Food and Nutrition Service
U.S. DEPARTMENT OF AGRICULTURE

Empirical Bayes Shrinkage Estimates of State Supplemental Nutrition Assistance Program Participation Rates: Fiscal Year 2020 and Fiscal Year 2022

Final Report

February 2025

Nondiscrimination 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, 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.

Food and Nutrition Service
U.S. DEPARTMENT OF AGRICULTURE

Empirical Bayes Shrinkage Estimates of State Supplemental Nutrition Assistance Program Participation Rates: Fiscal Year 2020 and Fiscal Year 2022

Final Report

February 2025

Karen Cunnyngham, Mathematica

Submitted to:

U.S. Department of Agriculture
Food and Nutrition Service
1320 Braddock Place
Alexandria, VA 22314
Project Officer: Aja Weston
Contract Number: 12-3198-23-F-0047

Submitted by:

Mathematica
1100 1st Street, NE, 12th Floor
Washington, DC 20002-4221
Telephone: (202) 484-9220
Project Director: Joshua Leftin
Reference Number: 51916.700

Suggested citation

Cunnyngham, Karen. "Empirical Bayes Shrinkage Estimates of State Supplemental Nutrition Assistance Program Participation Rates: Fiscal Year 2020 and Fiscal Year 2022." Prepared by Mathematica, Contract No. 12-3198-23-F-0047. U.S. Department of Agriculture, Food and Nutrition Service, Office of Policy Support, February 2025.

Acknowledgements

This report was prepared by Karen Cunnyngham 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, Jason Pamintuan, and Sharon Clark from Mathematica for their contributions to this report, and Aja Weston and Holly Figueroa from FNS for providing guidance and review.

Contents

Tables

Exhibits

Executive Summary

The Supplemental Nutrition Assistance Program (SNAP) helps eligible individuals with low incomes buy food to feed themselves and their households. 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 2024, the program served 41.7 million people in an average month and provided $93.7 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 2020 and 2022. The program's effective reach is measured by estimated SNAP participation rates, or the percentage of people eligible for SNAP benefits under Federal income and resource rules who participate in the program.

The COVID-19 public health emergency affected the quality of the data used to estimate SNAP participation rates from March 2020 through June 2021. As a result, the fiscal year 2020 participation rates reflect the pre-pandemic period of October 2019 through February 2020, and we did not estimate participation rates for fiscal year 2021 due to inadequate data for most of that year. Because of seasonality both in the data and introduced by our methodology, using 5 months rather than 12 months of fiscal year 2020 data resulted in an underestimate of SNAP participation rates for fiscal year 2020 (Vigil and Rahmi 2024). In addition, because of the smaller sample size for fiscal year 2020, this report does not include estimates of SNAP participation rates for any State subgroups, such as people in households with earnings. However, to maintain consistency with estimates for earlier years, we used estimates for people in households with earnings along with estimates of all eligible people to derive this report's final shrinkage estimates.

The State participation rate estimates for all eligible people were derived by 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 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 a State's population receiving SNAP benefits. Shrinkage estimators improve precision by "borrowing strength," that is, by using data for several 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 confidence intervals for fiscal year 2022 shrinkage estimates were 41 percent narrower than the corresponding confidence intervals for direct estimates. This report describes the shrinkage estimator in detail.

Final shrinkage estimates for fiscal year 2020 presented in this report differ slightly from the estimates presented in Cunnyngham (2023a) and Cunnyngham (2023b) because of annual updates to the years of data and regression model used. As a result, the estimates presented in this report should not be compared to those published in earlier reports.

I. Introduction

The Supplemental Nutrition Assistance Program (SNAP) provides nutrition assistance to eligible individuals and households that need this assistance. 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. During fiscal year (FY) 2024, the program served 41.7 million people in an average month, providing $93.7 billion in benefits annually.

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 2020 to FY 2022. Cunnyngham (2025) also reports the estimates presented here and compares them with one another. The program's effective reach is measured by estimated SNAP participation rates—the percentage of people eligible for SNAP benefits under Federal income and resource rules who participate in the program.

The COVID-19 public health emergency affected the quality of the data used to estimate SNAP participation rates from March 2020 through June 2021. As a result, the fiscal year 2020 participation rates reflect the pre-pandemic period of October 2019 through February 2020, and we did not estimate participation rates for fiscal year 2021. Because of seasonality both in the data and introduced by our methodology, using 5 months rather than 12 months of fiscal year 2020 data resulted in an underestimate of SNAP participation rates for fiscal year 2020 (Vigil and Rahmi 2024). In addition, because of the smaller sample size for fiscal year 2020, this report does not include estimates of SNAP participation rates for any State subgroups, such as people in households with earnings. However, to maintain consistency with estimates for earlier years, we used estimates for people in households with earnings along with estimates of all eligible people to derive this report's final shrinkage estimates.

We derived estimates for each State in both fiscal years by 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 (1) 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 (2) by 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 rest of this introductory chapter provides an overview of indirect estimation and our

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 survey's Annual Social and Economic Supplement includes additional data on work experience, income, and noncash benefits and is based on a sample size of just under 100,000 households.

The **American Community Survey** is conducted monthly. 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** by 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. ◢

shrinkage estimator. In Chapter II, we describe, step by step, how we derived the shrinkage estimates presented here; in Chapter III, we present State SNAP participation rate estimates. Technical details and additional information about our estimation methods appear in Appendix A. The figures presented in Cunnyngham (2024) appear in Appendix B.

Direct estimates. The principal challenge in deriving State estimates such as those presented in this report is the small sample size of the CPS ASEC. The optimal survey for estimating State SNAP eligibility (1) would be based on a large sample for all States, (2) would be representative at the State level, and (3) would contain detail on the 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 size 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 it is not representative at the State level and is based on even smaller State samples than the CPS ASEC. The third candidate, the ACS, is much larger than the CPS ASEC, but it has fewer details on relationships and income sources. In addition, unlike the CPS ASEC's fixed reference period of the previous calendar year for all households, the ACS's reference period is the previous 12 months and therefore varies across households by up to a year, depending on when respondents completed the survey. For these reasons, we use the CPS ASEC to estimate SNAP eligibility.

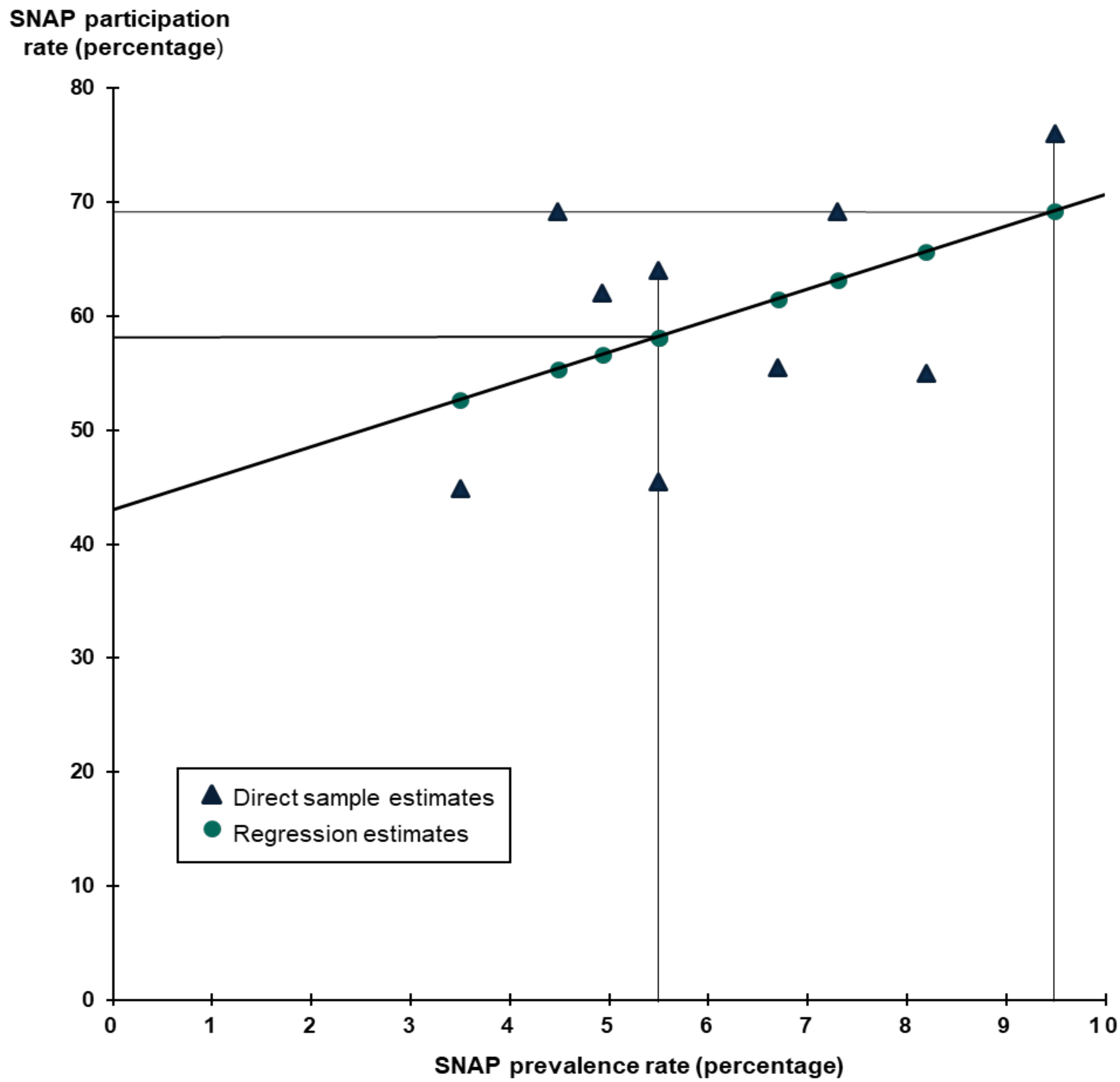
However, for many States, estimates of SNAP eligibility and participation rates based solely on the CPS ASEC sample for the State and time period in question, or "direct" estimates, are imprecise. For example, to directly estimate the number of people in New Jersey who were eligible for SNAP in FY 2022, we used only FY 2022 CPS ASEC data on households from New Jersey. Given 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, a 90 percent confidence interval—that New Jersey's SNAP participation rate in FY 2022 ranged between about 76 and 89 percent. This range is wide, although typical, reflecting our substantial uncertainty about New Jersey's actual participation rate.

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 participation rates for the Food Stamp Program and later, SNAP, since Schirm (2000) estimated rates for September 1997.

Regression estimates. Regression estimates are predictions based on either non-sample or highly precise sample data. In Exhibit I.1, we illustrate how a regression estimator works. The simple example in the exhibit involves 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. 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 direct estimate of the participation rate in that State (vertical axis).

Exhibit I.1. Example of a regression estimator



Not surprisingly, the graph suggests that prevalence and participation rates are systematically associated. States with higher percentages of all people participating in SNAP tend to have higher percentages of eligible people participating in the program, although the relationship is far from perfect. To measure the 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, as indicated by 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 a prevalence rate of about 9.5 percent, the predicted participation rate is nearly 70 percent.

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. With Tennessee as an example again, we used only one year of CPS ASEC sample data from the State to estimate Tennessee's participation rate in that year. To derive regression estimates, we estimated a regression line from sample, administrative, and ACS data for several years and all the States and used the estimated line (with administrative and ACS data for Tennessee) to predict Tennessee's participation rate in a given year. In other words, the regression estimator not only uses the direct estimates from every State for several years to develop a regression estimate for a single State in a single year, but it 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 people in households with earnings—by deriving estimates for the groups jointly.

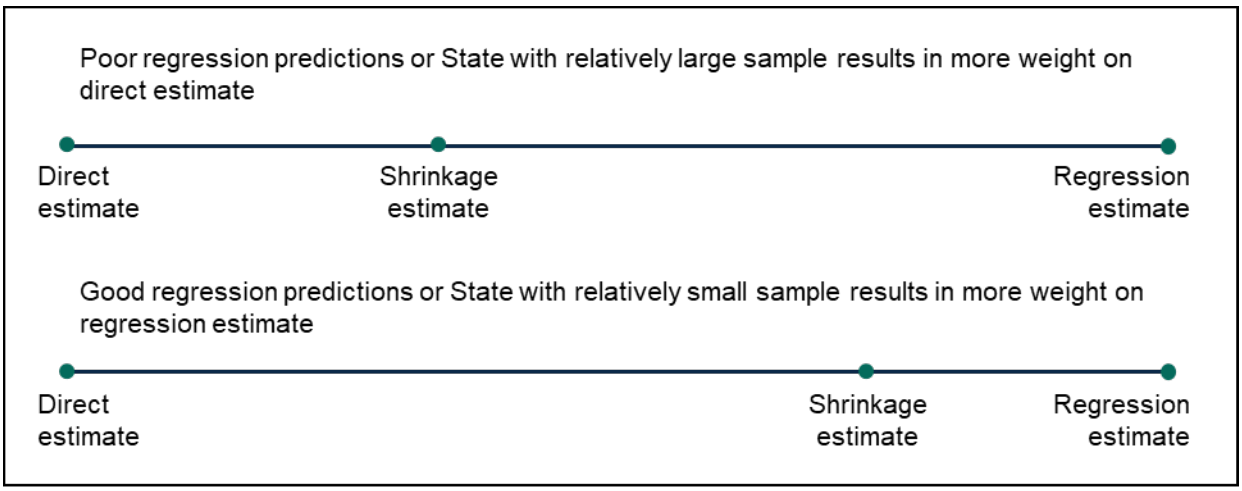
The regression estimator can improve precision by using additional data to identify States with direct estimates that seem too high or too low because of sampling error (error from drawing a sample of the population that has a higher or lower participation rate than does the entire State population). 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 by using data for all the States and several 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). It makes no allowance 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 the rates do lie on the regression line.

