Contract No.: 53-3198-9-008
MPR Reference No.: 8659-211

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Policy Research, Inc.

Empirical Bayes Shrinkage Estimates of State Food Stamp Participation Rates for 1998-2000

Final Report

March 2003

Laura A. Castner
Allen L. Schirm

Submitted to:

U.S. Department of Agriculture
Food and Nutrition Service
3101 Park Center Drive
Room 1014
Alexandria, VA 22302

Project Officer:
Jenny Genser

Submitted by:

Mathematica Policy Research, Inc.
600 Maryland Ave., SW, Suite 550
Washington, DC 20024-2512
Telephone: (202) 484-9220
Facsimile: (202) 863-1763

Project Director:
Carole Trippe

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EXECUTIVE SUMMARY

The Food Stamp Program 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 Stamp Act of 1977, as amended). The Food Stamp Program 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 2002, the program served over 19 million people in an average month at a total annual cost of over $18 billion in benefits. The average monthly food stamp benefit was about $185 per household.

This report presents estimates that, for each state, measure the need for the Food Stamp Program and the program's effectiveness in each of the three years from 1998 to 2000. The estimated numbers of people eligible for food stamps measure the need for the program. The estimated food stamp participation rates measure, state by state, the program's performance in reaching its target population.

The estimates presented in this report were derived using empirical Bayes shrinkage estimation methods and data from the Current Population Survey, the decennial census, 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 food stamps. 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 and program eligibility. Shrinkage estimators improve precision by "borrowing strength," that is, by using data for several years from all the states to derive each state's estimate for a given year and by using not only sample survey data but also census and administrative data. This report describes our shrinkage estimator in detail.

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I. INTRODUCTION

This report presents estimates of the food stamp participation rate and the number of people eligible for food stamps in each state for the years 1998 to 2000. 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. Technical details and additional information about our estimation methods are provided in Appendix A. The estimates presented here are also reported and compared with one another in Schirm and Castner (2002).

The principal challenge in deriving state estimates like those presented in this report is that the leading national surveys collecting current income data for families—the Current Population Survey (CPS) and the Survey of Income and Program Participation (SIPP)—have small samples for most states. Thus, "direct" estimates from these surveys are imprecise. For example, because of the potential errors introduced by the CPS surveying only a small number of families in Alabama rather than all families in the state, we can be confident—by a commonly used standard—only that Alabama's food stamp participation rate in 2000 was between about 40 and 62 percent. This range is wide (but typical), reflecting our substantial uncertainty about what Alabama's participation rate actually was.

Why small samples make direct estimates imprecise is easy to see. By the definition of "direct," a direct estimate is based on data from one source for the state and time period in question. Thus, a 2000 estimate for Alabama would be calculated using just 2000 data on households in one sample from Alabama. If 2000 data are collected for only a small number of Alabama households, as in the CPS or SIPP, a direct estimate will be imprecise, that is, subject to substantial sampling error because the estimator uses only the information contained in the small sample. Therefore, as illustrated before, estimates of participation rates will have large standard errors and wide confidence intervals, reflecting a lot of uncertainty about the true rate of participation.

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 in 2000 or what happened in Alabama (and other states) in other years is relevant to estimating what happened in Alabama in 2000. In an application of indirect estimation, the Census Bureau has improved the precision of state poverty rates from the CPS by calculating two- and three-year averages (Proctor and Dalaker 2002).

A generally superior indirect estimator is the so-called “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. 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 generation 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 and mean adjusted gross incomes according to tax return data. States with similar socioeconomic conditions, as reflected in these poverty rate and mean income statistics, are observed (and predicted) to have similar proportions of infants and children eligible for WIC. This contrasts with the direct estimator that ignores systematic patterns across states, using, for example, only Alabama data to derive an estimate for Alabama, even though conditions may be similar in Georgia or Mississippi. The shrinkage estimator uses data for all the states (with data for prior years and data from other sources) to estimate a regression model and formulate a prediction for Alabama. Then, the shrinkage estimator optimally averages the direct sample and regression estimates for Alabama to obtain a shrinkage estimate. In another application of shrinkage methods, shrinkage estimates of poor school-aged children by state and county are used in allocating Title I compensatory education funds for disadvantaged youth (National Research Council 2000).

In these and other applications of shrinkage estimation, the gain in precision from borrowing strength via a shrinkage estimator can be substantial. The confidence intervals for the shrinkage estimates of WIC eligibles in 1992 were, on average, 61 percent narrower than the corresponding direct sample confidence intervals (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, an option that is surely not available to us. Therefore, we must use an indirect estimator and borrow strength (while recognizing that the gain in precision will often not be quite as large as for the 1992 WIC estimates).

As noted before, we have used a shrinkage estimator to derive state estimates of food stamp participation rates and counts of eligible people. The estimator combined direct sample and regression estimates and borrowed strength across states and over time. Like the estimators used in the other applications described in this chapter, our estimator also borrowed strength by using data from outside the main sample survey (the CPS), specifically, data from administrative records systems and the decennial census. In all, our estimator used one year of census data, three years of CPS data, and three years of Food Stamp Program (FSP) and income tax data for all the states to obtain estimates for each state in each year (1998 to 2000).

Although the shrinkage estimates derived for any one application are not guaranteed to be more accurate than estimates obtained using some other method, shrinkage estimators have good statistical properties in general, 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 food stamp participation rates and numbers of people eligible for food stamps. This procedure, summarized by the flow chart in Figure II.1, has the following four steps:

1. From CPS data and FSP administrative data, derive direct sample estimates of state food stamp participation rates for September in each of the three years 1998 to 2000.
2. Using a regression model, predict state food stamp participation rates based on administrative and decennial census data.
3. Using "shrinkage" methods, average the direct sample estimates and regression predictions to obtain preliminary shrinkage estimates of state food stamp participation rates.
4. Adjust the preliminary shrinkage estimates to obtain final shrinkage estimates of state food stamp participation rates.

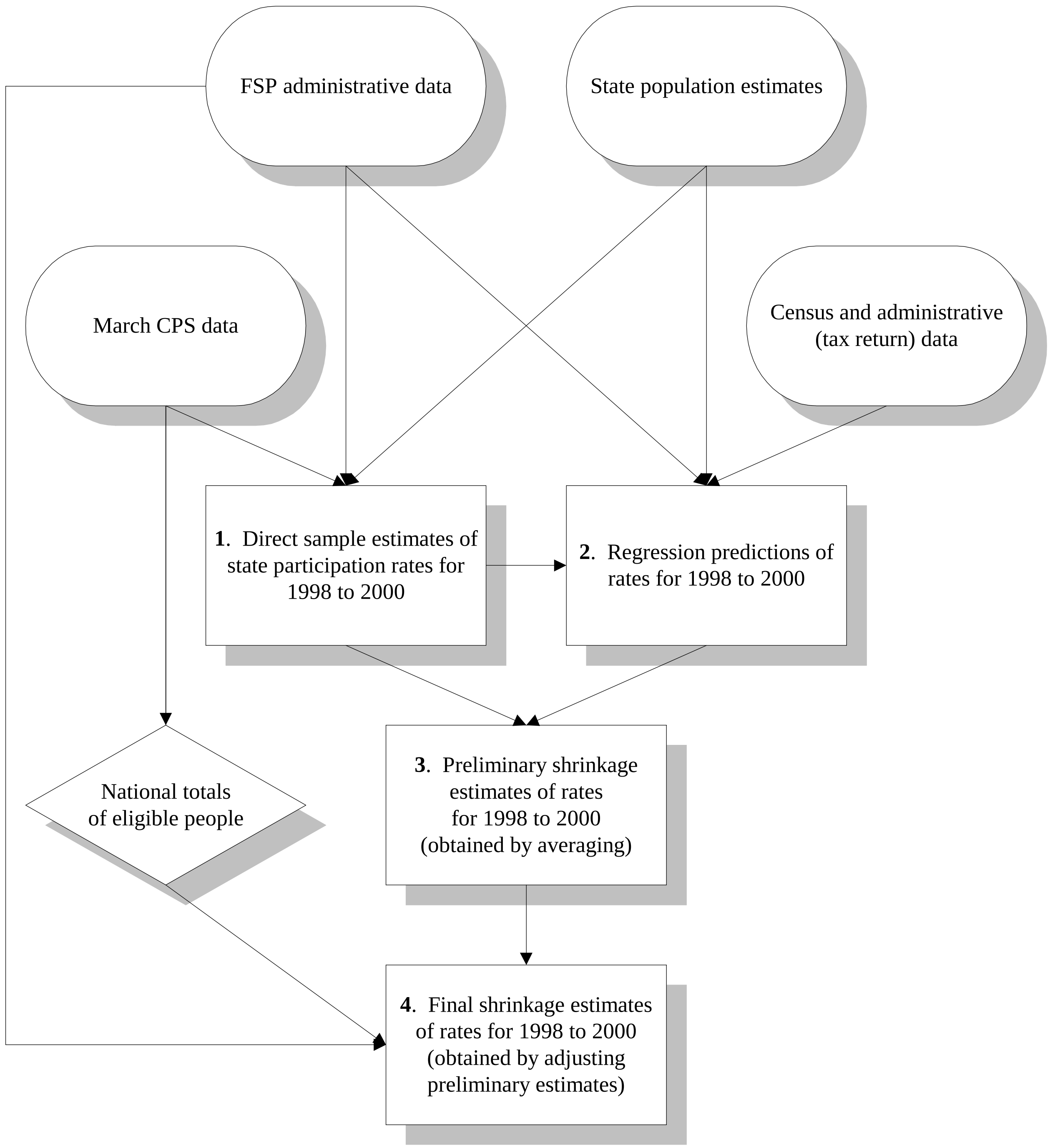
Each step is described in the remainder of this chapter, and additional technical details are provided in Appendix A.

1. From CPS data and FSP administrative data, derive direct sample estimates of state food stamp participation rates for September in each of the three years 1998 to 2000.

A food stamp participation rate is obtained by dividing an estimate of the number of people receiving food stamps by an estimate of the number of people eligible for food stamps, with the resulting ratio expressed as a percentage. We used FSP administrative data to estimate numbers of recipients. To derive direct sample estimates of participation rates, we used CPS data to estimate numbers of eligibles. Because the CPS collects family income data for the prior calendar year, we obtained estimates of eligibles in 2000, for example, from the March 2001 CPS.

FIGURE II.1

THE ESTIMATION PROCEDURE



As noted in Chapter I, direct sample estimates of participation rates are relatively imprecise. 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 Alabama's participation rate in 2000 was between 40 percent and 62 percent. This range is so wide and our uncertainty so great because the CPS sample for Alabama 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—Alabama and 2000 in our example—is the fundamental problem of "small area estimation."

