode Island	15.079	28.569	33.5	81.9	5.3	10.7	15.1
South Carolina	14.339	35.976	28.0	79.9	10.2	14.5	14.5
South Dakota	10.684	24.319	28.1	77.8	7.3	12.9	13.6
Tennessee	15.607	33.877	27.3	80.0	9.2	14.2	14.6
Texas	13.671	33.616	29.6	80.2	9.1	12.9	16.1
Utah	6.653	22.339	34.6	81.0	4.5	9.8	10.6
Vermont	12.262	25.086	38.3	77.5	4.9	11.8	12.3
Virginia	9.163	27.262	38.7	75.0	6.5	10.3	11.0
Washington	12.521	23.496	35.5	78.7	6.6	10.6	11.6
West Virginia	18.729	37.837	20.2	76.9	11.9	19.6	16.5
Wisconsin	11.945	24.275	30.4	82.5	5.9	11.1	12.4
Wyoming	5.672	25.338	27.6	72.3	7.2	11.3	11.9

Table A.16. Values for FY 2018 predictors

	SNAP prevalence rate	Combined poverty and non- filer rate	Bachelor's degree rate	Private sector employmen t rate	Child 50 percent of poverty rate	Non-elderly adult poverty rate	Elderly 125 percent of poverty rate
Alabama	15.686	38.520	25.5	79.3	11.3	16.0	16.4
Alaska	12.514	26.683	30.2	67.9	6.0	10.4	10.2
Arizona	11.815	35.479	29.7	80.4	8.1	13.3	12.8
Arkansas	12.375	38.841	23.3	78.6	9.7	16.3	16.2
California	10.006	30.426	34.2	78.5	7.5	11.7	15.2
Colorado	7.904	25.578	41.7	80.6	5.2	9.3	11.2
Connecticut	10.845	25.719	39.6	81.6	6.0	9.9	10.9
Delaware	14.531	28.975	31.3	80.2	7.6	12.2	9.2
District of Columbia	16.005	38.018	60.4	72.2	15.5	14.1	21.0
Florida	14.499	35.209	30.4	82.7	8.2	12.6	15.5
Georgia	14.808	37.359	31.9	80.6	8.8	12.9	15.1
Hawaii	11.517	27.222	33.5	73.1	5.9	8.5	9.7
Idaho	9.018	26.072	27.7	78.9	5.6	11.6	13.3
Illinois	14.352	27.707	35.1	83.6	6.9	11.4	13.0
Indiana	9.216	28.671	27.1	85.0	7.9	12.6	12.3
Iowa	10.970	24.709	29.0	80.5	5.4	11.5	12.2
Kansas	7.468	27.063	33.8	78.4	5.9	11.8	12.2
Kentucky	13.793	35.663	24.8	80.8	11.0	16.4	16.3
Louisiana	18.614	40.463	24.3	79.2	11.6	17.2	19.4
Maine	12.536	28.211	31.5	79.4	6.2	11.6	14.6
Maryland	10.711	26.545	40.8	74.2	5.9	8.4	10.7
Massachusetts	11.196	24.872	44.5	82.5	5.5	9.5	13.3
Michigan	12.839	30.766	29.6	85.0	9.3	13.6	13.3
Minnesota	7.652	21.145	36.7	83.2	4.7	9.4	11.5
Mississippi	16.951	42.179	23.2	76.1	14.3	18.4	19.2
Missouri	12.033	31.505	29.5	82.6	7.7	12.7	13.7
Montana	10.863	29.453	31.7	75.0	7.0	13.1	13.3
Nebraska	8.819	23.179	32.4	79.5	4.8	11.1	12.4
Nevada	14.532	31.141	24.9	82.7	7.1	12.0	13.9
New Hampshire	6.391	20.685	36.8	81.4	5.5	7.3	9.4
New Jersey	8.556	23.574	40.8	82.2	5.9	8.4	11.6
New Mexico	21.802	38.318	27.7	71.7	13.2	18.6	18.8
New York	14.319	30.526	37.2	78.8	8.6	12.4	16.4
North Carolina	10.469	34.162	31.9	80.5	8.8	13.2	14.1
North Dakota	6.941	22.294	29.7	76.5	4.7	11.1	14.7
Ohio	12.173	29.419	29.0	83.4	8.8	13.3	13.2
Oklahoma	14.848	36.159	25.6	77.1	10.0	14.9	14.2
Oregon	15.160	29.455	34.0	79.4	6.8	12.8	12.7
Pennsylvania	14.207	27.984	31.8	84.6	7.8	11.9	13.0
Rhode Island	14.840	28.182	34.4	82.6	8.2	11.8	17.2
South Carolina	12.945	35.631	28.3	80.0	9.6	14.3	14.7
South Dakota	9.948	24.094	29.2	77.7	7.8	12.9	13.3
Tennessee	14.337	33.739	27.5	80.3	9.9	14.4	14.5
Texas	13.302	33.265	30.3	80.3	9.1	13.0	16.3
Utah	5.996	22.013	34.9	80.6	3.9	9.3	9.0
Vermont	11.701	24.921	38.7	76.7	5.8	11.2	13.3
Virginia	8.660	27.209	39.3	74.9	6.7	10.2	12.5
Washington	11.659	23.334	36.7	78.7	5.4	10.2	10.6
West Virginia	17.791	37.338	21.3	76.8	10.8	18.2	15.9
Wisconsin	11.242	24.158	30.0	83.5	5.9	10.8	12.2
Wyoming	5.078	24.404	26.9	72.1	5.8	11.0	10.5

Table A.17. Values for FY 2019 predictors

	SNAP prevalence rate	Combined poverty and non- filer rate	Bachelor's degree rate	Private sector employment rate	Child 50 percent of poverty rate	Non-elderly adult poverty rate	Elderly 125 percent of poverty rate
Alabama	14.822	39.066	26.3	78.5	10.2	14.7	15.7
Alaska	11.573	28.147	30.2	70.4	4.3	9.5	11.2
Arizona	10.946	35.886	30.2	80.0	8.5	12.7	12.5
Arkansas	11.748	39.299	23.3	78.3	8.7	15.5	16.0
California	9.603	31.351	35.0	78.1	6.4	10.7	14.9
Colorado	7.825	27.005	42.7	79.5	4.8	9.3	10.7
Connecticut	10.317	27.841	39.8	80.3	6.1	9.4	10.6
Delaware	13.327	30.658	33.2	79.6	5.8	10.8	10.0
District of Columbia	15.536	39.836	59.7	70.9	10.1	12.0	16.5
Florida	13.199	36.071	30.7	82.6	7.8	11.7	14.9
Georgia	13.320	38.570	32.5	80.4	7.6	11.9	15.2
Hawaii	11.121	28.589	33.6	73.6	6.2	8.5	11.5
Idaho	8.197	27.252	28.7	77.6	5.3	11.5	10.4
Illinois	14.028	29.230	35.8	83.1	6.3	10.7	12.3
Indiana	8.562	30.009	26.9	84.2	7.2	11.8	11.7
Iowa	10.135	25.856	29.3	79.3	5.2	11.6	11.2
Kansas	6.907	27.941	34.0	77.9	5.8	11.2	11.1
Kentucky	12.120	36.657	25.1	80.2	10.5	15.5	16.6
Louisiana	17.369	41.069	25.0	78.1	13.2	17.4	18.9
Maine	11.638	30.195	33.2	77.8	5.3	10.8	13.4
Maryland	10.234	29.326	40.9	72.8	6.0	8.3	10.7
Massachusetts	11.018	27.556	45.0	81.6	6.0	8.8	12.7
Michigan	11.814	32.086	30.0	84.0	7.7	12.7	12.0
Minnesota	7.262	22.476	37.3	82.1	4.9	8.5	11.0
Mississippi	15.276	42.154	22.3	76.6	12.4	18.0	20.1
Missouri	11.301	32.824	30.2	81.8	8.1	12.5	13.5
Montana	10.040	30.378	33.6	74.6	5.6	13.2	12.6
Nebraska	8.328	24.032	33.2	79.1	4.7	9.9	12.3
Nevada	13.693	32.084	25.7	82.9	6.4	11.7	13.7
New Hampshire	5.616	22.979	37.6	80.2	2.7	7.6	9.1
New Jersey	7.943	25.618	41.2	81.7	5.4	8.1	11.9
New Mexico	21.371	39.111	27.7	71.6	11.3	17.0	18.4
New York	13.676	31.302	37.8	78.7	8.4	11.6	16.1
North Carolina	12.314	34.839	32.3	80.8	8.8	12.7	14.0
North Dakota	6.386	23.602	30.4	75.8	5.2	11.3	13.2
Ohio	11.832	30.403	29.3	82.6	8.2	12.4	11.8
Oklahoma	14.493	37.068	26.2	75.8	8.8	14.7	14.5
Oregon	14.211	30.652	34.5	78.3	5.6	11.8	12.0
Pennsylvania	13.734	29.705	32.3	84.0	7.9	11.5	12.0
Rhode Island	14.396	29.578	34.8	81.8	6.6	10.4	12.7
South Carolina	11.652	36.279	29.6	79.3	8.8	12.9	14.3
South Dakota	9.149	25.411	29.7	75.4	7.1	11.9	12.3
Tennessee	13.253	34.782	28.7	79.9	8.4	12.9	14.5
Texas	11.793	33.598	30.8	79.8	8.6	11.9	15.2
Utah	5.375	23.366	34.8	80.1	3.9	8.9	9.0
Vermont	11.105	26.890	38.7	77.5	4.6	11.5	9.8
Virginia	8.243	29.394	39.6	75.2	6.1	9.4	10.6
Washington	10.834	24.499	37.0	78.5	5.5	9.6	10.7
West Virginia	17.072	38.503	21.1	76.2	10.1	17.0	14.0
Wisconsin	10.614	25.297	31.3	82.6	5.7	10.2	11.2
Wyoming	4.556	25.593	29.1	70.7	4.6	10.3	11.7