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; as a result, 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 (Appendix A describes 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



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

Here, we describe our procedure for estimating State SNAP participation rates and the number of people eligible for SNAP benefits. The procedure, summarized by the flowchart in Exhibit II.1, involves 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. Obtain final shrinkage estimates of State SNAP participation rates by using national estimates of eligible people derived from the CPS ASEC to adjust the preliminary shrinkage estimates from Step 3

We describe each step in the remainder of this chapter, with additional technical details 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 previous calendar year, we obtained estimates of eligible people in a fiscal year by using two years of CPS ASEC data. For example, we used the 2022 CPS ASEC to estimate SNAP eligibility for October to December 2021 and the 2023 CPS ASEC to estimate SNAP eligibility for January to September 2022. Appendix A presents direct estimates and their standard errors in each State for both fiscal years.

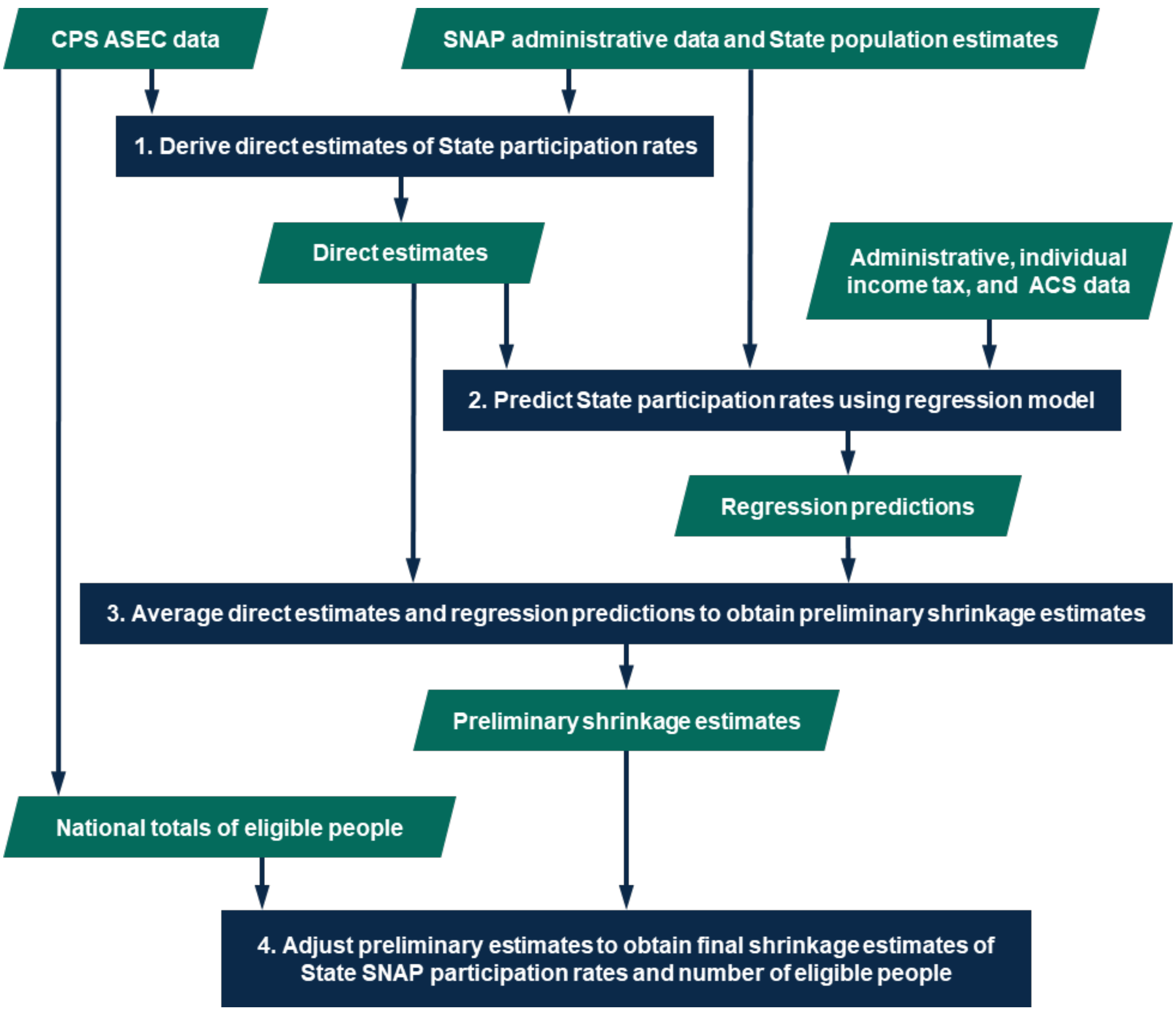
B. Using a regression model, predict State SNAP participation rates based on administrative, ACS, and other data

To derive regression estimates, we included both years and all States, not just one year and nine States as in our example in Chapter 1. We also used eight predictors, not just one. The eight predictors used for the estimates in this report measure the following:

1. The percentage of the population that correctly received SNAP benefits according to administrative data and population estimates.
2. The percentage of families with income under $20,000 in the past 12 months according to ACS one-year estimates.
3. The median household income according to ACS one-year estimates.

4. The percentage of the civilian employed population over age 16 who are private wage and salary workers according to ACS one-year estimates.
5. The change in the estimated population on July 1 compared to the previous year according to Census Bureau population estimates.
6. The percentage of people 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.
7. The percentage of individuals over age 65 that received Supplemental Security Income according to administrative records and population estimates.
8. An indicator of whether a State had a broad-based categorical eligibility (BBCE) policy that did not have a resource test and covered all income-eligible people.

Exhibit II.1. The estimation procedure



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

These eight predictors were selected as the best from a longer list in Table A.9, which provides complete definitions and sources for the predictors. The second, fourth, and seventh predictors were included in the model that estimated rates for fiscal years 2018 to 2020. In addition, the first, sixth, and eighth predictors are similar to predicators included the previous model. Those previous predictors were, respectively, (1) the percentage of the population receiving SNAP benefits according to administrative data and population estimates, (2) the percentage of all children 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, and (3) an indicator of whether a State had a resource test because it either did not use BBCE or included a resource test in its BBCE policy. Other predictors used in the previous model but not the current one are (1) the percentage of individuals age 25 and older who have completed a bachelor's degree and (2) the percentage of individuals over age 65 with household income under 100 percent of the federal poverty level 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 higher or lower participation rates.

Appendix A presents the regression estimates and their standard errors. The standard errors tend to be similar across the States and much smaller than the largest standard errors for direct estimates, reflecting substantial gains in precision from regression for 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 used an empirical Bayes shrinkage estimator to average the direct estimates calculated in Step 1 and the regression predictions from Step 2. (Appendix A describes 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.

D. Obtain final shrinkage estimates of State SNAP participation rates and number 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 exceeded 100 percent. We carried out these adjustments separately for each year; the following description of the adjustments focuses on the FY 2022 estimates. In Appendix A, we describe the results of the adjustments for other years and discuss our adjustment method in more detail.

To implement the first adjustment, we calculated preliminary estimates of the number of eligible people from the preliminary estimates of participation rates derived in Step 3 and the administrative estimates of the number of SNAP participants obtained in Step 1. For FY 2022, the State estimates of eligible people summed to 39,330,801, whereas the national total estimated directly from the CPS ASEC was 38,278,702.

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 38,278,702 divided by 39,330,801, or 0.9732. 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, the District of Columbia and eight States—Illinois, Massachusetts, New Mexico, Oregon, Pennsylvania, Rhode Island, Washington, and Wisconsin—had fewer estimated eligible people than estimated eligible participants in FY 2022, 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 the District of Columbia and the eight States listed above 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 42 States by an equivalent number and in proportion to their number of eligible people. The adjustment raised the participation rates of the 42 States by between 1.4 and 2.4 percentage points but did not change the national total or State rankings.

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

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

In Table III.1, we present our final shrinkage estimates of SNAP participation rates and the number of people eligible in each State for FY 2020 and FY 2022. The shrinkage estimates are relatively precise; they have much smaller standard errors and narrower confidence intervals than the CPS ASEC direct estimates. In Tables III.2 and III.3, we provide approximate 90 percent confidence intervals showing the uncertainty remaining after using shrinkage estimation to derive the estimates in Table III.1. 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 was 91 percent in FY 2022 (Table III.1), the true rate may have been higher or lower. However, according to Table III.3, the chances are 90 in 100 that the true rate was between 85 and 98 percent, an interval that is 44 percent narrower than the interval (76 and 99 percent, as cited in Chapter I) around the direct estimate. A narrower interval means we are less uncertain about the true value. On average, shrinkage confidence intervals for FY 2022 participation rates for all eligible people were 41 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 application of shrinkage methods. Nevertheless, as discussed in Cunnyngham (2024), 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 presented in this report for FY 2020 differ slightly from the estimates presented in Cunnyngham (2023a) and Cunnyngham (2023b) for two reasons:

1. **The shrinkage estimator uses data from multiple 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 FY 2020 estimates presented in this report are based on 2020 and 2022 data, while the corresponding estimates published in Cunnyngham (2023a) and Cunnyngham (2023b) are based on 2018 to 2020 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 years being estimated. Although we place a premium on maintaining consistency in regression predictors from year to year, differences between the data used in the previous estimates and 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.

Given these updates, the none of the estimates in this report should be compared to those published in earlier reports.

Table III.1. Final shrinkage estimates of SNAP participation rates and number of people eligible for SNAP

	Participation rate (percent)		Number of eligible people (thousands)	
	FY 2020	FY 2022	FY 2020	FY 2022
Alabama	88	90	762	797
Alaska	81	73	91	70
Arizona	73	77	920	822
Arkansas	64	59	505	454
California	67	81	5,290	4,618
Colorado	80	100	483	428
Connecticut	93	98	315	305
Delaware	96	91	96	92
District of Columbia	96	100	106	124
Florida	77	81	3,094	2,927
Georgia	76	92	1,618	1,535
Hawaii	85	81	162	161
Idaho	83	73	159	156
Illinois	100	100	1,464	1,540
Indiana	76	89	694	625
Iowa	89	98	277	224
Kansas	67	79	282	231
Kentucky	65	75	704	633
Louisiana	87	99	889	776
Maine	85	94	147	126
Maryland	91	85	579	543
Massachusetts	100	100	629	816
Michigan	84	100	1,185	1,027
Minnesota	80	93	429	372
Mississippi	63	74	661	546
Missouri	86	92	747	651
Montana	78	75	112	99
Nebraska	84	93	168	144
Nevada	89	98	370	350
New Hampshire	81	82	78	68
New Jersey	80	91	746	775
New Mexico	100	100	403	439
New York	84	91	2,651	2,558
North Carolina	73	95	1,468	1,273
North Dakota	67	81	56	46
Ohio	85	99	1,438	1,307
Oklahoma	89	98	602	597

	Participation rate (percent)		Number of eligible people (thousands)	
	FY 2020	FY 2022	FY 2020	FY 2022
Oregon	100	100	503	483
Pennsylvania	100	100	1,520	1,387
Rhode Island	100	100	119	112
South Carolina	72	76	750	733
South Dakota	83	84	92	80
Tennessee	87	84	939	869
Texas	74	74	3,895	3,846
Utah	78	76	203	197
Vermont	96	99	57	55
Virginia	79	83	834	804
Washington	100	100	657	625
West Virginia	91	98	291	255
Wisconsin	97	100	522	528
Wyoming	52	63	47	47
United States	81	88	40,807	38,279

Table III.2. Approximate 90 percent confidence intervals for final shrinkage estimates for FY 2020

	Participation rate (percent)		Number of eligible people (thousands)	
	Lower bound	Upper bound	Lower bound	Upper bound
Alabama	81	95	703	820
Alaska	74	87	83	98
Arizona	66	79	837	1,002
Arkansas	58	69	462	548
California	65	70	5,067	5,512
Colorado	74	87	443	523
Connecticut	86	100	292	338
Delaware	90	100	89	102
District of Columbia	88	100	97	114
Florida	73	81	2,931	3,256
Georgia	70	81	1,504	1,731
Hawaii	79	92	149	175
Idaho	77	90	146	172
Illinois	93	100	1,383	1,546
Indiana	71	81	648	741
Iowa	83	96	257	296
Kansas	61	73	255	309
Kentucky	59	70	642	765
Louisiana	82	92	837	941
Maine	78	91	135	159
Maryland	84	98	535	623
Massachusetts	93	100	586	671
Michigan	79	90	1,111	1,258
Minnesota	74	86	396	463
Mississippi	58	68	604	717
Missouri	79	93	686	808
Montana	72	84	104	121
Nebraska	78	91	155	180
Nevada	83	95	345	395
New Hampshire	73	88	71	85
New Jersey	74	86	686	806
New Mexico	92	100	375	432
New York	80	88	2,524	2,778
North Carolina	68	78	1,367	1,569
North Dakota	62	73	51	61
Ohio	80	91	1,345	1,531
Oklahoma	83	95	562	643