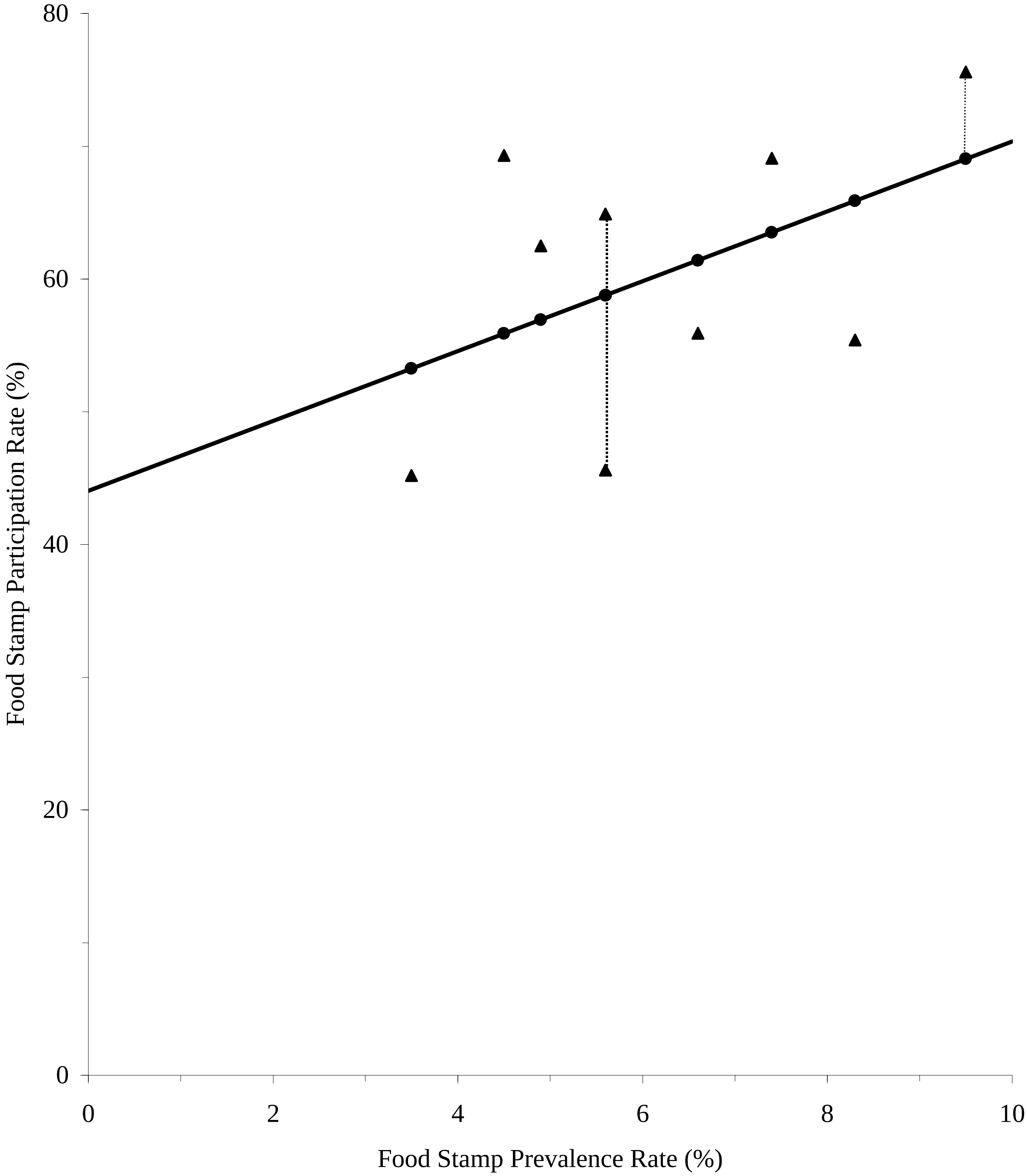
2. Using a regression model, predict state food stamp participation rates based on administrative and decennial census data.

The main limitation of the sample estimates derived in the previous step is imprecision. Regression can reduce that imprecision. Regression estimates are predictions based on nonsample or highly precise sample data, such as census 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 food stamp "prevalence" rate—that will be used to predict each state's food stamp participation rate. The food stamp prevalence rate is measured by the percentage of all people (eligible and ineligible combined) who receive food stamps, in contrast to the food stamp participation rate, which is measured by the percentage of eligible people who receive food stamps. 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 FSP

FIGURE II.2

AN ILLUSTRATIVE REGRESSION ESTIMATOR



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 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 food stamps, the predicted participation rate is nearly 70 percent.

To derive the regression estimates for 1998 to 2000 presented in Appendix A (in Table A.12), we included all of the states, not just nine as in our illustrative example, and we used three predictors, not just one. Adding two predictors improves our predictions. The three predictors used measure:

- The percentage of the population receiving food stamps, that is, the food stamp prevalence rate
- The tax return nonfiler rate for elderly people, that is, the percentage of the elderly population that is not claimed as exemptions on tax returns
- The percentage of families below the federal poverty level in 1999 according to Census 2000

The first two predictors are obtained from administrative data (and population estimates), and the third predictor is from the decennial census. These three predictors were selected as the best from a longer list described in Appendix A, which also provides complete definitions and sources for the predictors. Appendix A also presents standard errors for the regression estimates. These tend to be fairly equal across the states and much smaller than the largest standard errors for sample estimates, reflecting substantial gains in precision from regression for the states with the most error-prone 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 sample estimates in Step 1, we used only one year's CPS sample data from Alabama to estimate Alabama's participation rate in that year, even though Alabama, like nearly all states, has a small CPS sample. Deriving regression estimates in this step, we estimated a regression line from sample, administrative, and census data for several years and all the states and used the estimated line (with administrative and census data for Alabama) to predict Alabama's participation rate in a given year. In other words, the regression estimator not only uses the sample estimates from every state for several 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 census.

The regression estimator improves precision by using more data. It uses that additional data to identify states with 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 food stamp prevalence rate and values for other predictors that are consistent with a low food stamp participation rate. Then, our regression estimator would predict a low participation rate for that state, implying that a sample estimate showing a high rate is too high. The regression estimate will be lower than the 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 food stamp prevalence rate and the other predictors, the regression estimate for that state will be higher than the sample estimate.

3. Using "shrinkage" methods, average the direct sample estimates and regression predictions to obtain preliminary shrinkage estimates of state food stamp participation rates.

As noted before, the limitation of the direct sample estimator is imprecision. 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 food stamp prevalence rate and other predictors used. Such errors in regression estimates reflect bias.

These limitations arise for the following reasons. The 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 census. Although the regression estimator borrows strength, using data from all the states and several years as well as administrative and census 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 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.

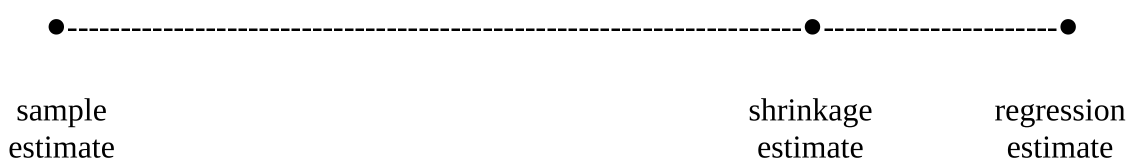
Using all of the information at hand, a shrinkage estimator addresses the limitations of the sample and regression estimators by combining the sample and regression estimates, striking a compromise. As illustrated in Figure II.3, a shrinkage estimator takes a weighted average of the sample and regression estimates, weighting them according to their relative accuracy. We calculated weights using the empirical Bayes methods described in Appendix A. Generally, the more precise the sample estimate for a state, the closer the shrinkage estimate will be to it. The larger samples drawn in large states support more precise sample estimates, so shrinkage estimates tend to be closer to the sample estimates for large states. Given the precision of the

FIGURE II.3

SHRINKAGE ESTIMATION

Poor predictions or state with relatively large sample ⇒ more weight on sample estimate:

Good predictions or state with relatively small sample ⇒ more weight on regression estimate:



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 sample estimate when the regression line fits well than when the line fits poorly. Striking a compromise between the sample and regression estimators, the shrinkage estimator strikes a compromise between imprecision and bias. The 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 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.

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.”

4. Adjust the preliminary shrinkage estimates to obtain final shrinkage estimates of state food stamp participation rates.

We adjusted the preliminary shrinkage estimates of participation rates so that the eligibles counts implied by the rates sum to the national eligibles count estimated directly from the CPS. This adjustment was carried out for each year separately. The following description of the adjustment will focus on the 2000 estimates. We describe the results of the adjustment for other years and discuss our adjustment method in more detail in Appendix A.

To implement the 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 food stamp recipients obtained in Step 1. The state eligibles counts summed to 29,319,215 for 2000, while the national total for 2000 estimated directly from the CPS was

28,197,705. 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 preliminary eligibles counts by 28,197,705 ÷ 29,319,215 (≈ 0.9617). Such benchmarking of estimates for smaller areas to a relatively precise estimated total for a larger area is common practice.

After completing this adjustment, we had obtained our final shrinkage estimates of the numbers of people eligible for food stamps. From those estimates and our administrative estimates of the numbers of food stamp recipients, we derived final shrinkage estimates of participation rates. Our final shrinkage estimates are presented in the next chapter.

III. STATE ESTIMATES OF FSP PARTICIPATION RATES AND NUMBERS OF ELIGIBLE PEOPLE FOR 1998 TO 2000

Table III.1 presents our final shrinkage estimates of September food stamp participation rates in each state for 1998 to 2000. For those same years, Table III.2 displays our final shrinkage estimates of the number of people eligible for food stamps in September in each state.

These shrinkage estimates are relatively precise; they have much smaller standard errors and narrower confidence intervals than the CPS direct sample estimates. Tables III.3 to III.5 display approximate 90-percent confidence intervals showing the uncertainty remaining after using shrinkage estimation. One interpretation of such an 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 Alabama's participation rate was 60 percent in 2000 (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 53 and 67 percent, an interval that is less than two-thirds as wide as the interval (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 60 percent as wide as the corresponding 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 Schirm and Castner (2002), the shrinkage estimates are sufficiently precise to show, for example, whether a state's food stamp participation rate was probably near the top, near the bottom, or in the middle of the distribution of rates in a given year. That would be enough information for many important purposes, such as guiding an initiative to improve program performance.

TABLE III.1

FINAL SHRINKAGE ESTIMATES OF SEPTEMBER FOOD STAMP
(Percent)

	1998	1999	2000
Alabama	58	61	60
Alaska	74	69	74
Arizona	47	46	46
Arkansas	65	69	66
California	55	52	53
Colorado	60	54	55
Connecticut	67	62	63
Delaware	58	53	49
District of Columbia	89	100	85
Florida	53	53	52
Georgia	58	57	56
Hawaii	95	98	97
Idaho	44	42	45
Illinois	67	65	69
Indiana	62	60	66
Iowa	60	56	60
Kansas	47	42	53
Kentucky	68	74	75
Louisiana	65	70	68
Maine	80	79	78
Maryland	69	57	58
Massachusetts	48	43	43
Michigan	77	69	76
Minnesota	64	60	65
Mississippi	57	59	60
Missouri	68	71	77
Montana	56	55	59
Nebraska	66	60	61
Nevada	42	34	39
New Hampshire	46	46	49
New Jersey	59	56	53
New Mexico	64	64	62
New York	59	61	59
North Carolina	52	53	52
North Dakota	53	51	54
Ohio	58	54	57
Oklahoma	64	64	61
Oregon	65	66	74
Pennsylvania	70	68	68
Rhode Island	64	69	66
South Carolina	63	62	63
South Dakota	62	59	64
Tennessee	71	72	69
Texas	51	46	47
Utah	53	50	51
Vermont	69	77	73
Virginia	60	57	58
Washington	63	56	61
West Virginia	86	89	83
Wisconsin	51	48	56
Wyoming	53	48	53
United States	60	58	59

TABLE III.2

FINAL SHRINKAGE ESTIMATES OF NUMBERS OF PEOPLE ELIGIBLE FOR FOOD STAMPS IN SEPTEMBER
(Thousands)

	1998	1999	2000
Alabama	691	636	632
Alaska	56	55	51
Arizona	560	548	572
Arkansas	383	357	371
California	3,742	3,662	3,249
Colorado	293	298	266
Connecticut	270	261	246
Delaware	68	68	59
District of Columbia	93	83	88
Florida	1,730	1,664	1,653
Georgia	998	997	953
Hawaii	127	123	115
Idaho	120	128	119
Illinois	1,243	1,192	1,179
Indiana	477	486	460
Iowa	205	216	198
Kansas	235	265	222
Kentucky	575	531	525
Louisiana	801	721	736
Maine	132	126	123
Maryland	423	392	357
Massachusetts	556	570	515
Michigan	909	872	800
Minnesota	319	326	295
Mississippi	523	465	471
Missouri	571	564	546
Montana	104	105	94
Nebraska	138	137	125
Nevada	150	166	157
New Hampshire	74	76	70
New Jersey	661	637	593
New Mexico	270	263	258
New York	2,535	2,411	2,294
North Carolina	943	908	904
North Dakota	61	61	55
Ohio	1,139	1,121	1,039
Oklahoma	432	397	406
Oregon	318	325	314
Pennsylvania	1,173	1,136	1,089
Rhode Island	112	109	107
South Carolina	500	474	464
South Dakota	70	71	67
Tennessee	718	668	699
Texas	2,874	2,864	2,791
Utah	163	158	147
Vermont	52	55	51
Virginia	604	592	553
Washington	485	497	467
West Virginia	282	257	262
Wisconsin	349	365	352
Wyoming	43	44	40
United States	30,350	29,502	28,198

