Empirical Bayes Shrinkage Estimates of State Supplemental Nutrition Assistance Program Participation Rates: Fiscal Year 2018 to Fiscal Year 2020

Final Report

August 2023

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Executive Summary

The Supplemental Nutrition Assistance Program (SNAP) provides nutrition assistance to eligible individuals and households in need. SNAP is the largest of the domestic nutrition assistance programs administered by the Food and Nutrition Service of the U.S. Department of Agriculture. During fiscal year 2022, the program served 41 million people in an average month, providing over $114 billion in benefits annually.

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 2018 to 2020. The program's effective reach is measured by estimated SNAP participation rates, or the percentage of eligible people who actually participate in the program. The COVID-19 public health emergency affected the quality of the data used to estimate SNAP participation rates starting in March 2020. As a result, the fiscal year 2020 participation rates were estimated only for the pre-pandemic period of October 2019 through February 2020. Because of the smaller sample size for fiscal year 2020, this report does not present estimates of State SNAP participation rates for eligible people who lived in a household with someone who earned income from a job, as did earlier reports in this series. However, to maintain consistency with estimates for earlier years, the report 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 2020 shrinkage estimates were 46 percent narrower than the corresponding confidence intervals for direct estimates. This report describes the shrinkage estimator in detail.

Final shrinkage estimates for fiscal year 2018 and fiscal year 2019 presented in this report differ slightly from the estimates presented in Cunnyngham (2022a) and Cunnyngham (2022b) because of annual data updates. As a result, the estimates presented in this report should not be compared to those published in earlier reports.

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I. Introduction

The Supplemental Nutrition Assistance Program (SNAP) provides nutrition assistance to eligible individuals and households that are in need of 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 (USDA). During fiscal year (FY) 2022, the program served 41 million people in an average month, providing over $114 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 2018 to FY 2020. Cunnyngham (2023) 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 eligible people who actually participate in the program. The COVID-19 public health emergency affected the quality of the data used to estimate SNAP participation rates starting in March 2020. Accordingly, the FY 2020 participation rates are estimates only for the pre-pandemic period of October 2019 through February 2020. Given the smaller sample size for FY 2020, this report does not include estimates of State SNAP participation rates for people in households with earnings as did earlier reports in this series. However, to maintain consistency with estimates for earlier years, this report uses estimates for people in households with earnings along with estimates of all eligible people to derive the final shrinkage estimates presented here.

We derived estimates for each State in each of the three 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 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 (2023) appear in Appendix B.

U.S. Census Bureau data

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

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

The Census Bureau develops annual **population estimates** 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.

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.

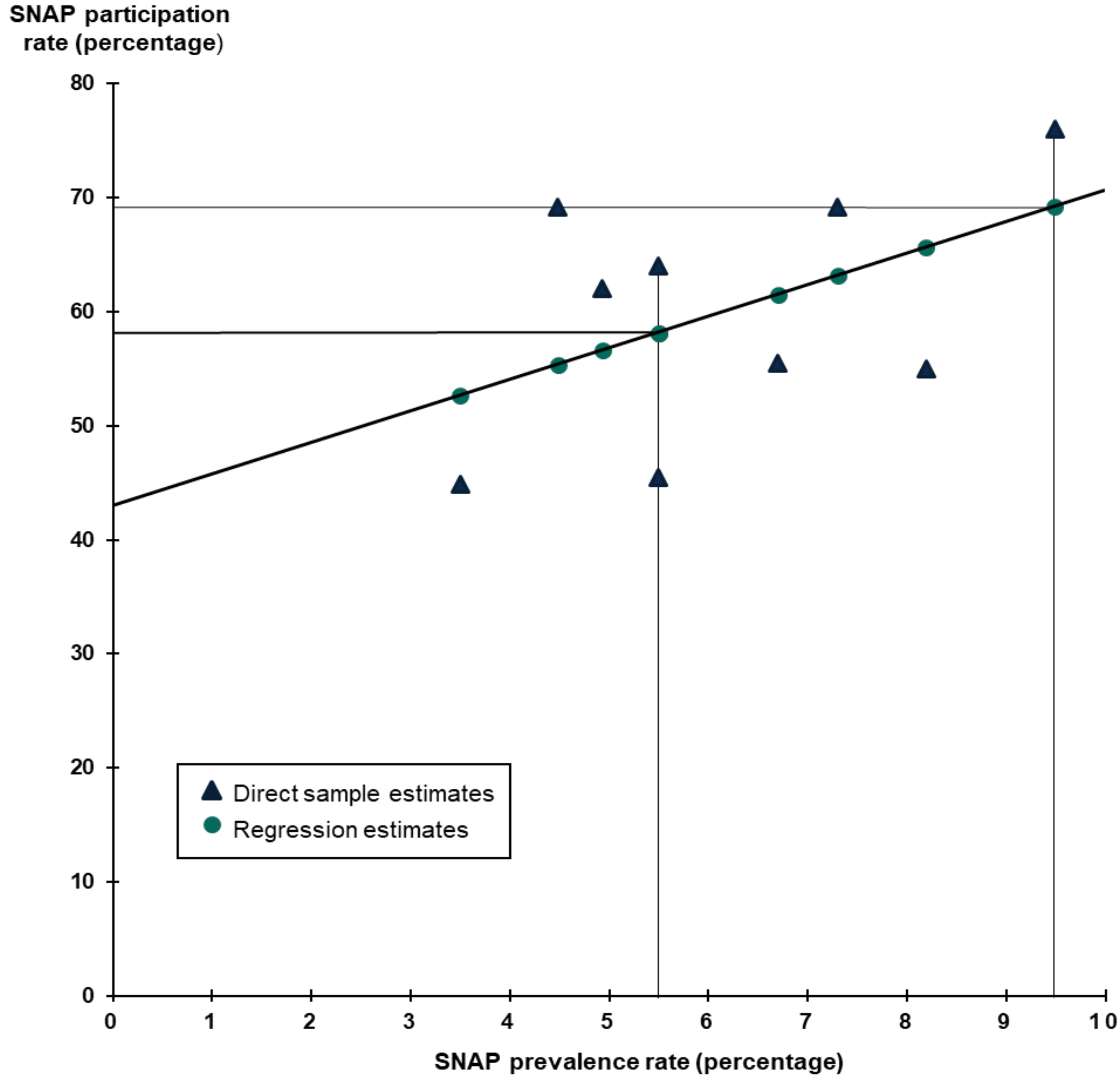
However, for many States, estimates of SNAP eligibility and participation rates based solely on the CPS ASEC sample for the State and time period in question, or "direct" estimates, are imprecise. For example, to directly estimate the number of people in Tennessee who were eligible for SNAP in FY 2020, we used only FY 2020 CPS ASEC data on households from Tennessee. Given the potential errors introduced by the CPS ASEC surveying a small number of families in Tennessee, we can be confident—by a commonly used standard, a 90 percent confidence interval—that Tennessee's SNAP participation rate in FY 2020 ranged between about 71 and 89 percent. This range is wide, although typical, reflecting our substantial uncertainty about Tennessee'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.

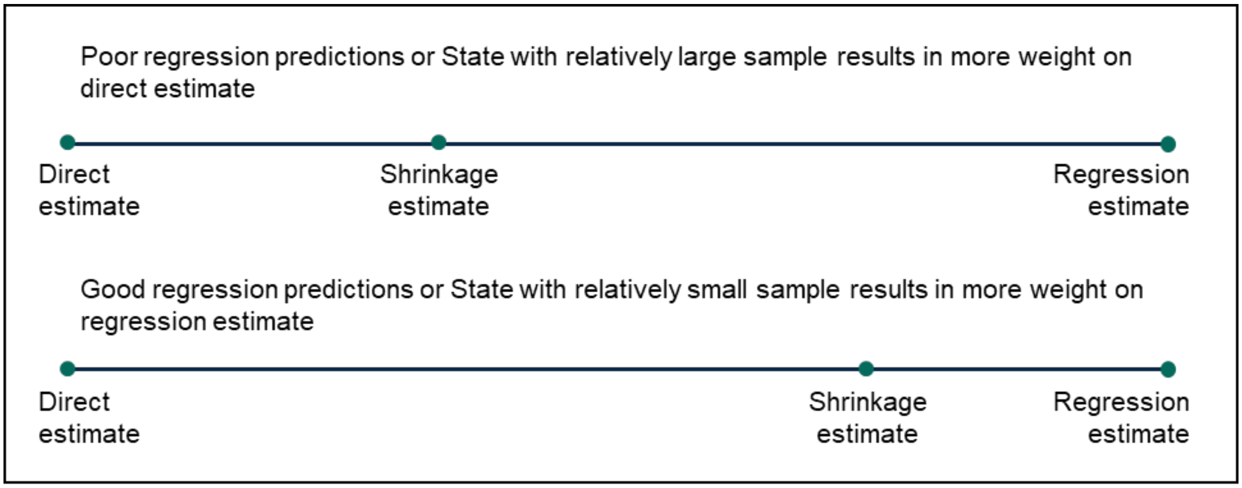
The regression estimator can improve precision by using additional data to identify States with direct estimates that seem too high or too low because of sampling error (error from drawing a sample of the population that has a higher or lower participation rate than does the entire State population). 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



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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 2020 CPS ASEC to estimate SNAP eligibility for October to December 2019 and the 2021 CPS ASEC to estimate SNAP eligibility for January and February 2020. (We restricted the FY 2020 estimates to October 2019 through February 2020 because of SNAP QC data limitations beginning in March 2020.) Appendix A presents direct estimates and their standard errors in each State for each of the three fiscal years.

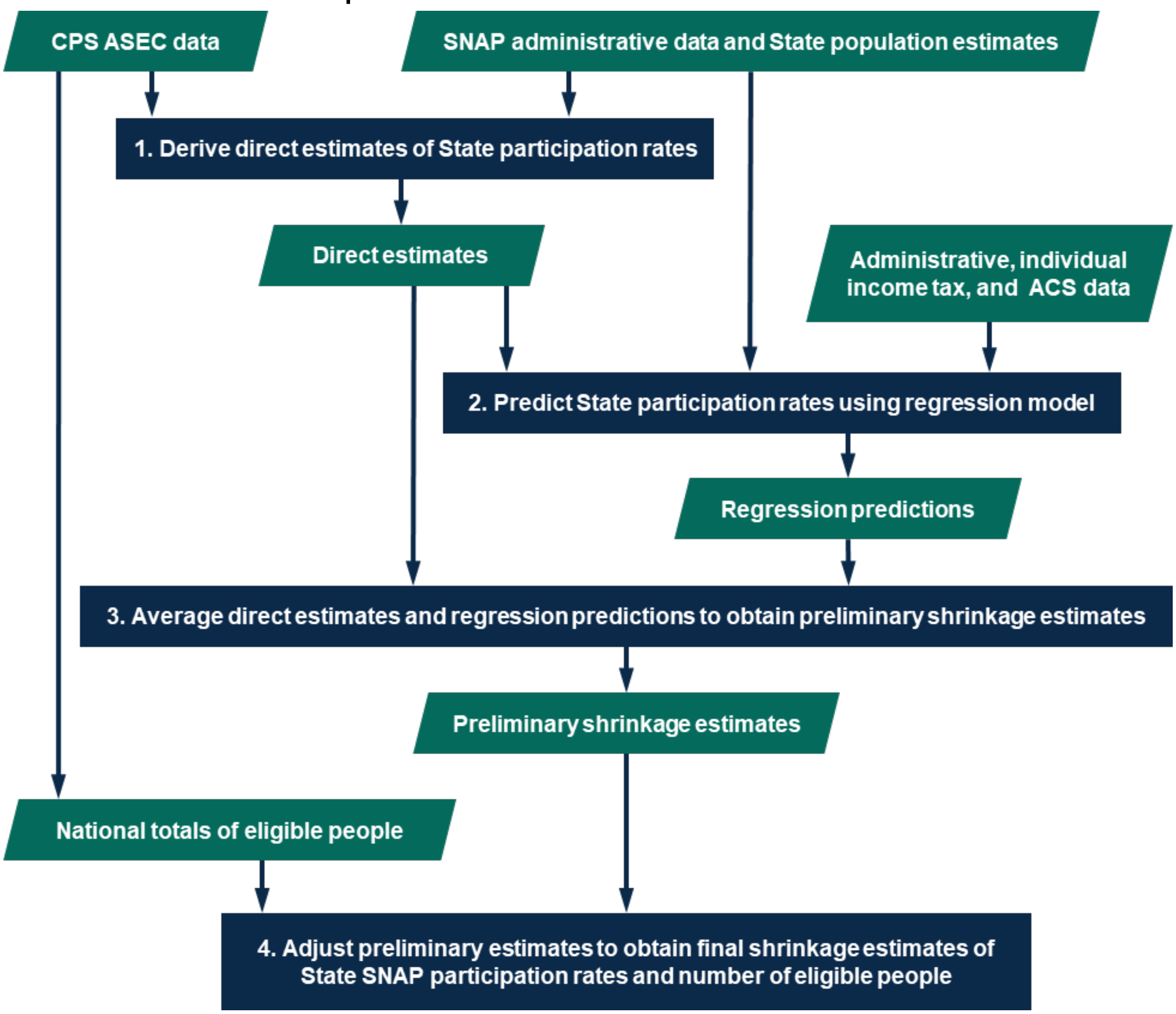
B. Using a regression model, predict State SNAP participation rates based on administrative, ACS, and other data