	Participation rate (percent)		Number of eligible people (thousands)	
	Lower bound	Upper bound	Lower bound	Upper bound
Oregon	93	100	469	536
Pennsylvania	93	100	1,436	1,605
Rhode Island	93	100	112	126
South Carolina	67	77	699	802
South Dakota	76	90	84	100
Tennessee	82	93	877	1,001
Texas	70	77	3,697	4,092
Utah	72	85	186	220
Vermont	89	100	52	61
Virginia	73	86	766	903
Washington	91	100	602	712
West Virginia	84	98	268	314
Wisconsin	90	100	484	560
Wyoming	46	58	42	53
United States	79	82	40,161	41,452

Table III.3. Approximate 90 percent confidence intervals for final shrinkage estimates for FY 2022

	Participation rate (percent)		Number of eligible people (thousands)	
	Lower bound	Upper bound	Lower bound	Upper bound
Alabama	84	96	738	856
Alaska	66	79	63	77
Arizona	72	83	763	882
Arkansas	54	63	417	491
California	77	85	4,383	4,852
Colorado	93	100	395	461
Connecticut	92	100	283	326
Delaware	85	98	85	99
District of Columbia	90	100	116	133
Florida	76	85	2,747	3,107
Georgia	86	98	1,428	1,642
Hawaii	73	88	146	177
Idaho	68	78	145	168
Illinois	93	100	1,466	1,614
Indiana	83	95	581	670
Iowa	91	100	207	241
Kansas	72	86	210	251
Kentucky	69	81	579	688
Louisiana	93	100	726	826
Maine	87	100	116	137
Maryland	77	93	492	595
Massachusetts	92	100	771	861
Michigan	94	100	965	1,089
Minnesota	86	100	344	401
Mississippi	69	78	508	585
Missouri	85	99	600	701
Montana	69	81	90	108
Nebraska	86	100	132	156
Nevada	92	100	326	375
New Hampshire	75	90	62	75
New Jersey	85	98	716	833
New Mexico	90	100	409	470
New York	86	96	2,415	2,700
North Carolina	89	100	1,194	1,352
North Dakota	75	88	42	50
Ohio	92	100	1,217	1,397
Oklahoma	92	100	556	639

	Participation rate (percent)		Number of eligible people (thousands)	
	Lower bound	Upper bound	Lower bound	Upper bound
Oregon	92	100	455	512
Pennsylvania	93	100	1,311	1,463
Rhode Island	93	100	104	120
South Carolina	70	82	674	792
South Dakota	76	92	72	89
Tennessee	78	90	804	934
Texas	70	77	3,654	4,039
Utah	70	82	180	214
Vermont	92	100	51	59
Virginia	77	90	737	871
Washington	93	100	579	671
West Virginia	92	100	239	272
Wisconsin	92	100	495	560
Wyoming	55	70	41	53
United States	86	89	37,609	38,948

References

Cunnyngham, Karen. "Empirical Bayes Shrinkage Estimates of State Supplemental Nutrition Assistance Program Participation Rates in Fiscal Year 2018 to Fiscal Year 2020." Prepared by Mathematica, Contract No. 12-3198-22-F-0020. U.S. Department of Agriculture, Food and Nutrition Service, Office of Policy Support, August 2023a.

Cunnyngham, Karen. "Reaching Those in Need: State Supplemental Nutrition Assistance Program Participation Rates in 2020." Prepared by Mathematica, Contract No. 12-3198-22-F-0020. U.S. Department of Agriculture, Food and Nutrition Service, Office of Policy Support, August 2023b.

Cunnyngham, Karen. "Reaching Those in Need: State Supplemental Nutrition Assistance Program Participation Rates in 2022." Prepared by Mathematica, Contract No. 12-3198-23-F-0047. U.S. Department of Agriculture, Food and Nutrition Service, Office of Policy Support, February 2025.

Doppelt, Lawrence, and Shane Haley. "CES National Benchmark Article: BLS Establishment Survey National Estimates Revised to Incorporate March 2019 Benchmarks," 2020. 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.

Leftin, Joshua, Mia Monkovic, Francisco Yang, Nima Rahimi, Andrew Wen, and Alma Vigil. "Technical Documentation for the Fiscal Year 2022 Supplemental Nutrition Assistance Program Quality Control Database and QC Minimodel." Prepared by Mathematica, Contract No. 12-3198-23-F-0016. U.S. Department of Agriculture, Food and Nutrition Service, Office of Policy Support, March 2024.

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. 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. Mathematica Policy Research, March 1998.

U.S. Census Bureau. "Current Population Survey: Design and Methodology, Technical Paper 66." October 2006. https://www2.census.gov/programs-surveys/cps/methodology/tp-66.pdf.

Vigil, Alma and Nima Rahimi. "Trends in Supplemental Nutrition Assistance Program Participation Rates: Fiscal Year 2020 and Fiscal Year 2022." Prepared by Mathematica, Contract No. 12-3198-23-F-0047. U.S. Department of Agriculture, Food and Nutrition Service, Office of Policy Support, October 2024.

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. Each step is discussed in turn.

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

We derived direct estimates of participation rates for all eligible people for a given fiscal year[1] according to the following formula:

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

where $Y_{1,i}$ is the estimated participation rate for all eligible people for State $i(i=1,\ldots,51)$; P_i is the number of people participating in SNAP according to adjusted SNAP Program Operations data; $\varepsilon_{1,i}$ 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. Data on participants, including counts of participants eligible only through disaster assistance, were provided by the U.S. Department of Agriculture'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 $\varepsilon_{1,i}$ (the correctly eligible rate for all households) from the SNAP QC sample data as follows:

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

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 $\varepsilon_{1,i,h}$ 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 used the following formula to estimate the percentage of people who were eligible for SNAP:

[1] The COVID-19 public health emergency affected the quality of the data used to estimate SNAP participation rates from March 2020 through June 2021. As a result, the fiscal year 2020 participation rates reflect the pre-pandemic period of October 2019 through February 2020 and we did not estimate participation rates for fiscal year 2021.

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

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 in Vigil and Rahimi (2024), 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 into account the restrictions on participation by noncitizens, distributing annual amounts across months, and imputing net income. Vigil and Rahimi (2024) also describes how we applied SNAP gross and net income tests and calculated the benefits an eligible household would qualify for.

To derive fiscal year estimates of eligibility, we combined two years of the CPS ASEC. For example, to estimate $Z_{1,i}$ for FY 2022, we used data from the 2022 CPS ASEC (simulating October through December 2021) and the 2023 CPS ASEC (simulating January through February 2022). We restricted the FY 2020 eligibility simulation to October 2019 through February 2020 to match the available months of SNAP QC data. To estimate N_i, we used a weighted average of population estimates from the two CPS ASEC files.

The Census Bureau derives population estimates (T_i) 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 people in households with earnings. This report does not present estimates of State SNAP participation rates for people in households with earnings because of the smaller sample size for FY 2020. However, to maintain consistency with estimates for prior years, we used direct estimates for people in households with earnings, along with direct estimates of all eligible people, to derive shrinkage estimates for all eligible people. We derived direct estimates of participation rates for people in households with earnings 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 people in households with earnings for State i; $\varepsilon_{2,i}$ is the percentage of SNAP participants who are in households with earnings, 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 in households with earnings and eligible for SNAP according to the CPS ASEC; $Z_{2,i}$ is the CPS ASEC estimate of the number of eligible people in households with earnings, and P_i, T_i, h, $m_{i,h}$, and N_i are as defined in the opening paragraphs of this appendix.

We defined households with earnings as those that were eligible for SNAP and had a member who earned money from a job. Households with earnings were identified slightly differently in the SNAP QC data than in the CPS ASEC. Specifically, a participant household was identified as having earnings if the household had earned income according to the edited SNAP QC data file or, before 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 households with earnings, and Leftin et al. (2024) describe the procedure for editing the SNAP QC data. An eligible household with earnings in the CPS ASEC was identified only on the basis of earnings.

Exhibit A.1. Algorithm to identify households with earnings

Households with earnings are defined 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 that, with unearned income, sums 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 $Y_{1,i(r)}$ and $Y_{2,i(r)}$ are the r^{th} $(r = 1, \ldots, 160)$ 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

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

Rates for correctly eligible 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 time using a set of bootstrap replicate weights:

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

and

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

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

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

where

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

and

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

where

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

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 people in households with earnings.

Covariances. We estimated the covariance between the estimates of participation rates for all eligible people and people in households with earnings for a given year according to:

$$(23)\quad \begin{aligned} \mathrm{cov}(Y_{1,i}, Y_{2,i}) &= \text{covariance due to } E_{1,i} \text{ and } E_{2,i} \text{ when } \varepsilon_{1,i} \text{ and } \varepsilon_{2,i} \text{ are fixed} \\ &\quad + \text{covariance due to } \varepsilon_{1,i} \text{ and } \varepsilon_{2,i} \text{ when } E_{1,i} \text{ and } E_{2,i} \text{ are fixed} \\ &= \mathrm{cov}_{E_1E_2|\varepsilon_1\varepsilon_2}(Y_{1,i}, Y_{2,i}) + \mathrm{cov}_{\varepsilon_1\varepsilon_2|E_1E_2}(Y_{1,i}, Y_{2,i}). \end{aligned}$$

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:

$$(24)\quad \mathrm{cov}_{E_1E_2|\varepsilon_1\varepsilon_2}(Y_{1,i}, Y_{2,i}) = \frac{4}{160}\sum_{r=1}^{160}(Y_{1,i(r)} - Y_{1,i})(Y_{2,i(r)} - Y_{2,i})\,.$$

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

$$(25)\quad \mathrm{cov}_{\varepsilon_1\varepsilon_2|E_1E_2}(Y_{1,i}, Y_{2,i}) = \left(100\frac{P_i}{T_iE_{1,i}}\right)\left(100\frac{P_i}{T_iE_{2,i}}\right)\mathrm{cov}(\varepsilon_{1,i}, \varepsilon_{2,i})$$

where

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

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 direct estimate for all eligible people for one year (year *t*) and the direct estimate for people in households with earnings for *g* years earlier, as follows:

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

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

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

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 people in households with earnings 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 to derive 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 percentage of participants who are income eligible and correctly receiving SNAP benefits (values of $\varepsilon_{1,i}$); and Table A.3 shows payment error-adjusted numbers of people receiving SNAP benefits under normal program eligibility rules (values of $P_i(\varepsilon_{1,i}/100)$). Tables A.4, A.5, and A.6 present CPS ASEC estimates of SNAP eligibility percentages (values of $E_{1,i}$), the number of eligible people (values of $Z_{1,i}$), and the population (values of N_i), respectively, and Table A.7 presents the population totals (values of T_i). Table A.8 gives direct estimates of participation rates (values of $Y_{1,i}$) and their standard errors.

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

As noted, this report does not present estimates of State SNAP participation rates for people in households with earnings because of the smaller sample size for FY 2020. However, to maintain consistency with estimates for prior years, we used regression predictions for people in households with earnings, along with regression predictions for all eligible people, to derive shrinkage estimates for all eligible people. Our regression model consisted of four equations, with two predicting SNAP participation rates for all eligible people in fiscal years 2020 and 2022 and two predicting SNAP participation rates for people in households with earnings in fiscal years 2020 and 2022. The four 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. The percentage of the population that correctly received SNAP benefits according to administrative data and population estimates.
2. The percentage of families with income under $20,000 in the past 12 months according to ACS one-year estimates.
3. The median household income according to ACS one-year estimates.
4. The percentage of the civilian employed population over age 16 who are private wage and salary workers according to ACS one-year estimates.
5. The change in the estimated population on July 1 compared to the previous year according to Census Bureau population estimates.
6. The percentage of people 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.
7. The percentage of individuals over age 65 that received Supplemental Security Income according to administrative records and population estimates.
8. An indicator of whether a State had a broad-based categorical eligibility (BBCE) policy that did not have a resource test and covered all income-eligible people.

For all the predictors, we used 2020 values for predicting FY 2020 rates and 2022 values for predicting FY 2022 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 people in households with earnings) in any one year were determined by the predictions and direct estimates for both years and both groups.

In addition to the predictors we selected for our model, we considered many other potential predictors, including the (1) the percentage of individuals age 25 and older who have completed a bachelor's degree and (2) the percentage of individuals over age 65 with household income under 100 percent of the federal poverty level according to ACS one-year estimates, both of which were used to produce the estimates in Cunnyngham (2023a). All of the predictors we considered had three characteristics: (1) it is plausible they are good indicators of differences between States in SNAP participation rates; (2) they could be defined and measured uniformly across States; and (3) they could be obtained from non-sample or highly precise sample data—such as the ACS or administrative records data—and thus measured with little or no sampling error. In addition, the second, fourth, and seventh predictors were included in the model that estimated rates for fiscal years 2018 to 2020 and the first, sixth, and eighth predictors are similar to predicators included the previous model. Those previous predictors were, respectively, (1) the percentage of the population receiving SNAP benefits according to administrative data and population estimates, (2) the percentage of all children 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, and (3) an indicator of whether a State had a resource test because it either did not use BBCE or included a resource test in its BBCE policy.