Table A.18. Regression estimates of SNAP participation rates

	All eligible people			Working poor people		
	FY 2017	FY 2018	FY 2019	FY 2017	FY 2018	FY 2019
Alabama	79.83	78.15	77.43	74.45	71.57	68.78
Alaska	72.83	84.82	86.97	69.53	74.74	68.24
Arizona	77.36	76.13	72.87	72.70	67.42	62.33
Arkansas	65.53	63.94	59.50	61.39	60.86	54.36
California	69.66	67.94	67.04	55.92	56.47	55.54
Colorado	77.37	79.10	81.35	62.33	62.67	63.81
Connecticut	89.66	91.73	91.55	81.06	76.37	74.98
Delaware	97.44	103.61	101.66	91.69	94.42	84.15
District of Columbia	87.50	81.62	91.95	41.08	38.30	54.64
Florida	84.47	82.10	77.60	76.96	71.00	66.99
Georgia	83.24	81.64	73.66	73.22	67.78	58.80
Hawaii	77.25	84.10	84.55	69.40	71.44	67.39
Idaho	73.36	70.47	77.00	72.39	67.79	68.63
Illinois	96.19	99.08	103.72	87.58	86.32	89.59
Indiana	72.52	74.05	71.58	72.61	73.54	69.43
Iowa	87.50	85.05	88.34	86.61	80.84	80.52
Kansas	67.84	69.39	69.90	60.15	61.26	59.89
Kentucky	74.98	74.79	65.58	70.00	71.85	64.54
Louisiana	83.94	81.80	79.55	76.21	73.87	75.62
Maine	87.61	82.43	83.22	78.52	72.84	69.15
Maryland	81.64	84.53	84.94	69.59	65.33	61.64
Massachusetts	86.13	92.03	92.57	66.40	71.35	74.40
Michigan	87.40	86.84	86.92	85.07	81.40	79.47
Minnesota	79.79	81.00	81.98	71.88	72.25	73.33
Mississippi	71.62	69.95	61.97	61.75	64.35	60.61
Missouri	78.92	79.95	77.60	74.59	73.12	70.40
Montana	78.88	75.92	78.74	71.57	66.77	64.73
Nebraska	75.97	78.62	79.23	70.66	72.35	71.22
Nevada	86.36	86.93	87.93	86.61	82.83	80.58
New Hampshire	72.35	76.31	76.99	65.51	67.83	63.41
New Jersey	79.74	81.58	79.16	66.83	66.81	65.97
New Mexico	97.00	97.49	104.59	84.84	84.75	90.06
New York	85.16	85.75	87.45	67.71	69.11	74.66
North Carolina	75.82	69.41	78.97	66.49	60.02	68.77
North Dakota	59.86	62.08	65.84	49.21	59.10	62.00
Ohio	82.56	84.22	89.07	82.47	79.76	82.69
Oklahoma	80.21	80.69	81.93	76.76	74.46	70.83
Oregon	103.43	100.05	102.06	94.82	86.72	84.31
Pennsylvania	92.98	96.50	100.98	87.80	87.88	91.58
Rhode Island	96.16	88.58	102.37	84.31	75.89	88.11
South Carolina	77.23	75.08	70.20	71.97	67.71	60.87
South Dakota	73.91	76.95	79.47	68.11	74.28	73.66
Tennessee	85.50	83.17	80.34	80.80	76.88	71.33
Texas	75.30	75.30	72.70	65.23	65.86	64.77
Utah	71.69	76.72	74.86	65.25	69.83	64.98
Vermont	93.16	88.64	100.82	79.68	73.04	82.02
Virginia	73.65	71.99	76.06	62.09	56.29	57.39
Washington	90.17	95.66	97.74	81.62	83.12	83.48
West Virginia	86.66	88.94	93.86	84.77	86.08	85.25
Wisconsin	87.06	87.99	92.43	82.73	83.46	84.99
Wyoming	48.64	56.24	53.51	45.31	56.32	45.14

