Empirical Bayes Shrinkage Estimates of State Supplemental Nutrition Assistance Program Participation Rates in 2009-2011 for All Eligible People and the Working Poor

March 2014

Karen Cunnyngham
Amang Sukasih
Laura Castner

MATHEMATICA
Policy Research

Contract Number:
AG-3198-K-13-0006

Mathematica Reference Number:
40202.700

Submitted to:
U.S. Department of Agriculture
Food and Nutrition Service
3101 Park Center Drive
Room 1014
Alexandria, VA 22302
Project Officer: Jenny Genser
Task Leader: Jenny Genser

Submitted by:
Mathematica Policy Research
1100 1st Street, NE
12th Floor
Washington, DC 20002-4221
Telephone: (202) 484-9220
Facsimile: (202) 863-1763
Project Director: Karen Cunnyngham

Empirical Bayes Shrinkage Estimates of State Supplemental Nutrition Assistance Program Participation Rates in 2009-2011 for All Eligible People and the Working Poor

March 2014

Karen Cunnyngham
Amang Sukasih
Laura Castner

MATHEMATICA
Policy Research

CONTENTS

TABLES

FIGURES

EXECUTIVE SUMMARY

The Supplemental Nutrition Assistance Program (SNAP) is a central component of American policy to alleviate hunger and poverty. The program's main purpose is "to permit low-income households to obtain a more nutritious diet . . . by increasing their purchasing power" (Food and Nutrition Act of 2008). SNAP is the largest of the domestic food and nutrition assistance programs administered by the U.S. Department of Agriculture's Food and Nutrition Service. During fiscal year 2013, the program served 47.6 million people in an average month at a total annual cost of over $76 billion in benefits.

This report presents estimates that, for each state, measure the need for SNAP and the program's effectiveness in each of the three fiscal years from 2009 to 2011. The estimated numbers of people eligible for SNAP measure the need for the program. The estimated SNAP participation rates measure, state by state, the program's performance in reaching its target population. In addition to the participation rates that pertain to all eligible people, we derived estimates of participation rates for the "working poor," that is, people who were eligible for SNAP and lived in households in which someone earned income from a job.

The estimates for all eligible people and for the working poor were derived jointly using empirical Bayes shrinkage estimation methods and data from the Current Population Survey, the American Community Survey, and administrative records. The shrinkage estimator that was used averaged sample estimates of participation rates in each state with predictions from a regression model. The predictions were based on observed indicators of socioeconomic conditions in the states, such as the percentage of the total state population receiving SNAP benefits. The shrinkage estimates derived are substantially more precise than direct sample estimates from the Current Population Survey or the Survey of Income and Program Participation, the best sources of current data on household incomes used to model program eligibility. Shrinkage estimators improve precision by "borrowing strength," that is, by using data for multiple years from all the states to derive each state's estimates for a given year and by using data from multiple sources, including sample surveys and administrative data. This report describes our shrinkage estimator in detail.

I. INTRODUCTION

This report presents estimates of the Supplemental Nutrition Assistance Program (SNAP) participation rate and the number of people eligible for SNAP in each state for the fiscal years 2009 to 2011.[1] It also presents estimates of the participation rates for the working poor and the numbers of eligible working poor, where we define as "working poor" any person who was eligible for SNAP and lived in a household in which a member earned income from a job or self-employment. These estimates were derived using "shrinkage" estimation methods. This introductory chapter overviews the advantages and some previous applications of shrinkage estimation. Chapter II describes how we derived shrinkage estimates, and Chapter III presents our state estimates for all eligible people and for the working poor. Technical details and additional information about our estimation methods are provided in Appendix A.

The principal challenge in deriving state estimates like those presented in this report is that two leading national surveys collecting current income data for families and used for estimating program eligibility—the Current Population Survey (CPS) and the Survey of Income and Program Participation (SIPP)—have small samples for most states. Thus, "direct" estimates—estimates calculated based only on the state sample size for the state and time period in question—from these surveys are imprecise. For example, to calculate a direct estimate of Delaware's 2011 SNAP participation rate, we use just 2011 data on households in the CPS from Delaware. Because of the potential errors introduced by the CPS surveying only a small number of families in Delaware rather than all families in the state, we can be confident—by a commonly used standard—only that Delaware's SNAP participation rate in 2011 was between about 78 and 96 percent. This range is wide (but typical), reflecting our substantial uncertainty about what Delaware's participation rate actually was.

[1] The estimates presented here are also reported and compared with one another in Cunnyngham (2013).

To improve precision, statisticians have developed "indirect" estimators. These estimators "borrow strength" by using data from other 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.

A generally superior indirect estimator is the "shrinkage" estimator. A shrinkage estimator averages estimates obtained from different methods. For example, Fay and Herriott (1979) developed a shrinkage estimator that combined direct sample and regression estimates of per capita income for small places (population less than 1,000). Their estimates were used to allocate funds under the General Revenue Sharing Program. In another application of shrinkage methods, shrinkage estimates of poor school-aged children by state and county were used in allocating Title I compensatory education funds for disadvantaged youth (National Research Council 2000).

Shrinkage estimators have also been used to develop state estimates of income-eligible infants and children for allocating funds under the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) (Schirm 2000). To borrow strength across both space (states) and time, the current WIC eligibles estimator uses several years of CPS data and combines direct sample estimates with predictions from a regression model. The predictions of WIC eligibles are based on, for example, state poverty rates according to tax return data and state single mother rates—the percentage of households headed by a female with related children and no husband present—according to American Community Survey (ACS) three-year estimates. States with similar economic and demographic characteristics, as reflected in these poverty rate and household composition statistics, are observed (and predicted) to have similar proportions of infants and children eligible for WIC.

In these and other applications of shrinkage estimation, the gain in precision from borrowing strength via a shrinkage estimator can be substantial. For example, the confidence intervals for the

shrinkage estimates of WIC eligibles in 1992 were, on average, 61 percent narrower than the corresponding confidence intervals for the direct estimates (Schirm 1995). To obtain that same gain in precision with a direct estimator would require—according to rough calculations—more than a six-fold increase in sample size. Therefore, we use an indirect estimator and borrow strength to derive state estimates of SNAP participation rates and counts of all eligible people and the eligible working poor (while recognizing that the gain in precision might not be the same as for the 1992 WIC estimates).

The shrinkage estimator we used to derive estimates of state SNAP participation rates first used data for all the states, all three years, and both groups (all eligible people and the working poor) to estimate a regression model and formulate a prediction for each state. In formulating regression predictions, the estimator borrowed strength by using data from outside the main sample survey (the CPS), specifically, data from administrative records systems, the ACS, and government population estimates. The shrinkage estimator next optimally averaged the direct sample and regression estimates for each state to obtain shrinkage estimates. This contrasts with the direct estimator that ignores systematic patterns across states, using, for example, only Delaware's data to derive an estimate for Delaware, even though conditions may be similar in Pennsylvania or Maryland.

U.S. Census Bureau Data

The **Current Population Survey (CPS)** is conducted monthly by the U.S. Census Bureau 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 (ASEC) Supplement includes additional data on work experience, income, and noncash benefits, and has a sample size of close to 100,000 households.

The **American Community Survey (ACS)** is conducted monthly by the U.S. Census Bureau 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 three million households annually.

Population Estimates are published each year by the U.S. Census Bureau's Population Division. The estimates are developed using decennial census population estimates and 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.

In all, our estimator used three years of CPS data, ACS data, SNAP and National School Lunch Program (NSLP) administrative data, population estimates, and tax return data for all states to obtain estimates for each state in each year (2009 to 2011) for all eligible people and for the working poor.

The shrinkage estimates derived for any one application are not guaranteed to be more accurate than estimates obtained using some other method. They have good statistical properties in general, however, and we have found for our specific application that as in previous applications, shrinkage estimation can greatly improve precision. Additional support for shrinkage estimators is provided by the findings from simulation studies. For example, in a comprehensive evaluation of the relative accuracy of alternative estimators of state poverty rates, Schirm (1994) found that shrinkage estimates are substantially more accurate than direct estimates or indirect estimates obtained from other methods that have been widely used.

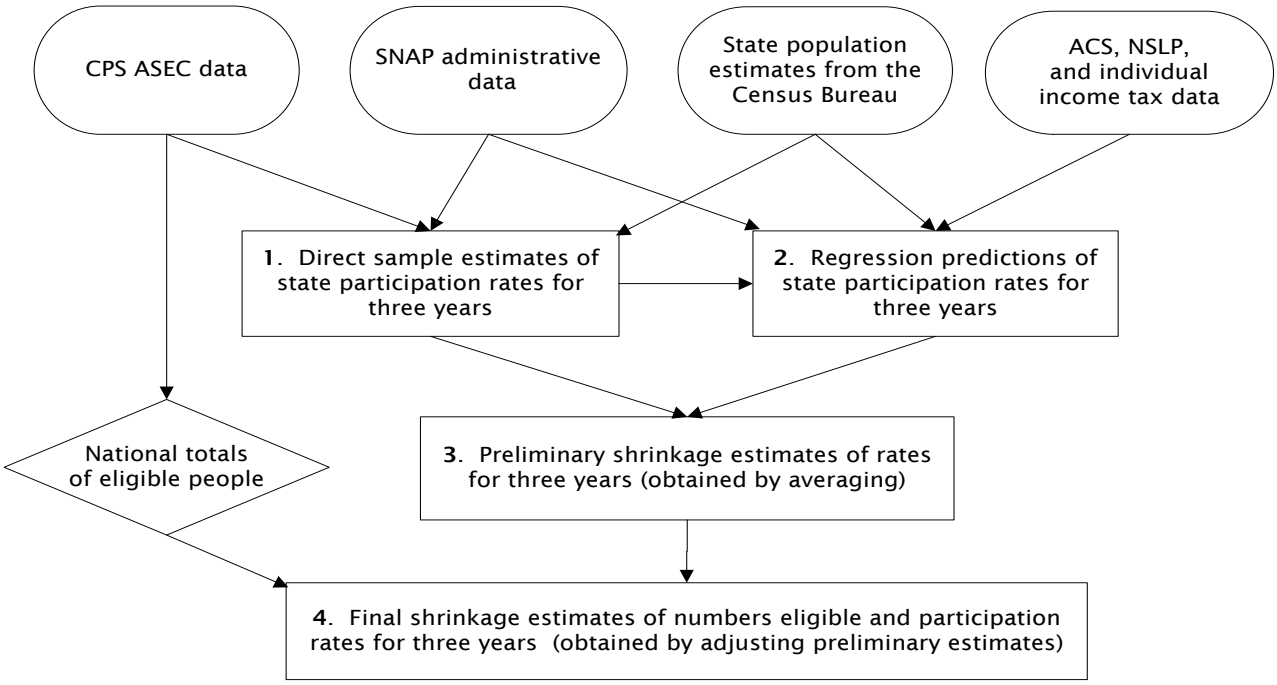
II. A STEP-BY-STEP GUIDE TO DERIVING STATE ESTIMATES

This chapter describes our procedure for estimating state SNAP participation rates for all eligible people and the working poor and the numbers of people eligible for SNAP benefits for 2009 to 2011. This procedure, summarized by the flow chart in Figure II.1, has the following four steps:

1. From CPS Annual Social and Economic Supplement (ASEC) data and SNAP administrative data, derive direct sample estimates of state SNAP participation rates for each of the three years.
2. Using a regression model, predict state SNAP participation rates based on administrative and ACS data.
3. Using "shrinkage" methods, average the direct sample estimates and regression predictions to obtain preliminary shrinkage estimates of state SNAP participation rates.
4. Adjust the preliminary shrinkage estimates to obtain final shrinkage estimates of state SNAP participation rates.

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

Figure II.1. The Estimation Procedure



A. From CPS ASEC Data and SNAP Administrative Data, Derive Direct Sample Estimates of State SNAP Participation Rates for Each of the Three Years 2009 to 2011

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 administrative data to estimate numbers of participants in an average month in the fiscal year and we used CPS ASEC data to estimate numbers of eligibles in an average month. Because the ASEC collects family income data for the prior calendar year, we obtained estimates of eligibles in fiscal year 2011 (October 2010 through September 2011), for example, from the 2011 and 2012 CPS ASEC. To derive a participation rate for the working poor, we divided the number of working poor participants by the number of working poor people who were eligible.

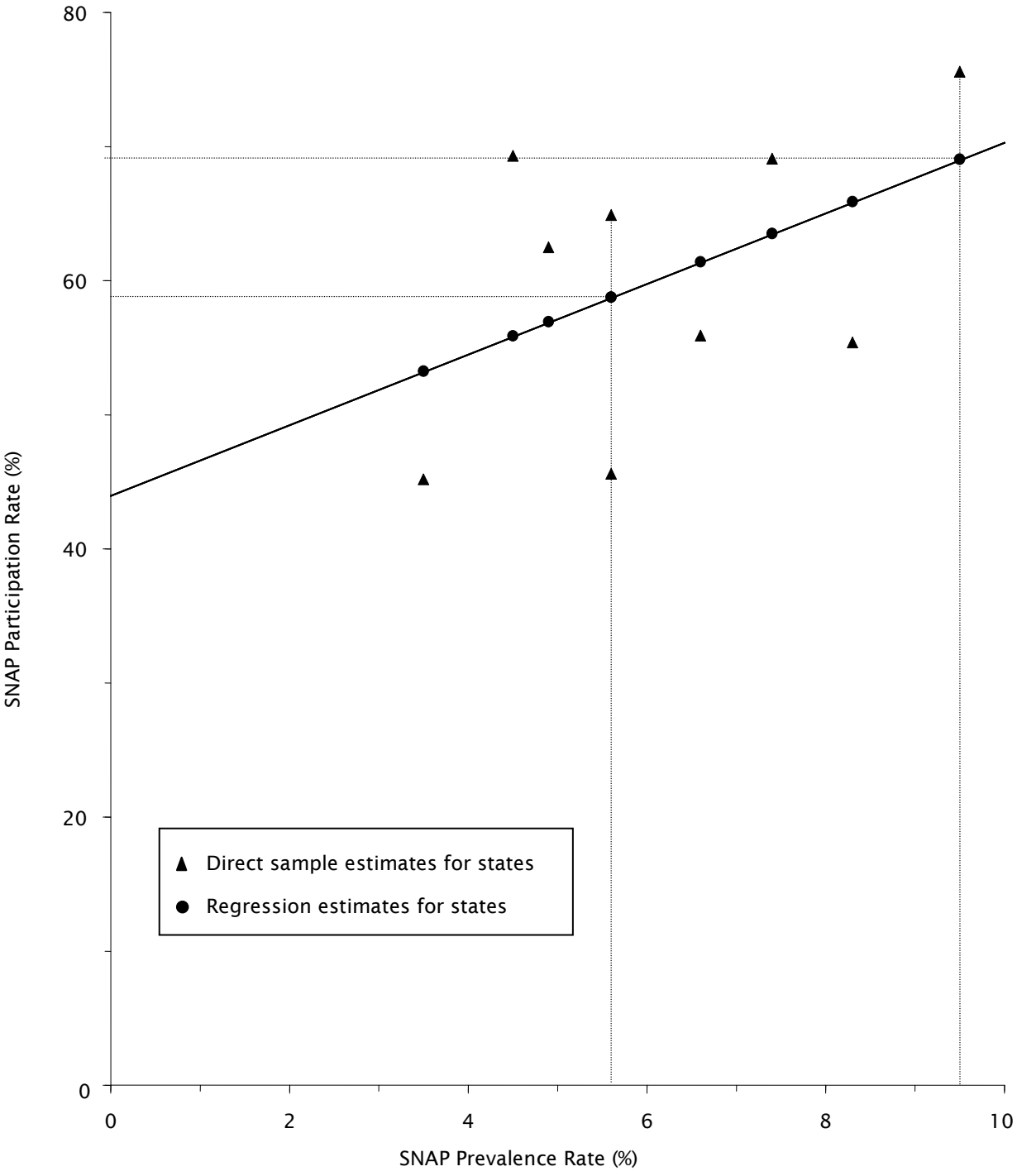
As noted in Chapter I, direct sample estimates of participation rates are relatively imprecise, especially when sample sizes are small. The standard errors for the estimates, reported in Appendix A along with the estimated rates, tend to be large, so our uncertainty about states' true rates is great. For example, according to commonly used statistical standards, we can be confident only that Delaware's participation rate for all eligible people in 2011 was between 78 percent and 96 percent. This range is so wide and our uncertainty so great because the CPS ASEC sample for Delaware is small. This lack of data, that is, the small number of sample observations that pertain directly to the target geographic area and time period— Delaware and 2011 in our example—is the fundamental problem of "small area estimation."

B. Using a Regression Model, Predict State SNAP Participation Rates Based on Administrative and ACS Data

Regression estimates are predictions based either on nonsample or on highly precise sample data, such as the ACS and administrative records data. The latter include records from government tax and transfer programs.

Figure II.2 illustrates how the regression estimator works. The simple example in the figure has only nine states and data for just one year on one predictor—the SNAP "prevalence" rate—that will be used to predict each state's SNAP participation rate for eligible people. The SNAP prevalence rate is measured by the percentage of all people (eligible and ineligible combined) who received

Figure II.2. An Illustrative Regression Estimator



SNAP benefits, in contrast to the SNAP participation rate, which is measured by the percentage of eligible people who received SNAP benefits. The triangles in the figure correspond to direct sample estimates; a triangle shows the prevalence rate in a state (read off the horizontal axis) and the sample estimate of the participation rate in that state (read off the vertical axis). Not surprisingly, the graph suggests that prevalence and participation rates are systematically associated. States with higher percentages of all people participating in the program tend to have higher percentages of eligible people participating, although the relationship is far from perfect. To measure this relationship between prevalence and participation rates and derive predictions, we can use a technique called "least squares regression" to draw a line through the triangles (that is, we "regress" the sample estimates on the predictor). Regression estimates of participation rates are points on that line, the circles in Figure II.2. 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 off the vertical axis. For example, the regression estimator predicts a participation rate of just under 60 percent for both states with prevalence rates of about 5.5 percent. In contrast, for the state with about 9.5 percent of people receiving SNAP benefits, the predicted participation rate is nearly 70 percent.

To derive the regression estimates for 2009 to 2011 and for all eligible people and the working poor, we included all of the states, not just nine as in our illustrative example, and we used seven predictors, not just one. Adding six predictors improves our predictions. The seven predictors used for the estimates in this report measure:

- the percentage of the population correctly receiving SNAP benefits under regular program rules
- the percentage of children age 5 to 17 approved to receive free lunches under the National School Lunch Program
- the median adjusted gross income according to individual income tax data
- the median family income according to ACS one-year estimates

- the percentage of individuals age 25 and over who have completed a bachelor's degree according to ACS one-year estimates
- the percentage of children under age 18 with household income under 50 percent of the federal poverty level according to ACS one-year estimates
- the percentage of households with a female householder, no husband present, and related children under age 18 according to ACS one-year estimates

These seven predictors were selected as the best from a longer list described in Appendix A, which provides complete definitions and sources for the predictors. Appendix A also 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 sample estimates, reflecting substantial gains in precision from regression for the states with the most error-prone direct sample estimates.

Comparing how the direct sample and regression estimators use data reveals how the regression estimator "borrows strength" to improve precision. When we derived direct sample estimates in Step 1, we used only one year's CPS ASEC sample data from Delaware to estimate Delaware's participation rate in that year, even though Delaware, like nearly all states, has a small CPS ASEC sample. Deriving regression estimates in this step, we estimated a regression line from sample, administrative, and ACS data for multiple years and all the states and used the estimated line (with administrative and ACS data for Delaware) to predict Delaware's participation rate in a given year. In other words, the regression estimator not only uses the sample estimates from every state for multiple years to develop a regression estimate for a single state in a single year but also incorporates data from outside the sample, namely, data in administrative records systems and the ACS. To improve precision even further, the estimator borrows strength across groups—all eligible people and the working poor—by deriving estimates for the groups jointly.

The regression estimator can improve precision by using more data. It uses that additional data to identify states with direct sample estimates that seem too high or too low because of sampling error, that is, error from drawing a sample—a subset of the population—that has a higher or lower

participation rate than the entire state population has. For example, suppose a state has a low SNAP prevalence rate and values for other predictors that are consistent with a low SNAP participation rate. Then, our regression estimator would predict a low participation rate for that state, implying that a direct sample estimate showing a high rate is too high. The regression estimate will be lower than the direct sample estimate for such a state. On the other hand, if the sample data for a state show a much 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 sample estimate.