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 between 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 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 and the predicted residual error sum of squares (PRESS). 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 of the model 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.9 and definitions, and data sources for the predictors in our chosen regression model are given in Table A.10. The values for the predictors listed above are in Tables A.11, A.12, A.13, and A.14.

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. To maintain consistency with estimates for prior years, we jointly estimated participation rates for people in households with earnings and all eligible people Because the shrinkage estimator incorporates data from other years and States, a State's shrinkage estimate in a given year does not have to fall between the direct and regression estimates for the year in question. In most cases, however, the shrinkage estimates presented in this report do fall 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 η_1 and η_2 capture intertemporal (between-year) correlations among regression prediction errors for all eligible people and for people in households with earnings, respectively; σ_1 and σ_2 capture additional within-year variance across States. Correlations between all eligible people and people in households with earnings 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 7,783,776 equally spaced points, starting with $\sigma_1 = 0.001$, $\sigma_2 = 0.001$, $\rho = -0.981$, $\eta_1 = 0.000$, $\eta_2 = 0.000$, and $\eta_{1,2} = -0.992$ and incrementing σ_1, σ_2, ρ, η_1, η_2, and $\eta_{1,2}$ by 0.700, 1.200, 0.099, 0.550, 1.300, and 0.181, respectively, up to $\sigma_1 = 8.401$, $\sigma_2 = 13.201$, $\rho = 0.999$, $\eta_1 = 9.400$, $\eta_2 = 13.000$, 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,…, 7,783,776), 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 204 elements— four direct estimates for each of the 50 States and the District of Columbia. The first four elements of *Y* pertain to the first State, the next four to the second State, and so forth. For a given State, the first two elements are the FY 2020 direct estimates for all eligible people and people in households with earnings, respectively and the second two elements are the FY 2022 estimates. The vector of shrinkage estimates, θ_k, has the same structure as the vector of direct estimates, *Y*. *V* is the (204×204) variance-covariance matrix for the direct estimates. Because State samples are independent in the CPS ASEC, *V* is block-diagonal with 51 (4×4) 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 (204×36) matrix containing values for each of the eight predictors (plus an intercept) for every State, both fiscal years, and both groups. The first four rows of *X* pertain to the first State, the next four rows pertain to the second State, and so forth. The four rows for State *i* are given by

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

where $x'_{i,t,1}$ is a row vector for fiscal year *t* ($t = 1$ for 2020 and $t = 2$ for 2022) with nine elements (an intercept plus the eight 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 eight predictors) to predict participation rates for people in households with earnings, and $\underline{0}$ is a row vector with nine zeros. In a given year, the values of the predictors are the same for the equations for all eligible people and for people in households with earnings. Thus, $x'_{i,t,1} = x'_{i,t,2}$. $\hat{B}_k$ is a (36×1) 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 (4×4) blocks, and every block equals

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

After calculating θ_k, U_k, and p_k^* 7,783,776 times (once for each combination of $\sigma_1,\ \sigma_2,\ \rho,\ \eta_1,\ \eta_2,$ and $\eta_{1,2}$), we calculated the probability of $(\sigma_{1,k},\ \sigma_{2,k},\ \rho_k,\ \eta_{1,k},\ \eta_{2,k},\ \eta_{1,2,k})$:

$$(37)\quad p_k = \frac{p_k^*}{\sum_{k=1}^{7,783,776} p_k^*},$$

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

To complete the numerical integration over $\sigma_1,\ \sigma_2,\ \rho,\ \eta_1,\ \eta_2,$ and $\eta_{1,2}$ and obtain a single set of shrinkage estimates, we calculated a weighted sum of the 7,783,776 sets of shrinkage estimates, weighting each set θ_k by its associated probability p_k. The resulting shrinkage estimates are:

$$(38)\quad \theta = \sum_{k=1}^{7,783,776} p_k \theta_k .$$

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

$$(39)\quad U = \sum_{k=1}^{7,783,776} p_k U_k + \sum_{k=1}^{7,783,776} p_k (\theta_k - \theta)(\theta_k - \theta)'.$$

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 $\sigma_1,\ \sigma_2,\ \rho,$ $\eta_1,\ \eta_2,$ and $\eta_{1,2}$ vary. Thus, the second term accounts for the variability from not knowing and thus having to estimate $\sigma_1,\ \sigma_2,\ \rho,\ \eta_1,\ \eta_2,$ 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 obtained the same way. They are

$$(40)\quad R = \sum_{k=1}^{7,783,776} p_k R_k ,$$

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

$$(41) \quad G = \sum_{k=1}^{7,783,776} p_k G_k + \sum_{k=1}^{7,783,776} p_k (R_k - R)(R_k - R)',$$

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

$$(42) \quad \hat{B} = \sum_{k=1}^{7,783,776} p_k \hat{B}_k .$$

Regression estimates of participation rates and their standard errors are in Table A.15. Preliminary shrinkage estimates of SNAP participation rates are in Table A.16.

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 the number of eligible people implied by the rates sums to the national number of eligible people estimated directly from the CPS ASEC. Second, we adjusted the rates so no State's estimated rate was greater than 100 percent. We made these adjustments separately for each year.

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 2022 estimates for all eligible people as an example, the eligible people counts for States from Equation (43) summed to 39,330,801, and the national total estimated directly from the CPS ASEC was 38,278,702. 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 38,278,702 divided by 39,330,801, or 0.9732. Exhibit A.2 shows the direct estimates of national totals and adjustment factors for both years.

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

	Direct estimate	Adjustment factor
FY 2020	40,806,758	0.9846
FY 2022	38,278,702	0.9732

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).

After calculating the final shrinkage participation rates, we found 16 instances in which a State had an implied participation rate higher than 100 percent because the estimated number of eligible people was smaller than the number of participants. Exhibit A.3 shows the estimated participation rates higher than 100 percent by State and year. To cap participation rates at 100 percent, we increased the number of eligible people in States with estimated participation rates higher than 100 percent so 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 by an equivalent number and in proportion to their numbers of eligible people. These adjustments, which we carried out separately for the two years, moved small numbers among State counts of eligible people but did not change the national totals or State rankings. The adjustment raised the participation rates of the States where participation rates were not initially higher than 100 percent by between 1.4 and 2.4 percentage points.

Exhibit A.3. Estimated participation rates higher than 100 percent

	FY 2020	FY 2022
District of Columbia		122.3
Illinois	109.3	123.1
Massachusetts	104.3	122.9
New Mexico	105.6	122.9
Oregon	106.2	116.8
Pennsylvania	108.9	109.3
Rhode Island	109.1	101.2
Washington	101.0	100.7
Wisconsin		113.5

In Tables III.2 to III.4 of Chapter III, we reported approximate 90 percent confidence intervals for our final shrinkage estimates. 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

$$(47) \quad e_i = \frac{1}{r}\sqrt{U(4i-1, 4i-1)}$$

and

$$(48) \quad e_i = \frac{\psi_{F,1,i}}{\theta_{F,1,i}} \; r \sqrt{U(4i-1, 4i-1)} \,,$$

where *r* is the ratio used to adjust preliminary estimates of State counts of eligible people to the direct estimate of the national total (approximately 0.9732 for FY 2022), and $U(4i-1,4i-1)$ is the $(4i-1,4i-1)$ diagonal element of *U* for all eligible people for FY 2022, which we derived according to Equation (39). To derive standard error estimates for all eligible people for 2020, we used the $(4i-3,4i-3)$ diagonal element of *U*. Our estimate of e_i does not take into account 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.17 presents final shrinkage estimates of participation rates (values of $\theta_{F,1,i}$) and their standard errors. Table A.18 shows final shrinkage estimates of the numbers of eligible people (values of $\psi_{F,1,i}$), and their standard errors.

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

	FY 2020	FY 2022
Alabama	711,394	761,074
Alaska	79,132	92,119
Arizona	784,361	825,666
Arkansas	345,889	286,335
California	4,043,491	4,627,738
Colorado	435,621	540,299
Connecticut	361,916	375,361
Delaware	118,750	118,842
District of Columbia	109,562	145,805
Florida	2,719,020	2,847,086
Georgia	1,354,316	1,608,203
Hawaii	153,968	169,014
Idaho	144,568	124,078
Illinois	1,773,222	1,981,714
Indiana	567,414	617,630
Iowa	299,948	278,827
Kansas	194,148	195,799
Kentucky	492,108	540,473
Louisiana	790,217	816,513
Maine	154,993	162,159
Maryland	603,502	772,731
Massachusetts	762,501	1,024,442
Michigan	1,155,952	1,349,306
Minnesota	393,530	435,910
Mississippi	432,256	413,651
Missouri	666,158	657,870
Montana	105,498	89,167
Nebraska	154,820	155,550
Nevada	415,558	455,231
New Hampshire	72,302	69,343
New Jersey	674,720	857,214
New Mexico	446,972	518,633
New York	2,570,220	2,839,326
North Carolina	1,228,704	1,599,917
North Dakota	47,727	47,417
Ohio	1,374,426	1,491,294
Oklahoma	575,676	650,640
Oregon	582,061	718,580
Pennsylvania	1,733,275	1,845,636
Rhode Island	146,973	139,362
South Carolina	576,192	618,978
South Dakota	78,229	71,012
Tennessee	866,329	825,338
Texas	3,253,941	3,440,726
Utah	164,388	156,291
Vermont	67,577	69,483
Virginia	688,614	794,646
Washington	797,467	874,543
West Virginia	305,521	310,879
Wisconsin	601,976	708,238
Wyoming	25,708	30,178
United States	37,202,811	41,146,259

Source: U.S. Department of Agriculture's Food and Nutrition Service.

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

	FY 2020	FY 2022
Alabama	94.08	94.11
Alaska	92.71	55.32
Arizona	85.38	76.93
Arkansas	92.77	93.39
California	88.16	80.47
Colorado	88.84	79.07
Connecticut	81.04	79.73
Delaware	77.34	70.87
District of Columbia	92.87	85.36
Florida	87.61	82.99
Georgia	90.27	87.96
Hawaii	89.76	77.03
Idaho	91.84	91.84
Illinois	82.59	77.69
Indiana	92.76	90.12
Iowa	82.43	78.54
Kansas	97.55	93.02
Kentucky	92.72	87.47
Louisiana	98.37	94.19
Maine	80.33	73.26
Maryland	87.37	59.75
Massachusetts	82.43	79.63
Michigan	86.58	76.11
Minnesota	87.16	79.71
Mississippi	96.55	97.10
Missouri	96.74	90.89
Montana	83.41	83.43
Nebraska	91.36	86.40
Nevada	79.70	75.56
New Hampshire	86.52	80.86
New Jersey	88.56	82.25
New Mexico	90.22	84.70
New York	86.56	82.23
North Carolina	87.14	75.37
North Dakota	78.90	78.89
Ohio	89.27	86.53
Oklahoma	92.90	90.38
Oregon	86.38	67.23
Pennsylvania	87.71	75.16
Rhode Island	80.92	80.30
South Carolina	93.44	89.74
South Dakota	97.17	95.00
Tennessee	94.53	88.92
Texas	88.08	82.49
Utah	96.63	96.00
Vermont	80.92	77.91
Virginia	95.92	84.19
Washington	82.40	71.49
West Virginia	86.95	80.12
Wisconsin	84.14	74.49
Wyoming	96.12	97.82

Source: SNAP Quality Control database.

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

	FY 2020	FY 2022
Alabama	669,251	716,224
Alaska	73,363	50,958
Arizona	669,711	635,160
Arkansas	320,881	267,408
California	3,564,580	3,724,080
Colorado	386,997	427,225
Connecticut	293,286	299,294
Delaware	91,841	84,219
District of Columbia	101,750	124,462
Florida	2,382,215	2,362,825
Georgia	1,222,514	1,414,511
Hawaii	138,203	130,188
Idaho	132,770	113,952
Illinois	1,464,451	1,539,693
Indiana	526,328	556,602
Iowa	247,247	218,988
Kansas	189,399	182,124
Kentucky	456,292	472,730
Louisiana	777,313	769,082
Maine	124,507	118,799
Maryland	527,256	461,699
Massachusetts	628,514	815,773
Michigan	1,000,869	1,026,970
Minnesota	342,981	347,460
Mississippi	417,360	401,663
Missouri	644,408	597,945
Montana	87,994	74,391
Nebraska	141,445	134,403
Nevada	331,187	343,991
New Hampshire	62,559	56,073
New Jersey	597,559	705,050
New Mexico	403,267	439,272
New York	2,224,885	2,334,664
North Carolina	1,070,742	1,205,777
North Dakota	37,656	37,409
Ohio	1,226,991	1,290,447
Oklahoma	534,803	588,068
Oregon	502,802	483,101
Pennsylvania	1,520,221	1,387,198
Rhode Island	118,935	111,905
South Carolina	538,423	555,496
South Dakota	76,018	67,462
Tennessee	818,932	733,866
Texas	2,866,136	2,838,117
Utah	158,856	150,032
Vermont	54,681	54,137
Virginia	660,491	669,020
Washington	657,121	625,211
West Virginia	265,657	249,076
Wisconsin	506,491	527,559
Wyoming	24,712	29,521
United States	32,882,852	33,551,281

Source: SNAP Quality Control database.