TABLE III.3

APPROXIMATE 90-PERCENT CONFIDENCE INTERVALS FOR FINAL SHRINKAGE ESTIMATES FOR SEPTEMBER 1998

	Participation Rate (Percent)		Number of Eligible People (Thousands)	
	Lower Bound	Upper Bound	Lower Bound	Upper Bound
Alabama	51	65	604	779
Alaska	66	82	50	62
Arizona	43	52	506	614
Arkansas	59	72	344	423
California	52	59	3,509	3,976
Colorado	53	67	257	329
Connecticut	60	74	241	299
Delaware	52	65	60	75
District of Columbia	80	97	84	102
Florida	50	56	1,636	1,824
Georgia	52	64	896	1,100
Hawaii	86	100	121	138
Idaho	37	51	101	140
Illinois	61	73	1,130	1,355
Indiana	55	68	427	527
Iowa	53	67	180	230
Kansas	41	54	202	267
Kentucky	60	76	509	640
Louisiana	58	72	717	886
Maine	71	89	117	146
Maryland	61	76	376	471
Massachusetts	42	55	483	630
Michigan	70	83	832	986
Minnesota	57	72	280	357
Mississippi	51	64	462	583
Missouri	61	76	505	637
Montana	49	63	91	117
Nebraska	59	73	123	153
Nevada	36	48	129	172
New Hampshire	39	53	63	85
New Jersey	53	65	592	731
New Mexico	56	71	237	303
New York	55	63	2,358	2,713
North Carolina	47	56	862	1,023
North Dakota	46	61	52	69
Ohio	53	64	1,032	1,247
Oklahoma	58	70	392	472
Oregon	58	71	288	349
Pennsylvania	64	77	1,060	1,285
Rhode Island	57	71	99	124
South Carolina	57	69	454	546
South Dakota	54	70	61	79
Tennessee	64	78	646	789
Texas	48	54	2,700	3,048
Utah	46	60	142	185
Vermont	61	76	46	58
Virginia	54	67	538	671
Washington	57	70	438	533
West Virginia	78	95	254	311
Wisconsin	43	59	298	400
Wyoming	46	60	38	49
United States	58	61	29,622	31,078

TABLE III.4

APPROXIMATE 90-PERCENT CONFIDENCE INTERVALS FOR FINAL SHRINKAGE ESTIMATES FOR SEPTEMBER 1999

	Participation Rate (Percent)		Number of Eligible People (Thousands)	
	Lower Bound	Upper Bound	Lower Bound	Upper Bound
Alabama	54	67	566	705
Alaska	61	77	48	61
Arizona	41	52	488	609
Arkansas	62	76	319	395
California	49	55	3,443	3,881
Colorado	46	61	257	339
Connecticut	55	69	233	290
Delaware	46	60	59	77
District of Columbia	88	100	83	93
Florida	49	58	1,527	1,800
Georgia	51	62	903	1,090
Hawaii	88	100	120	136
Idaho	35	49	106	149
Illinois	59	70	1,089	1,295
Indiana	53	67	429	544
Iowa	49	64	188	244
Kansas	39	45	246	284
Kentucky	66	81	476	585
Louisiana	63	78	644	797
Maine	71	88	113	140
Maryland	49	64	341	444
Massachusetts	37	49	493	648
Michigan	63	75	798	946
Minnesota	53	68	285	368
Mississippi	54	65	423	508
Missouri	64	79	501	627
Montana	49	62	93	118
Nebraska	53	67	120	153
Nevada	29	39	142	190
New Hampshire	39	52	65	88
New Jersey	50	62	570	704
New Mexico	57	71	234	291
New York	57	65	2,243	2,579
North Carolina	48	58	818	997
North Dakota	43	58	52	70
Ohio	49	59	1,012	1,229
Oklahoma	59	70	364	429
Oregon	59	72	293	357
Pennsylvania	62	74	1,037	1,234
Rhode Island	62	76	98	120
South Carolina	56	68	425	522
South Dakota	51	67	62	81
Tennessee	67	78	615	720
Texas	44	48	2,757	2,971
Utah	42	57	135	181
Vermont	69	85	49	60
Virginia	50	63	524	661
Washington	50	62	446	549
West Virginia	80	98	232	282
Wisconsin	41	56	310	421
Wyoming	43	54	39	49
United States	57	59	28,858	30,147

TABLE III.5

APPROXIMATE 90-PERCENT CONFIDENCE INTERVALS FOR FINAL SHRINKAGE ESTIMATES FOR SEPTEMBER 2000

	Participation Rate (Percent)		Number of Eligible People (Thousands)	
	Lower Bound	Upper Bound	Lower Bound	Upper Bound
Alabama	53	67	561	704
Alaska	67	82	46	56
Arizona	43	50	529	615
Arkansas	59	73	331	410
California	49	56	3,059	3,439
Colorado	48	63	231	301
Connecticut	56	71	217	275
Delaware	41	56	50	68
District of Columbia	81	90	83	93
Florida	47	56	1,509	1,796
Georgia	50	62	850	1,056
Hawaii	88	100	112	126
Idaho	39	51	103	135
Illinois	64	73	1,096	1,263
Indiana	59	73	411	508
Iowa	52	68	173	223
Kansas	47	60	195	249
Kentucky	67	83	469	582
Louisiana	62	74	670	801
Maine	69	87	109	137
Maryland	50	65	311	404
Massachusetts	37	49	445	586
Michigan	71	81	746	854
Minnesota	58	72	263	328
Mississippi	53	66	419	523
Missouri	69	86	487	605
Montana	53	66	83	105
Nebraska	53	68	110	140
Nevada	33	45	132	181
New Hampshire	42	56	60	80
New Jersey	47	58	532	653
New Mexico	56	68	232	283
New York	55	64	2,119	2,470
North Carolina	48	55	841	966
North Dakota	47	61	48	63
Ohio	52	63	945	1,133
Oklahoma	56	66	369	442
Oregon	66	81	283	344
Pennsylvania	61	75	978	1,201
Rhode Island	59	72	96	117
South Carolina	57	68	424	504
South Dakota	56	72	58	75
Tennessee	63	76	633	766
Texas	44	50	2,606	2,976
Utah	44	57	127	166
Vermont	65	82	45	56
Virginia	51	64	492	615
Washington	55	67	421	513
West Virginia	75	92	236	288
Wisconsin	49	63	306	397
Wyoming	47	60	35	45
United States	57	60	27,555	28,840

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APPENDIX A

THE ESTIMATION PROCEDURE: ADDITIONAL TECHNICAL DETAILS

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This appendix provides additional information and technical details about our four-step procedure to estimate state food stamp participation rates. Each step is discussed in turn.

1. From CPS data and FSP administrative data, derive direct sample estimates of state food stamp participation rates for September in each of the three years 1998 to 2000.

Table A.1 displays direct sample estimates of participation rates, and Table A.2 shows standard errors for the sample estimates. The method for obtaining the standard errors is described later.

We derived sample estimates of participation rates for September of a given year according to:

$$(1) \quad Y_i = 100\,\frac{P_i(1-\varepsilon_i/100)}{(E_i/100)T_i},$$

where Y_i is the estimated participation rate for state i; P_i is the number of persons receiving food stamps in September of the year in question according to FSP Statistical Summary of Operations ("Program Operations") data; ε_i is the issuance error rate, that is, the percentage of persons erroneously receiving food stamps according to FSP Quality Control (FSPQC) data; E_i is the percentage of persons who are eligible for food stamps according to the CPS; and T_i is the resident population according to decennial census and administrative records (mainly vital statistics) data.[1,2,3] As noted, we estimated eligibility percentages rather than eligibility counts

[1]If P_i includes persons who received disaster relief benefits issued after a major natural disaster, P_i is adjusted by linearly interpolating between the participant figures for the months immediately before and after the period during which disaster relief was provided. This adjustment seeks to exclude from our estimate of participants those persons who received food stamps only because of a natural disaster, are not otherwise eligible, and, thus, are not included in our estimate of eligibles. It allows us to measure a state's participation rate under "normal" circumstances. Because P_i is obtained from FSP Program Operations data, which include the full population of food stamp cases, it is not subject to sampling error. Participant figures were provided by the Food and Nutrition Service (FNS).

[2]ε_i is a fiscal year figure. We used fiscal year 1998, 1999, and 2000 issuance error rate estimates in Equation (1) when we derived, respectively, September 1998, 1999, and 2000 participation rates. We adjust for issuance errors to exclude from our estimate of participants those persons who were ineligible for food stamps and, thus, are

from the CPS. 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."[4] Tables A.3, A.4, and A.5 present estimates for 1998 to 2000 of, respectively, the number of people receiving food stamps, food stamp issuance error rates, and population totals. Table A.6 displays direct sample estimates of food stamp eligibility percentages for 1998 to 2000.

We derived food stamp eligibility estimates for states by applying food stamp program rules as of September to CPS households. However, some key information needed to determine whether a household is eligible for food stamps is not collected in the CPS. 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 food stamps under provisions of the Personal

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(continued)
not included in our estimate of eligibles. Although issuance error rates are estimated from FSPQC sample data and subject to sampling error, this sampling error is small relative to other sources of error in the estimated participation rates. Thus, the sampling error in ε_i is ignored in subsequent calculations. Issuance error estimates were provided by FNS.

[3]We obtained September 1 population estimates for a given year by averaging the July 1 estimates published by the Census Bureau for that year and the next year. The weights were 5/6 and 1/6, respectively. In broad terms, the estimates derived by the Census Bureau in its Population Estimates Program are obtained by subtracting from census counts persons "exiting" the population (due to death or net out-migration) and adding persons "entering" the population (due to birth or net in-migration). The 1998 and 1999 population estimates that we used were released on August 30, 2000 at http://www.census.gov/population/www/estimates/st_sasrh.html. Although the Census Bureau did not adjust these published population estimates for net undercount in the (1990) decennial census, we adjusted the estimates when deriving our T_i figures using a state net population adjustment matrix published by the Census Bureau at http://www.census.gov/population/www/censusdata/adjustment.html. The sampling errors in the net undercount estimates are ignored in our subsequent estimates of statistical uncertainty. The 2000 and 2001 population estimates that we used were released on December 27, 2001 at http://eire.census.gov/popest/data/states/tables/st-est2001-01.php. We did not adjust these estimates for net undercount in Census 2000.

[4]We obtained estimates for 1998 to 2000 from the March CPS samples for 1999 to 2001, for which the survey instruments collected family income data for the prior calendar years, that is, 1998 to 2000. Although the Census Bureau recently released revised March CPS public use files for 2000 and 2001 that include revised weights based on Census 2000 population estimates in both files and additional sample households in the March 2001 file (from the State Children's Health Insurance Program (SCHIP) sample expansion), these revised files were not available in time to be used to derive the estimates presented in this report.