C. Using "Shrinkage" Methods, Average the Direct Sample Estimates and Regression Predictions to Obtain Preliminary Shrinkage Estimates of State SNAP Participation Rates

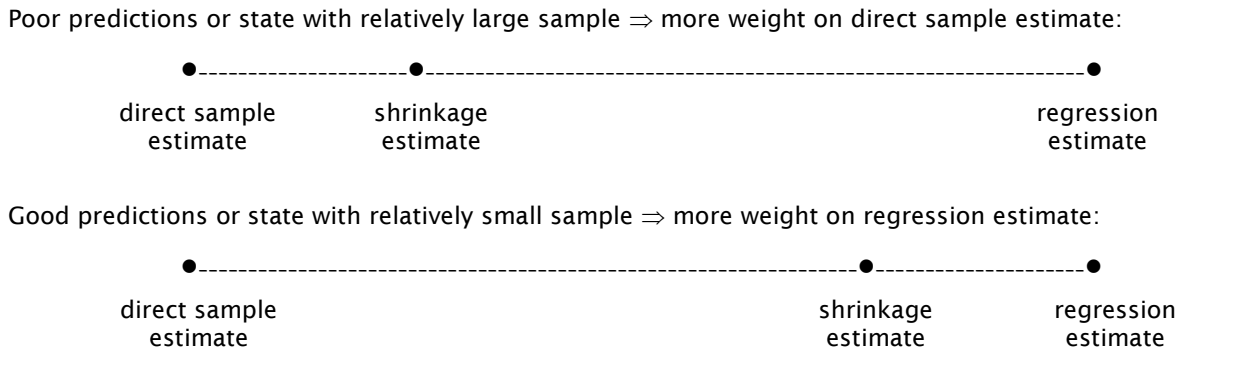
As noted before, the limitation of the direct sample estimator is imprecision when sample size is inadequate. The direct sample estimator uses relatively little information. It uses only the typically small number of sample observations for one state and one year to obtain an estimate for that state and year. It does not use sample data for other states or other years or data from other sources, such as administrative records or the ACS.

The limitation of the regression estimator is called "bias." Some states really have higher or lower participation rates than we expect (and predict with the regression estimator) based on the SNAP prevalence rate and other predictors used. Such errors in regression estimates reflect bias. Although the regression estimator borrows strength, using data from all the states and multiple years as well as administrative and ACS data, it makes no further use of the sample data after estimating the regression line. It treats the entire difference between the sample and regression estimates as sampling error, that is, error in the direct sample estimate. No allowance is made for prediction error, that is, error in the regression estimate. Although not all, if any, true state participation rates lie on the regression line, the assumption underlying the regression estimator is that they do.

Using all of the information at hand, the shrinkage estimator addresses the limitations of the direct sample and regression estimators by combining the two estimates, striking a compromise. As

illustrated in Figure II.3, the shrinkage estimator takes a weighted average of the direct sample and regression estimates, weighting them according to their relative accuracy. We calculated weights using the empirical Bayes methods described in Appendix A. When the direct sample estimate is more precise than the regression estimate, the estimator gives more weight to the direct sample estimate. On the other hand, when the regression estimate is more precise then the direct sample estimate, the estimator gives more weight to the regression estimate. The larger samples drawn in large states support more precise direct sample estimates, so shrinkage estimates tend to be closer to the direct sample 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 and farther from the direct sample estimate when the regression line fits well than when the line fits poorly. Striking a compromise between the direct sample and regression estimators, the shrinkage estimator strikes a compromise between imprecision and bias. The direct sample 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 tradeoff between imprecision and bias.

Figure II.3. Shrinkage Estimation



In the next step of our estimation procedure, we make some fairly small adjustments to the shrinkage estimates that we derive in this step. Thus, we call the estimates from this step "preliminary" and the estimates from the next step "final."

D. Adjust the Preliminary Shrinkage Estimates to Obtain Final Shrinkage Estimates of State SNAP Participation Rates

We adjusted the preliminary shrinkage estimates of participation rates in two ways. First, we adjusted the rates so that the eligibles counts implied by the rates sum to the national eligibles count estimated directly from the CPS ASEC. Second, we adjusted the rates so that no state's estimated rate was greater than 100 percent. These adjustments were carried out separately for each year and for the two groups of eligible people (all eligible people and the working poor). The following description of the adjustments will focus on the 2011 estimates for all eligible people. In Appendix A, we describe the results of the adjustments for other years and for the working poor and discuss our adjustment method in more detail.

To implement the first adjustment, we calculated preliminary estimates of eligibles counts from the preliminary estimates of participation rates derived in Step 3 and the administrative estimates of the numbers of SNAP participants obtained in Step 1. The state eligibles counts summed to 53,024,391 for 2011, while the national total for 2011 estimated directly from the CPS ASEC was 51,872,780. To obtain estimated eligibles counts for states that sum (aside from rounding error) to the direct estimate of the national total, we multiplied each of the state preliminary eligibles counts by 51,872,780 ÷ 53,024,391 (≈0.9783). Such benchmarking of estimates for smaller areas to a relatively precise estimated total for a larger area is common practice.

After carrying out this first adjustment, three states, Maine, Oregon, and Washington, had fewer estimated eligibles than participants in 2011, implying participation rates over 100 percent. To cap participation rates at 100 percent, we performed a second adjustment. Specifically, we increased the number of eligibles in Maine, Oregon, and Washington so that the number of eligibles in those

states equaled the number of participants. We reduced the number of eligibles in the other 47 states and the District of Columbia by an equivalent number and in proportion to their numbers of eligibles. This adjustment, which moved small numbers of eligibles among states, did not change the national total. Moreover, except for Maine, Oregon, and Washington, the states with participation rates initially over 100 percent, this adjustment did not change any state's participation rate by more than one-fifth of a percentage point. The rounded participation rates for some states did increase by one percentage point, however.

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

III. STATE ESTIMATES OF SUPPLEMENTAL NUTRITION ASSISTANCE PROGRAM PARTICIPATION RATES AND NUMBER OF ELIGIBLE PEOPLE FOR 2009 TO 2011 FOR ALL ELIGIBLE PEOPLE AND THE WORKING POOR

Tables III.1 and III.2 present our final shrinkage estimates of SNAP participation rates and the number of people eligible, respectively, in each state for 2009 to 2011 for all eligible people and for the working poor. These shrinkage estimates are relatively precise; they have much smaller standard errors and narrower confidence intervals than the CPS ASEC direct sample estimates. Tables III.3 to III.8 display approximate 90-percent confidence intervals showing the uncertainty remaining after using shrinkage estimation to derive the estimates in Tables III.1 and III.2. One interpretation of a 90-percent confidence interval is that there is a 90-percent chance that the true value—that is, the true participation rate or the true number of eligible people—falls within the estimated bounds. For example, while our best estimate is that Delaware's participation rate for all eligible people was 85 percent in 2011 (see Table III.1), the true rate may have been higher or lower. However, according to Table III.5, the chances are 90 in 100 that the true rate was between 80 and 90 percent, an interval that is 59 percent as wide as the interval (78 and 96 percent, as cited in Chapter I) around the direct sample estimate. A narrower interval means that we are less uncertain about the true value. According to our calculations, a shrinkage confidence interval for a participation rate is, on average, only about 58 percent as wide as the corresponding direct sample confidence interval. Thus, shrinkage substantially improves precision and reduces our uncertainty.

Despite the impressive gains in precision, however, substantial uncertainty about the true participation rates for some states remains even after the application of shrinkage methods. Nevertheless, as discussed in Cunnyngham (2014), the shrinkage estimates are sufficiently precise to show, for example, whether a state's SNAP participation rate was probably near the top, near the bottom, or in the middle of the distribution of rates in a given year. That is enough information for many important purposes, such as guiding an initiative to improve program performance.

Final shrinkage estimates for 2009 and 2010 presented in this report differ slightly from the estimates presented in Cunnyngham (2012) and Cunnyngham et al. (2013). There are several causes for the differences—two related to methodological updates and others related to the annual data update.

- **We refined the methodology used to estimate numbers of eligibles.** The changes, described in Eslami and Cunnyngham (2014), include improved unit formation methodologies, an updated Temporary Assistance to Needy Families (TANF) simulation, and a revised net income imputation.
- **We further improved the consistency between estimates of participants and eligible individuals.** Specifically, we updated the equation used to predict asset ineligibility among income-eligible SNAP participants.
- **The shrinkage estimates use 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 2009 and 2010 presented in this report are based on 2009 to 2011 data while the corresponding estimates published in Cunnyngham et al. (2013) are based on 2008 to 2010 data.
- **The shrinkage estimates incorporate a regression model that is updated each year.** Each year we choose a regression model that best predicts participation rates for all three years and both groups (all eligibles and eligible working poor.) While we place a premium on maintaining consistency in regression predictors from year to year, the methodological changes and differences between 2008 data (used in the previous estimates) and 2011 data (used in the current estimates) resulted in the use of a different regression model. Different regression models lead to slight differences in predicted participation rates, which in turn lead to slight differences in estimated participation rates. In addition, the regression model selected for the current estimates included one-year ACS estimates while the regression model used for prior estimates included three-year ACS estimates.

Table III.1. Final Shrinkage Estimates of SNAP Participation Rates

	Final Shrinkage Estimates of SNAP Participation Rates (Percent)					
	All Eligible People			Working Poor		
	2009	2010	2011	2009	2010	2011
Alabama	71	76	85	63	69	76
Alaska	60	68	68	55	61	60
Arizona	65	77	79	57	70	71
Arkansas	65	71	74	65	72	74
California	48	52	57	32	40	44
Colorado	54	66	66	38	57	54
Connecticut	70	77	85	51	60	66
Delaware	70	74	85	58	62	69
District of Columbia	81	87	99	34	39	46
Florida	63	76	82	48	63	66
Georgia	65	75	83	57	68	74
Hawaii	59	64	61	47	49	44
Idaho	62	78	85	59	76	80
Illinois	73	79	84	55	62	66
Indiana	65	72	71	65	72	70
Iowa	77	84	87	70	78	81
Kansas	56	66	69	45	60	63
Kentucky	83	88	90	65	70	69
Louisiana	72	71	77	69	67	72
Maine	99	100	100	91	94	100
Maryland	66	69	81	52	54	64
Massachusetts	77	83	88	55	63	66
Michigan	81	94	99	78	88	91
Minnesota	61	71	77	48	61	67
Mississippi	66	70	79	64	66	74
Missouri	80	89	91	66	76	79
Montana	57	73	75	52	71	73
Nebraska	65	71	69	56	64	61
Nevada	52	60	69	44	51	61
New Hampshire	68	80	78	56	69	65
New Jersey	54	61	67	42	51	57
New Mexico	70	77	86	65	74	80
New York	65	74	79	53	64	67
North Carolina	67	74	83	54	64	71
North Dakota	71	75	75	68	71	74
Ohio	72	80	85	63	71	74
Oklahoma	71	78	85	59	65	72
Oregon	97	100	100	82	90	93
Pennsylvania	73	81	84	69	77	80
Rhode Island	64	79	82	48	64	64
South Carolina	72	76	80	67	72	76
South Dakota	63	78	79	60	74	76
Tennessee	90	94	95	74	76	77
Texas	55	64	72	44	58	65
Utah	64	75	79	51	64	68
Vermont	84	92	97	67	77	79
Virginia	67	74	79	56	67	69
Washington	87	95	100	69	76	82
West Virginia	86	86	86	90	86	87
Wisconsin	71	83	89	68	79	84
Wyoming	57	62	57	55	60	57
United States	66	74	79	54	63	67

Table III.2. Final Shrinkage Estimates of Number of People Eligible for SNAP

	Final Shrinkage Estimates of Number of People Eligible for SNAP (Thousands)					
	All Eligible People			Working Poor		
	2009	2010	2011	2009	2010	2011
Alabama	944	1,013	982	422	445	387
Alaska	106	112	125	53	56	59
Arizona	1,117	1,140	1,142	518	507	583
Arkansas	619	635	644	261	259	271
California	5,465	5,921	6,129	3,172	3,272	3,171
Colorado	586	612	658	330	305	350
Connecticut	351	367	388	145	146	152
Delaware	117	134	137	58	63	66
District of Columbia	126	130	128	36	40	36
Florida	3,098	3,377	3,474	1,350	1,405	1,428
Georgia	1,918	2,025	2,029	948	923	1,010
Hawaii	192	214	232	103	114	138
Idaho	213	236	255	115	130	146
Illinois	1,926	1,998	2,001	888	952	980
Indiana	1,056	1,121	1,218	467	461	532
Iowa	374	399	392	207	216	208
Kansas	381	403	425	205	210	233
Kentucky	827	853	872	312	334	363
Louisiana	971	1,111	1,090	426	528	492
Maine	183	196	211	69	73	83
Maryland	613	709	698	285	312	287
Massachusetts	723	782	800	281	247	295
Michigan	1,577	1,633	1,719	651	674	841
Minnesota	534	572	587	269	289	278
Mississippi	755	808	750	321	346	318
Missouri	975	994	1,019	457	487	448
Montana	154	139	149	75	66	67
Nebraska	205	225	248	113	123	132
Nevada	357	397	420	161	174	191
New Hampshire	110	112	123	44	48	54
New Jersey	909	962	1,008	344	369	458
New Mexico	410	445	445	217	214	233
New York	3,255	3,414	3,422	1,453	1,428	1,395
North Carolina	1,676	1,772	1,645	836	812	693
North Dakota	65	68	68	32	37	33
Ohio	1,796	1,861	1,942	764	745	792
Oklahoma	644	713	692	333	326	359
Oregon	505	590	636	240	271	288
Pennsylvania	1,687	1,764	1,858	633	677	716
Rhode Island	153	157	171	60	62	75
South Carolina	904	1,003	1,006	347	428	426
South Dakota	115	119	125	59	60	64
Tennessee	1,169	1,286	1,289	553	581	557
Texas	4,958	5,080	4,965	2,783	2,733	2,753
Utah	282	325	353	169	188	210
Vermont	72	69	72	35	28	27
Virginia	942	1,019	1,072	461	473	509
Washington	760	862	887	331	401	394
West Virginia	342	370	374	116	136	137
Wisconsin	661	724	736	321	340	340
Wyoming	46	55	60	19	25	29
United States	47,922	51,025	51,873	22,851	23,542	24,085

Table III.3. Approximate 90-Percent Confidence Intervals for Final Shrinkage Estimates for 2009, All Eligible People

	Approximate 90-Percent Confidence Intervals for 2009, All Eligible People			
	Participation Rate (Percent)		Number of Eligible People (Thousands)	
	Lower Bound	Upper Bound	Lower Bound	Upper Bound
Alabama	66	75	888	999
Alaska	55	65	97	115
Arizona	61	69	1,045	1,189
Arkansas	60	69	577	661
California	46	50	5,254	5,676
Colorado	50	58	544	629
Connecticut	65	75	326	377
Delaware	65	74	109	124
District of Columbia	75	87	117	135
Florida	60	66	2,941	3,254
Georgia	61	69	1,802	2,034
Hawaii	54	64	176	207
Idaho	57	67	196	231
Illinois	70	76	1,839	2,014
Indiana	61	69	992	1,120
Iowa	72	82	349	398
Kansas	52	60	352	410
Kentucky	78	89	776	877
Louisiana	68	77	909	1,032
Maine	93	100	172	194
Maryland	62	70	573	654
Massachusetts	72	82	677	769
Michigan	77	85	1,496	1,658
Minnesota	57	65	496	572
Mississippi	62	70	711	799
Missouri	75	84	918	1,032
Montana	51	64	137	170
Nebraska	60	69	191	219
Nevada	48	56	328	385
New Hampshire	63	73	102	117
New Jersey	50	58	840	978
New Mexico	65	74	383	438
New York	62	68	3,113	3,397
North Carolina	64	71	1,587	1,765
North Dakota	66	77	60	70
Ohio	68	76	1,702	1,890
Oklahoma	67	76	603	685
Oregon	91	100	476	533
Pennsylvania	70	77	1,601	1,774
Rhode Island	60	67	144	162
South Carolina	68	75	856	952
South Dakota	58	68	106	125
Tennessee	85	95	1,100	1,238
Texas	52	57	4,719	5,197
Utah	59	68	262	302
Vermont	78	89	67	77
Virginia	62	71	877	1,006
Washington	82	92	716	804
West Virginia	80	92	318	367
Wisconsin	67	75	621	700
Wyoming	52	61	42	49
United States	65	67	47,263	48,580

Table III.4. Approximate 90-Percent Confidence Intervals for Final Shrinkage Estimates for 2010, All Eligible People

	Approximate 90-Percent Confidence Intervals for 2010, All Eligible People			
	Participation Rate (Percent)		Number of Eligible People (Thousands)	
	Lower Bound	Upper Bound	Lower Bound	Upper Bound
Alabama	72	81	955	1,070
Alaska	63	73	103	121
Arizona	73	82	1,076	1,204
Arkansas	67	75	597	674
California	50	54	5,697	6,144
Colorado	61	70	570	653
Connecticut	72	83	343	392
Delaware	69	78	125	142
District of Columbia	81	93	121	139
Florida	72	79	3,229	3,526
Georgia	71	79	1,923	2,128
Hawaii	59	69	196	231
Idaho	73	83	221	251
Illinois	76	83	1,911	2,085
Indiana	68	76	1,058	1,184
Iowa	79	89	375	423
Kansas	61	70	377	430
Kentucky	83	93	802	904
Louisiana	67	75	1,050	1,173
Maine	94	100	185	207
Maryland	65	73	664	755
Massachusetts	78	88	734	829
Michigan	89	98	1,556	1,709
Minnesota	66	75	538	607
Mississippi	66	74	760	855
Missouri	84	94	941	1,048
Montana	68	79	129	150
Nebraska	67	75	211	239
Nevada	56	64	370	423
New Hampshire	75	85	105	119
New Jersey	57	65	896	1,028
New Mexico	72	81	418	471
New York	70	77	3,267	3,562
North Carolina	71	78	1,685	1,859
North Dakota	70	81	63	73
Ohio	76	84	1,764	1,959
Oklahoma	73	83	670	755
Oregon	95	100	562	618
Pennsylvania	77	84	1,686	1,842
Rhode Island	75	83	149	165
South Carolina	72	80	951	1,054
South Dakota	73	83	111	127
Tennessee	88	99	1,214	1,357
Texas	61	66	4,875	5,284
Utah	70	79	305	345
Vermont	87	98	65	73
Virginia	70	79	956	1,083
Washington	90	100	817	907
West Virginia	79	92	343	398
Wisconsin	79	88	685	763
Wyoming	57	67	50	59
United States	73	75	50,367	51,683

Table III.5. Approximate 90-Percent Confidence Intervals for Final Shrinkage Estimates for 2011, All Eligible People

	Approximate 90-Percent Confidence Intervals for 2011, All Eligible People			
	Participation Rate (Percent)		Number of Eligible People (Thousands)	
	Lower Bound	Upper Bound	Lower Bound	Upper Bound
Alabama	80	89	931	1,033
Alaska	63	74	115	136
Arizona	74	84	1,074	1,209
Arkansas	69	78	606	681
California	55	59	5,913	6,345
Colorado	61	70	613	703
Connecticut	79	90	363	412
Delaware	80	90	128	145
District of Columbia	92	100	118	138
Florida	79	86	3,323	3,626
Georgia	79	88	1,925	2,134
Hawaii	55	66	212	253
Idaho	80	90	240	271
Illinois	80	87	1,919	2,083
Indiana	67	75	1,143	1,294
Iowa	81	92	368	416
Kansas	65	73	398	451
Kentucky	85	96	823	921
Louisiana	73	82	1,030	1,150
Maine	94	100	201	221
Maryland	76	86	658	739
Massachusetts	83	93	755	846
Michigan	94	100	1,638	1,800
Minnesota	72	81	553	621
Mississippi	75	84	704	797
Missouri	86	96	960	1,077
Montana	69	80	138	160
Nebraska	64	74	231	266
Nevada	65	73	395	445
New Hampshire	73	83	115	131
New Jersey	63	72	947	1,070
New Mexico	81	90	420	470
New York	76	82	3,286	3,558
North Carolina	79	88	1,563	1,727
North Dakota	69	81	63	73
Ohio	81	89	1,846	2,039
Oklahoma	80	90	653	732
Oregon	94	100	606	666
Pennsylvania	81	88	1,774	1,941
Rhode Island	78	87	163	180
South Carolina	77	84	959	1,053
South Dakota	74	84	117	133
Tennessee	90	100	1,218	1,359
Texas	70	75	4,764	5,165
Utah	74	83	331	375
Vermont	91	100	67	76
Virginia	74	83	1,011	1,134
Washington	95	100	842	931
West Virginia	80	92	348	399
Wisconsin	85	94	697	775
Wyoming	52	62	55	65
United States	78	80	51,179	52,567