Table A.4. Estimated percentage of people eligible for SNAP

	FY 2020	FY 2022
Alabama	15.80	15.31
Alaska	13.00	10.26
Arizona	11.47	12.06
Arkansas	15.86	15.73
California	13.68	12.65
Colorado	9.14	6.98
Connecticut	8.32	8.67
Delaware	10.26	9.53
District of Columbia	15.35	16.21
Florida	14.75	13.57
Georgia	15.83	13.73
Hawaii	11.55	11.66
Idaho	8.14	8.87
Illinois	10.05	9.37
Indiana	10.74	9.67
Iowa	9.39	6.59
Kansas	8.74	8.82
Kentucky	15.38	15.89
Louisiana	19.66	17.35
Maine	10.66	9.77
Maryland	9.73	7.83
Massachusetts	9.11	9.50
Michigan	12.00	10.82
Minnesota	7.97	7.02
Mississippi	22.60	19.51
Missouri	10.43	10.98
Montana	10.07	9.11
Nebraska	8.99	6.14
Nevada	11.71	11.48
New Hampshire	6.02	6.60
New Jersey	8.31	8.66
New Mexico	19.18	19.44
New York	14.19	13.42
North Carolina	15.26	13.24
North Dakota	7.40	6.46
Ohio	13.82	10.83
Oklahoma	14.72	15.79
Oregon	8.60	8.81
Pennsylvania	10.68	10.48
Rhode Island	10.53	8.34
South Carolina	14.79	14.13
South Dakota	11.23	8.47
Tennessee	14.24	11.62
Texas	13.99	13.53
Utah	6.43	6.38
Vermont	9.46	8.43
Virginia	9.45	8.83
Washington	6.96	7.52
West Virginia	15.83	16.37
Wisconsin	8.17	7.60
Wyoming	9.41	8.34

Source: Current Population Survey Annual Social and Economic Supplement.

Table A.5. Directly estimated number of people eligible for SNAP

	FY 2020	FY 2022
Alabama	791,012	763,294
Alaska	92,233	72,894
Arizona	824,495	876,252
Arkansas	470,195	472,565
California	5,377,566	4,906,317
Colorado	522,890	400,469
Connecticut	294,836	311,832
Delaware	101,615	97,891
District of Columbia	104,655	106,053
Florida	3,170,283	3,000,106
Georgia	1,667,838	1,492,913
Hawaii	164,760	166,450
Idaho	151,015	172,077
Illinois	1,272,395	1,161,063
Indiana	721,355	657,822
Iowa	297,621	209,710
Kansas	252,061	253,006
Kentucky	686,012	709,114
Louisiana	897,338	784,737
Maine	145,575	134,527
Maryland	594,806	485,087
Massachusetts	635,503	652,510
Michigan	1,191,299	1,076,468
Minnesota	449,197	393,923
Mississippi	663,151	564,518
Missouri	633,273	665,000
Montana	108,506	102,023
Nebraska	174,845	119,857
Nevada	365,342	362,133
New Hampshire	83,287	91,755
New Jersey	758,131	795,346
New Mexico	397,275	410,788
New York	2,793,238	2,613,122
North Carolina	1,588,911	1,419,063
North Dakota	56,600	49,363
Ohio	1,617,214	1,264,309
Oklahoma	573,721	623,579
Oregon	354,852	372,991
Pennsylvania	1,357,670	1,332,985
Rhode Island	114,769	89,741
South Carolina	755,804	742,739
South Dakota	98,158	75,132
Tennessee	983,966	814,136
Texas	4,040,250	4,038,112
Utah	210,686	212,890
Vermont	60,495	53,982
Virginia	802,523	750,400
Washington	528,244	579,221
West Virginia	279,051	287,603
Wisconsin	477,293	443,754
Wyoming	52,949	47,079
United States	40,806,758	38,278,701

Source: Current Population Survey Annual Social and Economic Supplement.

Table A.6. CPS ASEC population estimate

	FY 2020	FY 2022
Alabama	5,005,605	4,986,401
Alaska	709,572	710,359
Arizona	7,186,339	7,265,012
Arkansas	2,963,818	3,003,471
California	39,297,441	38,784,649
Colorado	5,723,019	5,740,021
Connecticut	3,542,384	3,596,505
Delaware	990,180	1,027,508
District of Columbia	681,677	654,292
Florida	21,494,817	22,103,684
Georgia	10,537,594	10,871,358
Hawaii	1,426,986	1,427,212
Idaho	1,854,421	1,940,875
Illinois	12,663,403	12,394,025
Indiana	6,716,538	6,802,163
Iowa	3,169,308	3,182,938
Kansas	2,883,649	2,869,816
Kentucky	4,459,701	4,463,735
Louisiana	4,564,378	4,522,374
Maine	1,365,275	1,376,966
Maryland	6,112,692	6,195,206
Massachusetts	6,977,036	6,867,158
Michigan	9,926,942	9,945,456
Minnesota	5,635,129	5,613,944
Mississippi	2,934,736	2,893,961
Missouri	6,069,909	6,057,582
Montana	1,077,584	1,119,326
Nebraska	1,944,669	1,951,882
Nevada	3,118,913	3,154,341
New Hampshire	1,382,600	1,389,689
New Jersey	9,126,074	9,184,742
New Mexico	2,071,450	2,113,134
New York	19,678,542	19,476,356
North Carolina	10,412,514	10,717,361
North Dakota	765,109	763,919
Ohio	11,702,685	11,673,534
Oklahoma	3,897,703	3,950,292
Oregon	4,124,540	4,234,450
Pennsylvania	12,710,781	12,719,149
Rhode Island	1,090,402	1,076,139
South Carolina	5,110,883	5,258,065
South Dakota	874,141	886,526
Tennessee	6,909,034	7,006,488
Texas	28,889,764	29,836,876
Utah	3,274,345	3,339,258
Vermont	639,566	640,067
Virginia	8,489,790	8,501,699
Washington	7,593,855	7,706,123
West Virginia	1,762,467	1,756,376
Wisconsin	5,842,360	5,837,550
Wyoming	562,567	564,229
United States	327,944,886	330,154,240

Source: Current Population Survey Annual Social and Economic Supplement.

Table A.7. State population on July 1

	FY 2020	FY 2022
Alabama	4,921,532	5,073,903
Alaska	731,158	733,276
Arizona	7,421,401	7,365,684
Arkansas	3,030,522	3,046,404
California	39,368,078	39,040,616
Colorado	5,807,719	5,841,039
Connecticut	3,557,006	3,608,706
Delaware	986,809	1,019,459
District of Columbia	712,816	670,949
Florida	21,733,312	22,245,521
Georgia	10,710,017	10,913,150
Hawaii	1,407,006	1,439,399
Idaho	1,826,913	1,938,996
Illinois	12,587,530	12,582,515
Indiana	6,754,953	6,832,274
Iowa	3,163,561	3,199,693
Kansas	2,913,805	2,936,716
Kentucky	4,477,251	4,511,563
Louisiana	4,645,318	4,588,023
Maine	1,350,141	1,389,338
Maryland	6,055,802	6,163,981
Massachusetts	6,893,574	6,982,740
Michigan	9,966,555	10,033,281
Minnesota	5,657,342	5,714,300
Mississippi	2,966,786	2,938,928
Missouri	6,151,548	6,177,168
Montana	1,080,577	1,122,878
Nebraska	1,937,552	1,968,060
Nevada	3,138,259	3,177,421
New Hampshire	1,366,275	1,399,003
New Jersey	8,882,371	9,260,817
New Mexico	2,106,319	2,113,476
New York	19,336,776	19,673,200
North Carolina	10,600,823	10,695,965
North Dakota	765,309	778,912
Ohio	11,693,217	11,759,697
Oklahoma	3,980,783	4,019,271
Oregon	4,241,507	4,239,379
Pennsylvania	12,783,254	12,972,091
Rhode Island	1,057,125	1,093,842
South Carolina	5,218,040	5,282,955
South Dakota	892,717	909,869
Tennessee	6,886,834	7,048,976
Texas	29,360,759	30,029,848
Utah	3,249,879	3,381,236
Vermont	623,347	647,110
Virginia	8,590,563	8,679,099
Washington	7,693,612	7,784,477
West Virginia	1,784,787	1,774,035
Wisconsin	5,832,655	5,890,543
Wyoming	582,328	581,629
United States	329,484,123	333,271,411

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

Table A.8. Direct estimates of SNAP participation rates and standard errors

	Direct estimates		Standard errors	
	FY 2020	FY 2022	FY 2020	FY 2022
Alabama	86.05	92.22	7.178	6.659
Alaska	77.19	67.72	5.632	6.335
Arizona	78.65	71.50	6.600	4.507
Arkansas	66.74	55.79	4.428	3.232
California	66.17	75.41	1.715	2.423
Colorado	72.93	104.84	8.723	12.002
Connecticut	99.07	95.65	8.997	9.023
Delaware	90.69	86.71	7.232	7.852
District of Columbia	92.98	114.45	5.395	8.164
Florida	74.32	78.26	2.859	3.409
Georgia	72.12	94.39	4.780	5.474
Hawaii	85.07	77.55	6.821	6.322
Idaho	89.24	66.29	5.460	4.153
Illinois	115.79	130.62	6.652	8.002
Indiana	72.55	84.24	4.043	6.185
Iowa	83.23	103.88	7.839	9.432
Kansas	74.36	70.34	7.800	7.487
Kentucky	66.25	65.96	5.166	5.860
Louisiana	85.12	96.60	3.880	5.459
Maine	86.49	87.52	9.005	9.843
Maryland	89.48	95.66	7.838	10.516
Massachusetts	100.10	122.95	7.234	8.307
Michigan	83.68	94.57	4.428	5.884
Minnesota	76.06	86.66	6.527	8.152
Mississippi	62.26	70.06	3.626	3.853
Missouri	100.41	88.18	9.313	8.332
Montana	80.87	72.69	5.759	6.065
Nebraska	81.19	111.21	6.333	14.302
Nevada	90.09	94.30	5.681	8.489
New Hampshire	76.01	60.71	7.851	6.676
New Jersey	80.98	87.92	5.601	7.011
New Mexico	99.83	106.92	6.464	11.696
New York	81.06	88.45	2.922	3.894
North Carolina	66.19	85.14	3.604	5.036
North Dakota	66.51	74.32	5.344	7.219
Ohio	75.93	101.32	4.471	7.144
Oklahoma	91.27	92.69	6.150	7.354
Oregon	137.79	129.37	13.643	17.094
Pennsylvania	111.34	102.04	7.075	7.643
Rhode Island	106.89	122.68	11.146	16.007
South Carolina	69.78	74.44	3.911	5.511
South Dakota	75.83	87.49	13.446	9.530
Tennessee	83.50	89.60	6.025	7.226
Texas	69.80	69.83	2.430	2.268
Utah	75.97	69.60	7.451	6.132
Vermont	92.74	99.20	8.677	8.678
Virginia	81.34	87.33	7.302	6.239
Washington	122.78	106.85	12.925	7.574
West Virginia	94.01	85.74	7.335	4.746
Wisconsin	106.29	117.82	9.673	11.091
Wyoming	45.09	60.83	5.047	5.872

Table A.9. Potential predictors

Predictor	Data source(s)
• Number of people receiving 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 SNAP benefits under federal eligibility rules • Percentage of children ages 5 to 17 approved to receive (1) free and (2) reduced price lunches under the National School Lunch Program • Percentage of people ages 65 and older who received Supplemental Security Income	Administrative data, population estimates
• Per capita personal income	Commerce Bureau, population estimates
• Mean adjusted gross income; median adjusted gross income • Percentages of exemptions for (1) all people, (2) people age 65 and older, and (3) children claimed on tax returns with adjusted gross income below the federal poverty level (FPL)	Individual income tax data
• Percentages of (1) all people, (2) people age 65 and older, and (3) people younger than age 65 not claimed on tax returns • Percentages of (1) all people, (2) people age 65 and older, and (3) people younger than age 65 not claimed on tax returns or claimed on returns with adjusted gross income below the FPL	Individual income tax data, population estimates
• Percentages of population that were (1) foreign-born and (2) noncitizens • Percentages of households that were (1) married-couple families and (2) nonfamily households • Percentages of (1) households and (2) families that had a female householder with no spouse present • Percentage of people age 15 and older with their own children younger than age 18 • Percentages of people 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 for 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 • Median earnings, people age 16 and older with earnings • Percentage of occupied housing units that were owner occupied • Median gross rent amount, renter-occupied housing units paying rent • Median household income; median family income • Percentages of population with household income below (1) 50 percent, (2) 100 percent, and (3) 200 percent of the FPL • Percentages of (1) children, (2) adults ages 18 to 64, and (3) adults age 65 and older with household income below 100 percent of the FPL • Percentages of (1) households and (2) families with income below $20,000	American Community Survey one-year estimates
• Indicators of whether a State had a BBCE policy that did not include a resource test and covered (1) all income-eligible people or (2) most income-eligible people or (3) did not have a BBCE policy or had a BBCE policy that included a resource test • Indicators of whether a State's resource test (1) exempted all vehicles, (2) exempted some vehicles, or (3) did not exempt additional vehicles beyond those exempted by the federal vehicle rules	SNAP policy data

Table A.10. Predictors in current model

Predictor	Numerator	Denominator
Percentage of population that correctly received regular SNAP benefits	People correctly receiving regular SNAP benefits according to SNAP Program Operations data	Resident population[a]
Percentage of people age 65 and older that received Supplemental Security Income	People age 65 and older receiving Supplemental Security Income	Resident population age 65 and older[a]
Percentage of families that had income under $20,000 in the past 12 months	Families with income under $20,000 in the past 12 months according to ACS one-year estimates[b]	Total families according to ACS one-year estimates[b]
Change in July 1 estimated population	Resident population minus previous year's resident population[a]	Previous year's resident population
Percentage of civilian employed population age 16 and older that were private wage and salary workers	Civilians age16 and older employed in the private sector according to ACS one-year estimates[b]	Total employed civilians age 16 and older according to ACS one-year estimates[b]
Percentage of people not claimed on tax returns or claimed on tax returns that had adjusted gross income below the federal poverty level	Children claimed on federal tax returns with adjusted gross income under the federal poverty level[c]	Total children claimed on federal tax returns[c]
Median household income	Median household income according to ACS one-year estimates[b]	10,000
Indicator	**Indicator = 1**	**Indicator = 0**
Indicator of whether a State had a BBCE policy that did not include a resource test and covered all income-eligible households	State did not apply a resource test for income-eligible households	State applied a resource test for some or all households

[a]Estimates of the resident population are from the annual July 1 population estimates released in June 2021, available at https://www.census.gov/programs-surveys/popest.html.