Responsibility and Work Opportunity Reconciliation Act of 1996 (P.L. 104-193) and subsequent legislation pertaining to noncitizens and unemployed able-bodied adults ages 18 to 50 with no dependent children. 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 food stamp household within the (potentially) larger CPS household, taking account of the restrictions on participation by noncitizens and unemployed able-bodied adults, distributing annual amounts across months, and imputing net income—are described in Cunnyngham (2002) and earlier reports in that series.[5]

In addition to our point estimates of participation rates, we need estimates of their sampling variability. We estimated variances for the sample estimates and covariances between sample estimates for different years using the jackknife estimator proposed by Rao, Wu, and Yue (1992), treating CPS rotation groups as clusters. A rotation group, about one-eighth of a monthly CPS sample, consists of a group of households (actually, housing units) that begin the CPS at the same time. They are in the CPS for four months, rotate out for eight months, and rotate back in for four months, after which they are dropped from the CPS.

To obtain jackknife estimates of sampling error variances and covariances, we let Z_i equal the CPS sample estimate of the number of eligible people in state i (i = 1, 2, ..., 51) and $Z_{i,r}$ equal the contribution of rotation group r (r = 1, 2, ..., 8) to that estimate. In other words:

(2) $$Z_i = \sum_{r=1}^{8} Z_{i,r} .$$

[5]These reports also describe how we applied the food stamp gross and net income tests and calculated the benefits for which an eligible household would qualify. The reports also note that an SSI recipient who receives cash instead of food stamps in an SSI cashout state is not eligible for food stamps. (The only SSI cashout state is California.) We excluded these SSI recipients when identifying the members of food stamp households.

We also let N_i equal the CPS sample estimate of the population in state i and $N_{i,r}$ equal the contribution of rotation group r to that estimate. That is:

$$(3) \qquad N_i = \sum_{r=1}^{8} N_{i,r} \, .$$

If, as described before, E_i equals the CPS sample estimate of the percentage eligible in state i:

$$(4) \qquad E_i = 100 \frac{Z_i}{N_i} \, .$$

If we were to exclude the observations in rotation group r, we could estimate the percentage eligible in state i and the participation rate for state i by:

$$(5) \qquad E_{i(r)} = 100 \frac{Z_i - Z_{i,r}}{N_i - N_{i,r}}$$

and

$$(6) \qquad Y_{i(r)} = 100 \frac{P_i(1-\varepsilon_i/100)}{(E_{i(r)}/100)T_i} \, .$$

The "(r)" subscript indicates that rotation group r has been excluded. By excluding each of the eight rotation groups in turn, we obtain eight alternative estimates for the participation rate in state i. Then, we can assess the degree of sampling variability (estimate the variance of Y_i) by measuring the variability among the eight estimates according to:

$$(7) \qquad \text{var}(Y_i) = \frac{7}{8} \sum_{r=1}^{8} (Y_{i(r)} - Y_i)^2 \, .$$

The factor 7/8 enters this expression because the $Y_{i(r)}$ are obtained from samples that are only 7/8 the size of the full CPS sample for state i and, hence, are expected to be more variable than Y_i (by a factor of 8/7). Our jackknife estimate of the standard error of Y_i is obtained by taking the square root of var(Y_i). Estimated jackknife standard errors for the direct estimates of participation rates are presented in Table A.2.

We derived a preliminary estimate of the covariance between $Y_{i,t}$ and $Y_{i,t-g}$, the sample estimate for one year and the sample estimate for g years earlier, according to either:

$$(8) \quad \text{cov}(Y_{i,t}, Y_{i,t-g}) = \frac{7}{8}\left[\sum_{r=1}^{4}(Y_{i(r),t} - Y_{i,t})(Y_{i(r+4),t-g} - Y_{i,t-g}) + \sum_{r=5}^{8}(Y_{i(r),t} - Y_{i,t})(Y_{i(r\text{-}4),t-g} - Y_{i,t-g})\right],$$

if g is odd, or:

$$(9) \quad \text{cov}(Y_{i,t}, Y_{i,t\text{-}g}) = \frac{7}{8}\left[\sum_{r=1}^{8}(Y_{i(r),t} - Y_{i,t})(Y_{i(r),t\text{-}g} - Y_{i,t\text{-}g})\right],$$

if g is even. The correlation between $Y_{i,t}$ and $Y_{i,t-g}$ is:

$$(10) \quad \text{corr}(Y_{i,t}, Y_{i,t\text{-}g}) = \frac{\text{cov}(Y_{i,t}, Y_{i,t\text{-}g})}{\sqrt{\text{var}(Y_{i,t})\,\text{var}(Y_{i,t\text{-}g})}}.$$

To improve the precision of estimated correlations (and covariances), we used a simple smoothing technique in which we "replaced" the state-specific correlation from Equation (10) by the average correlation between $Y_{i,t}$ and $Y_{i,t-g}$ across states:

$$(11) \quad \overline{\text{corr}}(Y_t, Y_{t-g}) = \frac{\sum_{i=1}^{51}(n_{i,t} + n_{i,t-g})\,\text{corr}(Y_{i,t}, Y_{i,t-g})}{\sum_{i=1}^{51}(n_{i,t} + n_{i,t-g})},$$

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

$$(12) \quad \text{cov}(Y_{i,t}, Y_{i,t-g}) = \overline{\text{corr}}(Y_t, Y_{t-g})\sqrt{\text{var}(Y_{i,t})\,\text{var}(Y_{i,t-g})}.$$

As described under Step 3, the variances and covariances obtained according to Equations (7) and (12) are the elements of a variance-covariance matrix used in deriving shrinkage estimates of participation rates.

2. Using a regression model, predict state food stamp participation rates based on administrative and decennial census data.

Our regression model consisted of three equations predicting food stamp participation rates for 1998, 1999, and 2000, respectively. The three equations were estimated jointly. Although the values of the regression coefficients could vary from equation to equation, each equation had the same “best” predictors. The predictors were (in addition to an intercept):

- The percentage of the population receiving food stamps
- The tax return nonfiler rate for elderly people, that is, the percentage of the elderly population that is not claimed as exemptions on tax returns
- The percentage of families below the federal poverty level in 1999 according to Census 2000

The value for the last predictor is the same in each of the three equations of our regression model. However, for the first two predictors, we used 1998 values in the equation for predicting 1998 participation rates, 1999 values in the equation for predicting 1999 rates, and 2000 values in the equation for predicting 2000 rates. Because prediction errors were allowed to be correlated and intertemporal correlations among direct sample estimates were taken into account as specified in the next step, the shrinkage estimates for any one year were determined by the predictions and sample estimates for all three years.

In addition to the three predictors that we selected for our “best” model, we considered many other potential predictors measuring, for example, Unemployment Insurance program participation, average adjusted gross income on tax returns, and the prevalence of households with no children. 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 food stamp 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 census 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.[6] 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, percentage of the population that is black or Hispanic, region, and welfare program characteristics. We found no strong evidence of correctable bias.

Definitions and data sources for the predictors in our best regression model are given in Table A.7. The values for the last predictor listed above are the same in each of the three year-specific regression equations, and are displayed in Table A.8. Values for the other predictors, which are updated each year, are presented in Tables A.9 to A.11. Regression estimates of participation rates are in Table A.12, and standard errors for the regression estimates are in Table A.13.

[6]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 food stamp participation rates.

To average the direct sample estimates and the regression predictions, we used an empirical Bayes shrinkage estimator.[7] The estimator does not have a closed-form expression from which we can calculate shrinkage estimates. Instead, we must numerically integrate over three scalar parameters—σ, ρ, and η—that measure the lack of fit of the regression model and the intertemporal correlations among regression prediction errors. To perform the numerical integration, we specified a grid of 153,720 equally-spaced points, starting with σ = 0.000, ρ = -0.990, and η = 0.000 and incrementing σ, ρ, and η by 0.200, 0.045, and 0.200, respectively, up to σ = 11.000, ρ = 0.990, and η = 12.000. For combination k of σ, ρ, and η (k = 1, 2, ..., 153720), we calculated a vector of shrinkage estimates:

$$(13) \quad \theta_k = (\Sigma_k^{-1} + V^{-1})^{-1}(\Sigma_k^{-1} X\hat{B}_k + V^{-1}Y) ,$$

a variance-covariance matrix:

$$(14) \quad U_k = (\Sigma_k^{-1} + V^{-1})^{-1} + (\Sigma_k^{-1} + V^{-1})^{-1}\Sigma_k^{-1} X(X'(\Sigma_k + V)^{-1} X)^{-1} X'\Sigma_k^{-1}(\Sigma_k^{-1} + V^{-1})^{-1} ,$$

and a probability:

$$(15) \quad p_k^* = |\Sigma_k + V|^{-1/2} | X'(\Sigma_k + V)^{-1} X|^{-1/2} \exp\left(-\frac{1}{2}(Y - X\hat{B}_k)'(\Sigma_k + V)^{-1}(Y - X\hat{B}_k) \right).$$

In these expressions, Y is a column vector of direct sample estimates (from Step 1) with 153 elements, three sample estimates for each of the 51 states. The first three elements of Y pertain to the first state, the next three to the second state, and so forth. For a given state, the three

[7] Although our shrinkage estimator averages direct sample and regression estimates, a state's shrinkage estimate in a given year does not have to be between the sample and regression estimates for that year. 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 estimate presented in this report is between the 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.

elements are the sample estimates for 1998, 1999, and 2000, respectively. The vector of shrinkage estimates, θ_k, has the same structure as the vector of sample estimates, Y. V is the (153 $\times$ 153) variance-covariance matrix for the sample estimates. Because state samples are independent in the CPS, V is block-diagonal with 51 (3 $\times$ 3) blocks. We described under Step 1 how we derived estimates for the elements of V. X is a (153 $\times$ 12) matrix containing values for each of the three predictors (plus an intercept) for every state and every year (1998, 1999, and 2000). The first three rows of X—one row for each of the three years (in chronological order)—pertain to the first state, the next three rows pertain to the second state, and so forth. The three rows for state i are given by:

$$(16) \quad X_i = \begin{pmatrix} x'_{i1} & \underline{0} & \underline{0} \\ \underline{0} & x'_{i2} & \underline{0} \\ \underline{0} & \underline{0} & x'_{i3} \end{pmatrix},$$

where x'_{it} is a row vector for year t (t = 1 for 1998, t = 2 for 1999, and t = 3 for 2000) with four elements—an intercept plus the three predictors listed under Step 2—and $\underline{0}$ is a row vector with four zeros. $\hat{B}_k$ is a (12 $\times$ 1) vector of regression coefficients, and is given by:

$$(17) \quad \hat{B}_k = (X'(\Sigma_k + V)^{-1} X)^{-1} X'(\Sigma_k + V)^{-1} Y .$$

Finally, Σ_k is a block-diagonal matrix with 51 (3 $\times$ 3) blocks, and every block equals:

$$(18) \quad \Sigma_k^* = \sigma_k^2 \begin{pmatrix} 1 & \rho_k & \rho_k^2 \\ \rho_k & 1 & \rho_k \\ \rho_k^2 & \rho_k & 1 \end{pmatrix} + \eta_k^2 \begin{pmatrix} 111 \\ 111 \\ 111 \end{pmatrix}.$$

More generally, the (f,g) element of Σ_k^* is $\Sigma_k^*(f,g) = \sigma_k^2 \, \rho_k^{|f-g|} + n$.[8]

[8]When both σ_k = 0 and η_k = 0, we set $\theta_k = X(X'V^{-1}X)^{-1}X'V^{-1}Y$ and $U_k = X(X'V^{-1}X)^{-1}X'$, their limiting values.

After calculating θ_k , U_k , and p_k^* 153,720 times (once for each combination of σ, ρ, and η), we calculated the probability of $(\sigma_k, \rho_k, \eta_k)$:

$$(19) \quad p_k = \frac{p_k^*}{\sum_{k=1}^{153,720} p_k^*} ,$$

which is also an estimate of the probability that the shrinkage estimates θ_k are the true values. As Equation (19) suggests, the p_k are obtained by normalizing the p_k^* to sum to one.