Table A.19. Standard errors of regression estimates of SNAP participation rates

	All eligible people			Working poor people		
	FY 2017	FY 2018	FY 2019	FY 2017	FY 2018	FY 2019
Alabama	4.092	4.084	4.164	4.388	4.377	4.523
Alaska	5.518	5.406	5.425	6.790	6.880	6.727
Arizona	4.405	4.417	4.418	4.917	4.957	5.033
Arkansas	4.445	4.466	4.592	5.046	5.056	5.467
California	4.174	4.111	4.212	4.605	4.477	4.707
Colorado	4.443	4.371	4.455	4.973	4.790	4.978
Connecticut	4.340	4.265	4.242	4.966	4.728	4.701
Delaware	4.296	4.869	4.571	4.808	6.277	5.502
District of Columbia	6.221	6.218	6.657	7.696	7.339	8.753
Florida	4.233	4.305	4.348	4.613	4.804	4.885
Georgia	4.275	4.412	4.606	4.697	4.947	5.377
Hawaii	4.971	5.104	5.277	5.984	6.415	6.600
Idaho	4.264	4.190	4.294	4.641	4.547	4.709
Illinois	4.234	4.330	4.565	4.715	4.873	5.268
Indiana	4.395	4.433	4.411	5.051	5.193	5.034
Iowa	4.315	4.177	4.388	4.844	4.539	4.951
Kansas	4.272	4.356	4.355	4.671	4.802	4.774
Kentucky	4.287	4.198	4.306	4.799	4.695	4.917
Louisiana	4.423	4.341	4.547	5.169	4.903	5.373
Maine	4.293	4.128	4.267	4.975	4.612	4.885
Maryland	4.846	4.616	5.015	5.811	5.460	6.111
Massachusetts	4.463	4.513	4.536	5.011	5.129	5.181
Michigan	4.224	4.354	4.346	4.746	5.133	4.880
Minnesota	4.286	4.325	4.465	4.694	4.792	5.057
Mississippi	4.420	4.504	4.627	5.083	5.204	5.592
Missouri	4.000	4.004	4.022	4.203	4.199	4.264
Montana	4.425	4.261	4.790	5.021	4.768	5.960
Nebraska	4.133	4.300	4.366	4.418	4.750	4.878
Nevada	4.381	4.403	4.599	4.941	4.991	5.405
New Hampshire	4.388	4.787	4.394	4.979	6.022	4.864
New Jersey	4.224	4.294	4.379	4.606	4.841	4.944
New Mexico	5.208	5.291	5.503	6.099	6.568	7.043
New York	4.132	4.142	4.388	4.494	4.531	5.089
North Carolina	4.016	4.226	4.044	4.215	4.548	4.303
North Dakota	4.948	4.971	4.872	5.850	6.041	5.742
Ohio	4.318	4.213	4.327	5.148	4.839	4.926
Oklahoma	4.224	4.132	4.252	4.607	4.542	4.778
Oregon	4.710	4.538	4.668	5.639	5.450	5.715
Pennsylvania	4.237	4.358	4.519	4.757	5.005	5.238
Rhode Island	4.805	4.700	4.477	6.010	5.723	5.150
South Carolina	4.084	4.043	4.137	4.398	4.268	4.467
South Dakota	4.596	4.623	4.685	5.187	5.419	5.399
Tennessee	3.981	4.012	3.979	4.180	4.343	4.187
Texas	4.114	4.088	4.104	4.467	4.473	4.507
Utah	4.268	4.390	4.401	4.626	4.844	4.818
Vermont	4.755	4.426	5.063	5.733	5.076	6.390
Virginia	4.388	4.234	4.563	4.943	4.585	5.201
Washington	4.325	4.358	4.378	4.875	4.970	4.922
West Virginia	4.815	4.692	4.911	5.569	5.738	6.072
Wisconsin	4.275	4.281	4.355	4.726	4.791	4.877
Wyoming	4.897	5.002	5.263	5.729	5.846	6.069

Table A.20. Preliminary shrinkage estimates of SNAP participation rates

	All eligible people			Working poor people		
	FY 2017	FY 2018	FY 2019	FY 2017	FY 2018	FY 2019
Alabama	78.54	75.83	76.14	77.12	73.49	71.64
Alaska	71.80	83.97	85.53	70.31	75.68	68.61
Arizona	76.89	75.04	72.91	72.54	66.88	62.67
Arkansas	66.70	64.75	61.37	62.96	60.17	56.59
California	70.00	68.41	67.19	55.76	56.05	53.57
Colorado	75.96	77.89	80.07	61.71	62.85	63.76
Connecticut	88.57	89.82	91.08	81.93	75.94	76.36
Delaware	98.24	104.48	102.66	92.34	94.90	85.10
District of Columbia	88.70	81.80	92.68	42.07	37.64	54.73
Florida	84.64	82.20	77.46	77.08	71.55	66.60
Georgia	83.92	82.26	74.36	72.37	67.19	58.39
Hawaii	76.77	83.10	84.53	69.42	70.43	68.35
Idaho	74.84	71.25	78.42	73.62	67.95	69.42
Illinois	96.96	100.37	104.86	88.06	87.98	91.24
Indiana	71.59	73.09	70.20	73.28	74.21	69.71
Iowa	87.68	85.30	87.61	88.78	82.43	81.56
Kansas	64.98	68.03	67.60	59.55	62.55	59.93
Kentucky	75.28	75.07	65.87	69.74	72.42	65.28
Louisiana	84.60	82.33	81.19	73.22	70.27	73.22
Maine	81.37	77.69	77.71	79.58	74.93	70.69
Maryland	83.88	86.81	86.90	69.46	66.07	61.55
Massachusetts	89.04	94.85	96.50	62.14	66.41	71.61
Michigan	86.86	86.61	86.25	85.05	82.27	80.34
Minnesota	74.22	73.88	76.69	73.64	71.99	75.15
Mississippi	72.07	69.01	61.97	62.71	63.00	60.68
Missouri	82.60	82.57	81.04	74.99	71.89	70.60
Montana	80.56	77.14	79.67	72.50	67.80	65.56
Nebraska	76.26	78.45	79.39	70.73	71.98	70.74
Nevada	88.50	88.40	89.88	85.72	80.81	79.09
New Hampshire	73.69	78.33	78.47	64.14	65.90	60.50
New Jersey	77.13	78.86	76.85	69.12	69.14	68.91
New Mexico	93.80	95.09	101.75	84.08	85.61	90.95
New York	84.35	84.60	85.31	70.83	70.53	74.89
North Carolina	70.05	67.13	72.37	63.83	63.11	66.12
North Dakota	60.03	62.64	66.59	48.27	59.18	62.36
Ohio	80.66	82.41	86.25	83.52	80.62	81.84
Oklahoma	83.34	83.77	85.68	75.47	74.17	71.00
Oregon	105.49	102.04	104.76	94.36	85.91	84.58
Pennsylvania	91.86	95.58	100.31	88.86	89.70	93.23
Rhode Island	97.44	90.64	103.37	83.67	76.16	87.50
South Carolina	77.59	75.91	70.84	72.24	66.55	60.53
South Dakota	74.19	77.12	79.89	69.18	74.71	74.79
Tennessee	89.77	88.99	84.07	78.14	75.75	67.45
Texas	72.78	72.89	70.23	65.67	68.69	66.79
Utah	72.60	77.25	75.90	64.02	68.44	64.89
Vermont	94.41	90.41	101.59	79.60	73.99	81.24
Virginia	72.11	70.97	74.12	63.36	58.26	58.29
Washington	93.41	99.06	101.50	79.30	81.00	81.13
West Virginia	84.91	87.19	92.06	84.42	85.47	83.10
Wisconsin	91.30	90.78	96.01	82.20	81.55	84.11
Wyoming	48.09	55.05	52.63	43.59	54.12	43.08