[b]ACS one-year estimates available at https://data.census.gov/.

[c]Counts of people claimed on tax returns are from individual income tax data provided by the Census Bureau Small Area Estimates Branch.

ACS = American Community Survey.

Table A.11. Values for first and second predictors

	Percentage of population that correctly received regular SNAP benefits		Percentage of people age 65 and older that received Supplemental Security Income	
	FY 2020	FY 2022	FY 2020	FY 2022
Alabama	14.082	14.725	0.858	0.810
Alaska	10.034	6.949	1.824	1.598
Arizona	10.015	10.652	1.272	1.280
Arkansas	10.588	8.778	0.846	0.820
California	10.122	11.344	5.756	5.535
Colorado	7.276	9.061	1.226	1.209
Connecticut	9.612	10.007	1.112	1.134
Delaware	11.407	10.802	0.645	0.654
District of Columbia	15.151	21.878	2.374	2.728
Florida	12.366	12.458	3.101	3.087
Georgia	11.887	14.502	1.639	1.638
Hawaii	10.620	9.814	1.910	1.786
Idaho	7.891	6.341	0.550	0.512
Illinois	13.582	14.974	1.427	1.389
Indiana	8.156	8.736	0.522	0.546
Iowa	9.119	8.574	0.548	0.513
Kansas	6.500	6.216	0.587	0.572
Kentucky	10.767	11.714	1.137	1.069
Louisiana	16.733	17.326	1.365	1.314
Maine	10.788	10.694	0.592	0.561
Maryland	9.966	9.526	1.519	1.496
Massachusetts	10.639	13.924	2.029	1.981
Michigan	11.218	12.858	1.058	1.051
Minnesota	6.791	7.503	1.173	1.122
Mississippi	14.080	13.681	1.443	1.369
Missouri	10.476	9.777	0.626	0.625
Montana	9.550	7.792	0.667	0.669
Nebraska	7.783	7.593	0.748	0.737
Nevada	12.620	13.848	2.820	2.818
New Hampshire	5.142	4.657	0.312	0.304
New Jersey	7.596	9.125	2.326	2.149
New Mexico	20.683	23.304	1.995	1.800
New York	12.926	13.586	3.283	3.130
North Carolina	11.285	14.233	0.912	0.918
North Dakota	6.043	5.799	0.493	0.470
Ohio	11.455	12.082	0.802	0.819
Oklahoma	13.990	15.371	0.919	0.897
Oregon	13.651	14.740	1.218	1.162
Pennsylvania	13.534	13.146	0.996	1.014
Rhode Island	12.981	11.936	1.681	1.579
South Carolina	10.926	11.397	0.760	0.790
South Dakota	8.659	7.623	0.977	0.935
Tennessee	11.891	10.411	0.885	0.866
Texas	11.032	11.227	2.577	2.414
Utah	4.931	4.476	0.719	0.690
Vermont	10.615	10.469	0.693	0.630
Virginia	7.689	8.954	1.224	1.203
Washington	10.222	10.783	1.407	1.354
West Virginia	16.599	16.619	0.591	0.613
Wisconsin	10.036	11.787	0.626	0.607
Wyoming	4.244	5.076	0.335	0.344

Table A.12. Values for third and fourth predictors

	Percentage of families that had income under $20,000 in the past 12 months		Change in July 1 estimated population	
	FY 2020	FY 2022	FY 2020	FY 2022
Alabama	9.0	9.9	0.276	0.466
Alaska	5.4	5.5	-0.333	-0.224
Arizona	7.7	7.0	1.777	1.282
Arkansas	10.3	9.7	0.316	0.593
California	6.6	6.6	-0.176	-0.267
Colorado	5.0	4.7	0.855	0.507
Connecticut	6.0	5.4	-0.253	0.139
Delaware	5.9	5.4	1.038	1.451
District of Columbia	6.7	7.7	0.644	0.286
Florida	7.5	7.3	1.123	1.900
Georgia	8.2	7.6	0.772	1.138
Hawaii	5.4	5.2	-0.608	-0.508
Idaho	6.1	5.4	2.116	1.809
Illinois	6.8	6.7	-0.628	-0.850
Indiana	7.5	7.3	0.356	0.271
Iowa	6.2	5.7	0.125	0.055
Kansas	6.7	5.8	0.040	-0.042
Kentucky	10.0	9.7	0.110	0.088
Louisiana	11.8	11.3	-0.278	-0.843
Maine	6.6	5.3	0.325	0.765
Maryland	4.8	5.3	0.014	-0.179
Massachusetts	5.8	5.8	-0.019	-0.132
Michigan	7.6	7.4	-0.183	-0.048
Minnesota	4.5	4.7	0.307	-0.064
Mississippi	14.2	11.5	-0.384	-0.361
Missouri	7.4	7.1	0.180	0.110
Montana	6.5	5.9	0.977	1.492
Nebraska	5.2	5.9	0.258	0.194
Nevada	7.0	7.4	1.536	0.978
New Hampshire	4.0	3.6	0.404	0.829
New Jersey	6.2	5.4	-0.100	-0.090
New Mexico	11.1	10.1	0.318	-0.164
New York	8.4	8.5	-0.649	-0.913
North Carolina	8.0	7.6	0.947	1.219
North Dakota	6.1	5.1	0.208	0.120
Ohio	8.1	7.7	-0.028	-0.047
Oklahoma	8.9	9.1	0.508	0.692
Oregon	6.3	6.1	0.602	-0.401
Pennsylvania	6.8	6.6	-0.122	-0.319
Rhode Island	6.0	5.9	-0.098	-0.296
South Carolina	8.9	8.2	1.170	1.716
South Dakota	6.7	6.4	0.630	1.514
Tennessee	8.6	7.9	0.827	1.224
Texas	8.2	8.3	1.290	1.585
Utah	4.2	4.2	1.451	1.256
Vermont	4.4	5.3	-0.112	0.003
Virginia	5.3	6.1	0.396	0.251
Washington	5.6	5.5	1.045	0.556
West Virginia	10.5	10.4	-0.584	-0.628
Wisconsin	5.6	5.7	0.139	0.180
Wyoming	5.6	6.9	0.381	0.359

Table A.13. Values for fifth and sixth predictors

	Percentage of civilian employed population age 16 and older that were private wage and salary workers		Percentage of people not claimed on tax returns or claimed on tax returns that had adjusted gross income below the federal poverty level	
	FY 2020	FY 2022	FY 2020	FY 2022
Alabama	73.8	73.9	39.6	39.4
Alaska	60.6	65.1	29.3	27.3
Arizona	75.4	76.2	36.5	33.3
Arkansas	73.8	74.0	39.7	37.9
California	73.3	74.0	32.4	30.7
Colorado	73.6	74.7	27.6	25.0
Connecticut	76.9	77.3	27.6	26.7
Delaware	74.7	76.9	30.8	29.6
District of Columbia	66.9	67.2	42.8	35.8
Florida	74.8	75.5	36.5	33.2
Georgia	74.4	75.5	38.2	37.1
Hawaii	66.0	66.4	30.5	30.6
Idaho	72.1	72.9	26.6	26.5
Illinois	77.8	77.8	30.4	29.3
Indiana	79.8	80.3	30.6	29.4
Iowa	75.4	74.6	26.3	26.0
Kansas	73.1	74.1	28.4	27.6
Kentucky	76.6	76.1	37.0	35.8
Louisiana	72.6	72.9	43.5	41.7
Maine	71.4	73.1	29.3	28.5
Maryland	68.6	68.0	29.1	28.4
Massachusetts	77.9	78.5	27.2	26.5
Michigan	79.5	79.6	32.4	31.9
Minnesota	76.7	78.0	23.7	22.5
Mississippi	70.8	71.5	42.9	41.7
Missouri	77.2	77.8	33.0	31.4
Montana	66.3	69.1	29.8	28.8
Nebraska	73.5	74.0	24.7	24.0
Nevada	76.6	78.7	33.9	31.7
New Hampshire	76.5	77.2	22.9	21.4
New Jersey	76.1	76.6	26.0	26.1
New Mexico	65.0	65.4	40.2	38.3
New York	73.0	73.7	33.1	33.8
North Carolina	75.9	76.3	35.5	32.4
North Dakota	70.5	71.2	24.7	24.1
Ohio	78.7	78.9	31.1	30.3
Oklahoma	70.4	71.9	37.9	36.7
Oregon	73.6	74.5	31.6	30.0
Pennsylvania	80.2	80.4	29.6	29.5
Rhode Island	79.1	76.5	29.3	29.6
South Carolina	74.5	74.0	36.7	33.5
South Dakota	72.7	72.4	25.5	23.5
Tennessee	76.4	77.1	34.8	32.8
Texas	74.4	75.5	34.8	33.3
Utah	74.8	75.2	23.2	22.6
Vermont	70.2	71.6	25.9	27.1
Virginia	70.8	70.7	29.9	27.8
Washington	73.5	74.6	25.8	25.0
West Virginia	72.3	73.1	38.9	37.1
Wisconsin	77.7	78.4	26.3	24.7
Wyoming	67.5	64.5	26.7	24.7

Table A.14. Values for seventh and eighth predictors

	Median household income		Indicator of whether a State had a BBCE policy that did not include a resource test and covered all income-eligible households	
	FY 2020	FY 2022	FY 2020	FY 2022
Alabama	5.40	6.00	0	0
Alaska	8.02	8.80	0	0
Arizona	6.48	7.50	1	1
Arkansas	5.12	5.50	0	0
California	8.31	9.20	1	1
Colorado	7.77	8.90	0	0
Connecticut	7.97	8.80	1	1
Delaware	7.09	8.20	1	1
District of Columbia	9.68	10.10	1	1
Florida	6.17	6.90	1	1
Georgia	6.28	7.30	1	1
Hawaii	8.64	9.20	1	1
Idaho	6.28	7.30	0	0
Illinois	7.12	7.70	1	1
Indiana	6.08	6.70	0	0
Iowa	6.22	7.00	0	0
Kansas	6.33	6.90	0	0
Kentucky	5.42	5.90	1	1
Louisiana	5.17	5.50	0	0
Maine	5.88	7.00	1	1
Maryland	8.87	9.50	1	1
Massachusetts	8.73	9.40	0	0
Michigan	6.15	6.70	1	1
Minnesota	7.55	8.20	1	1
Mississippi	4.72	5.30	0	0
Missouri	5.88	6.50	0	0
Montana	5.72	6.80	0	0
Nebraska	6.46	7.00	0	0
Nevada	6.46	7.20	1	1
New Hampshire	8.10	9.00	0	0
New Jersey	8.70	9.60	1	1
New Mexico	5.21	6.00	1	1
New York	7.34	8.00	1	1
North Carolina	5.96	6.70	1	1
North Dakota	6.20	7.20	0	0
Ohio	6.03	6.60	1	1
Oklahoma	5.45	6.00	0	0
Oregon	6.79	7.60	1	1
Pennsylvania	6.49	7.20	1	1
Rhode Island	7.57	8.20	1	1
South Carolina	5.70	6.40	1	1
South Dakota	6.06	7.00	0	0
Tennessee	5.70	6.50	0	0
Texas	6.60	7.20	0	0
Utah	7.78	8.90	0	0
Vermont	6.74	7.40	1	1
Virginia	7.92	8.60	0	1
Washington	8.04	9.10	1	1
West Virginia	4.94	5.40	1	1
Wisconsin	6.49	7.10	1	1
Wyoming	6.64	7.00	0	0