To complete the numerical integration over σ, ρ, and η and obtain a single set of shrinkage estimates, we calculated a weighted sum of the 153,720 sets of shrinkage estimates, weighting each set θ_k by its associated probability p_k. Thus, our shrinkage estimates are:

$$(20) \quad \theta = \sum_{k=1}^{153,720} p_k \theta_k .$$

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:

$$(21) \quad U = \sum_{k=1}^{153,720} p_k U_k + \sum_{k=1}^{153,720} p_k (\theta_k - \theta)(\theta_k - \theta)' .$$

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, ρ, and η vary. Thus, the second term accounts for the variability from not knowing and, thus, having to estimate σ, ρ, and η. 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:

$$(22) \quad R = \sum_{k=1}^{153,720} p_k R_k \ ,$$

where $R_k = X\hat{B}_k$ is the vector of regression estimates obtained when $\sigma = \sigma_k$, $\rho = \rho_k$, and $\eta = \eta_k$.

The variance-covariance matrix is:

$$(23) \quad G = \sum_{k=1}^{153,720} p_k G_k + \sum_{k=1}^{153,720} p_k (R_k - R)(R_k - R)' \ ,$$

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

$$(24) \quad \hat{B} = \sum_{k=1}^{153,720} p_k \hat{B}_k \ .$$

Regression estimates of participation rates were presented before in Table A.12. Preliminary shrinkage estimates of participation rates are displayed in Table A.14.

4. Adjust the preliminary shrinkage estimates to obtain final shrinkage estimates of state food stamp participation rates.

We adjusted the preliminary shrinkage estimates of participation rates so that the eligibles counts implied by the rates sum to the national eligibles count estimated directly from the CPS. This adjustment was carried out for each year separately. The following description of the adjustment will focus on the 2000 estimates.

To implement the adjustment, we calculated preliminary estimates of eligibles counts according to:

$$(25) \quad \psi_i = \frac{P_i(1-\varepsilon_i/100)}{(\theta_i/100)} \ ,$$

where ψ_i is the preliminary eligibles count for state i, P_i and ε_i are the participant count and issuance error rate figures used in Equation (1), and θ_i is the preliminary participation rate derived in Equation (20). The state eligibles counts from Equation (25) summed to 29,319,215 for 2000, while the national total for 2000 estimated directly from the CPS was 28,197,705. 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 (25) by 28,197,705 ÷ 29,319,215 (≈ 0.9617).[9,10]

Our final shrinkage estimates of the numbers of people eligible for food stamps were shown earlier in Table III.2 of Chapter III. From those final shrinkage estimates of the numbers of eligible people, we calculated final shrinkage estimates of participation rates according to:

$$(26) \quad \theta_{F,i} = 100\frac{P_i(1-\varepsilon_i/100)}{\psi_{F,i}},$$

where $\theta_{F,i}$ is the final shrinkage estimate of the participation rate in state i, and $\psi_{F,i}$ is the final shrinkage estimate of the number of eligible people. P_i and ε_i are the participant count and issuance error rate figures used in Equations (1) and (25). Participation rates for all states were shown in Chapter III, Table III.1.

In Tables III.3 to III.5 of Chapter III, we reported approximate 90-percent confidence intervals for our final shrinkage estimates. The upper and lower bounds of the confidence intervals were calculated according to:

$$(27) \quad Upper\ Bound_i = F_i + 1.645\, e_i$$

and:

$$(28) \quad Lower\ Bound_i = F_i - 1.645\, e_i\ ,$$

---

[9]The adjustment factors for the other two years (1998 and 1999) were, respectively, 0.9702, and 0.9784. The direct estimates of the national totals for those years were 30,349,933 and 29,502,439.

[10] Previously, in deriving estimates for other ranges of years (1994 to 1999, for example), a second adjustment was needed to ensure that no state’s estimated participation rate was greater than 100 percent. This adjustment was not needed in deriving the estimates for 1998 to 2000 because all estimated rates were less than 100 percent. (The District of Columbia had only slightly more eligibles than participants in 1999, resulting in a participation rate that rounded up to 100 percent.)

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:

$$(29) \quad e_i = \frac{1}{r}\sqrt{U(3i,3i)}$$

and

$$(30) \quad e_i = \frac{\psi_{F,i}}{\theta_{F,i}} \frac{1}{r}\sqrt{U(3i,3i)}\,,$$

where r is the ratio used to adjust preliminary estimates of state eligibles counts to the direct estimate of the national total ($\approx$ 0.9617 for 2000), and $U(3i,3i)$ is the $(3i,3i)$ diagonal element of U, which was derived according to Equation (21).[11] 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.15 presents final shrinkage estimates of participation rates (values of $\theta_{F,i}$), and Table A.16 presents standard errors for the rates. Tables A.17 and A.18 display final shrinkage estimates of the numbers of eligible people (values of $\psi_{F,i}$) and standard errors for those estimated counts.[12] Table A.19 shows issuance-error-adjusted numbers of people receiving food stamps (values of $P_i(1 - \varepsilon_i/100)$).

[11]The square root of $U(3i,3i)$ is the standard error of the preliminary shrinkage estimate of the 2000 participation rate for state i. When deriving estimates for 1998 and 1999, we would use the (i,i) and $(2i,2i)$ diagonal elements of U, respectively.

[12]The rates and counts in Tables A.15 and A.17 are the same as the rates and counts in Tables III.1 and III.2 of Chapter III, except for the number of digits displayed.

TABLE A.1

DIRECT SAMPLE ESTIMATES OF PARTICIPATION RATES

	1998	1999	2000
Alabama	65.384	53.319	51.339
Alaska	81.010	65.395	67.008
Arizona	44.730	49.908	44.183
Arkansas	62.587	64.598	53.104
California	54.245	50.635	52.004
Colorado	65.387	57.784	58.024
Connecticut	65.096	61.235	83.474
Delaware	48.743	45.614	49.218
District of Columbia	80.330	95.753	81.058
Florida	50.623	54.047	51.110
Georgia	54.270	50.064	59.467
Hawaii	98.803	89.367	123.016
Idaho	45.721	36.338	39.086
Illinois	64.617	67.203	63.500
Indiana	65.260	68.435	65.350
Iowa	57.863	65.025	72.004
Kansas	49.421	39.954	53.181
Kentucky	74.467	80.622	76.627
Lousiana	63.922	65.669	61.768
Maine	84.337	85.749	89.769
Maryland	77.579	61.545	57.784
Massachusetts	50.450	36.386	35.622
Michigan	72.619	65.822	77.123
Minnesota	62.774	59.714	73.826
Mississippi	55.741	60.425	60.301
Missouri	77.563	73.105	102.847
Montana	54.473	53.989	54.006
Nebraska	62.990	62.341	61.390
Nevada	41.275	30.794	34.658
New Hampshire	33.854	41.800	47.673
New Jersey	61.477	61.493	47.076
New Mexico	62.489	58.840	64.766
New York	56.145	58.741	59.677
North Carolina	48.660	50.441	49.329
North Dakota	44.878	51.503	50.819
Ohio	55.251	51.383	55.160
Oklahoma	62.364	68.623	55.739
Oregon	60.124	67.603	81.976
Pennsylvania	75.124	69.031	68.669
Rhode Island	72.358	64.981	64.345
South Carolina	60.092	63.340	64.292
South Dakota	75.043	69.099	74.212
Tennessee	73.873	72.873	58.950
Texas	50.134	44.914	44.840
Utah	53.021	65.753	44.555
Vermont	71.290	82.489	58.213
Virginia	62.999	57.337	57.495
Washington	69.096	57.721	56.987
West Virginia	75.705	81.624	81.997
Wisconsin	48.832	47.375	54.192
Wyoming	45.007	48.147	48.260

TABLE A.2

STANDARD ERRORS OF DIRECT SAMPLE ESTIMATES OF PARTICIPATION RATES

	1998	1999	2000
Alabama	9.348	6.236	6.605
Alaska	11.150	10.404	7.214
Arizona	3.927	4.322	2.286
Arkansas	6.586	9.831	8.213
California	2.385	1.997	1.967
Colorado	9.078	11.308	8.266
Connecticut	8.151	6.773	19.917
Delaware	5.836	7.357	12.260
District of Columbia	7.096	13.566	2.996
Florida	1.838	3.513	4.135
Georgia	5.519	3.976	5.317
Hawaii	7.939	11.717	18.682
Idaho	12.355	12.261	4.929
Illinois	7.673	4.778	3.506
Indiana	6.168	11.381	8.212
Iowa	8.210	9.680	16.484
Kansas	6.921	1.881	6.301
Kentucky	11.344	9.286	13.044
Lousiana	6.439	9.958	4.802
Maine	12.074	11.545	16.207
Maryland	9.934	9.900	9.976
Massachusetts	5.845	5.033	4.922
Michigan	7.189	4.956	3.586
Minnesota	12.319	9.274	6.680
Mississippi	5.831	3.879	6.268
Missouri	15.360	12.064	16.892
Montana	6.975	5.618	6.711
Nebraska	7.826	9.251	11.526
Nevada	5.494	3.617	6.231
New Hampshire	5.819	6.587	6.836
New Jersey	7.284	5.222	4.097
New Mexico	9.111	6.275	5.110
New York	3.074	3.277	3.613
North Carolina	3.340	5.206	2.363
North Dakota	8.925	11.530	7.476
Ohio	5.529	4.617	4.333
Oklahoma	6.828	4.056	4.327
Oregon	5.708	7.169	11.440
Pennsylvania	8.149	4.719	12.024
Rhode Island	9.484	8.550	5.784
South Carolina	5.182	8.322	4.238
South Dakota	8.985	7.889	12.866
Tennessee	9.392	4.434	5.965
Texas	2.124	1.045	2.146
Utah	8.355	10.844	6.918
Vermont	11.705	10.416	11.569
Virginia	7.664	6.900	6.371
Washington	6.613	5.274	5.443
West Virginia	9.331	10.048	9.120
Wisconsin	11.269	9.686	8.404
Wyoming	9.685	4.143	6.766

TABLE A.3

NUMBER OF PEOPLE RECEIVING FOOD STAMPS
IN SEPTEMBER

	1998	1999	2000
Alabama	413,293	401,175	397,910
Alaska	42,934	39,477	38,918
Arizona	271,920	260,441	268,213
Arkansas	254,806	249,511	247,364
California	2,089,896	1,924,820	1,740,317
Colorado	181,924	165,615	149,894
Connecticut	187,955	171,009	159,769
Delaware	42,188	38,240	30,122
District of Columbia	84,073	84,331	77,457
Florida	952,782	913,310	881,306
Georgia	606,519	584,664	556,647
Hawaii	122,344	122,543	114,157
Idaho	56,167	54,836	56,222
Illinois	861,736	795,445	833,396
Indiana	300,325	294,621	310,282
Iowa	130,402	124,105	122,100
Kansas	113,826	115,232	122,855
Kentucky	396,542	395,783	400,623
Lousiana	528,505	514,978	503,939
Maine	109,166	103,393	98,471
Maryland	304,036	232,194	212,329
Massachusetts	270,681	248,359	222,770
Michigan	734,400	629,481	623,200
Minnesota	209,297	199,514	194,846
Mississippi	301,924	277,854	285,901
Missouri	401,870	414,184	429,354
Montana	59,336	59,106	58,146
Nebraska	96,930	87,856	78,857
Nevada	65,332	59,057	62,687
New Hampshire	34,925	36,381	35,532
New Jersey	399,602	366,697	323,674
New Mexico	177,528	173,113	164,534
New York	1,537,380	1,502,730	1,397,208
North Carolina	502,209	489,523	478,644
North Dakota	33,421	32,281	30,919
Ohio	677,477	612,824	605,833
Oklahoma	283,796	263,328	253,317
Oregon	221,115	221,775	239,620
Pennsylvania	852,404	785,948	760,196
Rhode Island	72,206	75,740	72,557
South Carolina	323,037	298,015	295,158
South Dakota	43,299	42,180	42,972
Tennessee	522,898	496,776	494,767
Texas	1,494,394	1,332,659	1,319,716
Utah	89,113	83,951	80,149
Vermont	36,956	43,172	39,169
Virginia	372,858	347,605	331,595
Washington	323,251	284,762	291,516
West Virginia	254,490	235,838	221,365
Wisconsin	181,741	181,688	201,647
Wyoming	23,252	21,455	21,577