Table A.21. Final shrinkage estimates of SNAP participation rates

	All eligible people			Working poor people		
	FY 2017	FY 2018	FY 2019	FY 2017	FY 2018	FY 2019
Alabama	80.12	77.80	79.63	78.99	76.79	75.09
Alaska	73.24	86.15	89.45	72.01	79.08	71.91
Arizona	78.44	76.98	76.25	74.30	69.88	65.68
Arkansas	68.05	66.42	64.18	64.49	62.87	59.31
California	71.41	70.18	70.27	57.11	58.56	56.15
Colorado	77.49	79.91	83.74	63.20	65.67	66.83
Connecticut	90.36	92.15	95.25	83.91	79.35	80.04
Delaware	100.00	100.00	100.00	94.57	99.16	89.19
District of Columbia	90.49	83.92	96.93	43.09	39.33	57.36
Florida	86.34	84.33	81.01	78.94	74.77	69.80
Georgia	85.61	84.39	77.77	74.12	70.21	61.20
Hawaii	78.31	85.25	88.40	71.09	73.59	71.64
Idaho	76.34	73.10	82.01	75.40	71.00	72.76
Illinois	98.91	100.00	100.00	90.19	91.93	95.63
Indiana	73.03	74.99	73.42	75.05	77.54	73.06
Iowa	89.44	87.51	91.63	90.93	86.13	85.48
Kansas	66.28	69.79	70.70	60.99	65.36	62.82
Kentucky	76.79	77.02	68.89	71.42	75.67	68.42
Louisiana	86.30	84.47	84.91	74.99	73.43	76.74
Maine	83.01	79.70	81.28	81.50	78.29	74.09
Maryland	85.57	89.06	90.89	71.14	69.04	64.51
Massachusetts	90.83	97.31	100.00	63.64	69.39	75.06
Michigan	88.60	88.86	90.21	87.11	85.96	84.20
Minnesota	75.72	75.79	80.21	75.42	75.22	78.77
Mississippi	73.52	70.80	64.81	64.23	65.83	63.59
Missouri	84.26	84.71	84.76	76.80	75.12	73.99
Montana	82.18	79.14	83.32	74.26	70.85	68.71
Nebraska	77.79	80.48	83.03	72.44	75.21	74.14
Nevada	90.29	90.69	94.00	87.79	84.43	82.89
New Hampshire	75.18	80.36	82.07	65.69	68.86	63.41
New Jersey	78.68	80.90	80.37	70.79	72.24	72.23
New Mexico	95.69	97.55	100.00	86.11	89.46	95.33
New York	86.05	86.80	89.23	72.54	73.70	78.49
North Carolina	71.45	68.87	75.69	65.37	65.95	69.30
North Dakota	61.24	64.26	69.64	49.44	61.84	65.36
Ohio	82.29	84.54	90.21	85.54	84.24	85.77
Oklahoma	85.02	85.94	89.61	77.29	77.50	74.41
Oregon	100.00	100.00	100.00	96.64	89.77	88.65
Pennsylvania	93.71	98.06	100.00	91.01	93.73	97.71
Rhode Island	99.40	93.00	100.00	85.69	79.58	91.70
South Carolina	79.15	77.88	74.09	73.98	69.54	63.44
South Dakota	75.68	79.12	83.56	70.85	78.06	78.39
Tennessee	91.58	91.30	87.92	80.03	79.15	70.69
Texas	74.25	74.79	73.46	67.26	71.77	70.00
Utah	74.06	79.25	79.38	65.57	71.52	68.01
Vermont	96.31	92.75	100.00	81.53	77.31	85.14
Virginia	73.57	72.81	77.51	64.89	60.88	61.09
Washington	95.29	100.00	100.00	81.22	84.64	85.03
West Virginia	86.62	89.45	96.28	86.47	89.31	87.09
Wisconsin	93.14	93.14	100.00	84.19	85.22	88.16
Wyoming	49.06	56.48	55.04	44.65	56.55	45.15

Table A.22. Standard errors of final shrinkage estimates of SNAP participation rates

	All eligible people			Working poor people		
	FY 2017	FY 2018	FY 2019	FY 2017	FY 2018	FY 2019
Alabama	2.618	2.663	2.926	3.542	3.919	4.261
Alaska	4.567	4.201	4.253	6.353	6.419	6.064
Arizona	3.202	3.266	3.332	4.082	4.193	4.219
Arkansas	2.586	2.707	3.064	4.020	3.999	4.701
California	1.740	1.667	1.648	2.799	2.870	2.962
Colorado	3.415	3.407	3.629	4.003	4.066	4.232
Connecticut	3.571	3.545	3.767	4.645	4.528	4.801
Delaware	3.534	4.166	4.023	4.567	6.167	5.596
District of Columbia	4.120	4.131	4.987	6.253	5.708	7.930
Florida	2.366	2.609	2.454	3.350	3.704	3.665
Georgia	2.539	2.835	2.963	3.509	3.772	4.434
Hawaii	3.475	3.790	4.276	5.026	5.599	6.185
Idaho	3.013	3.013	2.945	3.845	3.907	3.997
Illinois	2.844	3.305	3.605	3.968	4.546	5.040
Indiana	2.875	3.070	2.808	4.398	4.567	4.280
Iowa	3.694	3.683	3.789	4.516	4.361	4.666
Kansas	2.795	3.130	3.221	3.627	3.858	3.991
Kentucky	3.200	3.104	3.253	4.190	4.214	4.464
Louisiana	2.133	2.289	2.734	3.867	3.705	4.240
Maine	3.431	3.822	3.807	4.919	5.023	5.160
Maryland	4.089	3.842	4.274	5.282	5.240	5.762
Massachusetts	3.584	3.786	3.940	4.630	4.943	5.216
Michigan	2.833	2.891	2.960	3.971	4.466	4.432
Minnesota	3.451	3.369	3.689	4.479	4.589	4.772
Mississippi	1.647	2.084	2.338	3.842	3.921	4.679
Missouri	3.247	3.388	3.467	3.822	3.907	4.300
Montana	3.427	3.393	3.434	4.681	4.615	5.657
Nebraska	3.209	3.369	3.308	3.830	4.045	4.174
Nevada	3.285	3.173	3.478	4.490	4.376	4.842
New Hampshire	3.428	4.043	3.744	4.690	5.830	4.528
New Jersey	3.037	3.141	3.297	4.248	4.563	4.882
New Mexico	3.976	4.469	4.315	4.880	6.090	6.654
New York	2.447	2.429	2.467	3.899	3.848	4.238
North Carolina	2.486	3.221	2.539	3.269	4.048	3.518
North Dakota	3.740	3.772	3.814	4.870	5.251	5.293
Ohio	2.587	2.915	3.065	4.415	4.243	4.308
Oklahoma	3.372	3.295	3.444	3.986	4.308	4.624
Oregon	4.018	3.727	4.208	5.387	5.043	5.709
Pennsylvania	2.712	3.083	3.361	4.194	4.697	4.989
Rhode Island	4.212	4.265	4.018	5.727	5.732	4.997
South Carolina	2.531	2.641	2.635	3.869	3.485	3.778
South Dakota	4.019	3.922	4.113	4.870	5.193	4.911
Tennessee	2.848	3.144	3.086	3.682	4.121	3.725
Texas	1.871	1.860	1.837	2.970	3.274	3.302
Utah	3.368	3.660	3.681	3.823	4.270	4.304
Vermont	3.888	3.688	4.457	5.296	4.958	6.144
Virginia	2.973	3.017	3.446	4.113	3.930	4.469
Washington	3.299	3.636	3.837	4.528	4.860	4.888
West Virginia	3.472	3.080	3.829	4.825	5.242	5.641
Wisconsin	3.450	3.482	3.719	4.183	4.401	4.653
Wyoming	2.701	3.448	3.995	4.100	4.822	5.119

Table A.23. Final shrinkage estimates of number of people eligible for SNAP

	FY 2017	FY 2018	FY 2019
Alabama	959,243	932,108	859,045
Alaska	117,740	104,550	89,166
Arizona	1,006,595	947,315	909,531
Arkansas	550,903	546,625	536,238
California	5,081,910	4,895,344	4,786,849
Colorado	550,819	522,651	488,754
Connecticut	386,824	357,546	327,318
Delaware	117,005	110,384	106,833
District of Columbia	124,442	120,404	104,062
Florida	3,312,972	3,239,936	3,108,785
Georgia	1,780,644	1,700,197	1,685,070
Hawaii	192,124	172,198	160,521
Idaho	207,643	198,882	166,838
Illinois	1,684,396	1,611,765	1,575,135
Indiana	890,824	778,859	721,806
Iowa	343,966	329,404	288,188
Kansas	348,272	302,940	275,826
Kentucky	797,708	739,691	716,340
Louisiana	1,068,855	1,016,430	940,412
Maine	176,002	176,611	149,757
Maryland	699,553	630,814	580,728
Massachusetts	736,668	680,310	650,816
Michigan	1,344,145	1,245,395	1,120,520
Minnesota	488,738	481,278	434,680
Mississippi	704,572	683,834	675,188
Missouri	854,207	825,294	785,292
Montana	129,560	124,345	111,110
Nebraska	208,725	194,199	178,886
Nevada	421,944	416,533	372,053
New Hampshire	105,934	92,476	80,711
New Jersey	922,718	828,683	798,217
New Mexico	441,201	422,919	404,351
New York	2,997,169	2,865,103	2,587,782
North Carolina	1,689,784	1,743,808	1,502,294
North Dakota	69,405	66,313	55,933
Ohio	1,667,660	1,520,405	1,386,464
Oklahoma	674,893	633,698	593,550
Oregon	563,160	519,012	514,197
Pennsylvania	1,705,237	1,595,365	1,550,192
Rhode Island	137,504	144,908	124,247
South Carolina	865,220	788,939	760,631
South Dakota	121,758	107,964	95,446
Tennessee	1,123,421	1,041,861	1,000,511
Texas	4,570,857	4,467,594	4,060,651
Utah	271,497	231,874	213,551
Vermont	68,522	65,730	57,806
Virginia	1,007,074	977,856	862,958
Washington	809,667	705,374	670,023
West Virginia	356,433	322,595	279,620
Wisconsin	629,932	583,141	521,225
Wyoming	65,711	50,899	47,573