Table A.15. Regression estimates of SNAP participation rates, with standard errors

	Regression estimates		Standard errors	
	FY 2020	FY 2022	FY 2020	FY 2022
Alabama	85.33	84.33	4.835	4.627
Alaska	79.54	69.87	5.312	5.100
Arizona	69.64	73.29	4.820	4.623
Arkansas	58.94	54.14	4.647	4.796
California	64.97	77.27	5.217	5.403
Colorado	79.26	94.75	4.413	4.719
Connecticut	89.91	92.73	4.573	4.562
Delaware	94.76	87.50	4.455	4.784
District of Columbia	94.77	120.79	6.362	6.953
Florida	75.19	75.74	4.638	4.987
Georgia	72.89	85.31	4.384	4.872
Hawaii	83.17	77.04	4.940	5.573
Idaho	79.89	69.80	5.190	4.535
Illinois	104.34	116.50	4.725	4.846
Indiana	74.37	84.62	4.561	4.738
Iowa	86.97	91.51	4.473	4.756
Kansas	63.90	74.85	4.458	4.814
Kentucky	63.05	71.94	4.626	4.850
Louisiana	85.40	93.90	4.819	5.045
Maine	83.03	90.15	4.599	5.018
Maryland	88.15	79.28	4.759	5.091
Massachusetts	102.98	119.23	5.465	5.868
Michigan	83.52	96.77	4.475	4.539
Minnesota	80.12	90.89	4.475	4.781
Mississippi	60.74	69.22	5.437	4.827
Missouri	81.85	86.12	4.612	4.696
Montana	74.77	70.20	4.823	4.894
Nebraska	82.04	87.21	4.521	4.832
Nevada	86.66	93.02	4.709	4.601
New Hampshire	81.80	83.13	4.785	4.959
New Jersey	77.42	86.22	5.097	4.868
New Mexico	106.03	121.65	6.076	6.833
New York	82.44	86.48	4.480	4.606
North Carolina	76.88	94.84	4.321	4.479
North Dakota	66.41	78.34	4.635	4.855
Ohio	86.37	94.29	4.401	4.592
Oklahoma	85.38	92.86	4.523	4.742
Oregon	102.00	111.79	4.487	4.905
Pennsylvania	107.19	107.20	4.842	4.765
Rhode Island	106.79	97.26	4.731	4.459
South Carolina	69.52	70.94	4.585	4.817
South Dakota	80.70	78.89	4.614	5.475
Tennessee	84.34	78.21	4.353	4.353
Texas	76.23	73.39	4.599	4.699
Utah	77.13	73.25	4.814	4.789
Vermont	93.50	92.97	5.047	4.859
Virginia	75.02	76.18	4.526	4.728
Washington	96.46	94.96	5.212	4.841
West Virginia	91.67	96.60	4.830	4.930
Wisconsin	92.45	108.72	4.516	5.035
Wyoming	52.87	60.17	5.051	5.883

Table A.16. Preliminary shrinkage estimates of SNAP participation rates

	FY 2020	FY 2022
Alabama	85.70	85.34
Alaska	78.65	69.11
Arizona	71.01	73.35
Arkansas	61.94	55.91
California	65.72	76.58
Colorado	78.15	94.87
Connecticut	90.83	93.27
Delaware	93.69	86.75
District of Columbia	93.78	119.06
Florida	75.10	76.65
Georgia	73.69	87.51
Hawaii	83.08	76.73
Idaho	81.35	69.25
Illinois	107.66	119.79
Indiana	73.92	84.53
Iowa	87.18	92.69
Kansas	65.42	74.94
Kentucky	63.24	70.86
Louisiana	85.28	94.15
Maine	82.64	89.19
Maryland	88.83	80.70
Massachusetts	102.68	119.59
Michigan	82.39	95.32
Minnesota	77.88	88.58
Mississippi	61.62	69.79
Missouri	84.14	87.23
Montana	76.34	71.30
Nebraska	82.32	88.49
Nevada	87.20	93.24
New Hampshire	78.57	78.17
New Jersey	78.14	86.44
New Mexico	103.95	119.59
New York	81.84	86.68
North Carolina	71.13	89.93
North Dakota	65.64	77.14
Ohio	83.21	93.75
Oklahoma	86.59	93.50
Oregon	104.57	113.65
Pennsylvania	107.26	106.40
Rhode Island	107.45	98.52
South Carolina	69.98	71.97
South Dakota	80.61	79.85
Tennessee	85.02	80.16
Texas	71.77	70.06
Utah	76.44	72.25
Vermont	93.93	93.98
Virginia	77.21	79.00
Washington	99.48	97.96
West Virginia	89.02	92.64
Wisconsin	94.70	110.51
Wyoming	50.77	59.39

Table A.17. Final shrinkage estimates of SNAP participation rates, with standard errors

	Final shrinkage estimates		Standard errors	
	FY 2020	FY 2022	FY 2020	FY 2022
Alabama	87.88	89.88	4.029	3.857
Alaska	80.65	72.78	3.970	4.066
Arizona	72.81	77.25	3.885	3.237
Arkansas	63.51	58.89	3.234	2.767
California	67.39	80.65	1.692	2.371
Colorado	80.14	99.92	3.951	4.469
Connecticut	93.14	98.22	4.048	4.058
Delaware	96.07	91.36	3.670	4.068
District of Columbia	96.16	100.00	4.679	6.145
Florida	77.01	80.73	2.408	2.878
Georgia	75.56	92.17	3.164	3.722
Hawaii	85.19	80.81	4.017	4.499
Idaho	83.42	72.93	4.038	3.107
Illinois	100.00	100.00	4.061	4.425
Indiana	75.80	89.02	3.008	3.679
Iowa	89.40	97.62	3.800	4.265
Kansas	67.08	78.92	3.816	4.031
Kentucky	64.85	74.63	3.382	3.717
Louisiana	87.45	99.16	3.040	3.708
Maine	84.74	93.93	4.055	4.505
Maryland	91.09	84.99	4.102	4.682
Massachusetts	100.00	100.00	4.482	5.065
Michigan	84.48	100.00	3.121	3.503
Minnesota	79.86	93.29	3.757	4.140
Mississippi	63.19	73.50	3.213	3.028
Missouri	86.28	91.87	4.182	4.116
Montana	78.28	75.08	3.701	3.814
Nebraska	84.42	93.19	3.758	4.578
Nevada	89.41	98.19	3.603	3.929
New Hampshire	80.56	82.33	4.371	4.486
New Jersey	80.13	91.03	3.840	3.961
New Mexico	100.00	100.00	4.823	6.317
New York	83.92	91.28	2.393	2.939
North Carolina	72.94	94.71	3.001	3.415
North Dakota	67.31	81.23	3.448	3.991
Ohio	85.32	98.73	3.301	3.937
Oklahoma	88.80	98.47	3.571	3.972
Oregon	100.00	100.00	4.542	4.882
Pennsylvania	100.00	100.00	4.015	3.996
Rhode Island	100.00	100.00	4.401	4.345
South Carolina	71.76	75.80	2.935	3.551
South Dakota	82.66	84.09	4.310	5.049
Tennessee	87.18	84.42	3.437	3.661
Texas	73.59	73.79	2.230	2.141
Utah	78.38	76.09	3.896	3.751
Vermont	96.32	98.98	4.386	4.291
Virginia	79.17	83.20	3.872	4.002
Washington	100.00	100.00	5.186	4.558
West Virginia	91.28	97.57	4.368	3.647
Wisconsin	97.11	100.00	4.214	4.880
Wyoming	52.06	62.55	3.775	4.540

Table A.18. Final shrinkage estimates of number of people eligible for SNAP, with standard errors

	Final shrinkage estimates		Standard errors	
	FY 2020	FY 2022	FY 2020	FY 2022
Alabama	761,585	796,869	35,599	35,931
Alaska	90,965	70,014	4,565	4,110
Arizona	919,765	822,250	50,024	36,204
Arkansas	505,245	454,106	26,226	22,414
California	5,289,523	4,617,552	135,400	142,604
Colorado	482,926	427,576	24,270	20,092
Connecticut	314,890	304,710	13,950	13,225
Delaware	95,599	92,179	3,723	4,312
District of Columbia	105,814	124,462	5,249	5,111
Florida	3,093,555	2,926,900	98,592	109,629
Georgia	1,617,862	1,534,743	69,055	65,109
Hawaii	162,228	161,104	7,798	9,424
Idaho	159,163	156,238	7,853	6,992
Illinois	1,464,451	1,539,693	49,736	44,974
Indiana	694,399	625,253	28,095	27,150
Iowa	276,566	224,333	11,983	10,297
Kansas	282,332	230,768	16,372	12,383
Kentucky	703,605	633,417	37,407	33,141
Louisiana	888,849	775,630	31,500	30,471
Maine	146,927	126,472	7,168	6,372
Maryland	578,842	543,232	26,574	31,441
Massachusetts	628,514	815,773	25,899	27,370
Michigan	1,184,717	1,026,970	44,619	37,506
Minnesota	429,491	372,438	20,599	17,363
Mississippi	660,526	546,475	34,235	23,652
Missouri	746,891	650,863	36,904	30,638
Montana	112,415	99,076	5,419	5,287
Nebraska	167,557	144,217	7,603	7,442
Nevada	370,395	350,325	15,217	14,727
New Hampshire	77,651	68,108	4,295	3,899
New Jersey	745,738	774,508	36,435	35,404
New Mexico	403,267	439,272	17,451	18,380
New York	2,651,224	2,557,581	77,069	86,496
North Carolina	1,468,010	1,273,122	61,572	48,226
North Dakota	55,942	46,050	2,921	2,377
Ohio	1,438,102	1,307,013	56,725	54,749
Oklahoma	602,287	597,177	24,688	25,303
Oregon	502,802	483,101	20,247	17,297
Pennsylvania	1,520,221	1,387,198	51,427	46,379
Rhode Island	118,935	111,905	4,395	4,746
South Carolina	750,306	732,890	31,279	36,075
South Dakota	91,962	80,223	4,888	5,060
Tennessee	939,318	869,286	37,743	39,608
Texas	3,894,503	3,846,398	120,290	117,238
Utah	202,667	197,170	10,269	10,212
Vermont	56,773	54,697	2,635	2,491
Virginia	834,282	804,116	41,595	40,640
Washington	657,121	625,211	33,385	28,131
West Virginia	291,023	255,283	14,196	10,025
Wisconsin	521,557	527,559	23,071	19,968
Wyoming	47,469	47,196	3,509	3,599

Appendix B

Data for Figures in Cunnyngham 2025

Table B.1a. How many people were eligible in 2022? What percentage participated? (States)

Eligible people (thousands)	State		Lower bound of confidence interval	FY 2022 participation rate	Upper bound of confidence interval
1,540	Illinois	*	93	100	100
439	New Mexico	*	90	100	100
816	Massachusetts	*	92	100	100
124	District of Columbia	*	90	100	100
483	Oregon	*	92	100	100
528	Wisconsin	*	92	100	100
1,387	Pennsylvania	*	93	100	100
112	Rhode Island	*	93	100	100
625	Washington	*	93	100	100
1,027	Michigan	*	94	100	100
428	Colorado	*	93	100	100
776	Louisiana	*	93	99	100
55	Vermont	*	92	99	100
1,307	Ohio	*	92	99	100
597	Oklahoma	*	92	98	100
305	Connecticut	*	92	98	100
350	Nevada	*	92	98	100
224	Iowa	*	91	98	100
255	West Virginia	*	92	98	100
1,273	North Carolina	*	89	95	100
126	Maine		87	94	100
372	Minnesota		86	93	100
144	Nebraska		86	93	100
1,535	Georgia		86	92	98
651	Missouri		85	92	99
92	Delaware		85	91	98
2,558	New York		86	91	96
775	New Jersey		85	91	98
797	Alabama		84	90	96
625	Indiana		83	89	95
543	Maryland		77	85	93
869	Tennessee	*	78	84	90
80	South Dakota		76	84	92
804	Virginia	*	77	83	90
68	New Hampshire	*	75	82	90
46	North Dakota	*	75	81	88
161	Hawaii	*	73	81	88
2,927	Florida	*	76	81	85
4,618	California	*	77	81	85
231	Kansas	*	72	79	86
822	Arizona	*	72	77	83
197	Utah	*	70	76	82
733	South Carolina	*	70	76	82
99	Montana	*	69	75	81
633	Kentucky	*	69	75	81
3,846	Texas	*	70	74	77
546	Mississippi	*	69	74	78
156	Idaho	*	68	73	78
70	Alaska	*	66	73	79
47	Wyoming	*	55	63	70
454	Arkansas	*	54	59	63

*State's participation rate was significantly different from the national participation rate of 88 percent.