TABLE A.4

FISCAL YEAR PERSON-LEVEL FOOD STAMP ISSUANCE
ERROR RATES

	1998	1999	2000
Alabama	2.72	4.03	4.32
Alaska	3.92	5.09	2.31
Arizona	2.40	2.22	1.58
Arkansas	1.78	1.40	1.16
California	1.24	1.65	1.94
Colorado	3.26	3.12	1.89
Connecticut	3.78	4.88	2.33
Delaware	6.42	5.78	4.31
District of Columbia	1.59	1.65	2.52
Florida	3.95	3.10	2.93
Georgia	4.63	3.52	3.70
Hawaii	1.33	1.72	2.20
Idaho	5.53	3.22	4.46
Illinois	2.80	2.92	2.92
Indiana	1.67	1.70	2.53
Iowa	5.59	1.92	2.38
Kansas	2.34	2.83	4.04
Kentucky	1.51	1.39	2.23
Louisiana	1.75	1.70	1.26
Maine	3.44	3.23	3.14
Maryland	4.58	3.98	3.20
Massachusetts	0.77	1.32	0.80
Michigan	4.72	4.54	2.85
Minnesota	1.81	1.47	0.97
Mississippi	0.65	0.49	1.65
Missouri	2.67	2.66	1.79
Montana	2.43	1.76	3.87
Nebraska	5.98	6.19	4.04
Nevada	3.12	3.32	2.47
New Hampshire	2.51	4.61	2.78
New Jersey	2.31	2.96	3.88
New Mexico	3.27	2.49	2.91
New York	2.40	1.78	3.01
North Carolina	3.01	1.63	2.26
North Dakota	3.19	3.40	3.09
Ohio	2.25	1.26	1.37
Oklahoma	2.72	2.90	2.26
Oregon	7.10	3.70	3.63
Pennsylvania	3.06	2.26	2.58
Rhode Island	1.10	1.17	3.19
South Carolina	2.49	1.34	1.42
South Dakota	0.20	0.21	0.11
Tennessee	2.72	2.74	2.23
Texas	1.91	1.22	0.84
Utah	2.53	6.63	7.11
Vermont	4.25	2.97	4.93
Virginia	2.43	3.48	3.50
Washington	4.83	1.76	1.72
West Virginia	4.18	2.98	1.26
Wisconsin	2.04	2.52	2.34
Wyoming	1.98	0.12	1.75

TABLE A.5

POPULATION ON SEPTEMBER 1

	1998	1999	2000
Alabama	4,427,624	4,444,675	4,453,637
Alaska	627,179	630,232	628,816
Arizona	4,775,618	4,917,682	5,188,950
Arkansas	2,582,351	2,607,444	2,680,373
California	33,603,785	33,990,955	34,083,893
Colorado	4,052,970	4,158,575	4,339,127
Connecticut	3,295,642	3,321,290	3,412,578
Delaware	757,884	769,187	787,889
District of Columbia	542,479	545,559	571,192
Florida	15,202,835	15,485,732	16,111,359
Georgia	7,804,455	7,980,710	8,255,505
Hawaii	1,210,651	1,207,468	1,214,301
Idaho	1,256,942	1,278,423	1,302,883
Illinois	12,194,318	12,275,285	12,443,692
Indiana	5,941,598	5,990,826	6,094,083
Iowa	2,874,057	2,888,791	2,926,787
Kansas	2,658,735	2,674,922	2,692,232
Kentucky	3,999,609	4,025,992	4,050,446
Louisiana	4,458,653	4,466,982	4,469,213
Maine	1,257,675	1,264,699	1,278,579
Maryland	5,238,188	5,279,171	5,321,616
Massachusetts	6,179,242	6,230,243	6,360,777
Michigan	9,893,995	9,933,903	9,958,475
Minnesota	4,754,259	4,817,826	4,937,960
Mississippi	2,810,683	2,829,088	2,850,588
Missouri	5,474,819	5,517,647	5,607,912
Montana	899,388	902,270	903,370
Nebraska	1,672,024	1,682,433	1,712,687
Nevada	1,783,716	1,868,356	2,033,282
New Hampshire	1,197,749	1,215,404	1,243,098
New Jersey	8,149,196	8,229,075	8,438,244
New Mexico	1,783,185	1,793,915	1,822,593
New York	18,445,078	18,561,777	18,993,006
North Carolina	7,689,457	7,826,998	8,095,517
North Dakota	641,365	638,414	639,841
Ohio	11,315,990	11,336,444	11,362,219
Oklahoma	3,400,055	3,421,814	3,454,391
Oregon	3,342,029	3,380,253	3,436,555
Pennsylvania	12,037,038	12,072,190	12,283,351
Rhode Island	989,790	1,002,028	1,051,683
South Carolina	3,920,309	3,969,551	4,030,034
South Dakota	738,057	742,593	755,691
Tennessee	5,528,513	5,592,749	5,708,359
Texas	20,254,061	20,599,851	21,009,589
Utah	2,135,851	2,173,798	2,246,261
Vermont	597,449	601,687	610,273
Virginia	6,929,908	7,017,042	7,117,969
Washington	5,791,258	5,858,366	5,921,639
West Virginia	1,836,838	1,828,576	1,806,235
Wisconsin	5,257,111	5,295,968	5,377,187
Wyoming	490,036	490,389	494,071

TABLE A.6

DIRECT SAMPLE ESTIMATES OF PERCENTAGES OF PEOPLE ELIGIBLE FOR FOOD STAMPS

	1998	1999	2000
Alabama	13.888	16.246	16.651
Alaska	8.119	9.091	9.023
Arizona	12.424	10.376	11.514
Arkansas	15.485	14.606	17.177
California	11.323	10.999	9.628
Colorado	6.641	6.677	5.841
Connecticut	8.430	7.998	5.478
Delaware	10.687	10.269	7.433
District of Columbia	18.986	15.877	16.308
Florida	11.891	10.574	10.389
Georgia	13.657	14.118	10.919
Hawaii	10.092	11.161	7.474
Idaho	9.233	11.424	10.548
Illinois	10.630	9.361	10.239
Indiana	7.616	7.064	7.594
Iowa	7.403	6.480	5.656
Kansas	8.460	10.477	8.234
Kentucky	13.113	12.024	12.620
Lousiana	18.219	17.257	18.025
Maine	9.938	9.226	8.310
Maryland	7.139	6.862	6.684
Massachusetts	8.616	10.811	9.753
Michigan	9.739	9.190	7.883
Minnesota	6.886	6.833	5.293
Mississippi	19.146	16.174	16.358
Missouri	9.211	9.995	7.311
Montana	11.817	11.920	11.457
Nebraska	8.653	7.858	7.197
Nevada	8.597	9.924	8.676
New Hampshire	8.397	6.831	5.829
New Jersey	7.792	7.032	7.832
New Mexico	15.411	15.992	13.533
New York	14.489	13.537	11.956
North Carolina	13.018	12.197	11.715
North Dakota	11.241	9.484	9.215
Ohio	10.592	10.388	9.534
Oklahoma	13.020	10.889	12.859
Oregon	10.223	9.346	8.197
Pennsylvania	9.138	9.218	8.780
Rhode Island	9.971	11.496	10.380
South Carolina	13.371	11.694	11.230
South Dakota	7.802	8.203	7.654
Tennessee	12.455	11.855	14.375
Texas	14.436	14.228	13.891
Utah	7.670	5.484	7.439
Vermont	8.308	8.440	10.482
Virginia	8.333	8.339	7.819
Washington	7.688	8.273	8.490
West Virginia	17.536	15.330	14.758
Wisconsin	6.935	7.059	6.758
Wyoming	10.334	9.076	8.891

TABLE A.7

DEFINITIONS AND DATA SOURCES FOR PREDICTORS

Predictor[a]	Definition	Principal Data Source[b]
Food stamp prevalence rate	$100 \times \frac{\text{Number of people receiving food stamps in September}}{\text{Resident population in September}}$	Counts of people receiving food stamps are from FSP Program Operations data and were provided by the Food and Nutrition Service. For more information, see the first footnote of Appendix A.
Elderly tax nonfiler rate	$100 - \left(100 \times \frac{\text{Number of exemptions for people ages 65 and over on tax returns}}{\text{Population of people ages 65 and over}}\right)$	All data for constructing this predictor were obtained from the U.S. Census Bureau.
Family poverty rate	$100 \times \frac{\text{Number of families below the poverty level}}{\text{Total number of families}}$	The data for constructing this predictor were obtained from the Census 2000 Demographic Profiles released between May 7, 2002 and June 4, 2002 at http://www2.census.gov/census_2000/datasets/100_and_sample_profile.

[a]Values for the first two predictors vary across the year-specific equations of our regression model, while values for the last predictor do not vary.

[b]For deriving elderly tax nonfiler rates for a given year, we used the July 1 population estimates published by the Census Bureau for that year. For deriving food stamp prevalence rates, we obtained September 1 population estimates for a given year by averaging the July 1 estimates published by the Census Bureau for that year and the next year. The weights were 5/6 and 1/6, respectively. The 1998 and 1999 population estimates that we used were released on August 30, 2000 at http://www.census.gov/population/www/estimates/st_sasrh.html. We adjusted these population estimates for net undercount in the (1990) decennial census using a state net population adjustment matrix published by the Census Bureau at http://www.census.gov/population/www/censusdata/adjustment.html. The 2000 and 2001 population estimates that we used were released on December 27, 2001 at http://eire.census.gov/popest/data/states/tables/st-est2001-01.php. We did not adjust these estimates for net undercount in Census 2000.

TABLE A.8

VALUES FOR TEMPORALLY CONSTANT PREDICTOR
(1999 Values Based on Census 2000 Data)

	Family Poverty Rate
Alabama	12.518
Alaska	6.686
Arizona	9.897
Arkansas	12.020
California	10.594
Colorado	6.190
Connecticut	5.643
Delaware	6.466
District of Columbia	16.699
Florida	9.040
Georgia	9.883
Hawaii	7.647
Idaho	8.326
Illinois	7.817
Indiana	6.691
Iowa	6.024
Kansas	6.692
Kentucky	12.655
Lousiana	15.771
Maine	7.771
Maryland	6.081
Massachusetts	6.653
Michigan	7.424
Minnesota	5.082
Mississippi	15.958
Missouri	8.565
Montana	10.474
Nebraska	6.713
Nevada	7.538
New Hampshire	4.284
New Jersey	6.253
New Mexico	14.540
New York	11.468
North Carolina	9.038
North Dakota	8.319
Ohio	7.815
Oklahoma	11.184
Oregon	7.914
Pennsylvania	7.759
Rhode Island	8.853
South Carolina	10.744
South Dakota	9.297
Tennessee	10.318
Texas	11.975
Utah	6.479
Vermont	6.255
Virginia	6.983
Washington	7.332
West Virginia	13.888
Wisconsin	5.605
Wyoming	8.049