Table III.6. Approximate 90-Percent Confidence Intervals for Final Shrinkage Estimates for 2009, Working Poor

	Approximate 90-Percent Confidence Intervals for 2009, Working Poor			
	Participation Rate (Percent)		Number of Eligible People (Thousands)	
	Lower Bound	Upper Bound	Lower Bound	Upper Bound
Alabama	57	69	384	461
Alaska	47	63	46	61
Arizona	52	63	467	568
Arkansas	59	71	237	285
California	29	34	2,905	3,439
Colorado	34	42	294	366
Connecticut	44	57	126	164
Delaware	52	64	52	64
District of Columbia	26	42	28	44
Florida	43	52	1,222	1,479
Georgia	52	63	857	1,040
Hawaii	41	53	89	116
Idaho	53	64	104	126
Illinois	50	59	815	961
Indiana	59	70	427	506
Iowa	64	77	188	226
Kansas	41	50	185	226
Kentucky	58	71	280	343
Louisiana	62	75	386	466
Maine	83	99	63	76
Maryland	46	58	251	319
Massachusetts	49	61	248	314
Michigan	71	85	594	707
Minnesota	42	53	237	302
Mississippi	58	70	291	352
Missouri	60	72	416	498
Montana	44	61	62	87
Nebraska	50	61	102	124
Nevada	39	50	141	182
New Hampshire	50	62	39	48
New Jersey	37	48	298	390
New Mexico	58	72	194	241
New York	49	58	1,328	1,578
North Carolina	49	59	753	918
North Dakota	61	75	28	35
Ohio	58	68	700	829
Oklahoma	53	65	301	366
Oregon	74	90	217	263
Pennsylvania	63	74	578	688
Rhode Island	43	53	54	67
South Carolina	61	73	316	379
South Dakota	55	66	54	65
Tennessee	68	80	508	599
Texas	41	48	2,564	3,003
Utah	45	56	151	187
Vermont	60	75	31	39
Virginia	50	61	415	507
Washington	62	75	298	363
West Virginia	80	100	103	129
Wisconsin	62	74	294	349
Wyoming	49	62	17	22
United States	52	55	22,268	23,433

Table III.7. Approximate 90-Percent Confidence Intervals for Final Shrinkage Estimates for 2010, Working Poor

	Approximate 90-Percent Confidence Intervals for 2010, Working Poor			
	Participation Rate (Percent)		Number of Eligible People (Thousands)	
	Lower Bound	Upper Bound	Lower Bound	Upper Bound
Alabama	63	75	405	484
Alaska	53	69	48	63
Arizona	64	76	464	551
Arkansas	66	77	239	279
California	37	43	3,008	3,537
Colorado	51	63	275	335
Connecticut	53	67	128	164
Delaware	55	69	56	70
District of Columbia	31	47	31	48
Florida	58	68	1,287	1,524
Georgia	62	73	843	1,003
Hawaii	43	56	99	129
Idaho	70	82	119	140
Illinois	58	67	882	1,022
Indiana	66	77	426	496
Iowa	71	84	197	234
Kansas	55	65	193	227
Kentucky	63	77	300	368
Louisiana	61	73	481	575
Maine	86	100	66	80
Maryland	48	61	275	349
Massachusetts	56	70	221	274
Michigan	81	95	621	728
Minnesota	56	67	262	316
Mississippi	60	72	316	376
Missouri	70	82	448	526
Montana	64	79	59	74
Nebraska	59	70	113	134
Nevada	45	57	155	193
New Hampshire	62	75	43	52
New Jersey	45	57	326	412
New Mexico	67	81	194	235
New York	59	69	1,315	1,541
North Carolina	59	70	741	884
North Dakota	64	79	33	41
Ohio	65	77	685	804
Oklahoma	59	71	296	356
Oregon	83	98	249	293
Pennsylvania	71	83	624	730
Rhode Island	59	70	57	67
South Carolina	66	79	390	466
South Dakota	68	80	55	65
Tennessee	69	82	531	631
Texas	55	62	2,560	2,907
Utah	59	70	171	205
Vermont	70	84	26	31
Virginia	61	73	432	515
Washington	69	83	364	438
West Virginia	76	97	119	152
Wisconsin	73	86	313	367
Wyoming	53	67	22	28
United States	62	65	22,979	24,104

Table III.8. Approximate 90-Percent Confidence Intervals for Final Shrinkage Estimates for 2011, Working Poor

	Approximate 90-Percent Confidence Intervals for 2011, Working Poor			
	Participation Rate (Percent)		Number of Eligible People (Thousands)	
	Lower Bound	Upper Bound	Lower Bound	Upper Bound
Alabama	70	82	355	419
Alaska	53	68	52	67
Arizona	65	78	529	637
Arkansas	68	80	249	293
California	40	47	2,918	3,424
Colorado	49	60	313	387
Connecticut	59	73	136	169
Delaware	62	77	59	73
District of Columbia	36	57	28	44
Florida	60	71	1,310	1,546
Georgia	68	81	920	1,099
Hawaii	38	50	119	158
Idaho	74	87	135	158
Illinois	61	70	912	1,047
Indiana	64	77	484	579
Iowa	74	87	191	225
Kansas	58	69	214	251
Kentucky	62	76	326	399
Louisiana	65	78	445	540
Maine	91	100	76	90
Maryland	58	70	258	315
Massachusetts	60	73	264	325
Michigan	84	99	772	911
Minnesota	61	73	253	303
Mississippi	67	82	285	350
Missouri	73	86	410	486
Montana	66	80	61	74
Nebraska	56	67	120	144
Nevada	55	66	174	209
New Hampshire	58	72	48	59
New Jersey	51	64	408	508
New Mexico	72	88	211	256
New York	62	72	1,290	1,500
North Carolina	65	77	637	749
North Dakota	66	81	30	36
Ohio	68	80	730	854
Oklahoma	65	78	327	392
Oregon	84	100	261	314
Pennsylvania	73	86	661	771
Rhode Island	58	70	68	82
South Carolina	69	82	390	462
South Dakota	70	82	59	69
Tennessee	70	83	510	605
Texas	60	69	2,567	2,940
Utah	62	75	191	229
Vermont	71	88	24	30
Virginia	63	75	466	552
Washington	75	89	360	428
West Virginia	78	96	123	151
Wisconsin	77	91	313	366
Wyoming	51	63	26	32
United States	67	69	23,468	24,702

REFERENCES

Cunnyngham, Karen E. "Reaching Those in Need: State Supplemental Nutrition Assistance Program Participation Rates in 2011." Alexandria, VA: U.S. Department of Agriculture, Food and Nutrition Service, February 2014.

Cunnyngham, Karen E. "Reaching Those in Need: State Supplemental Nutrition Assistance Program Participation Rates in 2010." Alexandria, VA: U.S. Department of Agriculture, Food and Nutrition Service, December 2012.

Cunnyngham, Karen E., Laura A. Castner, and Amang Sukasih. "Empirical Bayes Shrinkage Estimates of State Supplemental Nutrition Assistance Program Rates in 2008-2010 for All Eligible People and the Working Poor." Washington, DC: Mathematica Policy Research, Inc., February 2013.

Eslami, Esa, and Karen Cunnyngham. "Supplemental Nutrition Assistance Program Participation Rates: Fiscal Years 2010 and 2011." In *Current Perspectives on SNAP Participation*. Alexandria, VA: Food and Nutrition Service, U.S. Department of Agriculture, February 2014.

Fay, Robert E., and Roger Herriott. "Estimates of Incomes for Small-Places: An Application of James-Stein Procedures to Census Data." *Journal of the American Statistical Association,* vol. 74, no. 366, June 1979, pp. 269-277.

Leftin, Joshua, Esa Eslami, Katherine Bencio, Kai Filion, and Daisy Ewell. "Technical Documentation for the Fiscal Year 2011 Supplemental Nutrition Assistance Program Quality Control Database and the QC Minimodel." Washington, DC: Mathematica Policy Research, August 2012.

National Research Council, Committee on National Statistics, Panel on Estimates of Poverty for Small Geographic Areas. *Small-Area Income and Poverty Estimates: Priorities for 2000 and Beyond*, edited by Constance F. Citro and Graham Kalton. Washington, DC: National Academy Press, 2000.

Schirm, Allen L. "The Evolution of the Method for Deriving Estimates to Allocate WIC Funds." Paper presented at the Workshop on Formulas for Allocating Program Funds, Committee on National Statistics, National Research Council, Washington, DC, April 26-27, 2000. Washington, DC: Mathematica Policy Research, April 2000.

Schirm, Allen L. "State Estimates of Infants and Children Income Eligible for the WIC Program in 1992." Washington, DC: Mathematica Policy Research, May 1995.

Schirm, Allen L. "The Relative Accuracy of Direct and Indirect Estimators of State Poverty Rates." *1994 Proceedings of* the *Section on Survey Research Methods*. Alexandria, VA: American Statistical Association, 1994.

APPENDIX A

THE ESTIMATION PROCEDURE: ADDITIONAL TECHNICAL DETAILS

This appendix provides additional information and technical details about our four-step procedure to estimate state Supplemental Nutrition Assistance Program (SNAP) participation rates for all eligible people and the working poor. Each step is discussed in turn.

1. From CPS ASEC Data and SNAP Administrative Data, Derive Direct Sample Estimates of State SNAP Participation Rates for Each of the Three Years 2009 to 2011

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

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

where $Y_{1,i}$ is the estimated participation rate for all eligible people for state i (i = 1, 2, …, 51); P_i is the number of people participating in SNAP according to 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 number of people who are eligible for the SNAP according to the CPS ASEC, expressed as a percentage of the CPS ASEC population; and T_i is the resident population according to decennial census and administrative records (mainly vital statistics) data.[2,3,4]

We adjusted P_i by $\varepsilon_{1,i}$ to exclude from our estimates of participants two groups that are not included in our estimates of eligibles. First, we excluded participants who were ineligible for SNAP

[2] P_i is adjusted to exclude from our estimate of participants those people who received SNAP benefits only because of a natural disaster and, thus, are not included in our estimate of eligibles. Because P_i is obtained from SNAP Program Operations data, which include the full population of SNAP cases, it is not subject to sampling error. Participant figures, including counts of participants eligible only through disaster assistance, were provided by the Food and Nutrition Service (FNS).

[3] We obtained estimates for fiscal years 2009 to 2011 from the CPS ASEC samples for 2009 to 2012, for which the survey instruments collected family income data for the prior calendar years, that is, 2008 to 2011.

[4] In broad terms, the population estimates derived by the Census Bureau are obtained by subtracting from 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). Population estimates are available at http://www.census.gov/popest/.

but received benefits in error. Second, we excluded participants who were eligible through state expanded categorical eligibility rules but would not pass the federal SNAP income and asset tests.

We estimated the percentage of people who were eligible for SNAP according to:

$$(2) \quad E_{1,i} = 100 \frac{Z_{1,i}}{N_i},$$

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. To derive fiscal year estimates, we combined two years of the CPS ASEC. For example, to estimate $Z_{1,i}$ for 2011, we used data from the 2011 CPS ASEC (simulating October through December 2010) and the 2012 CPS ASEC (simulating January through September 2011). To estimate N_i for 2011, we used a weighted average of population estimates from the two CPS ASEC files. 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 out."

We similarly derived sample estimates of participation rates for the working poor for a given year according to:

$$(3) \quad Y_{2,i} = 100 \frac{P_i(\varepsilon_{2,i}/100)}{(E_{2,i}/100)T_i}$$

and

$$(4) \quad E_{2,i} = 100 \frac{Z_{2,i}}{N_i},$$

where $Y_{2,i}$ is the estimated participation rate for the working poor for state i; $\varepsilon_{2,i}$ is the percentage of participating people who are working poor, correctly receiving SNAP benefits, and eligible under federal SNAP rules according to SNAP QC data; $E_{2,i}$ is the percentage of people who are working poor and eligible for SNAP according to the CPS ASEC; $Z_{2,i}$ is the CPS ASEC estimate of the number of eligible people for SNAP, and P_i, T_i, and N_i are as defined above.

We define as "working poor" any person who is eligible for SNAP and lives in a household in which a member earns money from a job. Working poor who are participating in SNAP are identified slightly differently in the SNAP QC data than in the CPS. In the SNAP QC data, they are identified not just by their earnings but also by other indicators of earnings that suggest a household was very likely to have a member who worked. Specifically, a household is identified as working poor if the household had earnings according to the edited SNAP QC datafile, or if prior to the editing process, multiple earnings indicators suggest that a member of the household was working (Figure A.1).[5]

Figure A.1. Algorithm to Identify Working Poor Households

A household is identified as working poor if it meets 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 recorded earned income AND
      i) A recorded earned income deduction or at least one person with a recorded workforce participation variable indicating he or she is employed

      OR

      ii) Recorded earned and unearned income that sum to the recorded total income, or recorded earned income with the earned income deduction already subtracted and unearned income that sum to the recorded total income (some states subtract the earned income deduction from income deemed by an ineligible member before recording it on the file)
   b) A recorded earned income deduction AND
      i) At least one person with a recorded workforce participation variable indicating that he or she is employed

      OR

      ii) Earnings implied by the recorded earned income deduction and recorded unearned income that sum to the recorded total income

      OR

      iii) Recorded 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)

[5] Leftin et al. (2012) describe the procedure for editing the SNAP QC data to ensure consistency between a household's income and SNAP benefit.

We derived SNAP eligibility estimates for states 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 asset balances 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 ineligible for SNAP under provisions of the Personal Responsibility and Work Opportunity Reconciliation Act of 1996 (P.L. 104-193) and subsequent legislation pertaining to noncitizens. Yet another limitation is that only annual, rather than monthly, income amounts are recorded.

Methods have been developed to address these data limitations. These methods—including procedures for identifying the members of the SNAP household within the (potentially) larger CPS ASEC household, taking account of the restrictions on participation by noncitizens, distributing annual amounts across months, and imputing net income—are described in Eslami and Cunnyngham (2014) and earlier reports in that series.[6,7]

In addition to our point estimates of participation rates, we need estimates of their sampling variability. We can estimate the variances of $Y_{1,i}$ and $Y_{2,i}$ as follows:[8]

$$\text{(5)} \quad \begin{aligned} \text{var}(Y_{1,i}) &= \text{variance due to } E_{1,i} \text{ when } \varepsilon_{1,i} \text{ is fixed} + \text{variance due to } \varepsilon_{1,i} \text{ when } E_{1,i} \text{ is fixed} \\ &= \text{var}_{E_1|\varepsilon_1}(Y_{1,i}) + \text{var}_{\varepsilon_1|E_1}(Y_{1,i}) \end{aligned}$$

[6] These reports also describe how we applied SNAP gross and net income tests and calculated the benefits for which an eligible household would qualify.

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

[8] Correctly-eligible rates are estimated from SNAP QC sample data and are subject to sampling error, although it is small relative to other sources of error in the estimated participation rates. In taking into account this sampling error when deriving the estimates presented here, we take into account its correlation with the sampling error associated with the identification of the working poor participants, also estimated using the SNAP QC data. That is, we take into account the correlation between $\varepsilon_{1,i}$, the correctly eligible rate, and $\varepsilon_{2,i}$, the correctly eligible working poor rate.

and

$$(6) \quad \text{var}(Y_{2,i}) = \text{variance due to } E_{2,i} \text{ when } \varepsilon_{2,i} \text{ is fixed} + \text{variance due to } \varepsilon_{2,i} \text{ when } E_{2,i} \text{ is fixed}$$
$$= \text{var}_{E_2|\varepsilon_2}(Y_{2,i}) + \text{var}_{\varepsilon_2|E_2}(Y_{2,i}).$$

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

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

$$(7) \quad \text{var}_{E_1|\varepsilon_1}(Y_{1,i}) = \frac{4}{160}\sum_{r=1}^{160}(Y_{1,i(r)} - Y_{1,i})^2,$$

where $Y_{1,i(r)}$ is the rth (r = 1, 2, ..., 160) replicate estimate with the same form as $Y_{1,i}$ and calculated using the rth set of replicate weights.

The replicate estimates $Y_{1,i(r)}$ are obtained by replicating $E_{1,i}$; that is,

$$(8) \quad E_{1,i(r)} = 100\frac{Z_{1,i(r)}}{N_{i(r)}}$$

and

$$(9) \quad Y_{1,i(r)} = 100\frac{P_i(\varepsilon_{1,i}/100)}{(E_{1,i(r)}/100)T_i}.$$

Then, we can assess the degree of sampling variability (estimate the variance of $Y_{1,i}$) by using formula (7).

We obtain estimates of sampling error variances pertaining to the participation rates for the working poor in the same manner, substituting $Z_{2,i}$, the CPS sample estimate of the number of eligible working poor in state i, for $Z_{1,i}$; $Z_{2,i(r)}$, the rth replicate estimate of $Z_{2,i}$, for $Z_{1,i(r)}$; $E_{2,i}$ for $E_{1,i}$; $E_{2,i(r)}$ for $E_{1,i(r)}$; $\varepsilon_{2,i}$ for $\varepsilon_{1,i}$; and $Y_{2,i(r)}$ for $Y_{1,i(r)}$, in Equations (7) to (9). This results in:

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

Next, based on Equation (1) we can estimate $\text{var}_{\varepsilon_1|E_1}(Y_{1,i})$ according to:

$$(11) \quad \text{var}_{\varepsilon_1|E_1}(Y_{1,i}) = \left(100\frac{P_i}{T_i E_{1,i}}\right)^2 \text{var}(\varepsilon_{1,i}),$$

because P_i and T_i are constants (or, at least, subject to negligible sampling variability) and $E_{1,i}$ is held fixed at its point estimate. Also note that we estimated $\varepsilon_{1,i}$ (the correctly-eligible rate) and $\varepsilon_{2,i}$ (the percentage of participants who are working poor and correctly eligible) from the SNAP QC sample data as follows:

$$(12) \quad \varepsilon_{1,i} = 100\frac{\sum_h m_{i,h}\varepsilon_{1,i,h}}{\sum_h m_{i,h}},$$

and

$$(13) \quad \varepsilon_{2,i} = 100\frac{\sum_h m_{i,h}\varepsilon_{2,i,h}}{\sum_h m_{i,h}},$$

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; $\varepsilon_{1,i,h}$ is an indicator that household h is eligible to receive SNAP benefits; and $\varepsilon_{2,i,h}$ is an indicator that household h is working poor and eligible to receive SNAP benefits.

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

$$(14) \quad \varepsilon_{1,i(r)} = 100\frac{\sum_h m_{i,h(r)}\varepsilon_{1,i,h}}{\sum_h m_{i,h(r)}}, \ (r = 1, 2, ..., 500),$$

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

$$(15) \quad \text{var}(\varepsilon_{1,i}) = \frac{1}{499}\sum_{r=1}^{500}\left(\varepsilon_{1,i(r)} - \bar{\varepsilon}_{1,i}^{*}\right)^2,$$

where

$$(16) \quad \bar{\varepsilon}_{1,i}^{*} = \frac{1}{500}\sum_{r=1}^{500}\varepsilon_{1,i(r)}.$$

Similarly, variances $\text{var}_{\varepsilon_2|E_2}(Y_{2,i})$ pertaining to the working poor can be calculated in the same manner, by substituting $\varepsilon_{2,i,h}$ for $\varepsilon_{1,i,h}$; $\varepsilon_{2,i,(r)}$ for $\varepsilon_{1,i,(r)}$; $\text{var}(\varepsilon_{2,i})$ for $\text{var}(\varepsilon_{1,i})$ in Equations (11) to (16), resulting in

$$(17) \quad \text{var}_{\varepsilon_2|E_2}(Y_{2,i}) = \left(100\frac{P_i}{T_i E_{2,i}}\right)^2 \text{var}(\varepsilon_{2,i}).$$

Summing the estimates from Equations (7) and (11)—as indicated by Equation (5)—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 (17)—as indicated by Equation (6)—and taking the square root of the sum provides an estimated standard error of the participation rate for the working poor.