Table A.24. Final shrinkage estimates of number of working poor people eligible for SNAP

	FY 2017	FY 2018	FY 2019
Alabama	435,481	416,878	342,194
Alaska	55,215	49,155	46,430
Arizona	523,943	484,598	443,444
Arkansas	247,196	224,670	243,863
California	2,896,562	2,559,756	2,313,106
Colorado	279,628	270,933	237,703
Connecticut	161,533	139,627	141,627
Delaware	55,951	42,014	50,983
District of Columbia	46,768	41,925	30,004
Florida	1,501,516	1,449,328	1,350,478
Georgia	853,055	844,946	849,881
Hawaii	102,740	80,607	87,063
Idaho	114,330	110,054	93,224
Illinois	784,246	747,235	739,642
Indiana	402,611	362,846	340,355
Iowa	176,094	165,617	159,687
Kansas	184,293	158,362	144,198
Kentucky	301,367	270,736	286,848
Louisiana	477,462	448,066	388,103
Maine	78,563	67,892	53,508
Maryland	303,589	305,523	250,799
Massachusetts	284,408	246,108	230,007
Michigan	613,713	546,191	471,774
Minnesota	245,384	240,540	211,319
Mississippi	331,812	280,731	272,704
Missouri	409,872	353,471	370,502
Montana	58,816	64,535	53,249
Nebraska	119,459	106,344	99,905
Nevada	189,514	191,829	183,347
New Hampshire	49,314	33,090	33,165
New Jersey	440,946	397,478	369,558
New Mexico	222,174	226,303	215,190
New York	1,477,041	1,210,697	1,010,389
North Carolina	753,849	828,706	725,185
North Dakota	29,809	27,208	26,307
Ohio	733,772	688,278	612,992
Oklahoma	308,636	315,311	306,622
Oregon	232,299	210,836	215,848
Pennsylvania	729,138	729,008	706,600
Rhode Island	48,754	46,061	44,322
South Carolina	409,220	323,259	362,204
South Dakota	57,684	46,452	41,080
Tennessee	474,847	439,586	413,846
Texas	2,416,797	2,523,091	2,192,767
Utah	160,916	134,730	131,755
Vermont	29,663	30,030	22,018
Virginia	477,333	479,978	430,673
Washington	363,369	262,965	204,694
West Virginia	125,579	111,531	92,921
Wisconsin	350,381	299,346	255,100
Wyoming	29,528	24,886	24,454

Table A.25. Standard errors of final shrinkage estimates of number of people eligible for SNAP

	FY 2017	FY 2018	FY 2019
Alabama	31,400	32,034	32,110
Alaska	7,355	5,119	4,313
Arizona	41,162	40,355	40,420
Arkansas	20,972	22,363	26,035
California	124,024	116,766	114,164
Colorado	24,319	22,370	21,543
Connecticut	15,316	13,812	13,167
Delaware	4,124	4,019	3,792
District of Columbia	5,676	5,951	5,445
Florida	90,921	100,640	95,771
Georgia	52,908	57,353	65,298
Hawaii	8,540	7,687	7,897
Idaho	8,210	8,231	6,093
Illinois	48,514	50,442	48,016
Indiana	35,135	32,020	28,081
Iowa	14,230	13,918	12,122
Kansas	14,709	13,639	12,782
Kentucky	33,299	29,934	34,403
Louisiana	26,456	27,652	30,796
Maine	7,287	8,504	7,135
Maryland	33,484	27,325	27,778
Massachusetts	29,115	26,578	25,602
Michigan	43,050	40,688	37,398
Minnesota	22,311	21,480	20,335
Mississippi	15,812	20,206	24,771
Missouri	32,970	33,145	32,674
Montana	5,411	5,353	4,657
Nebraska	8,625	8,163	7,249
Nevada	15,378	14,630	14,002
New Hampshire	4,839	4,672	3,745
New Jersey	35,674	32,301	33,303
New Mexico	18,365	19,451	15,672
New York	85,395	80,508	72,762
North Carolina	58,896	81,883	51,251
North Dakota	4,246	3,908	3,116
Ohio	52,515	52,628	47,912
Oklahoma	26,815	24,393	23,202
Oregon	19,575	17,721	18,336
Pennsylvania	49,442	50,355	48,149
Rhode Island	5,837	6,673	4,344
South Carolina	27,715	26,865	27,515
South Dakota	6,476	5,373	4,779
Tennessee	34,997	36,018	35,723
Texas	115,408	111,560	103,285
Utah	12,368	10,751	10,073
Vermont	2,771	2,624	2,322
Virginia	40,770	40,685	39,019
Washington	28,080	24,932	23,204
West Virginia	14,312	11,151	11,312
Wisconsin	23,375	21,891	19,554
Wyoming	3,624	3,120	3,512

Table A.26. Standard errors of final shrinkage estimates of number of working poor people eligible for SNAP

	FY 2017	FY 2018	FY 2019
Alabama	19,529	21,277	19,418
Alaska	4,871	3,990	3,915
Arizona	28,784	29,077	28,484
Arkansas	15,408	14,291	19,327
California	141,973	125,433	122,020
Colorado	17,708	16,775	15,053
Connecticut	8,942	7,968	8,495
Delaware	2,702	2,613	3,198
District of Columbia	6,787	6,084	4,148
Florida	63,724	71,801	70,909
Georgia	40,386	45,398	61,578
Hawaii	7,263	6,133	7,517
Idaho	5,831	6,057	5,121
Illinois	34,503	36,950	38,977
Indiana	23,591	21,373	19,938
Iowa	8,745	8,385	8,718
Kansas	10,959	9,349	9,162
Kentucky	17,679	15,077	18,716
Louisiana	24,620	22,606	21,445
Maine	4,742	4,356	3,727
Maryland	22,542	23,188	22,403
Massachusetts	20,690	17,531	15,984
Michigan	27,977	28,378	24,830
Minnesota	14,574	14,673	12,801
Mississippi	19,850	16,720	20,064
Missouri	20,397	18,386	21,533
Montana	3,708	4,203	4,384
Nebraska	6,316	5,719	5,625
Nevada	9,694	9,941	10,709
New Hampshire	3,521	2,802	2,368
New Jersey	26,461	25,107	24,978
New Mexico	12,590	15,406	15,022
New York	79,391	63,213	54,552
North Carolina	37,696	50,868	36,810
North Dakota	2,936	2,310	2,130
Ohio	37,872	34,663	30,791
Oklahoma	15,916	17,529	19,052
Oregon	12,949	11,845	13,900
Pennsylvania	33,598	36,529	36,074
Rhode Island	3,258	3,318	2,415
South Carolina	21,402	16,200	21,570
South Dakota	3,965	3,090	2,574
Tennessee	21,843	22,888	21,807
Texas	106,727	115,098	103,436
Utah	9,381	8,045	8,337
Vermont	1,927	1,926	1,589
Virginia	30,256	30,984	31,507
Washington	20,257	15,099	11,768
West Virginia	7,008	6,546	6,019
Wisconsin	17,408	15,460	13,465
Wyoming	2,712	2,122	2,772

This page has been left blank for double-sided copying.