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

1. Percentage of the population that received SNAP benefits according to administrative data and population estimates
2. Percentage of people age 65 and older who received Supplemental Security Income according to administrative records and population estimates
3. Percentage of families that had income below $20,000 in the past 12 months according to ACS one-year estimates
4. Percentage of people age 25 and older who completed a bachelor's degree according to ACS one-year estimates

5. Percentage of people age 65 and older who had household income below 100 percent of the federal poverty level according to ACS one-year estimates
6. Percentage of the civilian employed population age 16 and older that were private wage and salary workers according to ACS one-year estimates
7. Percentage of exemptions for children claimed on tax returns that had adjusted gross income below the federal poverty level
8. Indicator of whether a State had a resource test because it either did not have a broad-based categorical eligibility (BBCE) policy or included a resource test in its BBCE policy

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 first, fourth, and sixth predictors were included in the model that estimated rates for fiscal years 2017 to 2019. However, data for some previously used predictors were not available for 2020, including the percentage of children age 17 and younger with household income below 50 percent of the federal poverty level and the percentage of individuals age 65 and older with household income below 125 percent of the federal poverty level according to ACS one-year estimates. We developed new potential predictors to replace some of those that were no longer available. New predictors used in our model include the percentage of families with income below $20,000 in the past 12 months and the percentage of individuals age 65 and older with household income below 100 percent of the federal poverty level according to ACS one-year estimates and the indicator of whether a State had a resource test.

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 fairly equal 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 2020 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 2020, the State estimates of eligible people summed to 43,379,354, whereas the national total estimated directly from the CPS ASEC was 42,185,669. 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 42,185,669 divided by 43,379,354, or 0.9725. 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, five States—Illinois, New Mexico, Oregon, Pennsylvania, and Rhode Island—had fewer estimated eligible people than estimated eligible participants in FY 2020, 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 Illinois, New Mexico, Oregon, Pennsylvania, and Rhode Island 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 45 States and the District of Columbia by an equivalent number and in proportion to their number of eligible people. The adjustment, which moved small numbers of eligible people among States, did not change the national total or State rankings. Moreover, except for the States with participation rates initially higher than 100 percent, the adjustment did not change any State's participation rate by more than half a percentage point.

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 2018 to FY 2020. 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 through III.4, we show 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 Tennessee's participation rate was 84 percent in FY 2020 (Table III.1), the true rate may have been higher or lower. However, according to Table III.4, the chances are 90 in 100 that the true rate was between 79 and 89 percent, an interval that is 41 percent narrower than the interval (71 and 89 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 2020 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 (2023), 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 2018 and FY 2019 differ slightly from the estimates presented in Cunnyngham (2022a) and Cunnyngham (2022b) for two reasons:

1. **The shrinkage estimator uses data from three years to estimate participation rates for each year.** Annually, data for the most recent year are added and data for the oldest year are dropped. As a result, the estimates for 2018 and 2019 presented in this report are based on 2018 to 2020 data, while the corresponding estimates published in Cunnyngham (2022a) and Cunnyngham (2022b) are based on 2017 to 2019 data.
2. **The shrinkage estimator incorporates a regression model that is updated each year.** Each year, we choose a regression model that best predicts participation rates for all three years. Although we place a premium on maintaining consistency in regression predictors from year to year, differences between the 2017 data (used in the previous estimates) and 2020 data (used in the current estimates) resulted in the use of a different regression model. In addition, for the previous estimates, we considered how well the regression model predicted participation rates for people in households with earnings. For the current estimates, we focused primarily on participation rates for all eligible people. 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 estimates in this report should not 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 (thousands)		
	FY 2018	FY 2019	FY 2020	FY 2018	FY 2019	FY 2020
Alabama	80	81	81	907	845	825
Alaska	88	89	81	102	90	90
Arizona	78	78	74	937	892	899
Arkansas	67	64	62	544	535	515
California	70	70	66	4,939	4,810	5,403
Colorado	80	83	76	524	492	510
Connecticut	90	97	89	367	321	331
Delaware	100	100	87	110	107	105
District of Columbia	84	97	93	120	104	110
Florida	84	79	73	3,261	3,205	3,263
Georgia	84	78	72	1,706	1,682	1,709
Hawaii	88	89	83	166	159	166
Idaho	73	78	79	200	175	167
Illinois	100	100	100	1,612	1,575	1,465
Indiana	75	71	73	779	741	720
Iowa	90	88	85	322	300	289
Kansas	71	69	70	299	283	273
Kentucky	77	69	65	742	715	705
Louisiana	84	85	83	1,019	940	931
Maine	88	89	90	159	137	138
Maryland	90	88	85	624	598	623
Massachusetts	94	100	100	701	651	628
Michigan	88	86	85	1,256	1,170	1,179
Minnesota	76	82	76	483	426	454
Mississippi	70	64	62	689	683	675
Missouri	86	84	84	814	792	764
Montana	78	79	79	126	118	111
Nebraska	77	80	78	202	186	181
Nevada	89	91	84	424	383	396
New Hampshire	82	83	79	90	80	79
New Jersey	81	79	72	829	816	830
New Mexico	96	100	100	429	404	403
New York	86	87	82	2,894	2,669	2,727
North Carolina	72	77	74	1,659	1,473	1,449
North Dakota	63	71	66	68	55	57
Ohio	83	86	81	1,548	1,452	1,511
Oklahoma	86	89	84	631	601	636
Oregon	100	100	100	519	514	503
Pennsylvania	100	100	100	1,569	1,550	1,520
Rhode Island	97	100	100	139	124	119
South Carolina	79	74	69	777	760	780
South Dakota	76	79	80	112	100	95
Tennessee	89	84	84	1,068	1,044	976
Texas	75	73	69	4,440	4,100	4,161
Utah	76	76	74	243	223	214
Vermont	91	100	96	67	58	57
Virginia	76	76	77	939	880	861
Washington	98	100	94	720	670	697
West Virginia	88	95	94	330	284	284
Wisconsin	90	94	92	602	556	549
Wyoming	53	54	49	54	48	50
United States	82	81	78	43,862	41,576	42,186

Table III.2. Approximate 90 percent confidence intervals for final shrinkage estimates for FY 2018

	Participation rate (percent)		Number of eligible people (thousands)	
	Lower bound	Upper bound	Lower bound	Upper bound
Alabama	75	85	855	959
Alaska	81	96	94	110
Arizona	73	83	879	996
Arkansas	62	71	508	579
California	66	73	4,715	5,163
Colorado	74	85	487	560
Connecticut	84	95	344	390
Delaware	93	100	104	117
District of Columbia	78	91	110	129
Florida	79	88	3,079	3,442
Georgia	79	89	1,605	1,807
Hawaii	82	94	155	178
Idaho	67	78	185	215
Illinois	94	100	1,521	1,702
Indiana	70	80	724	835
Iowa	84	96	300	344
Kansas	65	76	277	321
Kentucky	71	82	688	797
Louisiana	80	88	972	1,066
Maine	82	95	148	171
Maryland	84	96	580	668
Massachusetts	88	100	654	748
Michigan	83	93	1,186	1,325
Minnesota	70	81	447	518
Mississippi	67	74	654	724
Missouri	80	91	761	867
Montana	71	84	116	137
Nebraska	72	83	188	216
Nevada	84	95	398	450
New Hampshire	76	89	83	97
New Jersey	75	86	772	886
New Mexico	89	100	396	461
New York	82	90	2,757	3,032
North Carolina	67	77	1,544	1,774
North Dakota	56	70	60	75
Ohio	78	88	1,455	1,641
Oklahoma	81	92	591	671
Oregon	94	100	491	547
Pennsylvania	94	100	1,485	1,653
Rhode Island	90	100	130	149
South Carolina	74	84	731	824
South Dakota	70	82	104	121
Tennessee	84	94	1,003	1,132
Texas	72	78	4,250	4,631
Utah	70	82	224	262
Vermont	85	97	63	71
Virginia	71	81	873	1,005
Washington	92	100	676	765
West Virginia	82	93	310	349
Wisconsin	85	96	565	639
Wyoming	48	59	48	60
United States	81	83	43,200	44,524

Table III.3. Approximate 90 percent confidence intervals for final shrinkage estimates for FY 2019

	Participation rate (percent)		Number of eligible people (thousands)	
	Lower bound	Upper bound	Lower bound	Upper bound
Alabama	76	86	792	897
Alaska	82	96	82	97
Arizona	73	83	835	950
Arkansas	59	69	493	577
California	67	73	4,603	5,018
Colorado	77	89	456	528
Connecticut	90	100	298	344
Delaware	93	100	100	114
District of Columbia	89	100	95	113
Florida	74	83	3,030	3,379
Georgia	73	83	1,576	1,789
Hawaii	83	96	148	171
Idaho	73	83	164	186
Illinois	94	100	1,487	1,663
Indiana	67	76	692	790
Iowa	82	94	279	320
Kansas	63	74	261	306
Kentucky	63	75	653	776
Louisiana	80	90	888	991
Maine	83	95	127	146
Maryland	82	94	556	640
Massachusetts	92	100	606	695
Michigan	81	91	1,100	1,241
Minnesota	76	88	392	459
Mississippi	60	68	640	725
Missouri	78	90	737	848
Montana	73	84	109	126
Nebraska	74	85	174	199
Nevada	86	97	359	406
New Hampshire	76	90	73	87
New Jersey	73	84	757	875
New Mexico	93	100	379	429
New York	82	91	2,541	2,796
North Carolina	73	82	1,385	1,562
North Dakota	64	77	50	60
Ohio	81	91	1,363	1,541
Oklahoma	83	94	560	641
Oregon	93	100	486	542
Pennsylvania	94	100	1,469	1,632
Rhode Island	94	100	117	131
South Carolina	69	79	712	809
South Dakota	74	85	93	108
Tennessee	79	89	978	1,111
Texas	70	76	3,920	4,281
Utah	70	82	204	242
Vermont	93	100	54	62
Virginia	70	82	813	947
Washington	94	100	629	711
West Virginia	88	100	265	303
Wisconsin	88	99	522	591
Wyoming	48	61	42	54
United States	80	83	40,924	42,228

Table III.4. 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	75	87	766	884
Alaska	74	88	82	98
Arizona	70	79	840	959
Arkansas	58	67	478	553
California	63	69	5,180	5,626
Colorado	70	82	472	548
Connecticut	83	94	310	352
Delaware	82	92	99	112
District of Columbia	85	100	101	119
Florida	69	77	3,095	3,432
Georgia	67	76	1,598	1,820
Hawaii	78	89	155	178
Idaho	74	85	156	179
Illinois	94	100	1,386	1,544
Indiana	69	78	676	764
Iowa	80	91	270	309
Kansas	64	75	251	294
Kentucky	60	70	649	760
Louisiana	79	88	881	981
Maine	84	96	129	147
Maryland	79	90	581	666
Massachusetts	93	100	586	671
Michigan	80	90	1,115	1,243
Minnesota	70	81	418	490
Mississippi	57	66	624	726
Missouri	79	90	711	816
Montana	73	85	103	120
Nebraska	73	83	169	193
Nevada	78	89	371	421
New Hampshire	73	85	73	86
New Jersey	67	77	770	891
New Mexico	93	100	379	427
New York	78	85	2,604	2,850
North Carolina	69	78	1,362	1,536
North Dakota	60	71	53	62
Ohio	77	86	1,424	1,599
Oklahoma	79	89	595	678
Oregon	94	100	474	532
Pennsylvania	94	100	1,435	1,606
Rhode Island	93	100	112	126
South Carolina	65	73	729	830
South Dakota	73	87	86	104
Tennessee	79	89	914	1,039
Texas	66	72	3,970	4,352
Utah	69	80	198	230
Vermont	90	100	54	60
Virginia	71	82	797	925
Washington	88	100	648	745
West Virginia	87	100	264	303
Wisconsin	86	98	513	586
Wyoming	44	55	44	56
United States	77	79	41,531	42,840

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Appendix A

The Estimation Procedure: Additional Technical Details

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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 USDA's Food and Nutrition Service. SNAP Program Operations data include the full population of SNAP cases, so participant counts are not subject to sampling error.