We estimated the covariance between the estimates of participation rates for all eligible people and the working poor, for a given year, according to:[9]

$$\begin{aligned}(18) \quad \text{cov}(Y_{1,i}, Y_{2,i}) &= \text{covariance due to } E_{1,i} \text{ and } E_{2,i} \text{ when } \varepsilon_{1,i} \text{ and } \varepsilon_{2,i} \text{ are fixed} \\ &\quad + \text{covariance due to } \varepsilon_{1,i} \text{ and } \varepsilon_{2,i} \text{ when } E_{1,i} \text{ and } E_{2,i} \text{ are fixed} \\ &= \text{cov}_{E_1E_2|\varepsilon_1\varepsilon_2}(Y_{1,i}, Y_{2,i}) + \text{cov}_{\varepsilon_1\varepsilon_2|E_1E_2}(Y_{1,i}, Y_{2,i}).\end{aligned}$$

[9] We do not need to include additional terms because the CPS 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:

$$(19) \quad \mathrm{cov}_{E_1E_2|\varepsilon_1\varepsilon_2}(Y_{1,i}, Y_{2,i}) = \frac{4}{160}\sum_{r=1}^{160}(Y_{1,i(r)} - Y_{1,i})(Y_{2,i(r)} - Y_{2,i}).$$

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

$$(20) \quad \mathrm{cov}_{\varepsilon_1\varepsilon_2|E_1E_2}(Y_{1,i}, Y_{2,i}) = \left(100\frac{P_i}{T_iE_{1,i}}\right)\left(100\frac{P_i}{T_iE_{2,i}}\right)\mathrm{cov}(\varepsilon_{1,i}, \varepsilon_{2,i})$$

where

$$(21) \quad \mathrm{cov}(\varepsilon_{1,i}, \varepsilon_{2,i}) = \frac{1}{(\sum_h m_{i,h})^2}\left(\frac{n_i}{n_i - 1}\right)\sum_h m_{i,h}{}^2\left(\varepsilon_{1,i,h} - \varepsilon_{1,i}\right)\left(\varepsilon_{2,i,h} - \varepsilon_{2,i}\right).$$

Because CPS samples from different years are not independent, participation rates for different years are correlated.[10] We derived a preliminary SDRM estimate of the correlation between $Y_{1,i,t}$ and $Y_{2,i,t-g}$, the sample estimate for all eligibles for one year (year t) and the sample estimate for the working poor for g years earlier, as follows:

$$(22) \quad \mathrm{cov}(Y_{1,i,t}, Y_{2,i,t-g}) = \frac{4}{160}\sum_{r=1}^{160}(Y_{1,i(r),t} - Y_{1,i,t})(Y_{2,i(r),t-g} - Y_{2,i,t-g}).$$

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

$$(23) \quad \mathrm{corr}(Y_{1,i,t}, Y_{2,i,t-g}) = \frac{\mathrm{cov}(Y_{1,i,t}, Y_{2,i,t-g})}{\sqrt{\mathrm{var}(Y_{1,i,t})\,\mathrm{var}(Y_{2,i,t-g})}}.$$

To improve the precision of estimated correlations (and covariances), we used a simple smoothing technique in which we "replaced" the state-specific correlation from Equation (23) by the average correlation between $Y_{1,i,t}$ and $Y_{2,i,t-g}$ across states:

[10] In contrast, SNAP QC samples from different years are independent. Hence, sampling variability in estimates from the CPS is the only source of intertemporal covariation between participation rates.

$$(24) \quad \overline{\text{corr}}(Y_{1,t}, Y_{2,t-g}) = \frac{\sum_{i=1}^{51}(n_{i,t} + n_{i,t-g})\,\text{corr}(Y_{1,i,t}, Y_{2,i,t-g})}{\sum_{i=1}^{51}(n_{i,t} + n_{i,t-g})},$$

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

$$(25) \quad \text{cov}(Y_{1,i,t}, Y_{2,i,t-g}) = \overline{\text{corr}}(Y_{1,t}, Y_{2,t-g}) \sqrt{\text{var}(Y_{1,i,t})\,\text{var}(Y_{2,i,t-g})}\,.$$

Other intertemporal covariances—such as the covariance between the participation rates for the working poor in two different years—are similarly estimated. As described under Step 3, the variances and covariances obtained in this step are the elements of a variance-covariance matrix used in deriving shrinkage estimates of participation rates.[11]

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

[11] All interstate covariances equal zero because state samples are independent in both the CPS and the SNAP QC.

sample estimates of participation rates for all eligible people and for the working poor (values of $Y_{1,i}$ and $Y_{2,i}$), and Table A.12 presents standard errors for the direct sample estimates.

2. Using a Regression Model, Predict State SNAP Participation Rates Based on Administrative and ACS Data

Our regression model consisted of six equations, with three predicting SNAP participation rates for all eligible people in 2009, 2010, and 2011, and three predicting SNAP participation rates for the working poor in 2009, 2010, and 2011. 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):

- the percentage of the population correctly receiving SNAP benefits under regular program rules
- the percentage of children age 5 to 17 approved to receive free lunches under the National School Lunch Program
- the median adjusted gross income according to individual income tax data
- the median family income according to ACS one-year estimates
- the percentage of individuals age 25 years and over who have completed a bachelor's degree according to ACS one-year estimates
- the percentage of children under age 18 with household income under 50 percent of the federal poverty level according to ACS one-year estimates
- the percentage of households with a female householder, no husband present, and related children under age 18 according to ACS one-year estimates

For all the predictors, we used 2009 values in both equations for predicting 2009 rates, 2010 values in both equations for predicting 2010 rates, and 2011 values in both equations for predicting 2011 rates. Because prediction errors were allowed to be correlated and intergroup and intertemporal correlations among direct sample estimates were taken into account as specified in the next step, the shrinkage estimates for a group (all eligible people or the working poor) in any one year were determined by the predictions and sample estimates for all three years and both groups.

In addition to the predictors that we selected for our "best" model, we considered many other potential predictors measuring, for example, the poverty rate for children according to individual

income tax data and the percentage of foreign-born individuals entering the United States in 2000 or later according to ACS estimates. All of the predictors considered had three characteristics: (1) they are face valid, that is, it is plausible that they are good indicators of differences among states in SNAP participation rates; (2) they could be defined and measured uniformly across states; and (3) they could be obtained from nonsample or highly precise sample data—such as the ACS or administrative records data—and, thus, measured with little or no sampling error.

As shown in the next step, where we describe the regression estimation procedure in more detail, we do not have to calculate regression estimates as a separate step, although we do have to select a best regression model before we can calculate shrinkage estimates. We selected our best model on the basis of its strong relative performance in predicting participation rates, judging performance by examining functions of the regression residuals, such as mean squared error.[12] In addition to assessing the predictive fit of alternative specifications, we checked for potential biases as part of our extensive model evaluation. To check for biases, we looked for a persistent tendency to under- or overpredict the number of eligibles 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 strong evidence of correctable bias.

Predictors considered are listed in Table A.13 and definitions and data sources for the predictors in our best regression model are given in Table A.14. The values for the 2009, 2010, and 2011 predictors listed above are displayed in Tables A.15, A.16, and A.17, respectively. Regression estimates of participation rates for all eligible people and the working poor are in Table A.18, and the standard errors for the regression estimates are in Table A.19.

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

3. Using Shrinkage Methods, Average the Direct Sample Estimates and Regression Predictions to Obtain Preliminary Shrinkage Estimates of State SNAP Participation Rates

To average the direct sample estimates and the regression predictions, we used an empirical Bayes shrinkage estimator.[13] The estimator does not have a closed-form expression from which we can calculate shrinkage estimates. Instead, we must numerically integrate over six scalar parameters—σ_1, σ_2, ρ, η_1, η_2, and η_{12}—that measure the lack of fit of the regression model and the correlations among regression prediction errors. To perform the numerical integration, we specified a grid of 6,226,528 equally-spaced points, starting with σ_1 = 0.001, σ_2 = 0.001, ρ = -0.999, η_1 = 0.000, η_2 = 0.000, and η_{12} = -0.999 and incrementing σ_1, σ_2, ρ, η_1, η_2, and η_{12} by 0.300, 0.700, 0.333, 0.500, 0.600, and 0.133, respectively, up to σ_1 = 3.901, σ_2 = 7.001, ρ = 0.999, η_1 = 9.000, η_2 = 10.800, and η_{12} = 0.996. For combination k of σ_1, σ_2, ρ, η_1, η_2, and η_{12} (k = 1, 2, ..., 6226528), we calculated a vector of shrinkage estimates:

$$(26) \quad \theta_k = (\Sigma_k^{-1} + V^{-1})^{-1}(\Sigma_k^{-1} X\hat{B}_k + V^{-1}Y),$$

a variance-covariance matrix:

$$(27) \quad U_k = (\Sigma_k^{-1} + V^{-1})^{-1} + (\Sigma_k^{-1} + V^{-1})^{-1}\Sigma_k^{-1} X(X'(\Sigma_k + V)^{-1} X)^{-1} X'\Sigma_k^{-1}(\Sigma_k^{-1} + V^{-1})^{-1},$$

and a probability:

$$(28) \quad p_k^* = |\Sigma_k + V|^{-1/2} |X'(\Sigma_k + V)^{-1} X|^{-1/2} \exp\left(-\frac{1}{2}(Y - X\hat{B}_k)'(\Sigma_k + V)^{-1}(Y - X\hat{B}_k)\right).$$

[13] Although our shrinkage estimator averages direct sample and regression estimates, a state's shrinkage estimate for either all eligible people or the working poor in a given year does not have to be between the direct sample and regression estimates for the group and year in question. It may be above both of those estimates if, for example, they seem too low based on data from other years. In most cases, the shrinkage estimates presented in this report are between the direct sample and regression estimates. In the remaining cases, the shrinkage estimate is usually close to either the sample or regression estimate, and it is often close to both because the sample and regression estimates are close to each other.

In these expressions, Y is a column vector of direct sample estimates (from Step 1) with 306 elements, six sample estimates for each of the 51 states. 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 2009 sample estimates for all eligible people and the working poor, respectively; the second two elements are the 2010 estimates; and the final two elements are the 2011 estimates. The vector of shrinkage estimates, θ_k, has the same structure as the vector of sample estimates, Y. V is the (306 × 306) variance-covariance matrix for the sample estimates. Because state samples are independent in the CPS, V is block-diagonal with 51 (6 × 6) blocks. We described under Step 1 how we derived estimates for the elements of V. X is a (306 × 48) matrix containing values for each of the seven predictors (plus an intercept) for every state, every year (2009, 2010, and 2011), and both groups (all eligible people and the working poor). 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:

$$(29) \quad X_i = \begin{pmatrix} x'_{i11} & \underline{0} & \underline{0} & \underline{0} & \underline{0} & \underline{0} \\ \underline{0} & x'_{i12} & \underline{0} & \underline{0} & \underline{0} & \underline{0} \\ \underline{0} & \underline{0} & x'_{i21} & \underline{0} & \underline{0} & \underline{0} \\ \underline{0} & \underline{0} & \underline{0} & x'_{i22} & \underline{0} & \underline{0} \\ \underline{0} & \underline{0} & \underline{0} & \underline{0} & x'_{i31} & \underline{0} \\ \underline{0} & \underline{0} & \underline{0} & \underline{0} & \underline{0} & x'_{i32} \end{pmatrix},$$

where x'_{it1} is a row vector for year t (t = 1 for 2009, t = 2 for 2010, and t = 3 for 2011) with eight elements (an intercept plus the seven predictors listed under Step 2) to predict participation rates for all eligible people. x'_{it2} is a row vector for year t with eight elements to predict participation rates for the working poor. $\underline{0}$ 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 the working poor. Thus, $x'_{it1} = x'_{it2}$. $\hat{B}_k$ is a (48 × 1) vector of regression coefficients, and is given by:

$$(30) \quad \hat{B}_k = (X'(\Sigma_k + V)^{-1} X)^{-1} X'(\Sigma_k + V)^{-1} Y .$$

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

$$(31)\quad \Sigma_k^* = \begin{pmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{pmatrix} \otimes \begin{pmatrix} \sigma_{1,k}^2 & \sigma_{1,k}\sigma_{2,k}\rho_k \\ \sigma_{1,k}\sigma_{2,k}\rho_k & \sigma_{2,k}^2 \end{pmatrix} + \begin{pmatrix} 1 & 1 & 1 \\ 1 & 1 & 1 \\ 1 & 1 & 1 \end{pmatrix} \otimes \begin{pmatrix} \eta_{1,k}^2 & \eta_{1,k}\eta_{2,k}\eta_{12,k} \\ \eta_{1,k}\eta_{2,k}\eta_{12,k} & \eta_{2,k}^2 \end{pmatrix}.$$

After calculating θ_k, U_k, and p_k^* 6,226,528 times (once for each combination of σ_1, σ_2, ρ, η_1, η_2, and η_{12}), we calculated the probability of ($\sigma_{1,k}$, $\sigma_{2,k}$, ρ_k, $\eta_{1,k}$, $\eta_{2,k}$, $\eta_{12,k}$):

$$(32)\quad p_k = \frac{p_k^*}{\sum_{k=1}^{6,226,528} p_k^*},$$

which is also an estimate of the probability that the shrinkage estimates θ_k are the true values. As Equation (32) 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 η_{12} and obtain a single set of shrinkage estimates, we calculated a weighted sum of the 6,226,528 sets of shrinkage estimates, weighting each set θ_k by its associated probability p_k. Thus, our shrinkage estimates are:

$$(33)\quad \theta = \sum_{k=1}^{6,226,528} p_k \theta_k .$$

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:

$$(34)\quad U = \sum_{k=1}^{6,226,528} p_k U_k + \sum_{k=1}^{6,226,528} p_k (\theta_k - \theta)(\theta_k - \theta)' .$$

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 η_{12} 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 η_{12}. As described later, standard errors of the

final shrinkage estimates for states are calculated as functions of the square roots of the diagonal elements of *U*.

Regression estimates can be similarly obtained. They are:

$$(35) \quad R = \sum_{k=1}^{6,226,528} p_k R_k \ ,$$

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 $\eta_{12}=\eta_{12,k}$. The variance-covariance matrix is:

$$(36) \quad G = \sum_{k=1}^{6,226,528} p_k G_k + \sum_{k=1}^{6,226,528} p_k (R_k - R)(R_k - R)' \ ,$$

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

$$(37) \quad \hat{B} = \sum_{k=1}^{6,226,528} p_k \hat{B}_k \ .$$

Preliminary shrinkage estimates of SNAP participation rates are displayed in Table A.20.

4. Adjust the Preliminary Shrinkage Estimates to Obtain Final Shrinkage Estimates of State SNAP Participation Rates

We adjusted the preliminary shrinkage estimates of participation rates in two ways. First, we adjusted the rates so that the eligibles counts implied by the rates sum to the national eligibles count estimated directly from the CPS ASEC. Second, we adjusted the rates so that no state's estimated rate was greater than 100 percent. These adjustments were carried out separately for each year and for the two groups of eligible people (all eligible people and the working poor). The following description of the adjustments will focus on the 2011 estimates for all eligible people.

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

$$(38) \quad \psi_{1,i} = \frac{P_i(\varepsilon_{1,i}/100)}{(\theta_{1,i}/100)} \ ,$$

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 (100 minus the payment error rate) figures used in Equation (1), and $\theta_{1,i}$ is the preliminary participation rate derived in Equation (33). The state eligibles counts from Equation (38) summed to 53,024,391 for 2011, while the national total for 2011 estimated directly from the CPS was 51,872,780. To obtain estimated eligibles counts for states that sum (aside from rounding error) to the direct estimate of the national total, we multiplied each of the eligibles counts from Equation (38) by 51,872,780 ÷ 53,024,391 (≈0.9783).[14]

After carrying out this first adjustment, there were six instances where a state had fewer estimated eligibles than participants, implying a participation rate over 100 percent. Maine had preliminary estimated participation rates for all eligibles of 112 percent in 2011 and 104 percent in 2010 and for working poor of 102 percent in 2011. In addition, Oregon had preliminary estimated participation rates for all eligibles of 111 percent in 2011 and 104 percent in 2010 and Washington had a preliminary estimated participation rate for all eligibles of 102 percent in 2011. To cap participation rates at 100 percent, we increased the number of eligibles in states with preliminary estimated participation rates of over 100 percent so that the number of eligibles in that state equaled the number of participants each year. We reduced the number of eligibles in the other states and the District of Columbia by an equivalent number and in proportion to their numbers of eligibles. These adjustments, which were carried out separately for the three years and two groups, moved very small numbers of eligibles among states but did not change the national totals. Moreover, except for the states with participation rates initially over 100 percent, the adjustments did not change any state's

[14] The adjustment factors for 2009 and 2010 for all eligible people were, respectively, 0.9803, and 0.9823. The direct estimates of the national totals for all eligibles for those years were 4,792,1620 and 5,102,4816. The adjustment factors for 2009, 2010, and 2011 for working poor eligibles were, respectively, 0.9791, 0.9774 and 0.9791. The direct estimates of the national totals for working poor eligibles for those years were 22,850,778, 23,541,577, and 24,085,007.

participation rate by more than one-fifth of a percentage point. The rounded participation rates for some states did increase by one percentage point, however.

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

$$(39) \quad \theta_{F,1,i} = 100 \frac{P_i(\varepsilon_{1,i}/100)}{\psi_{F,1,i}},$$

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

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

$$(40) \quad Upper\ Bound_i = F_i + 1.645\, e_i$$

and:

$$(41) \quad Lower\ Bound_i = F_i - 1.645\, e_i\ ,$$

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 eligibles counts, the standard errors are, respectively:

$$(42) \quad e_i = \frac{1}{r}\sqrt{U(6i-1,6i-1)}$$

and

$$(43) \quad e_i = \frac{\psi_{F,1,i}}{\theta_{F,1,i}}\ r\sqrt{U(6i-1,6i-1)}\ ,$$

where *r* is the ratio used to adjust preliminary estimates of state eligibles counts to the direct estimate of the national total (≈0.9783) for all eligible people for 2011), and *U*(6*i*-1,6*i*-1*)* is the (6*i*-1,6*i*-1)

diagonal element of U, which was derived according to Equation (34).[15] Our estimate of e_i does not take account of the correlation between r and our preliminary shrinkage estimates for states, which were summed to obtain the denominator of r. Instead, r is treated as a constant.

Table A.21 presents final shrinkage estimates of participation rates for all eligible people and the working poor (values of $\theta_{F,1,i}$ and $\theta_{F,2,i}$), and Table A.22 presents standard errors for the rates. Tables A.23 and A.24 display final shrinkage estimates of the numbers of all eligible people and eligible working poor (values of $\psi_{F,1,i}$ and $\psi_{F,2,i}$), respectively, and Tables A.25 and A.26 present the standard errors for those estimated counts.[16]

[15] The square root of $U(6i\text{-}1,6i\text{-}1)$ is the standard error of the preliminary shrinkage estimate of the 2011 participation rate for all eligible people for state i. When deriving estimates for 2009 and 2010, we would use the $(6i\text{-}5,6i\text{-}5)$ and $(6i\text{-}3,6i\text{-}3)$ diagonal elements of U, respectively. When deriving estimates for the working poor for 2009, 2010, and 2011, we would use the $(6i\text{-}4,6i\text{-}4)$, $(6i\text{-}2,6i\text{-}2)$, and $(6i,6i)$ diagonal elements of U, respectively.

[16] The rates in Table A.20 are the same as the rates in Table III.1 of Chapter III, except for the number of digits displayed. Likewise, the counts in Tables A.22 and A.23 are the same as the counts in Table III.2 of Chapter III, except for the number of digits displayed.