Appendix B

Data for Figures in Cunnyngham 2022

This page has been left blank for double-sided copying.

Table B.1a. How many people were eligible in 2019? What percentage participated? (States)

Eligible people (thousands)	State		Lower bound of confidence interval	FY 2019 participation rate	Upper bound of confidence interval
1,575	Illinois	*	94	100	100
514	Oregon	*	93	100	100
124	Rhode Island	*	93	100	100
107	Delaware	*	93	100	100
404	New Mexico	*	93	100	100
58	Vermont	*	93	100	100
670	Washington	*	94	100	100
1,550	Pennsylvania	*	94	100	100
651	Massachusetts	*	94	100	100
521	Wisconsin	*	94	100	100
104	District of Columbia	*	89	97	100
280	West Virginia	*	90	96	100
327	Connecticut	*	89	95	100
372	Nevada	*	88	94	100
288	Iowa	*	85	92	98
581	Maryland	*	84	91	98
1,386	Ohio	*	85	90	95
1,121	Michigan	*	85	90	95
594	Oklahoma	*	84	90	95
89	Alaska	*	82	89	96
2,588	New York	*	85	89	93
161	Hawaii		81	88	95
1,001	Tennessee	*	83	88	93
940	Louisiana		80	85	89
785	Missouri		79	85	90
489	Colorado		78	84	90
95	South Dakota		77	84	90
111	Montana		78	83	89
179	Nebraska		78	83	88
81	New Hampshire		76	82	88
167	Idaho		77	82	87
150	Maine		75	81	88
3,109	Florida		77	81	85
798	New Jersey		75	80	86
435	Minnesota		74	80	86
859	Alabama		75	80	84
214	Utah		73	79	85
1,685	Georgia	*	73	78	83
863	Virginia	*	72	78	83
910	Arizona	*	71	76	82
1,502	North Carolina	*	72	76	80
761	South Carolina	*	70	74	78
4,061	Texas	*	70	73	76
722	Indiana	*	69	73	78
276	Kansas	*	65	71	76
4,787	California	*	68	70	73
56	North Dakota	*	63	70	76
716	Kentucky	*	64	69	74
675	Mississippi	*	61	65	69
536	Arkansas	*	59	64	69
48	Wyoming	*	48	55	62

*State's participation rate is significantly different from the national participation rate of 82 percent.

Table B.1b. How many people were eligible in 2019? What percentage participated? (Regions and national)

Eligible people (thousands)	Region	Lower bound of confidence interval	FY 2019 participation rate	Upper bound of confidence interval
3,978	Northeast Region	88	92	95
6,048	Midwest Region	88	91	94
4,283	Mid-Atlantic Region	87	90	93
2,039	Mountain Plains Region	78	81	84
10,308	Southeast Region	76	78	80
6,760	Western Region	75	78	80
7,658	Southwest Region	75	77	79
41,074	United States	81	82	84

Note: The regional estimates reflect FNS regional boundaries in FY 2020.

Table B.2a. How many working poor people were eligible in 2019? What percentage participated? (States)

Eligible people (thousands)	State		Lower bound of confidence interval	FY 2019 participation rate	Upper bound of confidence interval
707	Pennsylvania	*	90	98	100
740	Illinois	*	87	96	100
215	New Mexico	*	84	95	100
44	Rhode Island	*	83	92	100
51	Delaware	*	80	89	98
216	Oregon	*	79	89	98
255	Wisconsin	*	81	88	96
93	West Virginia	*	78	87	96
613	Ohio	*	79	86	93
160	Iowa	*	78	85	93
22	Vermont	*	75	85	95
205	Washington	*	77	85	93
472	Michigan	*	77	84	91
183	Nevada	*	75	83	91
142	Connecticut	*	72	80	88
211	Minnesota	*	71	79	87
1,010	New York	*	72	78	85
41	South Dakota		70	78	86
388	Louisiana		70	77	84
342	Alabama		68	75	82
230	Massachusetts		66	75	84
307	Oklahoma		67	74	82
100	Nebraska		67	74	81
54	Maine		66	74	83
371	Missouri		67	74	81
340	Indiana		66	73	80
93	Idaho		66	73	79
370	New Jersey		64	72	80
46	Alaska		62	72	82
87	Hawaii		61	72	82
414	Tennessee		65	71	77
2,193	Texas		65	70	75
1,350	Florida		64	70	76
725	North Carolina		64	69	75
53	Montana		59	69	78
287	Kentucky		61	68	76
132	Utah		61	68	75
238	Colorado	*	60	67	74
443	Arizona	*	59	66	73
26	North Dakota	*	57	65	74
251	Maryland	*	55	65	74
273	Mississippi	*	56	64	71
362	South Carolina	*	57	63	70
33	New Hampshire	*	56	63	71
144	Kansas	*	56	63	69
850	Georgia	*	54	61	68
431	Virginia	*	54	61	68
244	Arkansas	*	52	59	67
30	District of Columbia	*	44	57	70
2,313	California	*	51	56	61
24	Wyoming	*	37	45	54

*State's participation rate is significantly different from the national participation rate of 72 percent.

Table B.2b. How many working poor people were eligible in 2019? What percentage participated? (Regions and national)

Eligible people (thousands)	Region	Lower bound of confidence interval	FY 2019 participation rate	Upper bound of confidence interval
2,791	Midwest Region	82	86	91
1,932	Mid-Atlantic Region	74	79	84
1,535	Northeast Region	73	78	83
3,922	Southwest Region	68	71	75
997	Mountain Plains Region	66	70	74
4,603	Southeast Region	64	68	71
3,144	Western Region	59	63	67
18,924	United States	70	72	75

Note: The regional estimates reflect FNS regional boundaries in FY 2020.

Table B.3a. Estimates of participation rates (State percentage)

	All eligible people			Working poor people		
	FY 2017	FY 2018	FY 2019	FY 2017	FY 2018	FY 2019
Alabama	80	78	80	79	77	75
Alaska	73	86	89	72	79	72
Arizona	78	77	76	74	70	66
Arkansas	68	66	64	64	63	59
California	71	70	70	57	59	56
Colorado	77	80	84	63	66	67
Connecticut	90	92	95	84	79	80
Delaware	100	100	100	95	99	89
District of Columbia	90	84	97	43	39	57
Florida	86	84	81	79	75	70
Georgia	86	84	78	74	70	61
Hawaii	78	85	88	71	74	72
Idaho	76	73	82	75	71	73
Illinois	99	100	100	90	92	96
Indiana	73	75	73	75	78	73
Iowa	89	88	92	91	86	85
Kansas	66	70	71	61	65	63
Kentucky	77	77	69	71	76	68
Louisiana	86	84	85	75	73	77
Maine	83	80	81	82	78	74
Maryland	86	89	91	71	69	65
Massachusetts	91	97	100	64	69	75
Michigan	89	89	90	87	86	84
Minnesota	76	76	80	75	75	79
Mississippi	74	71	65	64	66	64
Missouri	84	85	85	77	75	74
Montana	82	79	83	74	71	69
Nebraska	78	80	83	72	75	74
Nevada	90	91	94	88	84	83
New Hampshire	75	80	82	66	69	63
New Jersey	79	81	80	71	72	72
New Mexico	96	98	100	86	89	95
New York	86	87	89	73	74	78
North Carolina	71	69	76	65	66	69
North Dakota	61	64	70	49	62	65
Ohio	82	85	90	86	84	86
Oklahoma	85	86	90	77	77	74
Oregon	100	100	100	97	90	89
Pennsylvania	94	98	100	91	94	98
Rhode Island	99	93	100	86	80	92
South Carolina	79	78	74	74	70	63
South Dakota	76	79	84	71	78	78
Tennessee	92	91	88	80	79	71
Texas	74	75	73	67	72	70
Utah	74	79	79	66	72	68
Vermont	96	93	100	82	77	85
Virginia	74	73	78	65	61	61
Washington	95	100	100	81	85	85
West Virginia	87	89	96	86	89	87
Wisconsin	93	93	100	84	85	88
Wyoming	49	56	55	45	57	45

Table B.3b. Estimates of participation rates (Regional and national percentage)

	All eligible people			Working poor people		
	FY 2017	FY 2018	FY 2019	FY 2017	FY 2018	FY 2019
Mid-Atlantic Region	85	87	90	77	77	79
Midwest Region	87	88	91	85	85	86
Mountain Plains Region	77	79	81	69	70	70
Northeast Region	87	89	92	73	74	78
Southeast Region	82	80	78	74	72	68
Southwest Region	78	78	77	70	73	71
Western Region	78	77	78	64	65	63
United States	82	82	82	73	74	72

Table B.4. How did your State rank in 2019?