Table B.1b. How many people were eligible in 2022? What percentage participated? (Regions and national)

Eligible people (thousands)	Region	Lower bound of confidence interval	FY 2022 participation rate	Upper bound of confidence interval
5,623	Midwest Region	94	98	100
4,039	Northeast Region	90	94	98
3,981	Mid-Atlantic Region	89	92	96
1,726	Mountain Plains Region	86	90	94
6,464	Western Region	81	85	88
9,314	Southeast Region	82	84	87
7,132	Southwest Region	77	80	82
38,279	United States	86	88	89

Table B.2a. Estimates of participation rates (States)

	FY 2020	FY 2022
Rates were significantly higher than half of the other States for both years		
Connecticut	93	98
District of Columbia	96	100
Illinois	100	100
Massachusetts	100	100
New Mexico	100	100
Oregon	100	100
Pennsylvania	100	100
Rhode Island	100	100
Vermont	96	99
Washington	100	100
Wisconsin	97	100
Rates were not significantly higher or lower than half of the other States for both years		
Alabama	88	90
Alaska	81	73
Colorado	80	100
Delaware	96	91
Georgia	76	92
Hawaii	85	81
Idaho	83	73
Indiana	76	89
Iowa	89	98
Louisiana	87	99
Maine	85	94
Maryland	91	85
Michigan	84	100
Minnesota	80	93
Missouri	86	92
Montana	78	75
Nebraska	84	93
Nevada	89	98
New Hampshire	81	82
New Jersey	80	91
New York	84	91
North Carolina	73	95
Ohio	85	99
Oklahoma	89	98
South Dakota	83	84
Tennessee	87	84
Utah	78	76
Virginia	79	83
West Virginia	91	98
Rates were significantly lower than half of the other States for both years		
Arizona	73	77
Arkansas	64	59
California	67	81
Florida	77	81
Kansas	67	79
Kentucky	65	75
Mississippi	63	74
North Dakota	67	81
South Carolina	72	76
Texas	74	74
Wyoming	52	63

Table B.2b. Estimates of participation rates (Regions and national)

	FY 2020	FY 2022
Mid-Atlantic Region	90	92
Midwest Region	88	98
Mountain Plains Region	80	90
Northeast Region	88	94
Southeast Region	76	84
Southwest Region	77	80
Western Region	75	85
United States	**81**	**88**

Table B.3. How did your State rank in 2022?

FY 2022 participation rate	State	Upper bound of confidence interval	FY 2022 rank	Lower bound of confidence interval
100	Illinois	1	1	5
100	New Mexico	1	2	6
100	Massachusetts	1	3	5
100	District of Columbia	1	4	6
100	Oregon	2	5	7
100	Wisconsin	3	6	7
100	Pennsylvania	5	7	8
100	Rhode Island	7	8	17
100	Washington	7	9	20
100	Michigan	8	10	20
100	Colorado	8	11	23
99	Louisiana	9	12	23
99	Vermont	8	13	24
99	Ohio	9	14	24
98	Oklahoma	9	15	25
98	Connecticut	9	16	25
98	Nevada	9	17	25
98	Iowa	9	18	26
98	West Virginia	9	19	26
95	North Carolina	13	20	28
94	Maine	12	21	31
93	Minnesota	13	22	31
93	Nebraska	13	23	32
92	Georgia	15	24	32
92	Missouri	15	25	32
91	Delaware	16	26	33
91	New York	18	27	31
91	New Jersey	16	28	33
90	Alabama	18	29	34
89	Indiana	20	30	35
85	Maryland	24	31	41
84	Tennessee	27	32	40
84	South Dakota	24	33	43
83	Virginia	28	34	42
82	New Hampshire	28	35	44
81	North Dakota	30	36	44
81	Hawaii	29	37	46
81	Florida	32	38	43
81	California	32	39	42
79	Kansas	32	40	47
77	Arizona	35	41	47
76	Utah	36	42	49
76	South Carolina	36	43	49
75	Montana	37	44	49
75	Kentucky	37	45	49
74	Texas	41	46	49
74	Mississippi	39	47	49
73	Idaho	41	48	49
73	Alaska	39	49	49
63	Wyoming	49	50	51
59	Arkansas	50	51	51

Table B.4a. How did your State compare with other States in 2022? (Illinois to Nevada)

	IL	NM	MA	DC	OR	WI	PA	RI	WA	MI	CO	LA	VT	OH	OK	CT	NV
IL		-	-	-	-	H	H	H	H	H	H	H	H	H	H	H	H
NM	-		-	-	-	-	H	H	H	H	H	H	H	H	H	H	H
MA	-	-		-	-	H	H	H	H	H	H	H	H	H	H	H	H
DC	-	-	-		-	-	H	H	H	H	H	H	H	H	H	H	H
OR	-	-	-	-		-	H	H	H	H	H	H	H	H	H	H	H
WI	L	-	L	-	-		-	H	H	H	H	H	H	H	H	H	H
PA	L	L	L	L	L	-		H	H	H	H	H	H	H	H	H	H
RI	L	L	L	L	L	L	L		-	-	-	-	-	-	-	-	-
WA	L	L	L	L	L	L	L	-		-	-	-	-	-	-	-	-
MI	L	L	L	L	L	L	L	-	-		-	-	-	-	-	-	-
CO	L	L	L	L	L	L	L	-	-	-		-	-	-	-	-	-
LA	L	L	L	L	L	L	L	-	-	-	-		-	-	-	-	-
VT	L	L	L	L	L	L	L	-	-	-	-	-		-	-	-	-
OH	L	L	L	L	L	L	L	-	-	-	-	-	-		-	-	-
OK	L	L	L	L	L	L	L	-	-	-	-	-	-	-		-	-
CT	L	L	L	L	L	L	L	-	-	-	-	-	-	-	-		-
NV	L	L	L	L	L	L	L	-	-	-	-	-	-	-	-	-	
IA	L	L	L	L	L	L	L	-	-	-	-	-	-	-	-	-	-
WV	L	L	L	L	L	L	L	-	-	-	-	-	-	-	-	-	-
NC	L	L	L	L	L	L	L	L	L	-	-	-	-	-	-	-	-
ME	L	L	L	L	L	L	L	L	L	-	-	-	-	-	-	-	-
MN	L	L	L	L	L	L	L	L	L	L	-	-	-	-	-	-	-
NE	L	L	L	L	L	L	L	L	L	-	-	-	-	-	-	-	-
GA	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	-	-	-	-	-
DE	L	L	L	L	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	L	L	L	L
NJ	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
IN	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
MD	L	L	L	L	L	L	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	L	L	L
SD	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
NH	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
HI	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
CA	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
AZ	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
SC	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
KY	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
MS	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
AK	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
AR	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L

Note: An “H” or an “L” indicates at least a 90 percent chance that either the State at the left of the row or the State at the top of the column has a higher true participation rate than the other. An “H” indicates the row State likely has the higher participation rate while an “L” indicates the column State likely has the higher rate.

Table B.4b. How did your State compare with other States in 2022? (Iowa to Virginia)

	IA	WV	NC	ME	MN	NE	GA	MO	DE	NY	NJ	AL	IN	MD	TN	SD	VA
IL	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
MA	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
OR	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
PA	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
WA	-	-	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
CO	-	-	-	-	-	-	H	H	H	H	H	H	H	H	H	H	H
LA	-	-	-	-	-	-	H	H	H	H	H	H	H	H	H	H	H
VT	-	-	-	-	-	-	-	-	H	H	H	H	H	H	H	H	H
OH	-	-	-	-	-	-	-	-	H	H	H	H	H	H	H	H	H
OK	-	-	-	-	-	-	-	-	-	H	-	H	H	H	H	H	H
CT	-	-	-	-	-	-	-	-	H	H	H	H	H	H	H	H	H
NV	-	-	-	-	-	-	-	-	-	H	-	H	H	H	H	H	H
IA		-	-	-	-	-	-	-	-	-	-	H	H	H	H	H	H
WV	-		-	-	-	-	-	-	-	H	-	H	H	H	H	H	H
NC	-	-		-	-	-	-	-	-	-	-	-	-	H	H	H	H
ME	-	-	-		-	-	-	-	-	-	-	-	-	H	H	H	H
MN	-	-	-	-		-	-	-	-	-	-	-	-	H	H	H	H
NE	-	-	-	-	-		-	-	-	-	-	-	-	-	H	H	H
GA	-	-	-	-	-	-		-	-	-	-	-	-	-	H	-	H
MO	-	-	-	-	-	-	-		-	-	-	-	-	-	H	-	H
DE	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	H
NY	-	L	-	-	-	-	-	-	-		-	-	-	-	H	-	H
NJ	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	H
AL	L	L	-	-	-	-	-	-	-	-	-		-	-	-	-	-
IN	L	L	-	-	-	-	-	-	-	-	-	-		-	-	-	-
MD	L	L	L	L	L	-	-	-	-	-	-	-	-		-	-	-
TN	L	L	L	L	L	L	L	L	-	L	-	-	-	-		-	-
SD	L	L	L	L	L	L	-	-	-	-	-	-	-	-	-		-
VA	L	L	L	L	L	L	L	L	L	L	L	-	-	-	-	-	
NH	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	-	-	-	-
HI	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	-	-	-	-
CA	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	-	-	-	-
AZ	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
SC	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
KY	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
MS	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
AK	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
AR	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L

Note: An “H” or an “L” indicates at least a 90 percent chance that either the State at the left of the row or the State at the top of the column has a higher true participation rate than the other. An “H” indicates the row State likely has the higher participation rate while an “L” indicates the column State likely has the higher rate.

Table B.4c. How did your State compare with other States in 2022? (New Hampshire to Arkansas)

	NH	ND	HI	FL	CA	KS	AZ	UT	SC	MT	KY	TX	MS	ID	AK	WY	AR
MA	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
OR	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
PA	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
WA	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
CO	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	H	H
VT	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
OK	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
WV	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H
NC	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H
ME	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H
MN	H	H	H	H	H	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	H	H	H	H	H
GA	H	H	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	H	H	H
DE	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
NJ	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H
AL	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H
IN	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
TN	-	H	-	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
VA	-	-	-	-	-	-	H	H	H	H	H	H	H	H	H	H	H
NH	-	-	-	-	-	-	-	H	H	H	H	H	H	H	H	H	H
ND	-	-	-	-	-	-	-	H	H	H	H	H	H	H	H	H	H
HI		-	-	-	-	-	-	-	-	-	-	H	H	H	H	H	H
FL	-		-	-	-	-	-	-	-	-	-	H	H	H	H	H	H
CA	-	-		-	-	-	-	-	-	-	-	H	H	H	H	H	H
KS	-	-	-		-	-	-	-	-	-	-	H	H	H	H	H	H
AZ	-	-	-	-		-	-	-	-	-	H	H	H	H	H	H	H
UT	-	-	-	-	-		-	-	-	-	-	-	-	-	-	H	H
SC	-	-	-	-	-	-		-	-	-	-	-	-	-	-	H	H
MT	-	-	-	-	-	-	-		-	-	-	-	-	-	-	H	H
KY	-	-	-	-	-	-	-	-		-	-	-	-	-	-	H	H
TX	-	-	-	-	-	-	-	-	-		-	-	-	-	-	H	H
MS	-	-	-	-	L	-	-	-	-	-		-	-	-	-	H	H
ID	L	L	L	L	L	-	-	-	-	-	-		-	-	-	H	H
AK	L	L	L	L	L	-	-	-	-	-	-	-		-	-	H	H
WY	L	L	L	L	L	-	-	-	-	-	-	-	-		-	H	H
AR	L	L	L	L	L	-	-	-	-	-	-	-	-	-		H	H
MA	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L		-
DC	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	-	

Note: An “H” or an “L” indicates at least a 90 percent chance that either the State at the left of the row or the State at the top of the column has a higher true participation rate than the other. An “H” indicates the row State likely has the higher participation rate while an “L” indicates the column State likely has the higher rate.

Table B.5. Estimates of participation rates varied widely

FY 2022 participation rates		
Above 98 percent (top quarter)	Between 81 and 98 percent	Below 81 percent (bottom quarter)
Colorado	Alabama	Alaska
District of Columbia	California	Arizona
Illinois	Connecticut	Arkansas
Louisiana	Delaware	Idaho
Massachusetts	Florida	Kansas
Michigan	Georgia	Kentucky
New Mexico	Hawaii	Mississippi
Ohio	Indiana	Montana
Oregon	Iowa	South Carolina
Pennsylvania	Maine	Texas
Rhode Island	Maryland	Utah
Vermont	Minnesota	Wyoming
Washington	Missouri	
Wisconsin	Nebraska	
	Nevada	
	New Hampshire	
	New Jersey	
	New York	
	North Carolina	
	North Dakota	
	Oklahoma	
	South Dakota	
	Tennessee	
	Virginia	
	West Virginia	

Table B.6. Supporting detail for Cunnyngham (2025)

Description	States		
In 19 States and the District of Columbia, the rates were statistically significantly higher than the national rate.	Colorado	Nevada	Rhode Island
	Connecticut	New Mexico	Vermont
	Illinois	North Carolina	Washington
	Iowa	Ohio	West Virginia
	Louisiana	Oklahoma	Wisconsin
	Massachusetts	Oregon	
	Michigan	Pennsylvania	
In 19 States, the participation rate was significantly lower than the national rate.	Alaska	Kansas	Tennessee
	Arizona	Kentucky	Texas
	Arkansas	Mississippi	Utah
	California	Montana	Virginia
	Florida	New Hampshire	Wyoming
	Hawaii	North Dakota	
	Idaho	South Carolina	

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