Table A.1. Number of People Receiving SNAP Benefits, Monthly Average

	Number of People Receiving SNAP Benefits (P_i)		
	2009	2010	2011
Alabama	679,138	805,095	874,520
Alaska	64,385	76,445	86,044
Arizona	813,987	1,018,171	1,067,617
Arkansas	411,144	466,598	485,941
California	2,670,341	3,238,548	3,672,980
Colorado	319,121	404,679	453,103
Connecticut	258,165	336,064	378,677
Delaware	90,933	112,513	134,927
District of Columbia	103,311	118,493	134,845
Florida	1,952,362	2,603,185	3,074,671
Georgia	1,286,078	1,591,078	1,778,873
Hawaii	114,599	138,166	159,644
Idaho	136,243	194,033	228,629
Illinois	1,455,566	1,636,085	1,793,568
Indiana	700,385	813,403	877,560
Iowa	295,106	339,925	373,856
Kansas	219,265	269,710	298,642
Kentucky	701,757	777,995	823,472
Louisiana	721,970	825,918	884,519
Maine	201,248	229,731	247,943
Maryland	454,196	560,848	667,738
Massachusetts	627,611	749,121	812,586
Michigan	1,450,272	1,776,368	1,928,478
Minnesota	344,784	430,346	505,919
Mississippi	505,920	575,222	621,083
Missouri	800,909	901,349	942,901
Montana	92,453	113,570	124,243
Nebraska	133,623	162,817	174,204
Nevada	200,056	278,105	332,959
New Hampshire	78,942	104,375	113,407
New Jersey	499,853	622,022	753,403
New Mexico	291,073	356,822	414,275
New York	2,322,742	2,757,836	2,999,447
North Carolina	1,137,294	1,346,495	1,574,997
North Dakota	53,070	59,888	60,672
Ohio	1,357,412	1,607,422	1,779,237
Oklahoma	472,892	582,492	614,683
Oregon	581,025	704,822	772,756
Pennsylvania	1,337,803	1,574,783	1,717,174
Rhode Island	102,303	138,966	160,201
South Carolina	687,508	797,110	844,405
South Dakota	73,981	95,336	101,817
Tennessee	1,072,055	1,221,590	1,274,159
Texas	2,988,535	3,551,581	3,977,219
Utah	185,282	247,405	283,971
Vermont	72,125	85,538	92,038
Virginia	651,725	786,157	858,782
Washington	761,220	956,004	1,054,693
West Virginia	305,960	341,156	345,955
Wisconsin	547,878	715,213	800,800
Wyoming	26,762	34,799	36,031
United States	33,412,367	40,231,392	44,570,261

Source: USDA, Food and Nutrition Service

Table A.2. Estimated Percentage of Participants Who Are Correctly Receiving Benefits and Eligible under Federal SNAP Rules

	Percentage Who Are Correctly Receiving Benefits and Eligible under Federal Rules					
	All Participants ($\varepsilon_{1,i}$)			Working Poor Participants ($\varepsilon_{2,i}$)		
	2009	2010	2011	2009	2010	2011
Alabama	97.974	95.841	95.072	39.357	38.066	33.629
Alaska	98.687	99.687	99.398	45.374	44.251	41.355
Arizona	89.093	86.704	84.633	36.572	34.669	38.876
Arkansas	97.417	96.887	97.510	41.463	39.716	41.115
California	98.280	95.864	95.206	37.566	40.272	37.780
Colorado	99.047	99.642	95.157	39.636	42.996	42.011
Connecticut	95.262	84.562	86.763	28.380	26.115	26.430
Delaware	89.639	87.552	86.402	37.264	34.738	34.051
District of Columbia	98.734	95.193	94.468	11.948	13.184	12.325
Florida	99.713	97.993	92.895	33.144	33.959	30.433
Georgia	97.054	95.553	95.040	42.325	39.181	42.183
Hawaii	98.120	98.773	88.086	41.821	40.648	38.055
Idaho	97.328	95.264	94.594	49.575	50.685	51.405
Illinois	96.676	96.656	93.212	33.320	36.220	35.883
Indiana	97.623	99.107	98.615	43.314	40.597	42.670
Iowa	97.471	98.543	90.965	49.363	49.168	44.817
Kansas	97.243	97.937	98.215	42.558	46.977	49.392
Kentucky	98.352	96.624	95.809	28.701	29.957	30.587
Louisiana	97.056	95.322	95.334	40.545	43.139	39.852
Maine	89.750	85.234	85.034	31.309	30.031	33.493
Maryland	89.235	87.330	84.883	32.477	30.298	27.516
Massachusetts	89.048	86.835	86.579	24.632	20.732	24.055
Michigan	88.375	85.945	88.173	34.980	33.516	39.713
Minnesota	94.386	93.934	89.088	37.180	41.232	36.773
Mississippi	99.031	98.453	95.977	40.421	39.668	38.115
Missouri	96.967	97.934	98.163	37.565	40.932	37.673
Montana	95.560	90.015	89.762	42.154	41.607	39.572
Nebraska	99.437	98.014	97.994	47.277	48.563	46.483
Nevada	92.934	86.218	87.131	35.563	31.971	34.832
New Hampshire	94.665	86.015	84.310	30.708	31.442	30.854
New Jersey	98.429	94.548	90.298	29.220	30.120	34.897
New Mexico	98.256	95.563	92.071	48.586	44.397	44.988
New York	90.772	91.180	89.756	33.406	33.140	31.262
North Carolina	99.156	97.903	87.170	39.656	38.753	31.309
North Dakota	87.819	84.852	83.743	40.233	44.020	40.018
Ohio	94.955	92.810	92.736	35.468	32.898	32.955
Oklahoma	97.085	95.588	96.004	41.529	36.266	42.075
Oregon	83.918	83.715	82.288	33.954	34.675	34.451
Pennsylvania	92.562	90.408	91.235	32.432	33.243	33.187
Rhode Island	94.976	89.210	88.292	28.297	28.661	29.751
South Carolina	94.009	95.478	95.780	33.849	38.829	38.130
South Dakota	98.548	97.244	97.098	48.422	46.691	47.833
Tennessee	98.318	98.577	96.525	38.052	36.141	33.592
Texas	90.701	91.356	90.481	41.231	44.894	44.855
Utah	96.554	98.157	97.660	46.462	48.942	50.637
Vermont	83.408	74.095	75.537	32.646	25.530	23.051
Virginia	96.615	96.573	98.091	39.404	40.198	40.944
Washington	86.584	85.601	84.083	29.844	31.968	30.500
West Virginia	95.971	92.798	92.666	34.123	34.259	34.592
Wisconsin	85.535	84.386	82.078	40.045	37.655	35.604
Wyoming	97.049	97.556	94.963	39.890	42.834	45.169

Source: SNAP QC data

Table A.3. Estimated Number of Participants Who Are Correctly Receiving Benefits and Income Eligible under Federal SNAP Rules, Monthly Average

	Participants Correctly Receiving Benefits and Eligible under Federal Rules		
	2009	2010	2011
Alabama	665,381	771,615	831,421
Alaska	63,540	76,206	85,526
Arizona	725,209	882,799	903,552
Arkansas	400,524	452,074	473,839
California	2,624,403	3,104,587	3,496,888
Colorado	316,080	403,231	431,158
Connecticut	245,932	284,183	328,553
Delaware	81,511	98,507	116,580
District of Columbia	102,003	112,797	127,385
Florida	1,946,763	2,550,951	2,856,206
Georgia	1,248,188	1,520,326	1,690,647
Hawaii	112,444	136,471	140,624
Idaho	132,603	184,843	216,268
Illinois	1,407,186	1,581,365	1,671,814
Indiana	683,734	806,140	865,401
Iowa	287,643	334,972	340,077
Kansas	213,220	264,145	293,311
Kentucky	690,191	751,732	788,958
Louisiana	700,714	787,284	843,246
Maine	180,621	195,810	210,836
Maryland	405,302	489,786	566,795
Massachusetts	558,872	650,497	703,528
Michigan	1,281,681	1,526,703	1,700,386
Minnesota	325,427	404,242	450,713
Mississippi	501,017	566,324	596,095
Missouri	776,616	882,729	925,584
Montana	88,348	102,230	111,523
Nebraska	132,870	159,582	170,709
Nevada	185,920	239,778	290,110
New Hampshire	74,730	89,778	95,613
New Jersey	491,997	588,109	680,305
New Mexico	285,998	340,989	381,426
New York	2,108,396	2,514,596	2,692,190
North Carolina	1,127,694	1,318,255	1,372,916
North Dakota	46,605	50,816	50,809
Ohio	1,288,930	1,491,848	1,649,985
Oklahoma	459,106	556,793	590,119
Oregon	487,582	590,041	635,884
Pennsylvania	1,238,293	1,423,724	1,566,661
Rhode Island	97,164	123,971	141,445
South Carolina	646,319	761,061	808,769
South Dakota	72,907	92,709	98,862
Tennessee	1,054,020	1,204,210	1,229,876
Texas	2,710,628	3,244,577	3,598,633
Utah	178,898	242,845	277,327
Vermont	60,158	63,380	69,523
Virginia	629,665	759,216	842,390
Washington	659,093	818,350	886,815
West Virginia	293,633	316,585	320,582
Wisconsin	468,629	603,537	657,282
Wyoming	25,972	33,948	34,216
United States	31,590,361	37,551,249	40,909,361

Table A.4. Estimated Number of Working Poor Who Are Correctly Receiving Benefits and Eligible under Federal SNAP Rules, Monthly Average

	Working Poor Correctly Receiving Benefits and Eligible under Federal Rules		
	2009	2010	2011
Alabama	267,289	306,467	294,092
Alaska	29,214	33,827	35,584
Arizona	297,692	352,988	415,047
Arkansas	170,470	185,312	199,795
California	1,003,144	1,304,215	1,387,635
Colorado	126,487	173,994	190,353
Connecticut	73,266	87,762	100,085
Delaware	33,885	39,085	45,944
District of Columbia	12,344	15,622	16,619
Florida	647,092	884,024	935,709
Georgia	544,328	623,394	750,389
Hawaii	47,926	56,162	60,753
Idaho	67,543	98,345	117,528
Illinois	484,987	592,594	643,591
Indiana	303,362	330,218	374,452
Iowa	145,674	167,136	167,549
Kansas	93,314	126,702	147,506
Kentucky	201,414	233,060	251,877
Louisiana	292,723	356,295	352,496
Maine	63,009	68,990	83,043
Maryland	147,510	169,928	183,736
Massachusetts	154,592	155,308	195,466
Michigan	507,309	595,362	765,857
Minnesota	128,189	177,442	186,042
Mississippi	204,497	228,181	236,724
Missouri	300,864	368,943	355,220
Montana	38,973	47,253	49,165
Nebraska	63,173	79,068	80,974
Nevada	71,145	88,912	115,977
New Hampshire	24,242	32,817	34,991
New Jersey	146,058	187,354	262,916
New Mexico	141,422	158,420	186,375
New York	775,925	913,954	937,674
North Carolina	451,003	521,800	493,114
North Dakota	21,352	26,363	24,280
Ohio	481,445	528,811	586,350
Oklahoma	196,387	211,243	258,629
Oregon	197,279	244,400	266,223
Pennsylvania	433,882	523,499	569,873
Rhode Island	28,948	39,829	47,661
South Carolina	232,714	309,506	321,974
South Dakota	35,823	44,513	48,702
Tennessee	407,943	441,493	428,016
Texas	1,232,212	1,594,437	1,783,975
Utah	86,086	121,086	143,795
Vermont	23,546	21,838	21,216
Virginia	256,804	316,018	351,617
Washington	227,176	305,619	321,680
West Virginia	104,402	116,878	119,674
Wisconsin	219,398	269,311	285,117
Wyoming	10,675	14,906	16,275
United States	12,256,135	14,890,685	16,249,334

Table A.5. Estimated Percentage of People Eligible for SNAP

	Percentage of People Eligible for SNAP					
	All Eligible People ($E_{1,t}$)			Working Poor ($E_{2,t}$)		
	2009	2010	2011	2009	2010	2011
Alabama	21.187	21.679	19.905	9.936	9.500	7.832
Alaska	14.907	15.543	17.438	7.123	7.142	8.424
Arizona	19.316	19.782	18.987	9.242	9.376	10.023
Arkansas	21.851	21.380	22.182	9.013	9.155	8.536
California	15.034	16.038	16.622	8.651	8.811	8.810
Colorado	12.260	11.661	12.579	6.923	5.754	6.497
Connecticut	8.936	9.686	11.133	3.610	3.620	4.462
Delaware	12.720	13.982	14.724	6.051	6.473	6.976
District of Columbia	21.469	22.208	21.427	6.278	7.083	6.186
Florida	16.756	17.914	17.661	7.456	7.212	7.608
Georgia	19.033	20.487	20.568	9.365	9.255	9.497
Hawaii	15.758	16.266	17.731	8.674	9.200	10.594
Idaho	14.717	16.009	16.781	7.773	9.213	9.292
Illinois	14.863	16.199	16.147	6.899	7.952	7.969
Indiana	16.944	17.051	17.494	6.708	7.630	7.585
Iowa	11.320	12.109	12.201	6.254	6.650	6.055
Kansas	14.400	15.437	15.420	7.847	8.303	8.026
Kentucky	19.690	20.258	21.091	7.781	8.561	10.118
Louisiana	20.894	24.840	24.891	10.279	11.398	10.578
Maine	13.324	14.055	14.388	5.156	5.496	5.703
Maryland	11.476	12.644	12.285	5.027	5.351	5.597
Massachusetts	11.978	12.928	12.558	4.550	5.087	4.272
Michigan	15.941	16.955	16.579	6.744	6.630	6.745
Minnesota	10.719	10.856	10.857	6.134	5.285	4.705
Mississippi	27.110	26.896	23.003	11.421	11.782	9.752
Missouri	15.427	16.125	17.249	8.005	7.240	7.400
Montana	13.914	14.138	17.191	5.834	6.028	7.877
Nebraska	11.023	11.629	11.281	6.277	6.243	6.259
Nevada	13.154	15.373	16.664	6.236	7.262	7.743
New Hampshire	8.118	7.973	8.370	3.414	3.117	3.456
New Jersey	10.436	11.753	11.884	3.990	4.723	4.602
New Mexico	19.805	20.207	20.810	9.645	9.252	9.302
New York	17.341	17.767	18.289	7.491	7.374	7.681
North Carolina	17.806	19.090	19.339	8.194	9.132	8.971
North Dakota	10.432	9.788	9.598	5.186	4.650	4.635
Ohio	15.545	16.547	16.779	6.262	6.970	7.338
Oklahoma	16.259	18.761	17.496	8.186	9.328	8.758
Oregon	13.216	14.131	13.942	6.149	6.919	6.826
Pennsylvania	12.338	14.060	14.926	4.558	4.700	5.943
Rhode Island	15.357	14.927	15.554	6.677	6.136	5.683
South Carolina	18.658	20.651	22.475	6.921	8.205	9.235
South Dakota	13.498	13.947	15.659	6.743	7.056	7.973
Tennessee	20.205	19.856	19.773	10.479	9.490	8.627
Texas	20.380	21.023	19.895	11.603	11.256	10.811
Utah	10.699	11.847	12.232	6.729	7.161	7.489
Vermont	11.230	11.771	12.403	4.903	5.401	5.168
Virginia	12.416	12.664	13.002	5.818	5.693	5.972
Washington	11.369	12.106	12.890	5.005	5.152	6.297
West Virginia	19.534	21.053	22.022	5.529	6.225	8.111
Wisconsin	11.648	11.978	12.944	5.264	5.564	6.167
Wyoming	9.536	10.778	11.824	4.260	5.142	5.567

Source: CPS ASEC

Table A.6. Directly Estimated Number of People Eligible for SNAP

	Number of People Eligible for SNAP (Z_{1i})		
	2009	2010	2011
Alabama	991,958	1,012,636	943,876
Alaska	102,311	107,622	123,495
Arizona	1,259,209	1,316,587	1,252,489
Arkansas	621,821	614,236	643,666
California	5,527,569	5,952,486	6,238,595
Colorado	607,794	586,535	633,140
Connecticut	310,028	338,302	391,016
Delaware	111,769	123,316	132,120
District of Columbia	127,718	134,360	132,142
Florida	3,068,931	3,313,887	3,336,502
Georgia	1,835,058	2,006,058	1,999,207
Hawaii	197,379	204,197	233,871
Idaho	224,321	244,946	262,376
Illinois	1,895,139	2,084,332	2,060,108
Indiana	1,075,376	1,084,525	1,111,645
Iowa	338,944	359,696	367,931
Kansas	394,482	425,149	431,767
Kentucky	841,870	869,019	908,114
Louisiana	924,195	1,102,093	1,116,962
Maine	173,847	181,102	189,703
Maryland	646,669	722,210	711,344
Massachusetts	788,008	855,818	822,139
Michigan	1,564,585	1,658,663	1,611,434
Minnesota	555,465	563,468	571,136
Mississippi	776,582	782,485	674,604
Missouri	917,097	963,666	1,020,820
Montana	135,395	137,333	168,895
Nebraska	196,062	207,678	204,846
Nevada	344,661	405,480	445,451
New Hampshire	106,392	104,010	108,913
New Jersey	901,763	1,019,441	1,028,789
New Mexico	391,723	405,239	422,996
New York	3,333,295	3,422,294	3,534,772
North Carolina	1,660,280	1,770,146	1,825,824
North Dakota	65,822	62,065	63,843
Ohio	1,779,276	1,882,594	1,900,550
Oklahoma	587,999	687,361	655,037
Oregon	506,108	535,774	534,862
Pennsylvania	1,524,875	1,749,521	1,888,151
Rhode Island	159,029	155,824	161,864
South Carolina	839,128	933,741	1,031,769
South Dakota	107,940	112,266	126,884
Tennessee	1,259,878	1,250,259	1,251,664
Texas	5,001,484	5,262,120	5,069,750
Utah	298,489	334,288	344,642
Vermont	69,251	73,133	76,633
Virginia	964,803	984,312	1,030,346
Washington	758,382	813,617	875,737
West Virginia	352,263	380,370	400,998
Wisconsin	647,897	670,605	733,563
Wyoming	51,295	57,946	65,799
United States	47,921,618	51,024,814	51,872,779

Source: CPS ASEC

Table A.7. Directly Estimated Number of Working Poor Eligible for SNAP

	Number of Working Poor Eligible for SNAP (Z_{2i})		
	2009	2010	2011
Alabama	465,188	443,733	371,378
Alaska	48,888	49,455	59,658
Arizona	602,478	624,038	661,175
Arkansas	256,478	263,007	247,702
California	3,180,654	3,270,348	3,306,420
Colorado	343,207	289,445	326,999
Connecticut	125,234	126,433	156,703
Delaware	53,167	57,094	62,598
District of Columbia	37,348	42,852	38,150
Florida	1,365,578	1,334,177	1,437,298
Georgia	902,895	906,260	923,117
Hawaii	108,642	115,497	139,731
Idaho	118,486	140,970	145,275
Illinois	879,676	1,023,207	1,016,740
Indiana	425,733	485,286	481,996
Iowa	187,241	197,553	182,604
Kansas	214,955	228,666	224,736
Kentucky	332,700	367,243	435,643
Louisiana	454,661	505,686	474,679
Maine	67,278	70,811	75,185
Maryland	283,257	305,636	324,087
Massachusetts	299,324	336,764	279,658
Michigan	661,899	648,606	655,565
Minnesota	317,884	274,324	247,494
Mississippi	327,154	342,790	286,013
Missouri	475,860	432,705	437,918
Montana	56,766	58,557	77,387
Nebraska	111,651	111,491	113,659
Nevada	163,390	191,543	206,980
New Hampshire	44,742	40,665	44,978
New Jersey	344,757	409,612	398,421
New Mexico	190,768	185,536	189,076
New York	1,439,898	1,420,494	1,484,555
North Carolina	763,981	846,815	846,917
North Dakota	32,720	29,486	30,830
Ohio	716,718	793,001	831,156
Oklahoma	296,021	341,751	327,869
Oregon	235,482	262,324	261,878
Pennsylvania	563,358	584,867	751,759
Rhode Island	69,142	64,052	59,143
South Carolina	311,249	370,973	423,960
South Dakota	53,925	56,796	64,602
Tennessee	653,386	597,542	546,090
Texas	2,847,663	2,817,472	2,755,032
Utah	187,713	202,063	211,021
Vermont	30,236	33,557	31,929
Virginia	452,081	442,487	473,271
Washington	333,882	346,281	427,813
West Virginia	99,704	112,458	147,698
Wisconsin	292,771	311,523	349,482
Wyoming	22,913	27,646	30,978
United States	22,850,777	23,541,576	24,085,006