FY 2019 participation rate	State	Upper bound of confidence interval	FY 2019 rank	Lower bound of confidence interval
100	Illinois	1	1	7
100	Oregon	1	2	8
100	Rhode Island	1	3	9
100	Delaware	1	4	9
100	New Mexico	1	5	10
100	Vermont	1	6	10
100	Washington	1	7	10
100	Pennsylvania	2	8	10
100	Massachusetts	5	9	13
100	Wisconsin	6	10	14
97	District of Columbia	6	11	20
96	West Virginia	8	12	18
95	Connecticut	9	13	20
94	Nevada	10	14	21
92	Iowa	11	15	25
91	Maryland	11	16	27
90	Ohio	13	17	25
90	Michigan	13	18	25
90	Oklahoma	13	19	27
89	Alaska	12	20	30
89	New York	14	21	26
88	Hawaii	13	22	32
88	Tennessee	15	23	29
85	Louisiana	19	24	34
85	Missouri	18	25	35
84	Colorado	19	26	37
84	South Dakota	19	27	39
83	Montana	20	28	38
83	Nebraska	21	29	38
82	New Hampshire	21	30	40
82	Idaho	23	31	38
81	Maine	22	32	41
81	Florida	25	33	39
80	New Jersey	25	34	41
80	Minnesota	24	35	42
80	Alabama	26	36	41
79	Utah	26	37	43
78	Georgia	29	38	44
78	Virginia	29	39	44
76	Arizona	31	40	45
76	North Carolina	34	41	45
74	South Carolina	37	42	46
73	Texas	39	43	46
73	Indiana	37	44	47
71	Kansas	40	45	49
70	California	43	46	48
70	North Dakota	40	47	50
69	Kentucky	42	48	49
65	Mississippi	47	49	50
64	Arkansas	47	50	50
55	Wyoming	51	51	51

Table B.5a. How did your State compare with other States in 2019 for all eligible people? (Illinois to Ohio)

	IL	OR	RI	DE	NM	VT	WA	PA	MA	WI	DC	WV	CT	NV	IA	MD	OH
IL		-	-	-	-	-	-	-	H	H	H	H	H	H	H	H	H
OR	-		-	-	-	-	-	-	H	H	H	H	H	H	H	H	H
RI	-	-		-	-	-	-	-	H	H	H	H	H	H	H	H	H
DE	-	-	-		-	-	-	-	-	H	H	H	H	H	H	H	H
NM	-	-	-	-		-	-	-	-	-	H	H	H	H	H	H	H
VT	-	-	-	-	-		-	-	-	-	H	H	H	H	H	H	H
WA	-	-	-	-	-	-		-	-	-	H	H	H	H	H	H	H
PA	-	-	-	-	-	-	-		-	-	H	H	H	H	H	H	H
MA	L	L	L	-	-	-	-	-		-	-	-	-	H	H	H	H
WI	L	L	L	L	-	-	-	-	-		-	-	-	H	H	H	H
DC	L	L	L	L	L	L	L	L	-	-		-	-	-	-	-	-
WV	L	L	L	L	L	L	L	L	-	-	-		-	-	-	-	H
CT	L	L	L	L	L	L	L	L	-	-	-	-		-	-	-	-
NV	L	L	L	L	L	L	L	L	L	L	-	-	-		-	-	-
IA	L	L	L	L	L	L	L	L	L	L	-	-	-	-		-	-
MD	L	L	L	L	L	L	L	L	L	L	-	-	-	-	-		-
OH	L	L	L	L	L	L	L	L	L	L	-	L	-	-	-	-	-
MI	L	L	L	L	L	L	L	L	L	L	-	L	-	-	-	-	-
OK	L	L	L	L	L	L	L	L	L	L	-	L	-	-	-	-	-
AK	L	L	L	L	L	L	L	L	L	L	-	L	-	-	-	-	-
NY	L	L	L	L	L	L	L	L	L	L	L	L	L	-	-	-	-
HI	L	L	L	L	L	L	L	L	L	L	-	L	-	-	-	-	-
TN	L	L	L	L	L	L	L	L	L	L	L	L	L	L	-	-	-
LA	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	-	L
MO	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	-	-
CO	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	-	L
SD	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
MT	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
NE	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
NH	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
ID	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
ME	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
FL	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
NJ	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
MN	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
AL	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
UT	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
GA	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
VA	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
AZ	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
NC	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
SC	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
TX	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
IN	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
KS	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
CA	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
ND	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
KY	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
MS	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
AR	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
WY	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L

Note: An “H” indicates that there is at least a 90 percent chance the State identified at the top of the column has a higher true participation rate than the State identified at the left of the row. An “L” indicates that there is at least a 90 percent chance that the row State has a higher true participation rate than the column State.

**Table B.5b. How did your State compare with other States in 2019 for all eligible people?
(Michigan to New Jersey)**

	MI	OK	AK	NY	HI	TN	LA	MO	CO	SD	MT	NE	NH	ID	ME	FL	NJ
IL	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H
OR	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H
RI	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H
DE	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H
NM	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H
VT	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H
WA	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H
PA	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H
MA	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H
WI	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H
DC	-	-	-	H	-	H	H	H	H	H	H	H	H	H	H	H	H
WV	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H
CT	-	-	-	H	-	H	H	H	H	H	H	H	H	H	H	H	H
NV	-	-	-	-	-	H	H	H	H	H	H	H	H	H	H	H	H
IA	-	-	-	-	-	-	H	H	H	H	H	H	H	H	H	H	H
MD	-	-	-	-	-	-	-	-	-	H	H	H	H	H	H	H	H
OH	-	-	-	-	-	-	H	-	H	H	H	H	H	H	H	H	H
MI		-	-	-	-	-	H	-	H	H	H	H	H	H	H	H	H
OK	-		-	-	-	-	-	-	-	-	H	H	H	H	H	H	H
AK	-	-		-	-	-	-	-	-	-	-	-	H	H	H	H	H
NY	-	-	-		-	-	-	-	-	-	H	H	H	H	H	H	H
HI	-	-	-	-		-	-	-	-	-	-	-	-	-	-	H	H
TN	-	-	-	-	-		-	-	-	-	-	-	-	H	-	H	H
LA	L	-	-	-	-	-		-	-	-	-	-	-	-	-	-	-
MO	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	-
CO	L	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-
SD	L	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-
MT	L	L	-	L	-	-	-	-	-	-		-	-	-	-	-	-
NE	L	L	-	L	-	-	-	-	-	-	-		-	-	-	-	-
NH	L	L	L	L	-	-	-	-	-	-	-	-		-	-	-	-
ID	L	L	L	L	-	L	-	-	-	-	-	-	-		-	-	-
ME	L	L	L	L	-	-	-	-	-	-	-	-	-	-		-	-
FL	L	L	L	L	L	L	-	-	-	-	-	-	-	-	-		-
NJ	L	L	L	L	L	L	-	-	-	-	-	-	-	-	-	-	
MN	L	L	L	L	L	L	-	-	-	-	-	-	-	-	-	-	-
AL	L	L	L	L	L	L	L	-	-	-	-	-	-	-	-	-	-
UT	L	L	L	L	L	L	-	-	-	-	-	-	-	-	-	-	-
GA	L	L	L	L	L	L	L	L	-	-	-	-	-	-	-	-	-
VA	L	L	L	L	L	L	L	L	-	-	-	-	-	-	-	-	-
AZ	L	L	L	L	L	L	L	L	L	L	L	L	-	L	-	-	-
NC	L	L	L	L	L	L	L	L	L	L	L	L	L	L	-	L	-
SC	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
TX	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
IN	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
KS	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
CA	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
ND	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
KY	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
MS	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
AR	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
WY	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L