TABLE A.9

1998 VALUES FOR TEMPORALLY VARIABLE PREDICTORS

	Food Stamp Prevalence Rate	Elderly Tax Nonfiler Rate
Alabama	9.334	54.168
Alaska	6.846	34.656
Arizona	5.694	43.544
Arkansas	9.867	51.389
California	6.219	45.132
Colorado	4.489	36.908
Connecticut	5.703	40.005
Delaware	5.567	37.730
District of Columbia	15.498	47.669
Florida	6.267	44.200
Georgia	7.771	50.287
Hawaii	10.106	37.801
Idaho	4.469	40.476
Illinois	7.067	39.292
Indiana	5.055	38.581
Iowa	4.537	35.712
Kansas	4.281	36.003
Kentucky	9.915	51.343
Louisiana	11.853	53.476
Maine	8.680	46.006
Maryland	5.804	40.863
Massachusetts	4.380	43.749
Michigan	7.423	39.326
Minnesota	4.402	37.776
Mississippi	10.742	59.165
Missouri	7.340	42.759
Montana	6.597	36.213
Nebraska	5.797	34.915
Nevada	3.663	38.086
New Hampshire	2.916	39.558
New Jersey	4.904	40.016
New Mexico	9.956	43.897
New York	8.335	47.739
North Carolina	6.531	50.334
North Dakota	5.211	34.740
Ohio	5.987	42.668
Oklahoma	8.347	46.398
Oregon	6.616	39.697
Pennsylvania	7.082	43.960
Rhode Island	7.295	49.377
South Carolina	8.240	51.324
South Dakota	5.867	35.399
Tennessee	9.458	51.525
Texas	7.378	48.131
Utah	4.172	37.172
Vermont	6.186	39.934
Virginia	5.380	42.998
Washington	5.582	37.342
West Virginia	13.855	55.126
Wisconsin	3.457	38.907
Wyoming	4.745	34.525

TABLE A.10

1999 VALUES FOR TEMPORALLY VARIABLE PREDICTORS

	Food Stamp Prevalence Rate	Elderly Tax Nonfiler Rate
Alabama	9.026	52.950
Alaska	6.264	30.734
Arizona	5.296	44.654
Arkansas	9.569	51.150
California	5.663	41.983
Colorado	3.982	35.019
Connecticut	5.149	38.417
Delaware	4.971	37.859
District of Columbia	15.458	44.811
Florida	5.898	43.710
Georgia	7.326	49.302
Hawaii	10.149	35.205
Idaho	4.289	39.701
Illinois	6.480	37.988
Indiana	4.918	37.666
Iowa	4.296	35.924
Kansas	4.308	34.440
Kentucky	9.831	51.009
Louisiana	11.529	53.016
Maine	8.175	46.594
Maryland	4.398	38.962
Massachusetts	3.986	42.008
Michigan	6.337	37.201
Minnesota	4.141	36.780
Mississippi	9.821	58.244
Missouri	7.507	41.420
Montana	6.551	35.592
Nebraska	5.222	34.660
Nevada	3.161	37.637
New Hampshire	2.993	38.308
New Jersey	4.456	38.578
New Mexico	9.650	44.675
New York	8.096	46.382
North Carolina	6.254	48.556
North Dakota	5.056	35.021
Ohio	5.406	41.245
Oklahoma	7.696	45.180
Oregon	6.561	37.973
Pennsylvania	6.510	42.939
Rhode Island	7.559	47.465
South Carolina	7.508	50.244
South Dakota	5.680	35.172
Tennessee	8.883	50.996
Texas	6.469	46.618
Utah	3.862	35.988
Vermont	7.175	41.163
Virginia	4.954	41.949
Washington	4.861	35.605
West Virginia	12.897	54.610
Wisconsin	3.431	37.967
Wyoming	4.375	34.135

TABLE A.11

2000 VALUES FOR TEMPORALLY VARIABLE PREDICTORS

	Food Stamp Prevalence Rate	Elderly Tax Nonfiler Rate
Alabama	8.934	51.447
Alaska	6.189	28.932
Arizona	5.169	43.589
Arkansas	9.229	49.472
California	5.106	41.100
Colorado	3.454	33.272
Connecticut	4.682	36.497
Delaware	3.823	36.619
District of Columbia	13.561	43.472
Florida	5.470	42.739
Georgia	6.743	47.647
Hawaii	9.401	33.999
Idaho	4.315	38.131
Illinois	6.697	36.449
Indiana	5.092	35.173
Iowa	4.172	34.532
Kansas	4.563	32.780
Kentucky	9.891	49.117
Lousiana	11.276	51.745
Maine	7.702	44.321
Maryland	3.990	37.693
Massachusetts	3.502	40.045
Michigan	6.258	34.729
Minnesota	3.946	34.645
Mississippi	10.030	56.780
Missouri	7.656	38.897
Montana	6.437	33.695
Nebraska	4.604	33.058
Nevada	3.083	36.997
New Hampshire	2.858	36.059
New Jersey	3.836	36.768
New Mexico	9.027	47.151
New York	7.356	44.862
North Carolina	5.912	46.828
North Dakota	4.832	33.410
Ohio	5.332	39.418
Oklahoma	7.333	43.648
Oregon	6.973	36.361
Pennsylvania	6.189	40.795
Rhode Island	6.899	45.024
South Carolina	7.324	48.477
South Dakota	5.686	33.573
Tennessee	8.667	49.430
Texas	6.281	45.613
Utah	3.568	34.564
Vermont	6.418	38.374
Virginia	4.659	40.373
Washington	4.923	33.978
West Virginia	12.256	53.081
Wisconsin	3.750	35.917
Wyoming	4.367	32.558

TABLE A.12

REGRESSION ESTIMATES OF PARTICIPATION RATES

	1998	1999	2000
Alabama	58.554	62.908	61.321
Alaska	71.775	67.846	72.332
Arizona	47.029	44.579	45.372
Arkansas	65.577	69.626	66.421
California	47.429	45.447	43.510
Colorado	55.622	50.324	50.672
Connecticut	65.186	61.151	60.729
Delaware	62.001	56.660	50.912
District of Columbia	89.858	100.714	85.913
Florida	54.226	52.969	51.308
Georgia	59.172	60.080	55.764
Hawaii	90.289	94.667	91.442
Idaho	45.603	43.554	47.150
Illinois	66.939	63.655	68.479
Indiana	57.040	55.400	60.702
Iowa	57.146	53.310	56.285
Kansas	52.566	51.153	57.728
Kentucky	63.473	69.328	69.424
Lousiana	64.481	70.641	67.461
Maine	75.853	75.702	72.684
Maryland	63.839	53.257	53.119
Massachusetts	50.022	47.046	46.049
Michigan	71.032	64.180	67.330
Minnesota	58.918	55.500	57.946
Mississippi	53.188	54.936	54.580
Missouri	64.488	68.346	72.025
Montana	54.570	54.505	57.953
Nebraska	63.955	58.437	57.836
Nevada	43.876	37.893	40.977
New Hampshire	50.457	48.936	51.704
New Jersey	57.015	53.146	51.726
New Mexico	59.730	61.975	56.657
New York	58.222	60.847	56.055
North Carolina	53.443	54.811	52.791
North Dakota	53.541	50.822	53.511
Ohio	57.630	54.241	56.368
Oklahoma	60.003	58.958	57.512
Oregon	63.117	63.940	70.316
Pennsylvania	65.213	63.045	62.608
Rhode Island	60.122	66.339	62.067
South Carolina	58.767	58.026	56.724
South Dakota	54.204	52.075	56.496
Tennessee	69.165	70.655	68.344
Texas	49.144	45.650	45.409
Utah	52.088	48.021	49.866
Vermont	66.338	74.623	71.137
Virginia	56.320	53.631	53.713
Washington	58.917	52.914	57.593
West Virginia	85.580	88.655	81.438
Wisconsin	49.534	47.463	53.864
Wyoming	51.307	46.532	51.285

TABLE A.13

STANDARD ERRORS OF REGRESSION ESTIMATES OF PARTICIPATION RATES

	1998	1999	2000
Alabama	5.334	5.269	5.280
Alaska	5.540	5.694	5.644
Arizona	5.172	5.140	5.108
Arkansas	5.223	5.268	5.247
California	5.182	5.163	5.272
Colorado	5.142	5.114	5.161
Connecticut	5.328	5.224	5.217
Delaware	5.142	5.063	5.067
District of Columbia	7.027	7.929	6.277
Florida	4.979	4.975	4.992
Georgia	5.211	5.177	5.166
Hawaii	6.448	6.830	6.301
Idaho	5.217	5.111	5.077
Illinois	5.154	5.103	5.173
Indiana	5.073	5.039	5.097
Iowa	5.193	5.098	5.111
Kansas	5.205	5.125	5.156
Kentucky	5.200	5.268	5.265
Lousiana	5.631	5.680	5.458
Maine	5.688	5.631	5.670
Maryland	5.249	5.118	5.106
Massachusetts	5.252	5.238	5.151
Michigan	5.299	5.145	5.196
Minnesota	5.256	5.219	5.222
Mississippi	5.873	5.791	5.687
Missouri	5.033	5.135	5.233
Montana	5.739	5.522	5.514
Nebraska	5.303	5.152	5.143
Nevada	5.347	5.300	5.255
New Hampshire	5.483	5.463	5.332
New Jersey	5.113	5.086	5.078
New Mexico	5.932	5.719	5.338
New York	5.037	5.033	5.002
North Carolina	5.350	5.246	5.200
North Dakota	5.467	5.195	5.239
Ohio	5.001	4.982	4.981
Oklahoma	5.019	5.011	4.980
Oregon	5.060	5.111	5.223
Pennsylvania	5.152	5.093	5.099
Rhode Island	5.290	5.242	5.179
South Carolina	5.206	5.165	5.148
South Dakota	5.566	5.321	5.323
Tennessee	5.458	5.394	5.497
Texas	5.230	5.246	5.249
Utah	5.154	5.101	5.117
Vermont	5.257	5.589	5.497
Virginia	5.107	5.102	5.079
Washington	5.111	5.080	5.104
West Virginia	6.263	6.122	5.906
Wisconsin	5.237	5.206	5.136
Wyoming	5.487	5.271	5.318

TABLE A.14

PRELIMINARY SHRINKAGE ESTIMATES OF PARTICIPATION RATES

	1998	1999	2000
Alabama	56.413	59.252	57.908
Alaska	71.623	67.149	71.336
Arizona	45.947	45.441	44.389
Arkansas	63.322	67.409	63.445
California	53.511	50.576	50.521
Colorado	58.269	52.650	53.225
Connecticut	65.062	60.915	60.969
Delaware	56.658	51.905	46.740
District of Columbia	86.095	97.622	82.222
Florida	51.321	52.039	49.784
Georgia	56.253	55.355	54.105
Hawaii	92.414	95.682	93.523
Idaho	42.881	40.643	43.483
Illinois	65.397	63.395	65.979
Indiana	60.083	58.275	63.279
Iowa	58.252	55.155	57.821
Kansas	45.970	41.405	51.023
Kentucky	65.934	71.972	71.713
Lousiana	62.858	68.737	65.059
Maine	77.747	77.647	74.689
Maryland	66.509	55.584	55.328
Massachusetts	46.831	42.034	41.243
Michigan	74.689	67.416	72.792
Minnesota	62.546	58.912	62.801
Mississippi	55.666	58.155	57.454
Missouri	66.442	69.926	74.281
Montana	54.060	53.977	57.059
Nebraska	64.126	58.988	58.260
Nevada	40.866	33.598	37.517
New Hampshire	44.530	44.536	47.379
New Jersey	57.276	54.654	50.496
New Mexico	61.669	62.909	59.581
New York	57.420	59.895	56.809
North Carolina	50.137	51.905	49.793
North Dakota	51.754	49.704	52.071
Ohio	56.386	52.824	55.298
Oklahoma	61.995	63.046	58.673
Oregon	62.645	64.295	70.782
Pennsylvania	68.353	66.183	65.386
Rhode Island	61.958	67.178	63.424
South Carolina	61.141	60.747	60.336
South Dakota	59.969	57.662	61.776
Tennessee	68.761	70.810	66.550
Texas	49.474	44.969	45.095
Utah	51.603	48.617	48.795
Vermont	66.484	75.162	70.600
Virginia	58.387	55.412	55.605
Washington	61.517	55.049	58.967
West Virginia	83.818	87.107	80.290
Wisconsin	49.483	47.439	53.866
Wyoming	51.064	47.203	51.087