We estimated $\varepsilon_{1,i}$ (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 starting in March 2020. As a result, the fiscal year 2020 participation rates were estimated only for the pre-pandemic period of October 2019 through February 2020.

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

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

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

To derive fiscal year estimates of eligibility, we combined two years of the CPS ASEC. For example, to estimate $Z_{1,i}$ for FY 2020, we used data from the 2020 CPS ASEC (simulating October through December 2019) and the 2021 CPS ASEC (simulating January through February 2020). 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. People in 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 Cronquist et al. (2022) 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:

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

and

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

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 $\mathrm{var}_{E1|\varepsilon1}(Y_{1,i})$ and $\mathrm{var}_{E2|\varepsilon2}(Y_{2,i})$ 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:

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

and

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

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 $\mathrm{var}_{\varepsilon 1|E1}(Y_{1,i})$ and $\mathrm{var}_{\varepsilon 2|E2}(Y_{2,i})$ according to these formulas:

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

and

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

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 $\mathrm{var}(\varepsilon_{1,i})$ and $\mathrm{var}(\varepsilon_{2,i})$, 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:

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

and

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

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

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

where

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

and

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

where

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

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

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

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:

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

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

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

where

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

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

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

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:

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

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 $Y_{2,i,t\text{-}g}$:

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

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

Our regression model consisted of six equations, with three predicting SNAP participation rates for all eligible people in fiscal years 2018, 2019, and 2020, and three predicting SNAP participation rates for people in households with earnings in fiscal years 2018, 2019, and 2020. The six equations were estimated jointly, and the values of the regression coefficients could vary from equation to equation. The predictors used were (in addition to an intercept):

1. Percentage of the population that received SNAP benefits, according to administrative data and population estimates
2. Percentage of people age 65 and older who received Supplemental Security Income according to administrative records and population estimates
3. Percentage of families that had income lower than $20,000 in the past 12 months according to ACS one-year estimates
4. Percentage of people age 25 and older who completed a bachelor's degree according to ACS one-year estimates
5. Percentage of people age 65 and older who had household income below 100 percent of the federal poverty level according to ACS one-year estimates
6. Percentage of the civilian employed population age 16 and older who were private wage and salary workers according to ACS one-year estimates
7. Percentage of exemptions for children claimed on tax returns that had adjusted gross income below the federal poverty level
8. Indicator of whether a State had a resource test because it either did not have BBCE policy or included a resource test in its BBCE policy

For all the predictors, we used 2018 values in both equations for predicting FY 2018 rates, 2019 values in both equations for predicting FY 2019 rates, and 2020 values in both equations for predicting FY 2020 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 all three years and both groups.

In addition to the predictors we selected for our model, we considered many other potential predictors, including the percentage of households with earnings according to ACS one-year estimates, which was used to produce the estimates in Cunnyngham (2022a). 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 first, fourth, and sixth predictors were used to produce the estimates in Cunnyngham (2022a). However, data for some previously used predictors were not available for 2020, including the percentage of children age 17 and younger with household income below 50 percent of the federal poverty level and the percentage of individuals age 65 and older with household income below 125 percent of the federal poverty level according to ACS one-year estimates. We developed new potential predictors to replace some of those that no longer were available. New predictors used in our model include the percentage of families with income lower than $20,000 in the past 12 months and the percentage of individuals age 65 and older with household income below 100 percent of the federal poverty level according to ACS one-year estimates and the indicator of whether a State had a resource test.

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. 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 6,893,568 equally spaced points, starting with $\sigma_1 = 0.001$, $\sigma_2 = 0.001$, $\rho = -0.996$, $\eta_1 = 0.000$, $\eta_2 = 0.000$, and $\eta_{1,2} = -0.991$ and incrementing σ_1, σ_2, ρ, η_1, η_2, and $\eta_{1,2}$ by 0.350, 0.700, 0.133, 0.800, 0.800, and 0.199, respectively, up to $\sigma_1 = 5.601$, $\sigma_2 = 7.701$, $\rho = 0.999$, $\eta_1 = 8.800$, $\eta_2 = 12.000$, 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,…, 6,893,568), we calculated a vector of shrinkage estimates:

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

a variance-covariance matrix:

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

and a probability:

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

In these expressions, Y is a column vector of direct estimates (from Step 1) with 306 elements— six direct estimates for each of the 50 States and the District of Columbia. The first six elements of Y pertain to the first State, the next six to the second State, and so forth. For a given State, the first two elements are the FY 2018 direct estimates for all eligible people and people in households with earnings, respectively; the second two elements are the FY 2019 estimates; and the final two elements are the FY 2020 estimates. The vector of shrinkage estimates, θ_k, has the same structure as the vector of direct estimates, Y. V is the (306×306) variance-covariance matrix for the direct estimates. Because State samples are independent in the CPS ASEC, V is block-diagonal with 51 (6×6) blocks. We described under Step 1 how we derived estimates for the variance and covariance elements of V (Equations (21) and (30), respectively). X is a (306×48) matrix containing values for each of the eight predictors (plus an intercept) for every State, every fiscal year (2018, 2019, and 2020), and both groups. The first six rows of X pertain to the first State, the next six rows pertain to the second State, and so forth. The six rows for State i are given by

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

where $x'_{i,t,1}$ is a row vector for fiscal year t ($t = 1$ for 2018, $t = 2$ for 2019, and $t = 3$ for 2020) with eight 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 eight 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 (48×1) vector of regression coefficients, and is

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

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

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

After calculating θ_k, U_k, and p_k^* 6,893,568 times (once for each combination of σ_1, σ_2, ρ, η_1, η_2, and $\eta_{1,2}$), we calculated the probability of $(\sigma_{1,k}, \sigma_{2,k}, \rho_k, \eta_{1,k}, \eta_{2,k}, \eta_{1,2,k})$:

$$(37) \quad p_k = \frac{p_k^*}{\sum_{k=1}^{6,893,568} p_k^*},$$

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 σ_1, σ_2, ρ, η_1, η_2, and $\eta_{1,2}$ and obtain a single set of shrinkage estimates, we calculated a weighted sum of the 6,893,568 sets of shrinkage estimates, weighting each set θ_k by its associated probability p_k. The resulting shrinkage estimates are:

$$(38) \quad \theta = \sum_{k=1}^{6,893,568} p_k \theta_k .$$

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

$$(39) \quad U = \sum_{k=1}^{6,893,568} p_k U_k + \sum_{k=1}^{6,893,568} p_k (\theta_k - \theta)(\theta_k - \theta)' .$$

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

Regression estimates can be obtained the same way. They are

$$(40) \quad R = \sum_{k=1}^{6,893,568} p_k R_k ,$$

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

$$(41) \quad G = \sum_{k=1}^{6,893,568} p_k G_k + \sum_{k=1}^{6,893,568} p_k (R_k - R)(R_k - R)',$$

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

$$(42) \quad \hat{B} = \sum_{k=1}^{6,893,568} p_k \hat{B}_k .$$

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 2020 estimates for all eligible people as an example, the eligible people counts for States from Equation (43) summed to 43,379,354, and the national total estimated directly from the CPS ASEC was 42,185,669. 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 42,185,669 divided by 43,379,354, or 0.9725. Exhibit A.2 shows the direct estimates of national totals and adjustment factors for all three years.

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

	Direct estimate	Adjustment factor
FY 2018	43,862,367	0.9797
FY 2019	41,576,027	0.9716
FY 2020	42,185,669	0.9725

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 and the District of Columbia by an equivalent number and in proportion to their numbers of eligible people. These adjustments, which we carried out separately for the three years, moved small numbers among State counts of eligible people but did not change the national totals or State rankings. Except for the States where participation rates were initially higher than 100 percent, the adjustments did not change any State's participation rate by more than one-half of a percentage point.

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

	FY 2018	FY 2019	FY 2020
Delaware	103.5	100.1	
Illinois	101.8	106.1	105.5
Massachusetts		105.1	
New Mexico		106.2	108.2
Oregon	105.7	109.6	106.3
Pennsylvania		104.4	104.6
Rhode Island		105.4	106.4
Washington		102.1	

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

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

and

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

where r is the ratio used to adjust preliminary estimates of State counts of eligible people to the direct estimate of the national total (approximately 0.9725 for all eligible people for FY 2020), and

$U(6i-1,6i-1)$ is the $(6i-1,6i-1)$ diagonal element of U for all eligible people for FY 2020, which we derived according to Equation (39). To derive standard error estimates for all eligible people for 2018 and 2019, we used the $(6i-5,6i-5)$ and $(6i-3,6i-3)$ diagonal elements of U, respectively. 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 2018	FY 2019	FY 2020
Alabama	766,681	727,453	711,394
Alaska	91,995	84,900	79,132
Arizona	845,733	798,169	784,361
Arkansas	372,451	354,894	345,889
California	3,948,658	3,787,317	4,043,491
Colorado	449,824	450,596	435,621
Connecticut	387,329	367,918	361,916
Delaware	140,298	130,162	118,750
District of Columbia	112,282	110,033	109,562
Florida	3,080,213	2,836,821	2,719,020
Georgia	1,556,452	1,415,705	1,354,316
Hawaii	163,604	157,427	153,968
Idaho	157,858	146,641	144,568
Illinois	1,826,011	1,776,902	1,773,222
Indiana	617,032	576,302	567,414
Iowa	345,406	320,214	299,948
Kansas	217,420	201,164	194,148
Kentucky	615,305	542,044	492,108
Louisiana	867,342	809,106	790,217
Maine	167,858	156,623	154,993
Maryland	646,483	619,684	603,502
Massachusetts	770,566	759,669	762,501
Michigan	1,281,862	1,179,611	1,155,952
Minnesota	428,986	409,575	393,530
Mississippi	505,308	454,946	432,256
Missouri	736,590	693,955	666,158
Montana	115,223	107,439	105,498
Nebraska	169,811	160,946	154,820
Nevada	439,941	423,233	415,558
New Hampshire	86,502	76,420	72,302
New Jersey	760,303	706,216	674,720
New Mexico	456,251	448,706	446,972
New York	2,796,620	2,661,700	2,570,220
North Carolina	1,086,802	1,293,181	1,228,704
North Dakota	52,621	48,769	47,727
Ohio	1,421,366	1,383,876	1,374,426
Oklahoma	585,064	574,029	575,676
Oregon	633,970	599,143	582,061
Pennsylvania	1,818,589	1,757,826	1,733,275
Rhode Island	157,050	152,331	146,973
South Carolina	658,119	600,961	576,192
South Dakota	87,410	81,164	78,229
Tennessee	970,875	905,226	866,329
Texas	3,808,084	3,418,518	3,253,941
Utah	189,093	172,174	164,388
Vermont	73,058	69,301	67,577
Virginia	736,221	705,289	688,614
Washington	877,244	824,897	797,467
West Virginia	321,009	306,486	305,521
Wisconsin	652,885	618,225	601,976
Wyoming	29,330	26,429	25,708
United States	40,082,988	37,990,316	37,202,811

Source: USDA, Food and Nutrition Service.

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

	FY 2018	FY 2019	FY 2020
Alabama	94.58	94.04	94.10
Alaska	97.90	93.95	92.71
Arizona	86.23	86.89	85.37
Arkansas	97.49	96.98	92.77
California	87.01	88.82	88.17
Colorado	92.85	90.83	88.85
Connecticut	85.06	84.74	81.03
Delaware	78.68	82.08	77.32
District of Columbia	89.99	91.67	92.88
Florida	88.70	88.77	87.62
Georgia	92.19	92.56	90.30
Hawaii	89.73	90.14	89.75
Idaho	92.09	93.31	91.94
Illinois	88.27	88.64	82.60
Indiana	94.65	91.95	92.77
Iowa	83.46	82.47	82.37
Kansas	97.24	96.94	97.55
Kentucky	92.59	91.05	92.74
Louisiana	98.99	98.69	98.37
Maine	83.86	77.72	80.33
Maryland	86.90	85.18	87.37
Massachusetts	85.92	85.67	82.41
Michigan	86.33	85.69	86.61
Minnesota	85.03	85.13	87.10
Mississippi	95.81	96.19	96.55
Missouri	94.91	95.91	96.74
Montana	85.40	86.17	83.41
Nebraska	92.04	92.28	91.30
Nevada	85.87	82.63	79.73
New Hampshire	85.91	86.67	86.57
New Jersey	88.18	90.84	88.54
New Mexico	90.43	90.12	90.20
New York	88.93	86.75	86.56
North Carolina	110.51	87.93	87.16
North Dakota	80.98	79.87	78.83
Ohio	90.43	90.38	89.25
Oklahoma	93.09	92.65	92.91
Oregon	81.87	85.82	86.38
Pennsylvania	86.02	88.19	87.71
Rhode Island	85.81	81.56	80.93
South Carolina	93.36	93.77	93.47
South Dakota	97.72	98.26	97.17
Tennessee	97.98	97.18	94.53
Texas	87.74	87.25	88.20
Utah	97.18	98.46	96.63
Vermont	83.45	83.41	80.91
Virginia	96.70	94.84	95.92
Washington	80.41	81.23	82.39
West Virginia	89.89	87.84	86.96
Wisconsin	83.19	84.31	84.12
Wyoming	98.01	99.08	96.12

Source: SNAP QC database.