Note: An “H” indicates that there is at least a 90 percent chance the State identified at the top of the column has a higher true participation rate than the State identified at the left of the row. An “L” indicates that there is at least a 90 percent chance that the row State has a higher true participation rate than the column State.

**Table B.5c. How did your State compare with other States in 2019 for all eligible people?
(Minnesota to Wyoming)**

	MN	AL	UT	GA	VA	AZ	NC	SC	TX	IN	KS	CA	ND	KY	MS	AR	WY
IL	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H
OR	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H
RI	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H
DE	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H
NM	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H
VT	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H
WA	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H
PA	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H
MA	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H
WI	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H
DC	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H
WV	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H
CT	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H
NV	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H
IA	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H
MD	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H
OH	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H
MI	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H
OK	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H
AK	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H
NY	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H
HI	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H
TN	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H
LA	-	H	-	H	H	H	H	H	H	H	H	H	H	H	H	H	H
MO	-	-	-	H	H	H	H	H	H	H	H	H	H	H	H	H	H
CO	-	-	-	H	H	H	H	H	H	H	H	H	H	H	H	H	H
SD	-	-	-	-	-	H	H	H	H	H	H	H	H	H	H	H	H
MT	-	-	-	-	-	H	H	H	H	H	H	H	H	H	H	H	H
NE	-	-	-	-	-	H	H	H	H	H	H	H	H	H	H	H	H
NH	-	-	-	-	-	-	H	H	H	H	H	H	H	H	H	H	H
ID	-	-	-	-	-	H	H	H	H	H	H	H	H	H	H	H	H
ME	-	-	-	-	-	-	-	H	H	H	H	H	H	H	H	H	H
FL	-	-	-	-	-	-	H	H	H	H	H	H	H	H	H	H	H
NJ	-	-	-	-	-	-	-	H	H	H	H	H	H	H	H	H	H
MN		-	-	-	-	-	-	H	H	H	H	H	H	H	H	H	H
AL	-		-	-	-	-	-	H	H	H	H	H	H	H	H	H	H
UT	-	-		-	-	-	-	-	H	H	H	H	H	H	H	H	H
GA	-	-	-		-	-	-	-	-	-	H	H	H	H	H	H	H
VA	-	-	-	-		-	-	-	-	-	H	H	H	H	H	H	H
AZ	-	-	-	-	-		-	-	-	-	H	H	-	H	H	H	H
NC	-	-	-	-	-	-		-	-	-	H	H	-	H	H	H	H
SC	L	L	-	-	-	-	-		-	-	-	-	-	H	H	H	H
TX	L	L	L	-	-	-	-	-		-	-	H	-	-	H	H	H
IN	L	L	L	-	-	-	-	-	-		-	-	-	-	H	H	H
KS	L	L	L	L	L	L	L	-	-	-		-	-	-	H	H	H
CA	L	L	L	L	L	L	L	-	L	-	-		-	-	H	H	H
ND	L	L	L	L	L	-	-	-	-	-	-	-		-	-	-	H
KY	L	L	L	L	L	L	L	L	-	-	-	-	-		-	-	H
MS	L	L	L	L	L	L	L	L	L	L	L	L	-	-		-	H
AR	L	L	L	L	L	L	L	L	L	L	L	L	-	-	-		H
WY	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	

Note: An “H” indicates that there is at least a 90 percent chance the State identified at the top of the column has a higher true participation rate than the State identified at the left of the row. An “L” indicates that there is at least a 90 percent chance that the row State has a higher true participation rate than the column State.

Table B.6. Estimates of participation rates varied widely

FY 2019 participation rate for all eligible people		
Above 94 percent (top quarter)	Between 78 and 94 percent	Below 78 percent (bottom quarter)
Connecticut	Alabama	Arizona
Delaware	Alaska	Arkansas
District of Columbia	Colorado	California
Illinois	Florida	Indiana
Massachusetts	Georgia	Kansas
New Mexico	Hawaii	Kentucky
Oregon	Idaho	Mississippi
Pennsylvania	Iowa	North Carolina
Rhode Island	Louisiana	North Dakota
Vermont	Maine	South Carolina
Washington	Maryland	Texas
West Virginia	Michigan	Wyoming
Wisconsin	Minnesota	
	Missouri	
	Montana	
	Nebraska	
	Nevada	
	New Hampshire	
	New Jersey	
	New York	
	Ohio	
	Oklahoma	
	South Dakota	
	Tennessee	
	Utah	
	Virginia	

Table B.7. Supporting detail for Cunnyingham (2022)

Description	States		
In 21 States and the District of Columbia, the participation rate for all eligible people was significantly higher than the national rate	Alaska Connecticut Delaware Illinois Iowa Maryland Massachusetts Michigan	Nevada New Mexico New York Ohio Oklahoma Oregon Pennsylvania Rhode Island	Tennessee Vermont Washington West Virginia Wisconsin
In 14 States, the participation rate for all eligible people was significantly lower than the national rate	Arizona Arkansas California Georgia Indiana	Kansas Kentucky Mississippi North Carolina North Dakota	South Carolina Texas Virginia Wyoming
In 17 States, the participation rate for eligible working poor people was significantly higher than the national rate	Connecticut Delaware Illinois Iowa Michigan Minnesota	Nevada New Mexico New York Ohio Oregon Pennsylvania	Rhode Island Vermont Washington West Virginia Wisconsin
In 13 States and the District of Columbia, the participation rate for eligible working poor people was significantly lower than the national rate	Arizona Arkansas California Colorado Georgia	Kansas Maryland Mississippi New Hampshire North Dakota	South Carolina Virginia Wyoming
In 36 States and the District of Columbia, the participation rate for working poor people was significantly lower than the rate for all eligible people	Alaska Arizona California Colorado Connecticut Delaware Florida Georgia Hawaii Idaho Illinois Kansas	Louisiana Maryland Massachusetts Missouri Montana Nebraska Nevada New Hampshire New Jersey New Mexico New York North Carolina	Oklahoma Oregon Rhode Island South Carolina Tennessee Utah Vermont Virginia Washington West Virginia Wisconsin Wyoming
In 13 States and the District of Columbia, the difference between the rates for working poor people and all eligible people was significantly greater than 10 percentage points	Alaska California Colorado Delaware Georgia	Maryland Massachusetts New Hampshire Oregon Tennessee	Vermont Virginia Washington

Mathematica Inc.

Princeton, NJ • Ann Arbor, MI • Cambridge, MA
Chicago, IL • Oakland, CA • Seattle, WA
Tucson, AZ • Woodlawn, MD • Washington, DC

EDI Global, a Mathematica Company

Bukoba, Tanzania • High Wycombe, United Kingdom



mathematica.org

Mathematica, Progress Together, and the “spotlight M” logo are registered trademarks of Mathematica Inc.