Source: CPS ASEC

Table A.8. CPS ASEC Population Estimate

	CPS ASEC Population Estimate (N_j)		
	2009	2010	2011
Alabama	4,681,853	4,671,044	4,741,902
Alaska	686,336	692,426	708,197
Arizona	6,518,949	6,655,573	6,596,667
Arkansas	2,845,689	2,872,987	2,901,802
California	36,768,337	37,116,095	37,531,572
Colorado	4,957,557	5,029,970	5,033,282
Connecticut	3,469,348	3,492,676	3,512,264
Delaware	878,713	881,976	897,332
District of Columbia	594,910	605,004	616,721
Florida	18,315,693	18,499,302	18,891,459
Georgia	9,641,699	9,791,728	9,720,036
Hawaii	1,252,551	1,255,342	1,319,019
Idaho	1,524,241	1,530,103	1,563,505
Illinois	12,750,675	12,867,072	12,758,133
Indiana	6,346,495	6,360,530	6,354,345
Iowa	2,994,194	2,970,603	3,015,696
Kansas	2,739,379	2,754,112	2,799,968
Kentucky	4,275,591	4,289,815	4,305,702
Louisiana	4,423,165	4,436,830	4,487,373
Maine	1,304,766	1,288,490	1,318,457
Maryland	5,634,989	5,711,861	5,790,412
Massachusetts	6,578,826	6,619,785	6,546,509
Michigan	9,814,969	9,782,510	9,719,920
Minnesota	5,182,252	5,190,312	5,260,492
Mississippi	2,864,569	2,909,349	2,932,737
Missouri	5,944,670	5,976,228	5,918,064
Montana	973,075	971,360	982,483
Nebraska	1,778,700	1,785,936	1,815,826
Nevada	2,620,159	2,637,570	2,673,123
New Hampshire	1,310,623	1,304,588	1,301,272
New Jersey	8,640,884	8,673,611	8,656,871
New Mexico	1,977,953	2,005,465	2,032,683
New York	19,222,562	19,262,505	19,327,668
North Carolina	9,324,114	9,272,876	9,440,960
North Dakota	630,948	634,076	665,142
Ohio	11,445,765	11,377,222	11,326,907
Oklahoma	3,616,398	3,663,873	3,743,869
Oregon	3,829,629	3,791,587	3,836,287
Pennsylvania	12,358,765	12,443,294	12,649,964
Rhode Island	1,035,539	1,043,900	1,040,629
South Carolina	4,497,380	4,521,483	4,590,845
South Dakota	799,695	804,926	810,279
Tennessee	6,235,438	6,296,594	6,330,304
Texas	24,541,612	25,030,026	25,482,626
Utah	2,789,792	2,821,737	2,817,646
Vermont	616,671	621,288	617,878
Virginia	7,770,413	7,772,534	7,924,694
Washington	6,670,543	6,721,065	6,793,763
West Virginia	1,803,344	1,806,703	1,820,882
Wisconsin	5,562,297	5,598,651	5,667,177
Wyoming	537,929	537,624	556,507
United States	303,580,643	305,652,216	308,147,849

Source: CPS ASEC

Table A.9. Population on July 1

	Population on July 1 (T_j)		
	2009	2010	2011
Alabama	4,708,708	4,784,762	4,803,689
Alaska	698,473	714,046	723,860
Arizona	6,595,778	6,410,810	6,467,315
Arkansas	2,889,450	2,922,750	2,938,582
California	36,961,664	37,334,410	37,683,933
Colorado	5,024,748	5,048,472	5,116,302
Connecticut	3,518,288	3,576,616	3,586,717
Delaware	885,122	899,824	908,137
District of Columbia	599,657	604,989	619,020
Florida	18,537,969	18,845,967	19,082,262
Georgia	9,829,211	9,714,748	9,812,460
Hawaii	1,295,178	1,364,274	1,378,129
Idaho	1,545,801	1,570,784	1,583,744
Illinois	12,910,409	12,840,459	12,859,752
Indiana	6,423,113	6,489,856	6,516,353
Iowa	3,007,856	3,050,321	3,064,097
Kansas	2,818,747	2,858,837	2,870,386
Kentucky	4,314,113	4,346,655	4,366,814
Louisiana	4,492,076	4,544,125	4,574,766
Maine	1,318,301	1,327,585	1,328,544
Maryland	5,699,478	5,787,998	5,839,572
Massachusetts	6,593,587	6,563,259	6,607,003
Michigan	9,969,727	9,877,670	9,876,801
Minnesota	5,266,214	5,310,737	5,347,299
Mississippi	2,951,996	2,969,137	2,977,457
Missouri	5,987,580	5,996,092	6,008,984
Montana	974,989	990,735	997,667
Nebraska	1,796,619	1,829,696	1,842,234
Nevada	2,643,085	2,703,758	2,720,028
New Hampshire	1,324,575	1,316,843	1,317,807
New Jersey	8,707,739	8,803,388	8,834,773
New Mexico	2,009,671	2,064,767	2,078,674
New York	19,541,453	19,399,242	19,501,616
North Carolina	9,380,884	9,559,048	9,651,103
North Dakota	646,844	674,363	684,740
Ohio	11,542,645	11,538,290	11,541,007
Oklahoma	3,687,050	3,759,482	3,784,163
Oregon	3,825,657	3,838,212	3,868,229
Pennsylvania	12,604,767	12,711,308	12,743,948
Rhode Island	1,053,209	1,052,769	1,050,646
South Carolina	4,561,242	4,635,835	4,673,348
South Dakota	812,383	816,223	823,593
Tennessee	6,296,254	6,356,673	6,399,787
Texas	24,782,302	25,242,683	25,631,778
Utah	2,784,572	2,775,093	2,814,347
Vermont	621,760	625,916	626,592
Virginia	7,882,590	8,025,105	8,104,384
Washington	6,664,195	6,743,636	6,823,267
West Virginia	1,819,777	1,854,019	1,854,908
Wisconsin	5,654,774	5,689,591	5,709,843
Wyoming	544,270	564,367	567,356
United States	307,006,550	309,326,225	311,587,816

Source: U.S. Census Bureau, Population Division

Table A.10. Percentage of Working Poor Participants Without Reported Earned Income But with Other Indicators of Earnings

	Percentage of Working Poor Participants Without Reported Earned Income		
	2009	2010	2011
Alabama	0.0	0.3	0.0
Alaska	0.5	0.0	0.0
Arizona	0.0	0.0	0.0
Arkansas	2.3	2.6	2.0
California	0.0	0.0	0.3
Colorado	0.0	0.1	0.0
Connecticut	0.6	3.4	1.4
Delaware	0.0	0.9	0.0
District of Columbia	0.0	1.6	0.0
Florida	0.0	0.0	0.8
Georgia	0.0	0.0	0.0
Hawaii	1.0	0.3	0.0
Idaho	0.0	0.0	0.0
Illinois	0.0	0.0	0.0
Indiana	0.0	0.0	0.0
Iowa	0.7	0.5	0.0
Kansas	0.0	0.0	0.0
Kentucky	0.0	0.4	0.0
Louisiana	0.0	0.2	0.0
Maine	0.0	0.0	0.0
Maryland	0.0	0.0	0.3
Massachusetts	1.1	0.7	0.0
Michigan	0.0	0.0	0.0
Minnesota	2.0	0.4	1.5
Mississippi	0.0	0.0	0.1
Missouri	0.1	0.0	0.4
Montana	0.3	0.7	0.0
Nebraska	0.0	0.6	0.0
Nevada	0.0	0.5	0.0
New Hampshire	0.5	0.2	0.9
New Jersey	0.2	0.7	0.0
New Mexico	0.0	0.0	0.2
New York	0.0	0.0	0.0
North Carolina	0.0	0.0	0.0
North Dakota	0.0	0.0	0.0
Ohio	0.0	0.0	0.0
Oklahoma	0.0	0.3	0.0
Oregon	0.7	0.0	0.0
Pennsylvania	3.5	0.9	1.9
Rhode Island	0.0	0.8	0.8
South Carolina	0.5	0.2	0.0
South Dakota	0.0	0.0	0.0
Tennessee	0.0	0.0	0.0
Texas	0.1	0.1	0.0
Utah	0.0	0.0	0.0
Vermont	0.1	0.3	0.0
Virginia	0.4	0.0	0.0
Washington	0.0	0.0	0.0
West Virginia	0.0	0.0	0.0
Wisconsin	0.0	0.0	0.0
Wyoming	0.0	0.0	0.0

Table A.11. Direct Sample Estimates of SNAP Participation Rates

	Direct Sample Estimates of SNAP Participation Rates (Percent)					
	All Eligible People ($Y_{1,i}$)			Working Poor ($Y_{2,i}$)		
	2009	2010	2011	2009	2010	2011
Alabama	66.695	74.388	86.953	57.130	67.424	78.171
Alaska	61.026	68.665	67.756	58.720	66.329	58.356
Arizona	56.922	69.612	73.583	48.836	58.725	64.030
Arkansas	63.436	72.346	72.694	65.459	69.259	79.650
California	47.230	51.851	55.826	31.374	39.647	41.798
Colorado	51.309	68.496	66.993	36.362	59.893	57.268
Connecticut	78.222	82.031	82.281	57.690	67.784	62.543
Delaware	72.400	78.297	87.188	63.272	67.100	72.521
District of Columbia	79.233	83.953	96.042	32.789	36.456	43.401
Florida	62.674	75.562	84.749	46.818	65.041	64.451
Georgia	66.721	76.387	83.769	59.137	69.333	80.523
Hawaii	55.094	61.496	57.550	42.662	44.744	41.614
Idaho	58.288	73.508	81.373	56.210	67.956	79.866
Illinois	73.334	76.026	80.510	54.450	58.035	62.799
Indiana	62.823	72.850	75.913	70.406	66.690	75.756
Iowa	84.479	90.693	90.969	77.447	82.392	90.306
Kansas	52.529	59.854	66.266	42.189	53.380	64.025
Kentucky	81.251	85.372	85.663	59.999	62.632	57.008
Louisiana	74.656	69.749	74.052	63.395	68.794	72.841
Maine	102.830	104.937	110.296	92.693	94.559	109.614
Maryland	61.966	66.925	79.009	51.487	54.867	56.216
Massachusetts	70.763	76.664	84.789	51.532	46.515	69.255
Michigan	80.647	91.157	103.844	75.455	90.907	114.969
Minnesota	57.652	70.115	77.634	39.683	63.217	73.950
Mississippi	62.605	70.918	87.035	60.657	65.225	81.524
Missouri	84.075	91.298	89.299	62.772	84.982	79.888
Montana	65.124	72.984	65.026	68.521	79.117	62.564
Nebraska	67.094	75.004	82.141	56.017	69.222	70.222
Nevada	53.475	57.687	64.004	43.165	45.283	55.067
New Hampshire	69.501	85.513	86.687	53.610	79.951	76.819
New Jersey	54.141	56.839	64.795	42.040	45.065	64.661
New Mexico	71.858	81.728	88.177	72.963	82.932	96.391
New York	62.220	72.959	75.484	53.008	63.887	62.599
North Carolina	67.511	72.242	73.557	58.676	59.774	56.957
North Dakota	69.065	76.984	77.306	63.652	84.067	76.499
Ohio	71.833	78.138	85.206	66.610	65.754	69.238
Oklahoma	76.583	78.944	89.130	65.071	60.240	78.042
Oregon	96.440	108.791	117.906	83.864	92.035	100.820
Pennsylvania	79.621	79.662	82.361	75.514	87.620	75.246
Rhode Island	60.073	78.888	86.552	41.166	61.658	79.819
South Carolina	75.944	79.496	77.003	73.721	81.373	74.604
South Dakota	66.489	81.437	76.656	65.394	77.289	74.170
Tennessee	82.852	95.406	97.193	61.832	73.187	77.527
Texas	53.670	61.140	70.569	42.851	56.114	64.377
Utah	60.047	73.866	80.563	45.946	60.932	68.222
Vermont	86.158	86.023	89.461	77.237	64.596	65.522
Virginia	64.335	74.704	79.945	55.996	69.171	72.648
Washington	86.990	100.245	100.827	68.105	87.962	74.867
West Virginia	82.604	81.107	78.480	103.767	101.278	79.539
Wisconsin	71.148	88.560	88.932	73.713	85.068	80.973
Wyoming	50.044	55.810	51.007	46.048	51.362	51.532

Table A.12. Standard Errors of Direct Sample Estimates of SNAP Participation Rates

	Standard Errors of Direct Sample Estimates of SNAP Participation Rates					
	All Eligible People			Working Poor		
	2009	2010	2011	2009	2010	2011
Alabama	4.247	5.708	6.152	6.375	8.511	10.112
Alaska	4.010	4.717	5.524	7.074	8.006	6.818
Arizona	3.546	4.174	5.010	5.012	6.528	7.989
Arkansas	5.215	5.236	4.380	6.998	5.700	7.562
California	1.183	1.249	1.271	1.757	2.150	2.397
Colorado	3.203	4.449	4.271	3.154	5.510	5.495
Connecticut	4.937	5.227	5.450	6.767	8.406	7.633
Delaware	4.519	4.812	5.456	6.430	7.916	7.697
District of Columbia	3.797	3.885	5.338	5.419	5.317	7.441
Florida	2.319	2.464	2.923	3.648	5.008	5.528
Georgia	2.977	2.936	3.890	4.196	5.031	6.747
Hawaii	3.570	3.800	3.645	4.219	4.382	4.193
Idaho	7.224	5.754	6.544	6.333	6.366	8.766
Illinois	2.900	3.233	3.391	4.577	4.535	4.855
Indiana	3.788	4.378	4.677	5.780	5.477	7.245
Iowa	6.912	4.436	6.216	9.217	6.016	7.430
Kansas	4.682	4.662	4.096	4.214	5.122	4.984
Kentucky	5.225	6.628	4.576	6.033	7.510	6.381
Louisiana	6.406	3.376	3.936	7.899	5.371	7.646
Maine	6.844	7.848	6.797	10.504	11.104	10.848
Maryland	3.603	3.671	4.106	5.317	5.805	5.287
Massachusetts	5.477	5.477	5.376	7.223	6.493	8.513
Michigan	3.853	4.686	5.047	6.885	8.961	10.062
Minnesota	5.104	4.557	5.804	7.015	6.166	9.195
Mississippi	2.933	3.700	5.478	5.042	4.874	9.642
Missouri	4.709	6.354	8.013	6.489	7.983	9.508
Montana	6.963	6.042	6.081	10.722	9.286	7.312
Nebraska	4.619	4.583	7.494	5.564	6.220	6.921
Nevada	3.774	3.251	3.982	4.918	4.718	6.038
New Hampshire	5.259	6.682	7.069	6.663	10.008	11.375
New Jersey	3.700	3.913	3.756	5.026	5.426	7.337
New Mexico	5.181	5.417	5.607	8.441	8.880	10.732
New York	2.083	2.717	2.740	4.064	5.785	5.640
North Carolina	3.223	3.128	4.313	5.507	5.759	5.163
North Dakota	10.810	7.703	7.507	10.423	11.206	9.032
Ohio	3.157	4.004	4.778	5.038	5.078	6.549
Oklahoma	5.442	4.704	5.472	6.458	5.755	9.346
Oregon	5.708	6.290	7.588	8.481	9.039	12.207
Pennsylvania	4.002	3.196	3.542	7.592	7.800	7.144
Rhode Island	3.316	4.649	5.242	4.464	6.908	9.578
South Carolina	4.091	3.814	3.486	7.808	6.662	7.518
South Dakota	9.180	7.462	10.139	7.356	7.648	10.326
Tennessee	5.851	5.807	7.572	5.534	7.152	9.014
Texas	1.761	1.786	2.263	2.391	2.781	3.762
Utah	4.666	5.470	5.605	5.264	6.674	6.778
Vermont	6.046	6.160	6.306	9.437	8.344	9.207
Virginia	5.685	5.834	4.640	5.941	6.819	6.685
Washington	6.211	5.695	6.303	8.594	11.171	8.374
West Virginia	5.618	6.571	5.081	11.123	16.271	8.000
Wisconsin	4.438	6.054	6.119	6.387	8.550	9.470
Wyoming	3.589	4.816	4.212	5.943	6.772	5.089

Table A.13. Potential Predictors

Predictor	Data Source(s)
Number of people who received SNAP benefits	Administrative data
Population on July 1; Change in July 1 population	Census Bureau population estimates
Percentages of population that 1) received SNAP benefits, 2) correctly received regular SNAP benefits, 3) correctly received regular SNAP benefits under federal eligibility rules	Administrative data; population estimates
Percentage of children age 5 to 17 approved to receive free lunches under the National School Lunch Program	
Percentage of elderly individuals that received Supplemental Security Income	
Percentage of population that received unemployment	
Per capita personal income	Commerce Bureau estimates; population estimates
Mean adjusted gross income (AGI); Median AGI	Individual income tax data
Percentages of exemptions for all individuals, elderly individuals, and children claimed on tax returns with AGI below the federal poverty level (FPL)	
Percentages of all individuals, elderly individuals, and nonelderly individuals not claimed on tax returns	Individual income tax data; population estimates
Percentages of all individuals, elderly individuals, and nonelderly individuals not claimed on tax returns or claimed on returns with AGI below the FPL	
Four measures of state eligibility policy expansiveness; Four measures of state eligibility policy expansiveness in the previous year	State SNAP eligibility policies
Percentage of population that was foreign-born and entered the U.S. in 2000 or later; Percentage of population that was noncitizens	American Community Survey one-year estimates
Percentage of foreign-born individuals who entered the U.S. in 2000 or later	
Percentages of households that were married-couple families, were nonfamily households, and had one or more children under age 18	
Percentages of households and families that had a female householder, no husband present, and related children under age18	
Percentages of adults age 25 and over who had completed high school or equivalent and who had completed a bachelor's degree	
Employment/population ratio for the civilian population age 16 to 64	
Percentages of civilian employed population age 16 and over who were in service occupations and were private wage and salary workers	
Percentage of households that had earnings	
Percentage of occupied housing units that were owner-occupied	
Percentages of renter-occupied housing units that spent 30 percent or more and 50 percent or more of household income on rent and utilities	
Lower rent quartile among renter-occupied housing units paying cash rent	
Median monthly housing costs among occupied housing units with cost	
Median household income; Median family income	
Percentages of population with income under 100 and 200 percent of the FPL	
Percentages of children with income under 50 and 100 percent of the FPL	
Percentage of adults age 18 to 64 under 100 and 125 percent of the FPL	
Percentage of adults age 65 and over under 125 and 200 percent of the FPL	
Percentage of families with income under 130 percent of the FPL	

Table A.14. Definitions and Data Sources for Selected Predictors

Predictor	Definition	Principal Data Source[a]
SNAP prevalence rate (adjusted for disasters and errors)	$100 \times \frac{\text{Individuals correctly receiving SNAP benefits under regular program rules}}{\text{Resident population}}$	Counts of people receiving SNAP benefits are from SNAP Program Operations and Quality Control data.
Free lunch rate	$100 \times \frac{\text{Children approved to receive free lunches under the National School Lunch Program}}{\text{Resident population age 5 to 17}}$	Counts of children approved to receive a free lunch under the NSLP are from Program Operations data.
Median adjusted gross income	$\frac{\text{Median adjusted gross income}}{\text{Averaged poverty guidelines}}$	Income data were obtained from the Census Bureau.
Median family income	$\frac{\text{Median family income in inflation-adjusted dollars}}{10{,}000}$	The data for constructing these predictors were obtained from the American Community Survey One-Year Estimates available at http://factfinder2.census.gov/faces/nav/jsf/pages/index.xhtml
Bachelor's degree rate	$100 \times \frac{\text{Number of adults age 25 and over who have completed a bachelor's degree}}{\text{Number of adults age 25 and over}}$	
Rate of children with income under 50 percent of poverty	$100 \times \frac{\text{Children age 18 and under with income under 50 percent of the poverty level}}{\text{Total children age 18 and under}}$	
Single mother household rate	$100 \times \frac{\text{Female-headed households with no husband present and related children under age 18}}{\text{Total households}}$	

[a] For the 2010 and 2011 estimates of the resident population, we used the July 1 population estimates released by the Census Bureau in June 2013, available at http://www.census.gov/popest/. For the 2009 estimates of the resident population, we used estimates released by the Census Bureau in May 2010.