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

	FY 2018	FY 2019	FY 2020
Alabama	725,158	684,097	669,429
Alaska	90,067	79,761	73,363
Arizona	729,267	693,553	669,617
Arkansas	363,095	344,176	320,881
California	3,435,609	3,363,933	3,565,065
Colorado	417,657	409,276	387,054
Connecticut	329,466	311,777	293,246
Delaware	110,384	106,833	91,818
District of Columbia	101,041	100,865	101,762
Florida	2,732,180	2,518,359	2,382,324
Georgia	1,434,831	1,310,405	1,222,880
Hawaii	146,800	141,908	138,191
Idaho	145,375	136,832	132,920
Illinois	1,611,765	1,575,135	1,464,681
Indiana	584,033	529,915	526,379
Iowa	288,276	264,068	247,073
Kansas	211,428	195,016	189,399
Kentucky	569,699	493,509	456,356
Louisiana	858,556	798,499	777,313
Maine	140,761	121,720	124,500
Maryland	561,800	527,822	527,274
Massachusetts	662,039	650,816	628,408
Michigan	1,106,619	1,010,797	1,001,147
Minnesota	364,784	348,655	342,769
Mississippi	484,151	437,594	417,360
Missouri	699,090	665,600	644,408
Montana	98,405	92,579	87,995
Nebraska	156,297	148,527	141,357
Nevada	377,760	349,717	331,312
New Hampshire	74,314	66,237	62,591
New Jersey	670,443	641,548	597,424
New Mexico	412,574	404,351	403,169
New York	2,486,894	2,308,972	2,224,705
North Carolina	1,200,981	1,137,094	1,070,902
North Dakota	42,615	38,951	37,624
Ohio	1,285,398	1,250,706	1,226,716
Oklahoma	544,619	531,855	534,832
Oregon	519,012	514,197	502,755
Pennsylvania	1,564,423	1,550,192	1,520,273
Rhode Island	134,758	124,247	118,944
South Carolina	614,426	563,533	538,555
South Dakota	85,417	79,752	76,018
Tennessee	951,215	879,681	818,932
Texas	3,341,137	2,982,760	2,869,976
Utah	183,764	169,519	158,856
Vermont	60,965	57,806	54,675
Virginia	711,940	668,917	660,491
Washington	705,374	670,023	657,001
West Virginia	288,558	269,223	265,693
Wisconsin	543,115	521,225	506,406
Wyoming	28,747	26,186	24,712
United States	35,987,083	33,868,720	32,887,530

Source: SNAP QC database.

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

	FY 2018	FY 2019	FY 2020
Alabama	19.52	17.26	16.23
Alaska	14.26	13.23	13.20
Arizona	14.47	12.43	11.72
Arkansas	18.09	16.78	16.70
California	12.74	12.70	14.33
Colorado	9.87	9.35	9.63
Connecticut	10.94	7.62	8.72
Delaware	10.17	9.34	10.66
District of Columbia	17.75	15.25	15.75
Florida	15.66	15.22	15.22
Georgia	16.70	16.62	17.18
Hawaii	12.91	11.28	11.75
Idaho	11.49	9.40	8.46
Illinois	11.64	10.96	10.37
Indiana	11.82	11.44	10.94
Iowa	7.98	9.79	9.68
Kansas	10.34	10.07	8.93
Kentucky	16.55	16.46	16.25
Louisiana	22.81	20.74	20.50
Maine	13.12	12.06	10.90
Maryland	9.54	9.57	10.16
Massachusetts	10.45	9.00	9.68
Michigan	12.55	11.71	12.18
Minnesota	10.32	8.27	8.46
Mississippi	23.94	23.86	23.39
Missouri	13.08	11.05	10.66
Montana	10.67	10.63	10.10
Nebraska	10.84	9.76	9.18
Nevada	14.38	12.60	12.45
New Hampshire	6.48	5.72	6.16
New Jersey	9.45	8.85	8.82
New Mexico	20.72	19.29	18.86
New York	14.76	14.18	14.49
North Carolina	16.21	16.24	15.87
North Dakota	8.74	7.17	7.69
Ohio	13.44	13.46	14.25
Oklahoma	15.30	13.68	15.15
Oregon	11.57	9.36	8.79
Pennsylvania	12.42	11.46	10.88
Rhode Island	12.09	11.88	10.67
South Carolina	15.16	14.98	15.38
South Dakota	12.10	10.44	10.68
Tennessee	14.38	15.49	14.82
Texas	15.93	14.62	14.61
Utah	8.00	7.12	6.78
Vermont	9.82	9.53	10.01
Virginia	11.38	11.08	10.09
Washington	9.01	7.32	7.41
West Virginia	19.01	16.89	16.48
Wisconsin	10.30	9.09	8.55
Wyoming	10.19	9.78	9.85

Source: CPS ASEC.

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

	FY 2018	FY 2019	FY 2020
Alabama	949,204	841,764	793,415
Alaska	102,889	93,663	93,192
Arizona	1,040,232	906,154	870,718
Arkansas	528,307	489,603	495,878
California	4,997,272	5,000,373	5,623,434
Colorado	561,565	538,478	554,479
Connecticut	377,792	264,749	303,760
Delaware	99,178	90,951	104,458
District of Columbia	122,907	107,007	112,603
Florida	3,306,026	3,252,404	3,290,669
Georgia	1,735,768	1,728,094	1,806,704
Hawaii	180,438	155,180	161,748
Idaho	201,948	168,158	154,420
Illinois	1,466,107	1,374,213	1,294,018
Indiana	777,888	764,325	731,022
Iowa	247,438	306,903	303,450
Kansas	294,733	284,268	255,146
Kentucky	734,709	727,253	717,868
Louisiana	1,031,448	944,830	934,677
Maine	173,591	161,307	147,159
Maryland	575,676	581,223	608,165
Massachusetts	718,461	621,105	663,160
Michigan	1,246,940	1,161,602	1,197,548
Minnesota	590,047	471,679	473,704
Mississippi	698,279	695,134	686,253
Missouri	787,786	669,875	645,077
Montana	111,169	111,749	107,800
Nebraska	205,078	185,008	176,499
Nevada	432,825	388,333	391,363
New Hampshire	87,286	77,257	84,167
New Jersey	836,133	774,574	770,769
New Mexico	425,748	397,514	388,700
New York	2,874,174	2,718,230	2,746,184
North Carolina	1,679,494	1,699,340	1,674,544
North Dakota	65,019	53,944	57,964
Ohio	1,542,342	1,549,029	1,652,954
Oklahoma	590,841	533,485	591,946
Oregon	485,315	389,047	363,620
Pennsylvania	1,559,471	1,439,200	1,361,163
Rhode Island	125,710	124,276	112,423
South Carolina	761,734	767,566	796,282
South Dakota	103,735	89,749	93,529
Tennessee	963,229	1,041,731	1,016,951
Texas	4,528,506	4,193,312	4,242,147
Utah	253,252	229,271	219,590
Vermont	60,551	58,702	61,902
Virginia	951,631	926,396	850,912
Washington	678,728	553,121	562,475
West Virginia	337,513	296,238	288,229
Wisconsin	598,726	523,347	494,977
Wyoming	57,526	55,304	55,853
United States	43,862,365	41,576,026	42,185,668

Source: CPS ASEC.

Table A.6. CPS ASEC population estimate

	FY 2018	FY 2019	FY 2020
Alabama	4,863,571	4,876,418	4,890,050
Alaska	721,566	708,085	706,128
Arizona	7,187,373	7,290,801	7,429,920
Arkansas	2,920,062	2,917,800	2,969,883
California	39,240,144	39,368,072	39,253,235
Colorado	5,688,751	5,760,986	5,757,630
Connecticut	3,451,880	3,474,732	3,484,591
Delaware	975,502	973,695	980,046
District of Columbia	692,544	701,815	714,773
Florida	21,107,389	21,370,984	21,618,343
Georgia	10,395,999	10,399,034	10,517,508
Hawaii	1,397,484	1,376,072	1,376,504
Idaho	1,757,875	1,788,228	1,824,945
Illinois	12,600,165	12,533,483	12,479,126
Indiana	6,580,035	6,681,973	6,680,820
Iowa	3,100,009	3,134,551	3,133,900
Kansas	2,851,686	2,822,952	2,855,805
Kentucky	4,439,959	4,419,357	4,417,364
Louisiana	4,522,566	4,555,918	4,558,844
Maine	1,322,891	1,337,742	1,349,935
Maryland	6,031,940	6,073,686	5,988,280
Massachusetts	6,872,921	6,901,611	6,850,176
Michigan	9,936,957	9,921,148	9,833,527
Minnesota	5,716,201	5,700,269	5,602,659
Mississippi	2,916,597	2,913,781	2,933,940
Missouri	6,024,479	6,062,882	6,053,982
Montana	1,041,842	1,051,255	1,066,894
Nebraska	1,891,310	1,895,026	1,923,548
Nevada	3,009,090	3,083,048	3,143,923
New Hampshire	1,346,133	1,350,912	1,366,584
New Jersey	8,849,297	8,752,953	8,736,583
New Mexico	2,054,871	2,060,455	2,061,329
New York	19,475,315	19,172,861	18,952,548
North Carolina	10,360,068	10,461,528	10,554,046
North Dakota	744,104	752,338	753,397
Ohio	11,479,167	11,509,548	11,599,660
Oklahoma	3,862,179	3,898,392	3,906,843
Oregon	4,194,068	4,157,405	4,134,476
Pennsylvania	12,556,499	12,555,889	12,514,589
Rhode Island	1,039,996	1,045,886	1,053,738
South Carolina	5,024,763	5,124,836	5,177,106
South Dakota	857,574	859,604	875,401
Tennessee	6,697,665	6,725,083	6,863,470
Texas	28,425,458	28,682,740	29,032,693
Utah	3,166,083	3,220,214	3,238,241
Vermont	616,871	616,132	618,299
Virginia	8,363,593	8,362,221	8,434,534
Washington	7,530,083	7,556,122	7,590,436
West Virginia	1,775,598	1,754,139	1,748,849
Wisconsin	5,810,465	5,759,722	5,787,617
Wyoming	564,261	565,625	566,839
United States	324,052,896	325,040,009	325,963,558

Source: CPS ASEC.

Table A.7. State population on July 1

	FY 2018	FY 2019	FY 2020
Alabama	4,887,681	4,907,965	4,921,532
Alaska	735,139	733,603	731,158
Arizona	7,158,024	7,291,843	7,421,401
Arkansas	3,009,733	3,020,985	3,030,522
California	39,461,588	39,437,610	39,368,078
Colorado	5,691,287	5,758,486	5,807,719
Connecticut	3,571,520	3,566,022	3,557,006
Delaware	965,479	976,668	986,809
District of Columbia	701,547	708,253	712,816
Florida	21,244,317	21,492,056	21,733,312
Georgia	10,511,131	10,628,020	10,710,017
Hawaii	1,420,593	1,415,615	1,407,006
Idaho	1,750,536	1,789,060	1,826,913
Illinois	12,723,071	12,667,017	12,587,530
Indiana	6,695,497	6,731,010	6,754,953
Iowa	3,148,618	3,159,596	3,163,561
Kansas	2,911,359	2,912,635	2,913,805
Kentucky	4,461,153	4,472,345	4,477,251
Louisiana	4,659,690	4,658,285	4,645,318
Maine	1,339,057	1,345,770	1,350,141
Maryland	6,035,802	6,054,954	6,055,802
Massachusetts	6,882,635	6,894,883	6,893,574
Michigan	9,984,072	9,984,795	9,966,555
Minnesota	5,606,249	5,640,053	5,657,342
Mississippi	2,981,020	2,978,227	2,966,786
Missouri	6,121,623	6,140,475	6,151,548
Montana	1,060,665	1,070,123	1,080,577
Nebraska	1,925,614	1,932,571	1,937,552
Nevada	3,027,341	3,090,771	3,138,259
New Hampshire	1,353,465	1,360,783	1,366,275
New Jersey	8,886,025	8,891,258	8,882,371
New Mexico	2,092,741	2,099,634	2,106,319
New York	19,530,351	19,463,131	19,336,776
North Carolina	10,381,615	10,501,384	10,600,823
North Dakota	758,080	763,724	765,309
Ohio	11,676,341	11,696,507	11,693,217
Oklahoma	3,940,235	3,960,676	3,980,783
Oregon	4,181,886	4,216,116	4,241,507
Pennsylvania	12,800,922	12,798,883	12,783,254
Rhode Island	1,058,287	1,058,158	1,057,125
South Carolina	5,084,156	5,157,702	5,218,040
South Dakota	878,698	887,127	892,717
Tennessee	6,771,631	6,830,325	6,886,834
Texas	28,628,666	28,986,794	29,360,759
Utah	3,153,550	3,203,383	3,249,879
Vermont	624,358	624,046	623,347
Virginia	8,501,286	8,556,642	8,590,563
Washington	7,523,869	7,614,024	7,693,612
West Virginia	1,804,291	1,795,263	1,784,787
Wisconsin	5,807,406	5,824,581	5,832,655
Wyoming	577,601	580,116	582,328
United States	326,687,501	328,329,953	329,484,123