TABLE A.15

FINAL SHRINKAGE ESTIMATES OF PARTICIPATION RATES

	1998	1999	2000
Alabama	58.149	60.562	60.211
Alaska	73.826	68.633	74.173
Arizona	47.361	46.445	46.155
Arkansas	65.270	68.899	65.968
California	55.157	51.694	52.530
Colorado	60.061	53.814	55.342
Connecticut	67.064	62.262	63.394
Delaware	58.401	53.052	48.599
District of Columbia	88.744	99.780	85.492
Florida	52.900	53.190	51.764
Georgia	57.983	56.579	56.257
Hawaii	95.257	97.797	97.243
Idaho	44.200	41.541	45.212
Illinois	67.409	64.797	68.603
Indiana	61.931	59.563	65.796
Iowa	60.044	56.374	60.120
Kansas	47.385	42.320	53.053
Kentucky	67.962	73.563	74.565
Lousiana	64.792	70.256	67.646
Maine	80.139	79.364	77.659
Maryland	68.555	56.812	57.528
Massachusetts	48.271	42.963	42.884
Michigan	76.986	68.906	75.687
Minnesota	64.470	60.214	65.299
Mississippi	57.378	59.441	59.739
Missouri	68.486	71.472	77.235
Montana	55.723	55.170	59.328
Nebraska	66.099	60.293	60.577
Nevada	42.123	34.340	39.009
New Hampshire	45.900	45.520	49.263
New Jersey	59.038	55.862	52.505
New Mexico	63.566	64.300	61.951
New York	59.187	61.219	59.069
North Carolina	51.679	53.052	51.773
North Dakota	53.346	50.803	54.142
Ohio	58.121	53.992	57.497
Oklahoma	63.902	64.440	61.006
Oregon	64.573	65.716	73.597
Pennsylvania	70.456	67.646	67.986
Rhode Island	63.864	68.663	65.947
South Carolina	63.022	62.090	62.736
South Dakota	61.814	58.936	64.233
Tennessee	70.877	72.375	69.197
Texas	50.996	45.964	46.888
Utah	53.191	49.692	50.735
Vermont	68.530	76.824	73.408
Virginia	60.184	56.637	57.816
Washington	63.409	56.266	61.313
West Virginia	86.397	89.032	83.484
Wisconsin	51.005	48.488	56.008
Wyoming	52.635	48.247	53.119

TABLE A.16

STANDARD ERRORS OF FINAL SHRINKAGE ESTIMATES OF PARTICIPATION RATES

	1998	1999	2000
Alabama	4.459	4.020	4.126
Alaska	4.790	4.845	4.563
Arizona	2.774	3.110	2.115
Arkansas	4.115	4.417	4.297
California	2.092	1.880	1.866
Colorado	4.429	4.523	4.412
Connecticut	4.376	4.113	4.590
Delaware	3.999	4.100	4.492
District of Columbia	5.216	6.863	2.882
Florida	1.756	2.653	2.726
Georgia	3.603	3.226	3.695
Hawaii	5.326	6.055	5.851
Idaho	4.370	4.260	3.677
Illinois	3.698	3.397	2.964
Indiana	3.960	4.291	4.215
Iowa	4.448	4.456	4.647
Kansas	4.027	1.845	3.944
Kentucky	4.712	4.617	4.895
Lousiana	4.134	4.558	3.648
Maine	5.266	5.177	5.406
Maryland	4.664	4.556	4.560
Massachusetts	3.854	3.535	3.561
Michigan	3.949	3.535	3.094
Minnesota	4.731	4.648	4.342
Mississippi	4.035	3.300	4.022
Missouri	4.817	4.824	5.085
Montana	4.326	3.937	4.136
Nebraska	4.394	4.367	4.490
Nevada	3.668	3.021	3.709
New Hampshire	4.043	4.153	4.249
New Jersey	3.767	3.560	3.256
New Mexico	4.709	4.181	3.743
New York	2.521	2.597	2.750
North Carolina	2.691	3.169	2.176
North Dakota	4.572	4.496	4.306
Ohio	3.339	3.184	3.154
Oklahoma	3.593	3.194	3.331
Oregon	3.776	3.977	4.371
Pennsylvania	4.112	3.559	4.241
Rhode Island	4.330	4.272	3.919
South Carolina	3.528	3.851	3.276
South Dakota	4.942	4.651	4.998
Tennessee	4.293	3.445	4.004
Texas	1.877	1.043	1.894
Utah	4.223	4.384	4.109
Vermont	4.737	4.928	4.977
Virginia	4.030	3.984	3.911
Washington	3.786	3.551	3.659
West Virginia	5.306	5.261	5.017
Wisconsin	4.563	4.468	4.378
Wyoming	4.265	3.306	3.937

TABLE A.17

FINAL SHRINKAGE ESTIMATES OF NUMBERS OF PEOPLE ELIGIBLE FOR FOOD STAMPS

	1998	1999	2000
Alabama	691,419	635,727	632,307
Alaska	55,876	54,591	51,257
Arizona	560,365	548,302	571,932
Arkansas	383,437	357,069	370,624
California	3,742,018	3,662,065	3,248,724
Colorado	293,023	298,155	265,733
Connecticut	269,670	261,256	246,152
Delaware	67,601	67,914	59,309
District of Columbia	93,230	83,122	88,318
Florida	1,729,950	1,663,845	1,652,646
Georgia	997,589	996,983	952,868
Hawaii	126,727	123,148	114,811
Idaho	120,047	127,754	118,805
Illinois	1,242,573	1,191,755	1,179,336
Indiana	476,835	486,229	459,654
Iowa	205,038	215,918	198,259
Kansas	234,596	264,580	222,217
Kentucky	574,663	530,540	525,299
Louisiana	801,424	720,538	735,576
Maine	131,535	126,069	122,817
Maryland	423,182	392,437	357,275
Massachusetts	556,432	570,449	515,318
Michigan	908,909	872,061	799,921
Minnesota	318,766	326,469	295,496
Mississippi	522,780	465,155	470,688
Missouri	571,126	564,090	545,954
Montana	103,896	105,249	94,215
Nebraska	137,874	136,696	124,917
Nevada	150,258	166,265	156,728
New Hampshire	74,180	76,238	70,122
New Jersey	661,215	637,003	592,549
New Mexico	270,148	262,525	257,858
New York	2,535,165	2,410,998	2,294,193
North Carolina	942,535	907,679	903,604
North Dakota	60,651	61,381	55,342
Ohio	1,139,405	1,120,722	1,039,244
Oklahoma	432,029	396,792	405,847
Oregon	318,115	324,988	313,765
Pennsylvania	1,172,821	1,135,590	1,089,312
Rhode Island	111,818	109,015	106,514
South Carolina	499,816	473,544	463,796
South Dakota	69,908	71,419	66,826
Tennessee	717,689	667,585	699,066
Texas	2,874,415	2,864,007	2,790,965
Utah	163,296	157,742	146,743
Vermont	51,635	54,527	50,727
Virginia	604,481	592,384	553,457
Washington	485,164	497,190	467,281
West Virginia	282,248	256,996	261,819
Wisconsin	349,052	365,263	351,607
Wyoming	43,301	44,416	39,909

TABLE A.18

STANDARD ERRORS OF FINAL SHRINKAGE ESTIMATES OF NUMBERS OF PEOPLE ELIGIBLE FOR FOOD STAMPS

	1998	1999	2000
Alabama	53,024	42,194	43,325
Alaska	3,625	3,854	3,153
Arizona	32,826	36,715	26,209
Arkansas	24,176	22,891	24,139
California	141,939	133,152	115,389
Colorado	21,610	25,058	21,185
Connecticut	17,597	17,258	17,824
Delaware	4,629	5,248	5,482
District of Columbia	5,480	5,717	2,977
Florida	57,412	82,995	87,021
Georgia	61,982	56,845	62,591
Hawaii	7,085	7,625	6,908
Idaho	11,869	13,100	9,663
Illinois	68,170	62,472	50,955
Indiana	30,488	35,027	29,443
Iowa	15,188	17,067	15,326
Kansas	19,936	11,534	16,520
Kentucky	39,839	33,299	34,483
Lousiana	51,133	46,750	39,670
Maine	8,644	8,224	8,550
Maryland	28,791	31,468	28,322
Massachusetts	44,422	46,930	42,795
Michigan	46,627	44,734	32,700
Minnesota	23,391	25,201	19,650
Mississippi	36,763	25,827	31,692
Missouri	40,170	38,071	35,948
Montana	8,066	7,510	6,568
Nebraska	9,165	9,901	9,260
Nevada	13,083	14,629	14,902
New Hampshire	6,534	6,955	6,048
New Jersey	42,186	40,596	36,750
New Mexico	20,012	17,070	15,581
New York	107,971	102,263	106,800
North Carolina	49,077	54,226	37,976
North Dakota	5,198	5,433	4,401
Ohio	65,454	66,094	57,004
Oklahoma	24,294	19,667	22,159
Oregon	18,604	19,668	18,633
Pennsylvania	68,448	59,746	67,953
Rhode Island	7,580	6,783	6,330
South Carolina	27,980	29,373	24,218
South Dakota	5,589	5,636	5,200
Tennessee	43,475	31,781	40,451
Texas	105,769	65,011	112,734
Utah	12,966	13,916	11,884
Vermont	3,569	3,498	3,439
Virginia	40,481	41,668	37,436
Washington	28,968	31,374	27,884
West Virginia	17,333	15,187	15,735
Wisconsin	31,228	33,659	27,483
Wyoming	3,509	3,043	2,958

TABLE A.19

NUMBER OF PEOPLE RECEIVING FOOD STAMPS IN SEPTEMBER, ADJUSTED FOR ISSUANCE ERRORS

	1998	1999	2000
Alabama	402,051	385,008	380,720
Alaska	41,251	37,468	38,019
Arizona	265,394	254,659	263,975
Arkansas	250,270	246,018	244,495
California	2,063,981	1,893,060	1,706,555
Colorado	175,993	160,448	147,061
Connecticut	180,850	162,664	156,046
Delaware	39,480	36,030	28,824
District of Columbia	82,736	82,940	75,505
Florida	915,147	884,997	855,484
Georgia	578,437	564,084	536,051
Hawaii	120,717	120,435	111,646
Idaho	53,061	53,070	53,714
Illinois	837,607	772,218	809,061
Indiana	295,310	289,612	302,432
Iowa	123,113	121,722	119,194
Kansas	111,162	111,971	117,892
Kentucky	390,554	390,282	391,689
Louisiana	519,256	506,223	497,589
Maine	105,411	100,053	95,379
Maryland	290,111	222,953	205,534
Massachusetts	268,597	245,081	220,988
Michigan	699,736	600,903	605,439
Minnesota	205,509	196,581	192,956
Mississippi	299,961	276,493	281,184
Missouri	391,140	403,167	421,669
Montana	57,894	58,066	55,896
Nebraska	91,134	82,418	75,671
Nevada	63,294	57,096	61,139
New Hampshire	34,048	34,704	34,544
New Jersey	390,371	355,843	311,115
New Mexico	171,723	168,802	159,746
New York	1,500,483	1,475,981	1,355,152
North Carolina	487,093	481,544	467,827
North Dakota	32,355	31,183	29,964
Ohio	662,234	605,102	597,533
Oklahoma	276,077	255,691	247,592
Oregon	205,416	213,569	230,922
Pennsylvania	826,320	768,186	740,583
Rhode Island	71,412	74,854	70,242
South Carolina	314,993	294,022	290,967
South Dakota	43,212	42,091	42,925
Tennessee	508,675	483,164	483,734
Texas	1,465,851	1,316,401	1,308,630
Utah	86,858	78,385	74,450
Vermont	35,385	41,890	37,238
Virginia	363,798	335,508	319,989
Washington	307,638	279,750	286,502
West Virginia	243,852	228,810	218,576
Wisconsin	178,033	177,109	196,928
Wyoming	22,792	21,429	21,199