Table A.15. Values for 2009 Predictors

	Values for 2009 Predictors						
	SNAP prevalence rate (adjusted)	Free lunch rate	Median adjusted gross income	Bachelor's degree rate	Median family income	Child 50 percent of poverty rate	Single mother household rate
Alabama	14.131	42.578	2.810	22.0	5.08	11.2	10.4
Alaska	9.110	31.845	3.186	26.6	7.99	5.3	8.5
Arizona	12.005	34.644	3.086	25.6	5.79	10.6	8.4
Arkansas	13.866	44.590	2.701	18.9	4.69	12.0	9.9
California	7.157	42.507	3.361	29.9	6.70	7.9	8.4
Colorado	6.290	25.390	3.670	35.9	6.89	7.8	6.9
Connecticut	7.156	22.501	4.311	35.6	8.31	5.6	8.5
Delaware	10.232	36.798	3.613	28.7	6.76	7.2	9.2
District of Columbia	17.010	49.605	3.925	48.5	7.12	18.8	10.9
Florida	10.501	38.479	2.709	25.3	5.35	9.2	8.4
Georgia	12.936	41.766	2.706	27.5	5.62	9.9	10.9
Hawaii	8.682	28.341	2.905	29.6	7.51	5.2	7.6
Idaho	8.687	28.368	2.962	23.9	5.19	7.0	6.9
Illinois	10.900	34.384	3.508	30.6	6.68	8.5	8.4
Indiana	10.648	32.105	3.114	22.5	5.64	8.9	8.4
Iowa	9.572	27.460	3.499	25.1	6.12	6.3	6.9
Kansas	7.564	33.628	3.337	29.5	6.10	6.8	7.5
Kentucky	16.004	48.481	2.951	21.0	4.98	12.3	9.3
Louisiana	15.599	51.968	2.839	21.4	5.34	10.5	11.3
Maine	15.079	30.255	3.177	26.9	5.66	7.4	7.1
Maryland	7.827	24.150	4.254	35.7	8.43	5.3	9.3
Massachusetts	9.374	24.711	4.120	38.2	8.10	6.2	7.3
Michigan	14.359	33.458	3.091	24.6	5.67	10.7	8.4
Minnesota	6.420	25.406	3.815	31.5	6.94	6.3	6.5
Mississippi	16.972	54.270	2.494	19.6	4.56	14.0	12.7
Missouri	13.030	32.451	3.115	25.2	5.63	10.3	8.8
Montana	9.337	25.717	2.830	27.4	5.50	10.5	6.3
Nebraska	7.396	26.317	3.394	27.4	6.01	5.6	7.1
Nevada	7.393	30.701	3.154	21.8	6.08	7.5	8.5
New Hampshire	5.830	15.052	3.975	32.0	7.39	4.5	6.4
New Jersey	5.658	24.267	4.208	34.5	8.34	6.0	8.1
New Mexico	14.234	49.685	2.727	25.3	5.20	10.3	9.4
New York	11.589	38.026	3.409	32.4	6.69	9.6	9.1
North Carolina	12.021	38.154	2.974	26.5	5.43	10.2	9.2
North Dakota	8.077	19.632	3.470	25.8	6.35	5.7	5.4
Ohio	11.712	30.454	3.213	24.1	5.74	10.3	8.8
Oklahoma	12.531	46.874	2.960	22.7	5.24	9.5	8.8
Oregon	15.061	34.576	3.193	29.2	5.92	8.1	7.1
Pennsylvania	10.315	26.440	3.418	26.4	6.22	7.6	7.5
Rhode Island	9.516	31.333	3.468	30.5	6.94	8.0	8.7
South Carolina	14.690	43.784	2.776	24.3	5.24	11.5	10.2
South Dakota	9.072	28.843	3.185	25.1	5.78	7.6	7.7
Tennessee	16.740	41.215	2.824	23.0	5.13	11.2	9.1
Texas	11.850	55.661	3.030	25.5	5.66	10.6	10.1
Utah	6.447	23.088	3.477	28.5	6.29	4.9	6.5
Vermont	11.333	24.901	3.236	33.1	6.35	6.1	6.9
Virginia	7.994	25.183	3.936	34.0	7.13	6.7	7.9
Washington	11.329	28.066	3.789	31.0	6.84	7.0	7.0
West Virginia	16.596	45.749	2.908	17.3	4.77	11.2	7.0
Wisconsin	9.639	26.954	3.449	25.7	6.26	6.9	7.2
Wyoming	4.772	20.963	3.759	23.8	6.55	3.3	5.8

Table A.16. Values for 2010 Predictors

	Values for 2010 Predictors						
	SNAP prevalence rate (adjusted)	Free lunch rate	Median adjusted gross income	Bachelor's degree rate	Median family income	Child 50 percent of poverty rate	Single mother household rate
Alabama	16.432	45.141	2.782	21.9	5.04	12.9	10.3
Alaska	10.672	29.393	3.121	27.9	7.70	4.5	8.7
Arizona	15.498	40.264	3.029	25.9	5.54	11.7	8.8
Arkansas	15.472	46.547	2.710	19.5	4.70	11.8	9.9
California	8.588	45.587	3.289	30.1	6.55	9.3	8.7
Colorado	7.987	29.853	3.630	36.4	6.78	7.5	7.3
Connecticut	8.983	23.804	4.255	35.5	8.12	6.2	8.6
Delaware	12.455	40.465	3.548	27.8	6.87	7.6	9.5
District of Columbia	19.116	65.948	3.866	50.1	7.75	16.2	8.7
Florida	13.726	41.104	2.567	25.8	5.31	10.4	8.5
Georgia	16.275	47.620	2.636	27.3	5.52	11.3	10.7
Hawaii	10.003	28.793	2.882	29.5	7.61	7.2	7.0
Idaho	12.147	32.477	2.960	24.4	5.23	7.5	7.3
Illinois	12.706	37.540	3.489	30.8	6.54	8.6	8.4
Indiana	12.422	34.792	3.122	22.7	5.54	9.8	8.7
Iowa	10.982	28.884	3.543	24.9	6.09	6.7	6.6
Kansas	9.240	32.733	3.352	29.8	6.10	7.9	7.7
Kentucky	17.459	45.016	2.943	20.5	5.04	12.6	8.8
Louisiana	17.532	52.876	2.821	21.4	5.25	12.3	12.0
Maine	17.201	33.495	3.172	26.8	5.82	6.3	7.0
Maryland	9.420	27.674	4.213	36.1	8.31	6.9	9.4
Massachusetts	11.217	26.254	4.087	39.0	7.87	6.6	8.1
Michigan	17.871	36.954	3.056	25.2	5.61	10.8	8.6
Minnesota	7.995	27.167	3.826	31.8	6.96	6.4	6.7
Mississippi	19.259	57.313	2.443	19.5	4.55	15.5	12.4
Missouri	14.781	35.507	3.092	25.6	5.62	9.6	8.0
Montana	11.249	31.273	2.890	28.8	5.45	9.6	6.1
Nebraska	8.722	29.840	3.418	28.6	6.08	7.2	7.0
Nevada	9.996	35.394	3.035	21.7	6.02	10.0	8.4
New Hampshire	7.811	17.830	3.946	32.8	7.46	4.8	5.8
New Jersey	6.972	25.771	4.131	35.4	8.24	6.4	7.9
New Mexico	16.955	47.636	2.711	25.0	5.10	13.0	9.6
New York	13.936	40.403	3.359	32.5	6.59	10.1	9.1
North Carolina	13.951	39.992	2.955	26.5	5.29	11.5	9.5
North Dakota	8.749	20.735	3.638	27.6	6.52	7.9	5.8
Ohio	13.811	33.081	3.205	24.6	5.65	11.6	8.8
Oklahoma	15.166	49.397	2.978	22.9	5.20	10.7	8.9
Oregon	18.091	35.726	3.197	28.8	5.67	9.5	7.4
Pennsylvania	12.269	27.799	3.419	27.1	6.19	8.4	7.8
Rhode Island	12.934	33.563	3.433	30.2	6.78	8.3	8.8
South Carolina	16.892	46.289	2.757	24.5	5.17	13.3	10.5
South Dakota	11.602	31.038	3.250	26.3	6.00	7.8	7.1
Tennessee	18.944	43.580	2.794	23.1	5.11	12.2	9.3
Texas	14.030	50.288	3.009	25.9	5.66	10.6	10.3
Utah	8.751	26.556	3.437	29.3	6.16	6.5	6.5
Vermont	13.361	27.849	3.227	33.6	6.26	7.2	6.2
Virginia	9.461	27.512	3.905	34.2	7.25	6.2	8.0
Washington	14.056	31.568	3.771	31.1	6.73	7.8	7.1
West Virginia	17.872	47.232	2.913	17.5	4.89	10.9	7.0
Wisconsin	12.499	29.511	3.482	26.3	6.21	7.7	7.3
Wyoming	6.015	24.310	3.763	24.1	6.58	4.7	6.1

Table A.17. Values for 2011 Predictors

	Values for 2011 Predictors						
	SNAP prevalence rate (adjusted)	Free lunch rate	Median adjusted gross income	Bachelor's degree rate	Median family income	Child 50 percent of poverty rate	Single mother household rate
Alabama	17.795	47.355	2.805	22.3	5.20	12.1	10.1
Alaska	11.815	32.966	3.169	26.4	7.58	6.9	8.8
Arizona	16.216	40.522	3.039	26.6	5.53	12.3	9.0
Arkansas	16.125	47.362	2.749	20.3	4.87	12.6	9.5
California	9.701	45.654	3.310	30.3	6.55	9.5	8.7
Colorado	8.743	31.877	3.660	36.7	6.91	8.1	6.8
Connecticut	10.276	25.820	4.289	36.2	8.31	6.8	8.7
Delaware	14.650	45.612	3.576	28.8	6.97	8.7	8.9
District of Columbia	21.701	66.077	3.969	52.5	7.56	16.5	10.3
Florida	16.113	45.117	2.615	25.8	5.40	10.8	8.4
Georgia	17.936	48.682	2.651	27.6	5.50	11.6	10.6
Hawaii	11.488	32.272	2.914	29.1	7.42	8.6	7.3
Idaho	14.274	35.599	2.997	25.2	5.28	8.8	6.7
Illinois	13.841	38.907	3.514	31.0	6.56	9.8	8.4
Indiana	13.280	36.716	3.147	23.0	5.71	11.6	9.0
Iowa	12.095	30.614	3.624	25.8	6.28	8.1	6.8
Kansas	10.225	37.652	3.379	30.1	6.19	7.4	7.6
Kentucky	18.576	49.846	2.967	21.1	5.19	13.2	8.8
Louisiana	19.010	54.778	2.830	21.1	5.36	14.4	11.7
Maine	18.554	35.113	3.196	28.4	5.84	6.9	6.7
Maryland	11.318	29.888	4.225	36.9	8.38	7.1	9.6
Massachusetts	12.216	28.582	4.123	39.1	8.04	7.3	8.1
Michigan	19.485	38.585	3.055	25.6	5.81	11.7	8.2
Minnesota	9.319	28.720	3.890	32.4	7.13	6.4	6.7
Mississippi	20.595	58.465	2.459	19.8	4.63	15.2	12.7
Missouri	15.472	33.184	3.103	26.1	5.66	10.4	8.6
Montana	12.294	30.455	2.966	28.2	5.62	8.5	6.1
Nebraska	9.266	31.656	3.483	27.9	6.35	8.4	7.1
Nevada	12.042	40.582	3.047	22.5	5.65	9.6	8.8
New Hampshire	8.507	19.760	3.971	33.4	7.66	6.3	6.5
New Jersey	8.482	28.072	4.158	35.3	8.23	7.0	8.4
New Mexico	19.719	49.581	2.751	25.6	5.17	14.2	9.9
New York	15.162	42.000	3.381	32.9	6.69	10.3	9.3
North Carolina	16.207	41.643	2.962	26.9	5.41	11.5	9.6
North Dakota	8.701	20.919	3.819	26.3	6.69	7.2	6.0
Ohio	15.249	36.085	3.249	24.7	5.86	11.6	8.9
Oklahoma	15.990	50.414	3.058	23.8	5.37	10.6	8.7
Oregon	19.706	40.433	3.248	29.3	5.84	9.9	6.6
Pennsylvania	13.391	29.466	3.471	27.0	6.33	9.2	7.7
Rhode Island	14.849	36.926	3.457	31.1	6.96	10.6	8.9
South Carolina	17.845	48.241	2.787	24.1	5.22	13.1	10.1
South Dakota	12.199	32.046	3.290	26.3	6.21	7.7	7.6
Tennessee	19.237	45.891	2.821	23.6	5.23	12.0	8.8
Texas	15.397	52.783	3.068	26.4	5.80	11.1	10.2
Utah	9.937	31.309	3.503	29.7	6.28	6.1	7.2
Vermont	14.282	30.450	3.284	35.4	6.62	5.4	6.3
Virginia	10.406	29.466	3.939	35.1	7.45	7.1	8.0
Washington	15.242	33.817	3.825	31.9	6.86	8.0	7.1
West Virginia	18.098	48.073	2.975	18.5	4.97	11.7	7.2
Wisconsin	13.974	33.372	3.519	26.5	6.37	7.9	7.1
Wyoming	6.031	25.614	3.750	24.7	6.86	6.2	6.3

Table A.18. Regression Estimates of SNAP Participation Rates

	Regression Estimates of SNAP Participation Rates (Percent)					
	All Eligible People			Working Poor		
	2009	2010	2011	2009	2010	2011
Alabama	68.776	74.323	82.119	63.517	68.174	75.689
Alaska	58.803	66.837	66.826	52.095	57.367	57.467
Arizona	67.322	79.44	80.669	58.484	69.665	71.697
Arkansas	65.106	71.305	73.631	62.127	67.992	70.263
California	45.736	49.933	54.390	30.682	38.225	42.962
Colorado	54.376	65.717	65.219	36.192	53.587	51.626
Connecticut	65.785	73.182	80.320	49.362	58.129	64.493
Delaware	67.103	70.736	81.774	55.282	58.295	66.217
District of Columbia	78.997	84.957	96.866	35.286	39.549	46.881
Florida	57.035	69.657	75.373	49.272	63.139	66.365
Georgia	62.410	72.236	80.115	52.794	62.156	69.244
Hawaii	57.838	62.624	59.322	49.088	51.145	46.228
Idaho	61.456	77.299	83.167	57.834	74.364	78.879
Illinois	69.655	76.097	79.901	55.328	62.604	66.352
Indiana	64.485	71.293	69.964	60.865	67.747	66.532
Iowa	72.656	79.326	81.998	66.647	73.035	76.398
Kansas	56.186	65.720	68.740	44.335	58.557	61.487
Kentucky	78.880	83.413	85.451	70.664	74.996	75.835
Louisiana	72.913	71.808	77.949	66.165	63.823	68.605
Maine	96.519	101.816	109.409	87.548	90.320	98.430
Maryland	66.887	69.582	81.156	50.756	52.757	63.359
Massachusetts	76.892	82.717	86.800	55.764	63.794	66.790
Michigan	80.557	92.903	97.384	72.883	82.269	85.103
Minnesota	59.937	69.395	75.139	46.562	58.926	64.942
Mississippi	66.928	70.228	78.841	61.834	63.406	72.260
Missouri	74.186	83.372	85.091	66.867	75.089	79.663
Montana	57.924	73.738	75.133	49.139	66.972	69.897
Nebraska	61.562	67.603	64.901	54.510	61.697	59.662
Nevada	49.099	57.542	65.838	47.679	54.350	63.860
New Hampshire	64.994	77.061	73.993	54.785	66.515	63.979
New Jersey	55.405	62.695	68.503	39.471	47.671	53.760
New Mexico	70.066	76.759	85.473	58.605	66.814	73.010
New York	67.556	75.723	80.740	50.339	59.945	64.112
North Carolina	65.164	72.109	81.160	55.543	65.452	73.607
North Dakota	70.460	74.196	73.554	65.310	67.931	71.078
Ohio	68.421	76.871	80.987	62.826	70.744	74.235
Oklahoma	66.982	73.939	80.344	58.723	64.760	71.642
Oregon	93.467	101.161	106.777	80.118	87.227	90.238
Pennsylvania	72.074	80.083	82.931	64.951	72.867	76.119
Rhode Island	62.315	77.054	80.232	49.815	64.816	64.635
South Carolina	70.752	75.013	79.614	62.224	66.474	70.862
South Dakota	62.054	76.344	77.183	56.627	69.458	72.428
Tennessee	86.289	89.366	90.872	78.803	79.681	81.102
Texas	55.764	65.446	73.074	42.043	55.359	61.921
Utah	60.611	71.524	74.783	53.023	65.560	70.083
Vermont	80.947	89.788	93.606	67.513	76.888	79.673
Virginia	66.454	73.856	77.441	50.967	61.199	64.078
Washington	83.239	91.075	97.514	69.168	75.494	82.011
West Virginia	89.249	89.029	88.983	84.481	79.966	82.001
Wisconsin	70.434	82.364	88.018	63.984	74.153	79.672
Wyoming	58.981	63.623	58.695	56.802	61.025	58.070

Table A.19. Standard Errors of Regression Estimates of SNAP Participation Rates

	Standard Errors of Regression Estimates of SNAP Participation Rates					
	All Eligible People			Working Poor		
	2009	2010	2011	2009	2010	2011
Alabama	3.644	3.656	3.652	4.847	4.862	4.915
Alaska	4.569	4.600	4.618	6.268	6.389	6.119
Arizona	3.581	3.550	3.693	4.780	4.709	4.990
Arkansas	3.740	3.674	3.702	4.996	4.840	4.979
California	3.798	3.876	3.877	5.044	5.233	5.240
Colorado	3.893	3.957	4.062	5.090	5.327	5.425
Connecticut	4.007	4.041	4.083	5.329	5.488	5.529
Delaware	3.681	3.827	4.074	4.878	5.222	5.589
District of Columbia	5.303	5.461	6.163	7.189	7.501	8.451
Florida	3.739	3.816	3.811	4.897	5.111	5.079
Georgia	3.972	3.826	3.986	5.439	5.222	5.466
Hawaii	4.546	4.735	4.847	6.147	6.419	6.420
Idaho	3.837	3.784	3.859	5.017	5.051	5.139
Illinois	3.481	3.496	3.491	4.560	4.598	4.583
Indiana	3.579	3.572	3.785	4.740	4.712	5.176
Iowa	3.666	3.793	3.796	4.841	5.093	5.035
Kansas	3.705	3.674	3.794	4.861	4.865	5.071
Kentucky	3.857	3.872	3.930	5.185	5.265	5.385
Louisiana	3.938	3.925	4.010	5.261	5.274	5.530
Maine	4.250	4.326	4.472	5.825	6.190	6.424
Maryland	4.183	4.152	4.222	5.630	5.663	5.741
Massachusetts	3.904	3.944	3.906	5.202	5.321	5.260
Michigan	3.706	3.765	3.909	4.958	5.067	5.343
Minnesota	3.669	3.666	3.707	4.812	4.827	4.904
Mississippi	4.082	4.023	4.248	5.546	5.394	5.975
Missouri	3.582	3.550	3.794	4.752	4.687	5.145
Montana	4.481	4.143	4.163	6.114	5.631	5.559
Nebraska	3.722	3.696	3.718	4.895	4.869	4.906
Nevada	3.819	3.837	3.660	5.133	5.191	4.854
New Hampshire	3.748	3.798	3.860	4.928	5.032	5.175
New Jersey	3.943	3.905	3.917	5.256	5.242	5.253
New Mexico	3.731	3.613	3.759	4.984	4.789	5.108
New York	3.526	3.534	3.566	4.624	4.652	4.714
North Carolina	3.549	3.651	3.748	4.673	4.924	5.067
North Dakota	3.839	3.949	4.080	5.137	5.432	5.486
Ohio	3.681	3.783	3.723	4.963	5.197	5.067
Oklahoma	3.653	3.754	3.804	4.850	5.075	5.171
Oregon	4.190	3.987	4.280	5.766	5.441	5.986
Pennsylvania	3.551	3.578	3.667	4.671	4.746	4.892
Rhode Island	3.505	3.545	3.645	4.601	4.694	4.869
South Carolina	3.594	3.670	3.639	4.750	4.917	4.907
South Dakota	3.561	3.555	3.583	4.657	4.676	4.715
Tennessee	3.797	3.737	3.681	5.055	4.998	4.950
Texas	3.853	3.677	3.758	5.154	4.918	5.089
Utah	3.744	3.744	3.882	4.902	4.938	5.215
Vermont	4.188	4.097	4.500	5.701	5.552	6.376
Virginia	3.689	3.698	3.692	4.862	4.925	4.904
Washington	3.817	3.823	3.927	5.111	5.170	5.333
West Virginia	4.646	4.648	4.450	6.624	6.784	6.247
Wisconsin	3.565	3.623	3.741	4.689	4.811	5.012
Wyoming	4.007	4.104	4.091	5.322	5.567	5.469