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

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

	Direct estimates			Standard errors		
	FY 2018	FY 2019	FY 2020	FY 2018	FY 2019	FY 2020
Alabama	76.02	80.75	83.83	4.101	5.332	7.681
Alaska	85.92	82.20	76.03	6.071	6.017	6.330
Arizona	70.39	76.53	76.99	5.172	5.794	6.050
Arkansas	66.68	67.90	63.42	3.456	4.477	4.077
California	68.36	67.16	63.21	1.936	1.806	1.642
Colorado	74.34	76.04	69.20	6.223	7.901	8.014
Connecticut	84.29	114.75	94.57	7.329	11.992	8.459
Delaware	112.45	117.11	87.30	8.277	10.507	6.821
District of Columbia	81.15	93.40	90.62	4.403	5.570	5.105
Florida	82.11	76.99	72.01	3.802	3.220	2.783
Georgia	81.76	74.20	66.47	4.248	4.244	4.391
Hawaii	80.03	88.89	83.58	5.471	7.097	6.580
Idaho	72.29	81.33	85.98	5.172	4.663	5.714
Illinois	108.87	113.41	112.21	6.492	7.118	6.358
Indiana	73.79	68.83	71.22	5.377	4.130	3.830
Iowa	114.71	85.36	80.66	11.837	8.620	7.629
Kansas	70.27	66.49	72.75	5.390	6.209	7.018
Kentucky	77.17	67.06	62.72	5.744	6.069	4.988
Louisiana	80.79	82.66	81.62	2.718	3.485	3.550
Maine	80.11	75.01	84.59	9.376	8.470	9.023
Maryland	97.53	91.09	85.73	7.423	7.456	7.198
Massachusetts	92.02	104.89	94.16	6.225	7.620	6.520
Michigan	88.33	86.46	82.48	4.309	4.829	4.186
Minnesota	63.04	74.71	71.66	4.664	6.119	5.853
Mississippi	67.84	61.59	60.14	2.464	2.959	3.359
Missouri	87.33	98.11	98.31	7.035	9.922	9.996
Montana	86.95	81.38	80.59	8.315	5.171	5.307
Nebraska	74.86	78.72	79.51	6.894	5.793	5.926
Nevada	86.75	89.83	84.81	5.048	5.761	5.327
New Hampshire	84.68	85.11	74.38	7.587	8.994	7.685
New Jersey	79.85	81.54	76.24	5.389	5.932	5.096
New Mexico	95.15	99.82	101.51	7.576	6.176	5.983
New York	86.28	83.68	79.40	3.346	3.118	2.812
North Carolina	71.36	66.66	63.67	3.725	3.171	3.128
North Dakota	64.33	71.13	63.90	5.717	6.651	4.748
Ohio	81.93	79.45	73.62	5.049	5.413	4.640
Oklahoma	90.35	98.13	88.67	6.209	7.039	6.107
Oregon	107.26	130.33	134.78	6.667	11.193	12.072
Pennsylvania	98.40	105.67	109.34	5.306	6.013	6.797
Rhode Island	105.35	98.82	105.46	9.232	10.342	10.851
South Carolina	79.72	72.95	67.10	4.509	4.296	3.898
South Dakota	80.36	86.10	79.70	8.092	8.952	14.403
Tennessee	97.67	83.14	80.26	4.770	5.253	5.523
Texas	73.26	70.39	66.90	2.197	2.184	2.179
Utah	72.85	74.33	72.08	7.918	8.828	7.007
Vermont	99.48	97.22	87.61	7.305	9.815	8.087
Virginia	73.60	70.57	76.21	5.155	6.121	6.905
Washington	104.01	120.21	115.24	7.584	9.722	12.261
West Virginia	84.14	88.80	90.33	4.151	6.047	6.537
Wisconsin	90.76	98.49	101.52	6.049	8.275	9.765
Wyoming	48.82	46.17	43.07	4.683	6.027	4.812

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 age 65 and older who received Supplemental Security Income	Administrative data, 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 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	ACS 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 the population that received SNAP benefits	People who received SNAP benefits according to SNAP Program Operations data	Resident population[a]
Percentage of people age 65 and older who received Supplemental Security Income	People age 65 and older who received Supplemental Security Income	Resident population age 65 and older[a]
Percentage of families that had income below $20,000 in the past 12 months	Families with income below $20,000 in the past 12 months according to ACS one-year estimates[c]	Total families according to ACS one-year estimates[c]
Percentage of people age 25 and older who completed a bachelor's degree	People age 25 and older who completed a bachelor's degree according to ACS one-year estimates[c]	Total people age 25 and older according to ACS one-year estimates[c]
Percentage of people age 65 and older with household income below 100 percent of the federal poverty level	People age 65 and older with income below 100 percent of the poverty level according to ACS one-year estimates[c]	Total people age 65 and older according to ACS one-year estimates[c]
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[c]	Total employed civilians age 16 and older according to ACS one-year estimates[c]
Percentage of exemptions for children claimed on tax returns that had adjusted gross income below the federal poverty level	Children claimed on federal tax returns with adjusted gross income below the federal poverty level[b]	Total children claimed on federal tax returns[b]
Indicator	**Indicator = 1**	**Indicator = 0**
Indicator of whether a State did not have a BBCE policy or had a BBCE policy that included a resource test	State applied a resource test for most households	State did not apply a resource test for most households

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

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

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

ACS = American Community Survey.

Table A.11. Values for first and second predictors

	Percentage of population that received SNAP benefits			Percentage of people age 65 and older who received Supplemental Security Income		
	FY 2018	FY 2019	FY 2020	FY 2018	FY 2019	FY 2020
Alabama	15.686	14.822	14.455	0.979	0.925	0.858
Alaska	12.514	11.573	10.823	2.012	1.946	1.824
Arizona	11.815	10.946	10.569	1.385	1.352	1.272
Arkansas	12.375	11.748	11.414	0.951	0.908	0.846
California	10.006	9.603	10.271	6.284	6.068	5.756
Colorado	7.904	7.825	7.501	1.327	1.292	1.226
Connecticut	10.845	10.317	10.175	1.180	1.157	1.112
Delaware	14.531	13.327	12.034	0.710	0.686	0.645
District of Columbia	16.005	15.536	15.370	2.466	2.470	2.374
Florida	14.499	13.199	12.511	3.317	3.236	3.101
Georgia	14.808	13.320	12.645	1.748	1.710	1.639
Hawaii	11.517	11.121	10.943	2.087	1.975	1.910
Idaho	9.018	8.197	7.913	0.644	0.602	0.550
Illinois	14.352	14.028	14.087	1.553	1.501	1.427
Indiana	9.216	8.562	8.400	0.554	0.543	0.522
Iowa	10.970	10.135	9.481	0.592	0.580	0.548
Kansas	7.468	6.907	6.663	0.635	0.609	0.587
Kentucky	13.793	12.120	10.991	1.268	1.218	1.137
Louisiana	18.614	17.369	17.011	1.562	1.465	1.365
Maine	12.536	11.638	11.480	0.630	0.613	0.592
Maryland	10.711	10.234	9.966	1.648	1.601	1.519
Massachusetts	11.196	11.018	11.061	2.158	2.124	2.029
Michigan	12.839	11.814	11.598	1.137	1.112	1.058
Minnesota	7.652	7.262	6.956	1.249	1.224	1.173
Mississippi	16.951	15.276	14.570	1.644	1.558	1.443
Missouri	12.033	11.301	10.829	0.672	0.650	0.626
Montana	10.863	10.040	9.763	0.717	0.692	0.667
Nebraska	8.819	8.328	7.990	0.773	0.782	0.748
Nevada	14.532	13.693	13.242	3.014	2.963	2.820
New Hampshire	6.391	5.616	5.292	0.352	0.326	0.312
New Jersey	8.556	7.943	7.596	2.573	2.492	2.326
New Mexico	21.802	21.371	21.221	2.267	2.140	1.995
New York	14.319	13.676	13.292	3.639	3.523	3.283
North Carolina	10.469	12.314	11.591	1.028	0.980	0.912
North Dakota	6.941	6.386	6.236	0.567	0.512	0.493
Ohio	12.173	11.832	11.754	0.835	0.826	0.802
Oklahoma	14.848	14.493	14.461	0.984	0.969	0.919
Oregon	15.160	14.211	13.723	1.303	1.274	1.218
Pennsylvania	14.207	13.734	13.559	1.051	1.039	0.996
Rhode Island	14.840	14.396	13.903	1.853	1.785	1.681
South Carolina	12.945	11.652	11.042	0.858	0.817	0.760
South Dakota	9.948	9.149	8.763	1.017	1.005	0.977
Tennessee	14.337	13.253	12.579	0.992	0.944	0.885
Texas	13.302	11.793	11.083	2.904	2.776	2.577
Utah	5.996	5.375	5.058	0.817	0.778	0.719
Vermont	11.701	11.105	10.841	0.764	0.733	0.693
Virginia	8.660	8.243	8.016	1.342	1.291	1.224
Washington	11.659	10.834	10.365	1.503	1.465	1.407
West Virginia	17.791	17.072	17.118	0.646	0.624	0.591
Wisconsin	11.242	10.614	10.321	0.685	0.662	0.626
Wyoming	5.078	4.556	4.415	0.360	0.349	0.335

Table A.12. Values for third and fourth predictors

	Percentage of families that had income below $20,000 in the past 12 months			Percentage of people age 25 and older who completed a bachelor's degree		
	FY 2018	FY 2019	FY 2020	FY 2018	FY 2019	FY 2020
Alabama	12.2	11.0	9.0	25.5	26.3	27.8
Alaska	6.9	5.2	5.4	30.2	30.2	31.9
Arizona	8.9	8.3	7.7	29.7	30.2	33.0
Arkansas	11.9	10.7	10.3	23.3	23.3	24.9
California	8.2	7.2	6.6	34.2	35.0	36.9
Colorado	6.0	5.3	5.0	41.7	42.7	44.2
Connecticut	6.7	6.4	6.0	39.6	39.8	42.4
Delaware	7.1	6.6	5.9	31.3	33.2	34.7
District of Columbia	11.7	8.8	6.7	60.4	59.7	63.6
Florida	9.5	8.4	7.5	30.4	30.7	33.7
Georgia	10.0	8.7	8.2	31.9	32.5	34.8
Hawaii	5.3	5.4	5.4	33.5	33.6	35.5
Idaho	8.2	7.0	6.1	27.7	28.7	30.9
Illinois	8.0	7.2	6.8	35.1	35.8	37.6
Indiana	8.8	7.3	7.5	27.1	26.9	28.9
Iowa	7.0	6.7	6.2	29.0	29.3	29.5
Kansas	7.4	6.9	6.7	33.8	34.0	35.1
Kentucky	12.5	11.3	10.0	24.8	25.1	27.4
Louisiana	13.5	13.6	11.8	24.3	25.0	27.2
Maine	7.7	6.5	6.6	31.5	33.2	33.5
Maryland	5.9	5.4	4.8	40.8	40.9	43.1
Massachusetts	6.4	5.9	5.8	44.5	45.0	46.9
Michigan	9.1	8.0	7.6	29.6	30.0	32.1
Minnesota	5.2	5.0	4.5	36.7	37.3	37.9
Mississippi	15.2	13.9	14.2	23.2	22.3	24.5
Missouri	8.6	8.6	7.4	29.5	30.2	31.9
Montana	7.5	7.8	6.5	31.7	33.6	34.6
Nebraska	6.7	5.7	5.2	32.4	33.2	33.3
Nevada	8.2	7.6	7.0	24.9	25.7	28.0
New Hampshire	4.9	4.3	4.0	36.8	37.6	40.2
New Jersey	6.7	5.6	6.2	40.8	41.2	43.1
New Mexico	14.5	12.3	11.1	27.7	27.7	30.1
New York	9.6	8.7	8.4	37.2	37.8	39.5
North Carolina	9.7	9.1	8.0	31.9	32.3	34.8
North Dakota	5.8	6.2	6.1	29.7	30.4	31.8
Ohio	9.4	8.5	8.1	29.0	29.3	30.6
Oklahoma	10.8	9.6	8.9	25.6	26.2	27.0
Oregon	7.9	6.5	6.3	34.0	34.5	36.3
Pennsylvania	8.0	7.8	6.8	31.8	32.3	34.0
Rhode Island	8.5	6.5	6.0	34.4	34.8	38.0
South Carolina	10.2	9.5	8.9	28.3	29.6	31.7
South Dakota	7.7	7.2	6.7	29.2	29.7	28.4
Tennessee	11.1	9.3	8.6	27.5	28.7	30.7
Texas	10.1	9.1	8.2	30.3	30.8	33.2
Utah	5.4	5.2	4.2	34.9	34.8	36.9
Vermont	6.3	6.0	4.4	38.7	38.7	42.1
Virginia	6.9	6.2	5.3	39.3	39.6	42.0
Washington	6.0	5.7	5.6	36.7	37.0	38.4
West Virginia	13.1	11.3	10.5	21.3	21.1	23.1
Wisconsin	6.7	6.0	5.6	30.0	31.3	31.8
Wyoming	7.2	7.0	5.6	26.9	29.1	28.2

Table A.13. Values for fifth and sixth predictors

	Percentage of people age 65 and older with household income below 100 percent of the federal poverty level			Percentage of civilian employed population age 16 and older that were private wage and salary workers		
	FY 2018	FY 2019	FY 2020	FY 2018	FY 2019	FY 2020
Alabama	10.3	10.5	10.9	79.3	78.5	73.8
Alaska	6.7	6.9	5.7	67.9	70.4	60.6
Arizona	8.6	9.0	8.7	80.4	80.0	75.4
Arkansas	10.2	10.5	9.3	78.6	78.3	73.8
California	10.5	10.5	10.5	78.5	78.1	73.3
Colorado	7.4	7.2	7.6	80.6	79.5	73.6
Connecticut	7.9	7.3	8.0	81.6	80.3	76.9
Delaware	6.1	7.3	7.5	80.2	79.6	74.7
District of Columbia	16.7	13.3	11.5	72.2	70.9	66.9
Florida	10.6	10.7	10.6	82.7	82.6	74.8
Georgia	10.2	10.4	10.3	80.6	80.4	74.4
Hawaii	6.5	8.7	8.4	73.1	73.6	66.0
Idaho	8.6	6.9	7.1	78.9	77.6	72.1
Illinois	8.8	8.6	9.4	83.6	83.1	77.8
Indiana	7.9	7.7	7.2	85.0	84.2	79.8
Iowa	7.1	7.4	8.1	80.5	79.3	75.4
Kansas	8.0	7.2	7.5	78.4	77.9	73.1
Kentucky	10.2	11.6	10.6	80.8	80.2	76.6
Louisiana	12.4	13.2	13.6	79.2	78.1	72.6
Maine	9.1	8.5	8.6	79.4	77.8	71.4
Maryland	7.3	7.8	8.1	74.2	72.8	68.6
Massachusetts	9.1	9.1	9.8	82.5	81.6	77.9
Michigan	9.0	8.4	9.1	85.0	84.0	79.5
Minnesota	7.6	7.4	7.1	83.2	82.1	76.7
Mississippi	12.4	13.2	13.0	76.1	76.6	70.8
Missouri	8.2	8.9	9.2	82.6	81.8	77.2
Montana	9.4	8.6	10.9	75.0	74.6	66.3
Nebraska	7.6	8.1	7.2	79.5	79.1	73.5
Nevada	9.8	9.5	9.6	82.7	82.9	76.6
New Hampshire	5.5	6.2	6.6	81.4	80.2	76.5
New Jersey	8.0	8.8	8.6	82.2	81.7	76.1
New Mexico	13.3	13.5	13.6	71.7	71.6	65.0
New York	11.8	12.0	11.7	78.8	78.7	73.0
North Carolina	8.7	9.1	9.6	80.5	80.8	75.9
North Dakota	10.3	8.0	6.6	76.5	75.8	70.5
Ohio	8.6	8.3	8.5	83.4	82.6	78.7
Oklahoma	8.7	9.7	9.2	77.1	75.8	70.4
Oregon	7.9	8.1	8.5	79.4	78.3	73.6
Pennsylvania	8.3	8.3	8.4	84.6	84.0	80.2
Rhode Island	11.2	8.9	9.8	82.6	81.8	79.1
South Carolina	9.5	10.1	10.5	80.0	79.3	74.5
South Dakota	9.0	7.7	10.5	77.7	75.4	72.7
Tennessee	9.2	9.7	10.0	80.3	79.9	76.4
Texas	11.1	10.6	10.5	80.3	79.8	74.4
Utah	6.1	6.2	5.7	80.6	80.1	74.8
Vermont	9.3	6.1	7.5	76.7	77.5	70.2
Virginia	8.4	7.1	7.3	74.9	75.2	70.8
Washington	7.2	7.5	7.6	78.7	78.5	73.5
West Virginia	10.0	9.3	9.7	76.8	76.2	72.3
Wisconsin	7.9	7.4	9.0	83.5	82.6	77.7
Wyoming	7.3	7.4	1.8	72.1	70.7	67.5

Table A.14. Values for seventh and eighth predictors

	Percentage of children claimed on tax returns with adjusted gross income below the federal poverty level			Indicator of whether a State did not have a BBCE policy or had a BBCE policy that included a resource test		
	FY 2018	FY 2019	FY 2020	FY 2018	FY 2019	FY 2020
Alabama	26.650	26.913	27.505	0	0	0
Alaska	15.232	16.456	17.129	1	1	1
Arizona	21.092	21.068	21.354	0	0	0
Arkansas	26.951	27.493	27.916	1	1	1
California	18.188	18.479	19.815	0	0	0
Colorado	14.447	14.876	15.064	0	0	0
Connecticut	14.611	15.110	15.806	0	0	0
Delaware	19.464	19.899	20.519	0	0	0
District of Columbia	23.981	24.412	27.110	0	0	0
Florida	25.772	25.643	26.579	0	0	0
Georgia	26.546	26.874	26.763	0	0	0
Hawaii	15.310	16.087	16.895	0	0	0
Idaho	15.721	16.003	15.771	1	1	1
Illinois	18.671	18.897	19.272	0	0	0
Indiana	18.912	19.381	20.171	1	1	1
Iowa	14.930	15.510	15.617	0	0	0
Kansas	16.621	16.765	17.222	1	1	1
Kentucky	23.597	24.672	25.420	0	0	0
Louisiana	28.773	29.331	31.613	1	1	1
Maine	17.177	17.962	17.654	1	1	0
Maryland	16.008	16.681	17.243	0	0	0
Massachusetts	12.238	12.758	12.816	0	0	0
Michigan	21.133	21.894	22.049	1	1	1
Minnesota	12.630	13.246	13.511	0	0	0
Mississippi	31.292	31.370	32.051	0	1	1
Missouri	20.591	20.996	21.461	1	1	1
Montana	18.140	18.830	18.406	0	0	0
Nebraska	15.272	15.526	15.505	0	0	0
Nevada	20.393	20.841	23.222	0	0	0
New Hampshire	10.353	10.997	11.486	1	1	1
New Jersey	15.932	16.244	17.152	0	0	0
New Mexico	26.064	26.618	27.433	0	0	0
New York	22.375	22.096	23.885	0	0	0
North Carolina	22.447	22.469	23.062	0	0	0
North Dakota	12.804	13.565	14.051	0	0	0
Ohio	19.764	20.424	20.953	0	0	0
Oklahoma	23.167	23.952	24.841	0	0	0
Oregon	15.556	16.567	16.705	0	0	0
Pennsylvania	17.576	18.064	18.144	0	0	0
Rhode Island	17.867	18.200	18.868	0	0	0
South Carolina	23.990	23.869	24.684	0	0	0
South Dakota	16.065	17.170	16.877	1	1	1
Tennessee	23.881	24.015	24.660	1	1	1
Texas	24.326	24.317	25.596	1	1	1
Utah	11.928	12.092	12.104	1	1	1
Vermont	14.587	15.236	15.050	0	0	0
Virginia	16.423	16.931	17.873	1	1	1
Washington	12.287	13.005	13.675	0	0	0
West Virginia	23.281	24.447	25.538	0	0	0
Wisconsin	15.535	16.074	16.765	0	0	0
Wyoming	14.053	14.403	15.577	1	1	1

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

	Regression estimates			Standard errors		
	FY 2018	FY 2019	FY 2020	FY 2018	FY 2019	FY 2020
Alabama	80.09	78.07	78.60	3.722	3.863	3.954
Alaska	86.70	86.71	79.02	5.254	5.170	5.133
Arizona	78.30	75.39	71.78	3.601	3.621	3.603
Arkansas	65.00	60.10	60.27	3.939	3.977	3.871
California	67.92	67.82	65.49	4.716	4.675	4.561
Colorado	79.44	80.99	74.48	3.951	3.984	3.886
Connecticut	89.88	91.97	87.32	3.812	4.019	3.931
Delaware	101.04	95.11	86.16	4.427	4.040	3.876
District of Columbia	83.04	93.62	89.53	5.813	6.126	5.960
Florida	81.73	75.22	68.94	4.073	4.021	3.971
Georgia	83.12	74.87	71.18	4.038	4.146	3.820
Hawaii	88.60	86.08	81.83	4.569	4.349	4.063
Idaho	70.36	73.89	74.79	3.947	3.877	3.896
Illinois	96.99	101.15	99.74	3.836	4.028	4.020
Indiana	72.91	70.94	69.08	4.060	4.001	3.935
Iowa	85.58	85.65	81.73	3.776	3.856	3.872
Kansas	68.17	67.76	65.20	3.864	3.935	3.907
Kentucky	74.39	67.38	62.06	4.047	4.178	4.018
Louisiana	84.68	80.65	82.14	4.082	4.225	4.139
Maine	86.65	88.68	86.52	3.933	4.109	3.741
Maryland	86.60	84.18	80.75	4.257	4.169	3.878
Massachusetts	93.62	100.82	99.40	4.264	4.617	4.684
Michigan	85.32	81.95	83.25	3.947	3.996	3.979
Minnesota	79.18	80.78	75.97	3.900	3.960	3.814
Mississippi	69.71	63.16	60.13	4.135	4.149	4.585
Missouri	83.45	79.60	80.66	3.803	3.799	3.846
Montana	74.48	75.24	75.21	4.123	3.881	4.571
Nebraska	76.05	77.56	74.52	3.723	3.992	3.765
Nevada	86.97	87.92	80.66	4.227	4.146	4.091
New Hampshire	81.14	79.14	78.41	4.224	4.283	4.340
New Jersey	78.70	76.07	67.11	3.986	3.943	3.995
New Mexico	93.88	104.00	106.09	4.873	5.076	5.091
New York	81.94	83.91	77.31	3.735	3.839	3.726
North Carolina	71.37	80.74	75.53	3.929	3.757	3.657
North Dakota	61.19	68.45	64.06	5.442	4.516	4.153
Ohio	82.02	83.66	80.49	3.753	3.805	3.818
Oklahoma	83.53	82.68	80.67	3.775	3.911	3.934
Oregon	102.45	104.94	101.41	4.168	4.130	4.105
Pennsylvania	97.47	100.80	99.98	3.952	4.195	4.261
Rhode Island	92.34	103.23	101.90	4.175	4.103	4.151
South Carolina	76.44	71.35	66.98	3.727	3.826	3.874
South Dakota	73.82	74.15	77.59	3.871	3.840	4.544
Tennessee	82.92	80.14	80.28	3.833	3.735	3.794
Texas	75.25	69.59	66.60	3.882	3.809	3.855
Utah	74.30	73.07	72.00	4.035	4.145	4.092
Vermont	87.65	95.78	93.22	4.022	4.292	3.989
Virginia	73.88	74.93	72.76	4.034	4.209	4.022
Washington	94.50	96.76	89.95	3.957	3.983	3.919
West Virginia	88.23	92.70	91.62	4.372	4.565	4.433
Wisconsin	87.04	90.17	87.64	3.894	3.887	3.996
Wyoming	54.17	54.23	50.03	4.612	4.828	4.915