Table A.20. Preliminary Shrinkage Estimates of SNAP Participation Rates

	Preliminary Shrinkage Estimates of SNAP Participation Rates (Percent)					
	All Eligible People			Working Poor		
	2009	2010	2011	2009	2010	2011
Alabama	69.096	74.697	82.656	61.933	66.876	74.368
Alaska	58.734	66.680	66.691	53.682	59.021	58.804
Arizona	63.636	75.902	77.264	56.264	67.498	69.676
Arkansas	63.388	69.743	71.875	63.968	69.496	72.290
California	47.058	51.396	55.694	30.953	38.675	42.836
Colorado	52.825	64.619	63.968	37.504	55.326	53.248
Connecticut	68.593	75.819	82.754	49.507	58.314	64.338
Delaware	68.494	72.255	83.153	57.208	60.124	68.011
District of Columbia	79.206	85.083	97.033	33.730	37.976	45.314
Florida	61.583	74.033	80.248	46.905	61.040	64.141
Georgia	63.761	73.574	81.324	56.185	65.535	72.754
Hawaii	57.534	62.542	59.087	45.712	47.760	43.019
Idaho	60.929	76.718	82.649	57.460	73.569	78.581
Illinois	71.578	77.571	81.558	53.451	60.402	64.313
Indiana	63.433	70.493	69.331	63.609	69.479	68.950
Iowa	75.386	82.275	84.671	68.825	75.226	78.848
Kansas	54.834	64.221	67.418	44.513	58.504	62.099
Kentucky	81.807	86.356	88.322	63.229	67.659	68.009
Louisiana	70.749	69.435	75.512	67.234	65.482	70.084
Maine	96.754	101.937	109.495	88.870	91.583	99.926
Maryland	64.744	67.670	79.245	50.740	52.811	62.716
Massachusetts	75.766	81.587	85.797	53.810	60.982	64.945
Michigan	79.651	91.650	96.563	76.303	85.670	89.102
Minnesota	59.716	69.231	74.993	46.561	59.532	65.489
Mississippi	64.997	68.722	77.552	62.289	63.970	72.892
Missouri	78.074	87.007	88.698	64.443	73.485	77.596
Montana	56.278	71.950	73.132	51.201	69.096	71.392
Nebraska	63.614	69.614	67.108	54.675	62.174	60.094
Nevada	51.082	59.219	67.449	43.182	49.571	59.289
New Hampshire	66.729	78.801	75.870	54.454	66.575	63.911
New Jersey	53.038	59.935	65.862	41.562	49.287	56.175
New Mexico	68.280	75.154	83.660	63.701	71.787	78.190
New York	63.466	72.186	76.789	52.269	62.091	65.806
North Carolina	65.932	72.925	81.476	52.818	62.326	69.695
North Dakota	69.942	73.708	73.112	66.300	69.372	72.203
Ohio	70.326	78.555	82.921	61.671	68.878	72.473
Oklahoma	69.860	76.576	83.189	57.658	62.886	70.429
Oregon	94.668	102.484	108.131	80.476	87.527	90.623
Pennsylvania	71.907	79.122	82.327	67.090	75.014	77.903
Rhode Island	62.289	77.266	80.515	46.881	62.275	62.598
South Carolina	70.085	74.407	78.467	65.590	70.175	73.997
South Dakota	62.028	76.385	77.097	59.029	71.769	74.580
Tennessee	88.343	91.804	93.169	72.184	73.722	75.152
Texas	53.575	62.609	70.759	43.331	56.600	63.425
Utah	62.255	73.268	76.641	49.732	62.442	66.994
Vermont	81.848	90.421	94.325	65.941	74.704	77.580
Virginia	65.528	73.008	76.686	54.506	64.762	67.649
Washington	84.994	93.072	99.272	67.269	73.968	79.911
West Virginia	84.027	83.806	83.702	88.266	83.675	85.335
Wisconsin	69.518	81.718	87.162	66.890	76.938	82.176
Wyoming	55.755	60.666	55.591	54.115	58.520	55.570

Table A.21. Final Shrinkage Estimates of SNAP Participation Rates

	Final Shrinkage Estimates of SNAP Participation Rates (Percent)					
	All Eligible People			Working Poor		
	2009	2010	2011	2009	2010	2011
Alabama	70.513	76.208	84.675	63.275	68.922	75.975
Alaska	59.939	68.028	68.320	54.845	60.827	60.075
Arizona	64.942	77.437	79.151	57.483	69.563	71.182
Arkansas	64.688	71.153	73.630	65.354	71.623	73.852
California	48.024	52.435	57.054	31.624	39.858	43.761
Colorado	53.909	65.926	65.530	38.317	57.020	54.398
Connecticut	70.000	77.353	84.775	50.580	60.099	65.728
Delaware	69.899	73.716	85.184	58.447	61.964	69.481
District of Columbia	80.830	86.804	99.403	34.461	39.138	46.293
Florida	62.846	75.530	82.208	47.922	62.908	65.527
Georgia	65.069	75.062	83.310	57.402	67.540	74.326
Hawaii	58.714	63.807	60.530	46.702	49.221	43.948
Idaho	62.179	78.269	84.667	58.705	75.821	80.279
Illinois	73.046	79.140	83.549	54.609	62.251	65.703
Indiana	64.734	71.918	71.024	64.987	71.605	70.440
Iowa	76.932	83.939	86.738	70.316	77.528	80.551
Kansas	55.959	65.520	69.065	45.478	60.294	63.441
Kentucky	83.485	88.103	90.479	64.599	69.730	69.478
Louisiana	72.201	70.839	77.356	68.691	67.486	71.598
Maine	98.739	100.000	100.000	90.796	94.386	100.000
Maryland	66.072	69.039	81.180	51.840	54.427	64.072
Massachusetts	77.321	83.237	87.893	54.975	62.848	66.348
Michigan	81.285	93.504	98.921	77.957	88.291	91.028
Minnesota	60.941	70.632	76.824	47.570	61.354	66.904
Mississippi	66.331	70.112	79.446	63.639	65.927	74.467
Missouri	79.675	88.767	90.864	65.839	75.734	79.273
Montana	57.432	73.405	74.919	52.311	71.210	72.935
Nebraska	64.919	71.022	68.747	55.859	64.077	61.393
Nevada	52.130	60.417	69.096	44.118	51.088	60.570
New Hampshire	68.098	80.395	77.723	55.634	68.613	65.292
New Jersey	54.126	61.147	67.471	42.463	50.795	57.389
New Mexico	69.680	76.674	85.704	65.081	73.983	79.879
New York	64.768	73.646	78.664	53.401	63.991	67.228
North Carolina	67.285	74.400	83.465	53.962	64.234	71.201
North Dakota	71.377	75.199	74.897	67.738	71.496	73.763
Ohio	71.768	80.144	84.946	63.007	70.986	74.039
Oklahoma	71.293	78.125	85.221	58.907	64.810	71.951
Oregon	96.610	100.000	100.000	82.220	90.206	92.582
Pennsylvania	73.382	80.722	84.337	68.544	77.310	79.586
Rhode Island	63.567	78.829	82.481	47.897	64.181	63.951
South Carolina	71.523	75.912	80.383	67.011	72.323	75.596
South Dakota	63.300	77.929	78.980	60.307	73.966	76.192
Tennessee	90.156	93.660	95.444	73.747	75.978	76.776
Texas	54.674	63.875	72.487	44.270	58.332	64.796
Utah	63.532	74.749	78.513	50.809	64.352	68.442
Vermont	83.526	92.250	96.628	67.368	76.989	79.258
Virginia	66.873	74.484	78.559	55.687	66.743	69.111
Washington	86.737	94.954	100.000	68.727	76.232	81.638
West Virginia	85.751	85.500	85.746	90.179	86.236	87.179
Wisconsin	70.944	83.370	89.291	68.339	79.293	83.952
Wyoming	56.899	61.892	56.949	55.287	60.311	56.770

Table A.22. Standard Errors of Final Shrinkage Estimates of SNAP Participation Rates

	Standard Errors of Final Shrinkage Estimates of SNAP Participation Rates					
	All Eligible People			Working Poor		
	2009	2010	2011	2009	2010	2011
Alabama	2.512	2.634	2.650	3.541	3.739	3.832
Alaska	3.078	3.275	3.429	4.801	5.006	4.519
Arizona	2.549	2.630	2.849	3.413	3.646	3.984
Arkansas	2.674	2.640	2.573	3.615	3.362	3.653
California	1.128	1.201	1.219	1.619	1.959	2.122
Colorado	2.388	2.713	2.717	2.538	3.436	3.465
Connecticut	3.112	3.178	3.242	4.031	4.391	4.299
Delaware	2.720	2.882	3.205	3.627	4.115	4.414
District of Columbia	3.456	3.632	4.719	4.859	5.081	6.560
Florida	1.926	2.020	2.175	2.766	3.229	3.291
Georgia	2.392	2.297	2.595	3.377	3.542	3.996
Hawaii	2.958	3.186	3.201	3.648	3.945	3.809
Idaho	3.124	3.018	3.109	3.492	3.634	3.844
Illinois	2.008	2.086	2.076	2.722	2.791	2.759
Indiana	2.381	2.439	2.668	3.345	3.284	3.846
Iowa	3.076	3.010	3.222	3.948	3.982	4.056
Kansas	2.614	2.606	2.637	2.759	3.018	3.133
Kentucky	3.100	3.191	3.074	3.985	4.282	4.253
Louisiana	2.760	2.390	2.589	3.887	3.641	4.173
Maine	3.485	3.646	3.690	4.979	5.401	5.538
Maryland	2.678	2.672	2.849	3.761	3.905	3.860
Massachusetts	2.994	3.079	3.014	3.925	4.087	4.139
Michigan	2.534	2.658	2.825	4.097	4.254	4.565
Minnesota	2.623	2.585	2.700	3.486	3.473	3.682
Mississippi	2.341	2.496	2.975	3.655	3.495	4.630
Missouri	2.828	2.885	3.148	3.581	3.709	4.083
Montana	3.747	3.367	3.385	5.252	4.686	4.355
Nebraska	2.705	2.673	2.902	3.272	3.385	3.483
Nevada	2.531	2.454	2.462	3.396	3.432	3.449
New Hampshire	2.903	3.019	3.107	3.720	4.069	4.217
New Jersey	2.515	2.547	2.490	3.424	3.587	3.804
New Mexico	2.838	2.784	2.910	4.316	4.329	4.664
New York	1.716	1.934	1.895	2.803	3.084	3.078
North Carolina	2.161	2.212	2.517	3.244	3.447	3.499
North Dakota	3.337	3.373	3.497	4.259	4.666	4.474
Ohio	2.287	2.549	2.558	3.233	3.447	3.498
Oklahoma	2.781	2.827	2.913	3.470	3.632	3.963
Oregon	3.310	3.168	3.530	4.699	4.475	5.139
Pennsylvania	2.285	2.166	2.289	3.610	3.696	3.722
Rhode Island	2.233	2.399	2.520	2.994	3.342	3.650
South Carolina	2.303	2.369	2.271	3.718	3.858	3.880
South Dakota	3.132	3.099	3.163	3.502	3.628	3.673
Tennessee	3.218	3.171	3.175	3.692	3.950	4.006
Texas	1.603	1.561	1.774	2.125	2.249	2.667
Utah	2.738	2.808	2.983	3.276	3.518	3.791
Vermont	3.379	3.271	3.689	4.742	4.449	5.299
Virginia	2.786	2.811	2.723	3.360	3.577	3.540
Washington	3.031	3.002	3.149	4.063	4.311	4.266
West Virginia	3.710	3.874	3.553	6.062	6.460	5.322
Wisconsin	2.576	2.729	2.836	3.562	3.820	3.999
Wyoming	2.750	3.051	2.922	3.897	4.233	3.760

Table A.23. Final Shrinkage Estimates of Number of People Eligible for SNAP

	Final Shrinkage Estimates of Number of People Eligible for SNAP		
	2009	2010	2011
Alabama	943,626	1,012,511	981,904
Alaska	106,008	112,021	125,185
Arizona	1,116,704	1,140,013	1,141,555
Arkansas	619,161	635,352	643,544
California	5,464,836	5,920,828	6,129,140
Colorado	586,324	611,638	657,960
Connecticut	351,334	367,386	387,558
Delaware	116,613	133,631	136,857
District of Columbia	126,194	129,944	128,151
Florida	3,097,650	3,377,367	3,474,390
Georgia	1,918,262	2,025,423	2,029,347
Hawaii	191,512	213,882	232,322
Idaho	213,261	236,163	255,435
Illinois	1,926,421	1,998,186	2,000,997
Indiana	1,056,220	1,120,912	1,218,458
Iowa	373,891	399,065	392,073
Kansas	381,031	403,155	424,691
Kentucky	826,727	853,242	871,979
Louisiana	970,508	1,111,371	1,090,085
Maine	182,926	195,809	210,836
Maryland	613,421	709,432	698,193
Massachusetts	722,800	781,501	800,440
Michigan	1,576,778	1,632,769	1,718,917
Minnesota	534,003	572,324	586,681
Mississippi	755,335	807,742	750,313
Missouri	974,727	994,435	1,018,641
Montana	153,830	139,269	148,859
Nebraska	204,671	224,696	248,317
Nevada	356,648	396,871	419,863
New Hampshire	109,739	111,672	123,018
New Jersey	908,984	961,795	1,008,301
New Mexico	410,441	444,727	445,054
New York	3,255,330	3,414,427	3,422,362
North Carolina	1,676,000	1,771,864	1,644,884
North Dakota	65,295	67,576	67,838
Ohio	1,795,958	1,861,460	1,942,404
Oklahoma	643,972	712,698	692,458
Oregon	504,692	590,042	635,885
Pennsylvania	1,687,467	1,763,749	1,857,613
Rhode Island	152,852	157,267	171,488
South Carolina	903,650	1,002,566	1,006,146
South Dakota	115,176	118,965	125,174
Tennessee	1,169,114	1,285,716	1,288,584
Texas	4,957,825	5,079,580	4,964,525
Utah	281,585	324,879	353,223
Vermont	72,022	68,704	71,949
Virginia	941,586	1,019,301	1,072,304
Washington	759,874	861,838	886,818
West Virginia	342,424	370,274	373,874
Wisconsin	660,561	723,925	736,110
Wyoming	45,646	54,851	60,082

Table A.24. Final Shrinkage Estimates of Number of Working Poor Eligible for SNAP

	Final Shrinkage Estimates of Number of Working Poor Eligible for SNAP		
	2009	2010	2011
Alabama	422,421	444,658	387,089
Alaska	53,267	55,613	59,232
Arizona	517,880	507,438	583,078
Arkansas	260,839	258,737	270,532
California	3,172,126	3,272,178	3,170,943
Colorado	330,110	305,151	349,925
Connecticut	144,855	146,032	152,270
Delaware	57,976	63,077	66,125
District of Columbia	35,819	39,915	35,901
Florida	1,350,311	1,405,256	1,427,974
Georgia	948,280	923,006	1,009,582
Hawaii	102,621	114,100	138,237
Idaho	115,055	129,708	146,397
Illinois	888,097	951,941	979,535
Indiana	466,807	461,167	531,595
Iowa	207,170	215,578	208,005
Kansas	205,188	210,139	232,509
Kentucky	311,787	334,238	362,523
Louisiana	426,145	527,949	492,327
Maine	69,396	73,094	83,044
Maryland	284,549	312,208	286,764
Massachusetts	281,204	247,116	294,608
Michigan	650,754	674,323	841,342
Minnesota	269,470	289,209	278,072
Mississippi	321,341	346,108	317,892
Missouri	456,967	487,155	448,096
Montana	74,502	66,357	67,410
Nebraska	113,093	123,394	131,897
Nevada	161,258	174,039	191,475
New Hampshire	43,573	47,830	53,591
New Jersey	343,966	368,842	458,127
New Mexico	217,298	214,127	233,319
New York	1,453,038	1,428,245	1,394,794
North Carolina	835,779	812,335	692,569
North Dakota	31,521	36,873	32,916
Ohio	764,117	744,953	791,939
Oklahoma	333,384	325,936	359,450
Oregon	239,943	270,933	287,554
Pennsylvania	632,992	677,154	716,050
Rhode Island	60,440	62,057	74,528
South Carolina	347,276	427,956	425,910
South Dakota	59,401	60,181	63,920
Tennessee	553,156	581,081	557,484
Texas	2,783,388	2,733,390	2,753,238
Utah	169,430	188,159	210,098
Vermont	34,951	28,365	26,768
Virginia	461,158	473,484	508,777
Washington	330,554	400,903	394,036
West Virginia	115,773	135,531	137,272
Wisconsin	321,041	339,645	339,618
Wyoming	19,309	24,715	28,668

Table A.25. Standard Errors of Final Shrinkage Estimates of Number of People Eligible for SNAP

	Standard Errors of Estimates of Number of People Eligible for SNAP		
	2009	2010	2011
Alabama	33,620	35,038	30,845
Alaska	5,443	5,400	6,308
Arizona	43,833	38,764	41,249
Arkansas	25,596	23,607	22,579
California	128,345	135,830	131,430
Colorado	25,969	25,200	27,389
Connecticut	15,621	15,114	14,877
Delaware	4,537	5,231	5,168
District of Columbia	5,395	5,443	6,107
Florida	94,946	90,457	92,281
Georgia	70,505	62,058	63,449
Hawaii	9,648	10,694	12,335
Idaho	10,716	9,118	9,415
Illinois	52,943	52,731	49,908
Indiana	38,847	38,059	45,949
Iowa	14,950	14,327	14,618
Kansas	17,799	16,053	16,275
Kentucky	30,700	30,939	29,742
Louisiana	37,104	37,544	36,628
Maine	6,456	6,610	6,208
Maryland	24,858	27,494	24,596
Massachusetts	27,991	28,945	27,552
Michigan	49,152	46,472	49,283
Minnesota	22,983	20,976	20,698
Mississippi	26,652	28,791	28,204
Missouri	34,601	32,363	35,429
Montana	10,035	6,396	6,752
Nebraska	8,527	8,467	10,523
Nevada	17,315	16,142	15,016
New Hampshire	4,678	4,200	4,936
New Jersey	42,236	40,113	37,351
New Mexico	16,715	16,166	15,171
New York	86,233	89,791	82,745
North Carolina	53,829	52,756	49,785
North Dakota	3,053	3,035	3,179
Ohio	57,240	59,287	58,721
Oklahoma	25,118	25,827	23,762
Oregon	17,293	17,121	18,364
Pennsylvania	52,547	47,390	50,605
Rhode Island	5,368	4,792	5,259
South Carolina	29,101	31,325	28,537
South Dakota	5,700	4,736	5,032
Tennessee	41,731	43,588	43,026
Texas	145,341	124,333	121,964
Utah	12,136	12,220	13,474
Vermont	2,914	2,439	2,757
Virginia	39,229	38,516	37,313
Washington	26,551	27,286	27,101
West Virginia	14,816	16,800	15,552
Wisconsin	23,988	23,726	23,472
Wyoming	2,206	2,708	3,094

Table A.26. Standard Errors of Final Shrinkage Estimates of Number of Working Poor Eligible for SNAP

	Standard Errors of Estimates of Number of Working Poor Eligible for SNAP		
	2009	2010	2011
Alabama	23,639	24,123	19,527
Alaska	4,662	4,577	4,456
Arizona	30,752	26,598	32,636
Arkansas	14,427	12,145	13,382
California	162,403	160,845	153,774
Colorado	21,865	18,386	22,295
Connecticut	11,544	10,670	9,960
Delaware	3,597	4,189	4,201
District of Columbia	5,051	5,182	5,088
Florida	77,939	72,122	71,726
Georgia	55,789	48,403	54,279
Hawaii	8,016	9,144	11,982
Idaho	6,843	6,217	7,011
Illinois	44,264	42,678	41,135
Indiana	24,030	21,147	29,032
Iowa	11,633	11,073	10,476
Kansas	12,448	10,520	11,485
Kentucky	19,234	20,524	22,193
Louisiana	24,113	28,481	28,702
Maine	3,806	4,183	4,413
Maryland	20,643	22,398	17,278
Massachusetts	20,077	16,069	18,382
Michigan	34,197	32,487	42,201
Minnesota	19,746	16,368	15,303
Mississippi	18,458	18,350	19,765
Missouri	24,854	23,855	23,085
Montana	7,480	4,367	4,025
Nebraska	6,625	6,519	7,484
Nevada	12,414	11,692	10,903
New Hampshire	2,914	2,836	3,462
New Jersey	27,739	26,044	30,372
New Mexico	14,409	12,528	13,626
New York	76,255	68,827	63,870
North Carolina	50,239	43,587	34,034
North Dakota	1,982	2,406	1,997
Ohio	39,205	36,174	37,424
Oklahoma	19,636	18,263	19,803
Oregon	13,714	13,441	15,964
Pennsylvania	33,334	32,370	33,488
Rhode Island	3,778	3,232	4,254
South Carolina	19,268	22,827	21,861
South Dakota	3,449	2,952	3,082
Tennessee	27,694	30,207	29,094
Texas	133,589	105,362	113,352
Utah	10,924	10,287	11,640
Vermont	2,460	1,639	1,790
Virginia	27,825	25,377	26,065
Washington	19,541	22,670	20,594
West Virginia	7,783	10,152	8,381
Wisconsin	16,732	16,363	16,181
Wyoming	1,361	1,735	1,899

MATHEMATICA
Policy Research

www.mathematica-mpr.com

Improving public well-being by conducting high-quality, objective research and surveys

Princeton, NJ ■ Ann Arbor, MI ■ Cambridge, MA ■ Chicago, IL ■ Oakland, CA ■ Washington, DC