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

	FY 2018	FY 2019	FY 2020
Alabama	78.36	77.98	78.47
Alaska	86.35	85.64	78.77
Arizona	76.41	75.00	72.02
Arkansas	65.49	62.14	60.21
California	68.05	67.44	63.82
Colorado	78.15	80.13	73.40
Connecticut	87.91	92.84	85.67
Delaware	101.30	96.72	84.19
District of Columbia	82.46	93.44	89.68
Florida	82.08	75.96	70.60
Georgia	82.30	75.26	69.20
Hawaii	86.50	85.95	80.44
Idaho	71.20	75.38	76.85
Illinois	99.67	102.73	102.62
Indiana	73.21	69.74	70.72
Iowa	87.46	85.11	82.55
Kansas	69.21	66.60	67.22
Kentucky	75.06	67.01	62.61
Louisiana	82.43	81.53	80.74
Maine	86.01	86.05	87.01
Maryland	88.04	85.18	81.79
Massachusetts	92.34	101.41	96.79
Michigan	85.84	83.11	82.15
Minnesota	74.21	78.88	73.06
Mississippi	68.85	61.92	59.79
Missouri	84.07	80.80	81.59
Montana	76.06	76.24	76.56
Nebraska	75.94	77.27	75.65
Nevada	87.16	88.07	80.95
New Hampshire	80.63	79.93	76.43
New Jersey	79.39	76.15	69.58
New Mexico	93.74	102.71	105.27
New York	83.95	83.58	78.91
North Carolina	70.65	74.65	71.47
North Dakota	61.54	68.72	63.38
Ohio	81.22	82.87	78.51
Oklahoma	84.47	85.18	81.27
Oregon	103.46	106.06	103.33
Pennsylvania	97.55	100.92	101.68
Rhode Island	94.27	102.51	103.46
South Carolina	77.31	71.78	66.82
South Dakota	74.47	76.24	77.42
Tennessee	86.91	81.24	81.12
Texas	73.69	70.07	66.71
Utah	74.11	73.09	71.75
Vermont	88.72	96.23	92.76
Virginia	74.20	73.32	74.17
Washington	95.76	98.78	91.23
West Virginia	85.64	90.90	90.62
Wisconsin	88.12	90.70	89.15
Wyoming	52.27	52.59	47.86

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

	Final shrinkage estimates			Standard errors		
	FY 2018	FY 2019	FY 2020	FY 2018	FY 2019	FY 2020
Alabama	79.95	80.96	81.13	2.796	3.011	3.477
Alaska	88.46	89.08	81.45	4.331	4.243	4.260
Arizona	77.81	77.71	74.47	2.947	2.976	2.958
Arkansas	66.80	64.38	62.26	2.629	3.024	2.711
California	69.56	69.93	65.99	1.915	1.806	1.639
Colorado	79.72	83.16	75.89	3.363	3.612	3.418
Connecticut	89.72	97.10	88.58	3.403	4.140	3.406
Delaware	100.00	100.00	87.05	4.020	4.040	3.211
District of Columbia	84.33	97.02	92.73	4.101	4.850	4.498
Florida	83.79	78.58	73.00	2.828	2.562	2.268
Georgia	84.10	77.89	71.55	3.009	2.960	2.800
Hawaii	88.30	89.21	83.17	3.722	3.867	3.436
Idaho	72.69	78.30	79.46	3.265	2.964	3.261
Illinois	100.00	100.00	100.00	3.544	3.830	3.651
Indiana	74.93	71.50	73.12	3.256	2.822	2.709
Iowa	89.60	88.13	85.35	3.703	3.591	3.418
Kansas	70.66	68.80	69.50	3.170	3.330	3.341
Kentucky	76.73	69.05	64.74	3.384	3.541	3.060
Louisiana	84.27	84.96	83.48	2.354	2.783	2.706
Maine	88.25	89.11	89.96	3.829	3.762	3.540
Maryland	89.97	88.28	84.57	3.843	3.746	3.435
Massachusetts	94.45	100.00	100.00	3.829	4.582	4.040
Michigan	88.11	86.38	84.94	2.958	3.110	2.772
Minnesota	75.58	81.94	75.54	3.376	3.904	3.598
Mississippi	70.30	64.11	61.82	2.168	2.393	2.805
Missouri	85.88	83.99	84.36	3.368	3.519	3.492
Montana	77.86	78.78	79.17	3.892	3.236	3.599
Nebraska	77.43	79.75	78.22	3.281	3.207	3.118
Nevada	89.16	91.40	83.70	3.326	3.387	3.161
New Hampshire	82.39	83.11	79.03	3.941	4.380	3.933
New Jersey	80.89	78.64	71.95	3.386	3.416	3.152
New Mexico	96.26	100.00	100.00	4.420	4.233	4.191
New York	85.92	86.52	81.59	2.478	2.472	2.212
North Carolina	72.39	77.18	73.90	3.046	2.777	2.676
North Dakota	63.04	70.86	65.53	4.365	3.884	3.088
Ohio	83.04	86.15	81.18	3.016	3.151	2.830
Oklahoma	86.26	88.55	84.03	3.321	3.548	3.315
Oregon	100.00	100.00	100.00	3.653	3.963	3.942
Pennsylvania	99.72	100.00	100.00	3.232	3.481	3.735
Rhode Island	96.77	100.00	100.00	4.004	3.896	3.957
South Carolina	79.04	74.14	69.09	2.886	2.837	2.672
South Dakota	76.17	79.38	80.05	3.529	3.558	4.351
Tennessee	89.10	84.22	83.88	3.267	3.201	3.235
Texas	75.24	72.74	68.98	1.953	1.918	1.902
Utah	75.58	75.93	74.19	3.602	3.851	3.404
Vermont	90.99	100.00	95.91	3.610	4.029	3.470
Virginia	75.81	76.01	76.69	3.212	3.470	3.433
Washington	97.92	100.00	94.32	3.688	3.859	3.913
West Virginia	87.57	94.79	93.69	3.147	3.838	3.902
Wisconsin	90.17	93.67	92.18	3.347	3.505	3.691
Wyoming	53.29	54.24	49.49	3.494	4.090	3.550

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

	Final shrinkage estimates			Standard errors		
	FY 2018	FY 2019	FY 2020	FY 2018	FY 2019	FY 2020
Alabama	906,964	844,956	825,085	31,807	31,904	35,747
Alaska	101,820	89,543	90,071	5,000	4,331	4,764
Arizona	937,248	892,471	899,175	35,603	34,700	36,109
Arkansas	543,590	534,617	515,391	21,453	25,496	22,689
California	4,939,090	4,810,207	5,402,706	136,353	126,099	135,661
Colorado	523,880	492,142	510,011	22,160	21,705	23,225
Connecticut	367,201	321,103	331,056	13,966	13,902	12,869
Delaware	110,384	106,833	105,471	4,139	4,304	3,933
District of Columbia	119,819	103,966	109,739	5,844	5,277	5,382
Florida	3,260,705	3,204,647	3,263,413	110,350	106,100	102,528
Georgia	1,706,013	1,682,337	1,709,056	61,211	64,911	67,628
Hawaii	166,259	159,073	166,154	7,029	7,002	6,940
Idaho	200,000	174,743	167,274	9,009	6,717	6,942
Illinois	1,611,765	1,575,135	1,464,681	55,120	53,620	48,029
Indiana	779,390	741,177	719,875	33,965	29,709	26,966
Iowa	321,728	299,635	289,483	13,335	12,398	11,722
Kansas	299,202	283,461	272,512	13,460	13,930	13,246
Kentucky	742,479	714,669	704,900	32,842	37,215	33,684
Louisiana	1,018,809	939,818	931,126	28,546	31,262	30,518
Maine	159,494	136,591	138,390	6,939	5,855	5,506
Maryland	624,429	597,889	623,497	26,746	25,762	25,607
Massachusetts	700,961	650,816	628,411	28,502	26,988	25,626
Michigan	1,255,898	1,170,130	1,178,629	42,284	42,779	38,895
Minnesota	482,646	425,513	453,732	21,622	20,586	21,851
Mississippi	688,690	682,568	675,077	21,299	25,874	30,971
Missouri	814,046	792,495	763,840	32,018	33,718	31,968
Montana	126,391	117,512	111,153	6,336	4,901	5,110
Nebraska	201,847	186,249	180,720	8,578	7,604	7,284
Nevada	423,677	382,634	395,851	15,851	14,397	15,114
New Hampshire	90,198	79,694	79,204	4,327	4,264	3,985
New Jersey	828,880	815,813	830,370	34,795	35,984	36,785
New Mexico	428,614	404,351	403,169	19,739	15,180	14,419
New York	2,894,388	2,668,561	2,726,791	83,721	77,400	74,736
North Carolina	1,658,946	1,473,332	1,449,162	70,002	53,825	53,057
North Dakota	67,599	54,973	57,411	4,694	3,059	2,735
Ohio	1,547,953	1,451,832	1,511,155	56,376	53,929	53,263
Oklahoma	631,343	600,636	636,487	24,372	24,439	25,386
Oregon	519,012	514,197	502,755	16,964	16,951	17,553
Pennsylvania	1,568,798	1,550,192	1,520,273	50,986	49,520	51,948
Rhode Island	139,254	124,247	118,944	5,779	4,357	4,159
South Carolina	777,351	760,144	779,502	28,469	29,536	30,481
South Dakota	112,133	100,463	94,967	5,210	4,573	5,219
Tennessee	1,067,560	1,044,460	976,371	39,255	40,311	38,074
Texas	4,440,493	4,100,349	4,160,846	115,612	109,771	116,031
Utah	243,130	223,264	214,132	11,620	11,499	9,934
Vermont	66,999	57,806	57,007	2,666	2,347	2,085
Virginia	939,082	880,031	861,235	39,900	40,793	38,983
Washington	720,390	670,023	696,534	27,209	24,811	29,211
West Virginia	329,530	284,008	283,574	11,877	11,676	11,939
Wisconsin	602,343	556,442	549,364	22,423	21,143	22,239
Wyoming	53,946	48,280	49,937	3,547	3,697	3,622

Appendix B

Data for Figures in Cunnyngham 2023

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Table B.1a. How many people were eligible in 2020? What percentage participated? (States)

Eligible people (thousands)	State		Lower bound of confidence interval	FY 2020 participation rate	Upper bound of confidence interval
403	New Mexico	*	93	100	100
119	Rhode Island	*	93	100	100
503	Oregon	*	94	100	100
1,465	Illinois	*	94	100	100
1,520	Pennsylvania	*	94	100	100
628	Massachusetts	*	93	100	100
57	Vermont	*	90	96	100
697	Washington	*	88	94	100
284	West Virginia	*	87	94	100
110	District of Columbia	*	85	93	100
549	Wisconsin	*	86	92	98
138	Maine	*	84	90	96
331	Connecticut	*	83	89	94
105	Delaware	*	82	87	92
289	Iowa	*	80	85	91
1,179	Michigan	*	80	85	90
624	Maryland	*	79	85	90
764	Missouri	*	79	84	90
636	Oklahoma	*	79	84	89
976	Tennessee	*	79	84	89
396	Nevada	*	78	84	89
931	Louisiana	*	79	83	88
166	Hawaii	*	78	83	89
2,727	New York	*	78	82	85
90	Alaska		74	81	88
1,511	Ohio		77	81	86
825	Alabama		75	81	87
95	South Dakota		73	80	87
167	Idaho		74	79	85
111	Montana		73	79	85
79	New Hampshire		73	79	85
181	Nebraska		73	78	83
861	Virginia		71	77	82
510	Colorado		70	76	82
454	Minnesota		70	76	81
899	Arizona	*	70	74	79
214	Utah		69	74	80
1,449	North Carolina	*	69	74	78
720	Indiana	*	69	73	78
3,263	Florida	*	69	73	77
830	New Jersey	*	67	72	77
1,709	Georgia	*	67	72	76
273	Kansas	*	64	70	75
780	South Carolina	*	65	69	73
4,161	Texas	*	66	69	72
5,403	California	*	63	66	69
57	North Dakota	*	60	66	71
705	Kentucky	*	60	65	70
515	Arkansas	*	58	62	67
675	Mississippi	*	57	62	66
50	Wyoming	*	44	49	55

*State's participation rate was significantly different from the national participation rate of 78 percent.

Table B.1b. How many people were eligible in 2020? What percentage participated? (Regions and national)

Eligible people (thousands)	Region	Lower bound of confidence interval	FY 2020 participation rate	Upper bound of confidence interval
4,334	Mid-Atlantic Region	84	87	90
6,167	Midwest Region	84	86	89
4,079	Northeast Region	83	86	89
2,041	Mountain Plains Region	75	78	81
7,760	Southwest Region	72	74	76
10,383	Southeast Region	71	73	75
7,421	Western Region	70	73	75
42,186	United States	77	78	79

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

	FY 2018	FY 2019	FY 2020	Rates for all three years were:
Alabama	80	81	81	
Alaska	88	89	81	
Arizona	78	78	74	
Arkansas	67	64	62	Lower than in two-thirds of the States
California	70	70	66	Lower than in two-thirds of the States
Colorado	80	83	76	
Connecticut	90	97	89	Higher than in half of the States
Delaware	100	100	87	Higher than in half of the States
District of Columbia	84	97	93	
Florida	84	79	73	
Georgia	84	78	72	
Hawaii	88	89	83	
Idaho	73	78	79	
Illinois	100	100	100	Higher than in two-thirds of the States
Indiana	75	71	73	Lower than in half of the States
Iowa	90	88	85	
Kansas	71	69	70	Lower than in two-thirds of the States
Kentucky	77	69	65	Lower than in half of the States
Louisiana	84	85	83	
Maine	88	89	90	
Maryland	90	88	85	
Massachusetts	94	100	100	Higher than in half of the States
Michigan	88	86	85	
Minnesota	76	82	76	
Mississippi	70	64	62	Lower than in two-thirds of the States
Missouri	86	84	84	
Montana	78	79	79	
Nebraska	77	80	78	
Nevada	89	91	84	
New Hampshire	82	83	79	
New Jersey	81	79	72	
New Mexico	96	100	100	Higher than in two-thirds of the States
New York	86	87	82	
North Carolina	72	77	74	Lower than in half of the States
North Dakota	63	71	66	Lower than in two-thirds of the States
Ohio	83	86	81	
Oklahoma	86	89	84	
Oregon	100	100	100	Higher than in two-thirds of the States
Pennsylvania	100	100	100	Higher than in two-thirds of the States
Rhode Island	97	100	100	Higher than in two-thirds of the States
South Carolina	79	74	69	
South Dakota	76	79	80	
Tennessee	89	84	84	
Texas	75	73	69	Lower than in half of the States
Utah	76	76	74	Lower than in half of the States
Vermont	91	100	96	Higher than in half of the States
Virginia	76	76	77	
Washington	98	100	94	Higher than in two-thirds of the States
West Virginia	88	95	94	
Wisconsin	90	94	92	Higher than in half of the States
Wyoming	53	54	49	Lower than in two-thirds of the States

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

	FY 2018	FY 2019	FY 2020
Mid-Atlantic Region	89	89	87
Midwest Region	88	88	86
Mountain Plains Region	79	80	78
Northeast Region	88	90	86
Southeast Region	81	77	73
Southwest Region	78	77	74
Western Region	77	77	73
United States	**82**	**81**	**78**

Table B.3. How did your State rank in 2020?

FY 2020 participation rate	State	Upper bound of confidence interval	FY 2020 rank	Lower bound of confidence interval
100	New Mexico	1	1	5
100	Rhode Island	1	2	6
100	Oregon	1	3	6
100	Illinois	1	4	6
100	Pennsylvania	1	5	6
100	Massachusetts	3	6	9
96	Vermont	6	7	11
94	Washington	6	8	14
94	West Virginia	6	9	15
93	District of Columbia	6	10	18
92	Wisconsin	7	11	16
90	Maine	8	12	19
89	Connecticut	9	13	22
87	Delaware	10	14	24
85	Iowa	11	15	28
85	Michigan	12	16	27
85	Maryland	12	17	29
84	Missouri	12	18	30
84	Oklahoma	13	19	30
84	Tennessee	13	20	30
84	Nevada	13	21	30
83	Louisiana	14	22	30
83	Hawaii	13	23	31
82	New York	17	24	32
81	Alaska	14	25	37
81	Ohio	17	26	33
81	Alabama	16	27	35
80	South Dakota	15	28	39
79	Idaho	19	29	37
79	Montana	19	30	38
79	New Hampshire	18	31	39
78	Nebraska	22	32	38
77	Virginia	24	33	41
76	Colorado	25	34	42
76	Minnesota	25	35	43
74	Arizona	29	36	43
74	Utah	29	37	44
74	North Carolina	30	38	43
73	Indiana	32	39	44
73	Florida	32	40	43
72	New Jersey	32	41	45
72	Georgia	34	42	46
70	Kansas	36	43	48
69	South Carolina	38	44	47
69	Texas	40	45	47
66	California	44	46	49
66	North Dakota	42	47	50
65	Kentucky	43	48	50
62	Arkansas	46	49	50
62	Mississippi	46	50	50
49	Wyoming	51	51	51

Table B.4a. How did your State compare with other States in 2020? (New Mexico to Maryland)

	NM	RI	OR	IL	PA	MA	VT	WA	WV	DC	WI	ME	CT	DE	IA	MI	MD
NM		-	-	-	-	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
OR	-	-		-	-	H	H	H	H	H	H	H	H	H	H	H	H
IL	-	-	-		-	-	H	H	H	H	H	H	H	H	H	H	H
PA	-	-	-	-		-	H	H	H	H	H	H	H	H	H	H	H
MA	L	L	L	-	-		-	-	-	H	H	H	H	H	H	H	H
VT	L	L	L	L	L	-		-	-	-	-	H	H	H	H	H	H
WA	L	L	L	L	L	-	-		-	-	-	-	-	H	H	H	H
WV	L	L	L	L	L	-	-	-		-	-	-	-	H	H	H	H
DC	L	L	L	L	L	L	-	-	-		-	-	-	-	-	H	H
WI	L	L	L	L	L	L	-	-	-	-		-	-	-	H	H	H
ME	L	L	L	L	L	L	L	-	-	-	-		-	-	-	-	-
CT	L	L	L	L	L	L	L	-	-	-	-	-		-	-	-	-
DE	L	L	L	L	L	L	L	L	L	-	-	-	-		-	-	-
IA	L	L	L	L	L	L	L	L	L	-	L	-	-	-		-	-
MI	L	L	L	L	L	L	L	L	L	L	L	-	-	-	-		-
MD	L	L	L	L	L	L	L	L	L	L	L	-	-	-	-	-	
MO	L	L	L	L	L	L	L	L	L	L	L	-	-	-	-	-	-
OK	L	L	L	L	L	L	L	L	L	L	L	-	-	-	-	-	-
TN	L	L	L	L	L	L	L	L	L	L	L	-	-	-	-	-	-
NV	L	L	L	L	L	L	L	L	L	L	L	L	-	-	-	-	-
LA	L	L	L	L	L	L	L	L	L	L	L	L	-	-	-	-	-
HI	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	-	-	-
AK	L	L	L	L	L	L	L	L	L	L	L	L	-	-	-	-	-
OH	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	-	-	-
SD	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	-
MT	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	-
NE	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
CO	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
MN	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
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
NC	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
FL	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
NJ	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
GA	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
SC	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
TX	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
CA	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
ND	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
KY	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
AR	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
WY	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 2020? (Missouri to Colorado)

	MO	OK	TN	NV	LA	HI	NY	AK	OH	AL	SD	ID	MT	NH	NE	VA	CO
NM	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
OR	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H
IL	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H
PA	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H
MA	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H
VT	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H
WA	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H
WV	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
WI	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
CT	-	-	-	-	-	-	H	-	H	H	H	H	H	H	H	H	H
DE	-	-	-	-	-	-	H	-	H	H	-	H	H	H	H	H	H
IA	-	-	-	-	-	-	-	-	-	-	-	H	H	-	H	H	H
MI	-	-	-	-	-	-	-	-	-	-	-	H	-	H	H	H	H
MD	-	-	-	-	-	-	-	-	-	-	-	-	-	-	H	H	H
MO		-	-	-	-	-	-	-	-	-	-	-	-	-	H	H	H
OK	-		-	-	-	-	-	-	-	-	-	-	-	-	H	H	H
TN	-	-		-	-	-	-	-	-	-	-	-	-	-	-	H	H
NV	-	-	-		-	-	-	-	-	-	-	-	-	-	-	H	H
LA	-	-	-	-		-	-	-	-	-	-	-	-	-	-	H	H
HI	-	-	-	-	-		-	-	-	-	-	-	-	-	-	H	H
NY	-	-	-	-	-	-		-	-	-	-	-	-	-	-	-	H
AK	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	-
OH	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-
AL	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-
SD	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-
ID	-	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-
MT	-	-	-	-	-	-	-	-	-	-	-	-		-	-	-	-
NH	-	-	-	-	-	-	-	-	-	-	-	-	-		-	-	-
NE	L	L	-	-	-	-	-	-	-	-	-	-	-	-		-	-
VA	L	L	L	L	L	L	-	-	-	-	-	-	-	-	-		-
CO	L	L	L	L	L	L	L	-	-	-	-	-	-	-	-	-	
MN	L	L	L	L	L	L	L	-	L	-	-	-	-	-	-	-	-
AZ	L	L	L	L	L	L	L	L	L	L	-	-	-	-	-	-	-
UT	L	L	L	L	L	L	L	L	L	L	-	-	-	-	-	-	-
NC	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	-	-	-
FL	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	-	-
GA	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
SC	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
TX	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
CA	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
ND	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
KY	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
AR	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
WY	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 2020? (Minnesota to Wyoming)

	MN	AZ	UT	NC	IN	FL	NJ	GA	KS	SC	TX	CA	ND	KY	AR	MS	WY
NM	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
OR	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H
IL	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H
PA	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H
MA	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H
VT	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H
WA	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H
WV	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
WI	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
CT	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
IA	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
MD	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
OK	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H
TN	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H
NV	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
HI	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
AK	-	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
AL	-	H	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	H	H
ID	-	-	-	-	H	H	H	H	H	H	H	H	H	H	H	H	H
MT	-	-	-	-	H	H	H	H	H	H	H	H	H	H	H	H	H
NH	-	-	-	-	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
VA	-	-	-	-	-	-	-	-	H	H	H	H	H	H	H	H	H
CO	-	-	-	-	-	-	-	-	H	H	H	H	H	H	H	H	H
MN		-	-	-	-	-	-	-	-	H	H	H	H	H	H	H	H
AZ	-		-	-	-	-	-	-	-	H	H	H	H	H	H	H	H
UT	-	-		-	-	-	-	-	-	-	H	H	H	H	H	H	H
NC	-	-	-		-	-	-	-	-	H	H	H	H	H	H	H	H
IN	-	-	-	-		-	-	-	-	-	H	H	H	H	H	H	H
FL	-	-	-	-	-		-	-	-	-	H	H	H	H	H	H	H
NJ	-	-	-	-	-	-		-	-	-	-	H	H	H	H	H	H
GA	-	-	-	-	-	-	-		-	-	-	H	H	H	H	H	H
KS	-	-	-	-	-	-	-	-		-	-	-	-	-	H	H	H
SC	L	L	-	L	-	-	-	-	-		-	-	-	-	H	H	H
TX	L	L	L	L	L	L	-	-	-	-		-	-	-	H	H	H
CA	L	L	L	L	L	L	L	L	-	-	-		-	-	-	H	H
ND	L	L	L	L	L	L	L	L	-	-	-	-		-	-	-	H
KY	L	L	L	L	L	L	L	L	-	-	-	-	-		-	-	H
AR	L	L	L	L	L	L	L	L	L	L	L	-	-	-		-	H
MS	L	L	L	L	L	L	L	L	L	L	L	L	-	-	-		H
WY	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	

Note: An “H” 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 2020 participation rates		
Above 87 percent (top quarter)	**Between 74 and 87 percent**	**Below 74 percent (bottom quarter)**
Connecticut	Alabama	Arkansas
District of Columbia	Alaska	California
Illinois	Arizona	Florida
Maine	Colorado	Georgia
Massachusetts	Delaware	Indiana
New Mexico	Hawaii	Kansas
Oregon	Idaho	Kentucky
Pennsylvania	Iowa	Mississippi
Rhode Island	Louisiana	New Jersey
Vermont	Maryland	North Dakota
Washington	Michigan	South Carolina
West Virginia	Minnesota	Texas
Wisconsin	Missouri	Wyoming
	Montana	
	Nebraska	
	Nevada	
	New Hampshire	
	New York	
	North Carolina	
	Ohio	
	Oklahoma	
	South Dakota	
	Tennessee	
	Utah	
	Virginia	

Table B.6. Supporting detail for Cunnyngham (2023)

Description	States		
In 23 States and the District of Columbia, the participation rate was statistically significantly higher than the national rate.	Connecticut	Massachusetts	Pennsylvania
	Delaware	Michigan	Rhode Island
	Hawaii	Missouri	Tennessee
	Illinois	Nevada	Vermont
	Iowa	New Mexico	Washington
	Louisiana	New York	West Virginia
	Maine	Oklahoma	Wisconsin
	Maryland	Oregon	
In 15 States, the participation rate was significantly lower than the national rate.	Arizona	Indiana	North Carolina
	Arkansas	Kansas	North Dakota
	California	Kentucky	South Carolina
	Florida	Mississippi	Texas
	Georgia	New Jersey	Wyoming

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