Assessment of SNAP unit simulation

Final Report

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I. Introduction

This report summarizes the methodology and findings from Mathematica's study of linked survey and Supplemental Nutrition Assistance Program (SNAP) administrative data in three States and considers their implications for the simulation of SNAP unit composition as part of an overall simulation of SNAP eligibility.

II. Background and Purpose of Project

To provide critical information to the Food and Nutrition Service (FNS) about the performance of SNAP, Mathematica uses microsimulation to estimate the number of persons eligible for SNAP and combines these with counts of participants from SNAP administrative data to estimate SNAP participation rates. For some subgroups, the number of participants exceeds the number of simulated eligible persons, resulting in an estimated participation rate in excess of 100 percent. Possible explanations for the discrepancies include, for example, under-representation of eligible people in the surveys used in the simulations and differences between the survey and administrative sources in the measurement of the characteristics of simulated eligible people versus participants. Attention has also focused on the challenge of grouping the survey household members into units whose eligibility is then jointly determined. Depending on the relationships among household members, there may be more than one way to define simulated eligibility units within a given household.

Simulation of eligibility units was the focus of a previous project that linked SNAP administrative records from two States to sample respondents from three surveys (Czajka, Cunnyngham, and Rosso 2015). Key findings included:

- Nearly half of the households receiving SNAP benefits in New York, and more than half in Colorado, included persons who were not recipients
- More than 10 percent of the households receiving SNAP benefits had administrative unit members who were not matched to anyone in the survey household
- Only 6 to 7 percent of the SNAP households contained more than one SNAP unit
- Using the entire household as a proxy for the SNAP unit yielded too few units overall and far too few one-person units

These findings underscored the importance of correctly simulating the eligibility unit when estimating the number and characteristics of persons eligible for SNAP but raised a number of questions for further research. In particular, what role do the relationships among household members play in determining SNAP unit composition and the number of SNAP units within a household? Also, what characterizes SNAP participants who appear to be missing from surveyed household rosters, and what is their contribution to the under-estimation of SNAP eligibles?

The current project was designed to evaluate these and other questions related to SNAP eligibility simulation by analyzing a new and more extensive set of linked survey and administrative data. For this project, SNAP administrative data from Illinois, Mississippi, and

Tennessee were linked to multiple years of data from the Current Population Survey Annual Social and Economic Supplement (CPS ASEC), which serves as the base of an annual SNAP eligibility model used to generate the denominators for estimates of SNAP participation rates at the national and State levels. The ultimate goal of this project is to improve estimates of SNAP participation rates by using the knowledge gained to enhance the simulation of eligibility, particularly among subgroups where the simulation appears most problematic. In the sections that follow, we describe our creation of the linked data, present estimates of subgroups of SNAP participants and units for which the estimated participation rates are at issue, examine selected characteristics of these subgroups, show the extent of multiple SNAP units and nonparticipating members conditional on these household characteristics, and discuss the implications of these findings for SNAP eligibility simulation.

III. Creating the Linked Data

Linked survey and administrative data were prepared using the standardized State files produced under project 50664. The linked files cover a somewhat different set of years by State, which was determined by the years for which standardized State data were available at the time the linked files were created. For Illinois, the linked survey and administrative data cover the years 2009 through 2016; for Mississippi, the linked data cover 2010 through 2017; and, for Tennessee, the linked data cover 2004 through 2017. For each State and year, we created two linked files—one based on the State CPS ASEC sample and the other based on the State SNAP administrative data.

The linkage process for each State and year involved four steps. First, to prepare the CPS ASEC data for linkage to the SNAP State administrative data, we extracted selected fields from sample records for each of the three States; merged household- and family-level variables to person-level records, and matched the resulting file to a cross-walk file in order to attach a Protected Identification Key (PIK) and a Master Address File Identifier (MAFID)—where available—to each CPS ASEC record. The PIK is a unique personal identifier created by the Census Bureau to facilitate matching between files while eliminating the need to retain personally identifiable information on these files. The MAFID is a unique housing unit identifier. Second, we extracted the February, March, and April records from the State SNAP administrative files that Mathematica had converted to a standard format. The Census Bureau had already attached PIKs and MAFIDs to the State administrative files, so it was not necessary to add these fields to the SNAP data. Third, for each State and year we searched the State administrative file for records matching the CPS ASEC records on PIK and survey month (February, March, or April); where we found matches, we appended a set of SNAP fields onto the CPS ASEC record, and we appended a set of CPS ASEC fields onto the corresponding SNAP record.

The only significant complication in the matching process was the occurrence of duplicate PIKs. A duplicate PIK is a PIK appearing on two records (almost necessarily in the same household, given how the PIK assignment works). Duplicate PIKs are rare in the CPS ASEC, but they occurred in all three States in nearly every year that we performed links.[1] To be assigned the

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[1] In each of the three States, an average of 0.1 percent of the PIKs were duplicated (DRB approval number CBDRB-FY21-CES014-018).

same PIK, presumably, two records would have to be identical on the variables used in PIK assignment; although the likelihood of duplication in a given instance is increased if key variables—such as first names—are missing. Duplicate PIKs are more common in the SNAP files than the CPS ASEC in two of the three States.[2] In the SNAP files, PIK assignment is based almost entirely on the Social Security number (SSN), implying that two records assigned the same PIK most likely had the same SSN on their SNAP records. Given the potential sources of duplication, it is likely that duplicate PIKs occurred most frequently for siblings (especially twins), with some incidence of parent-child pairs in the SNAP files.[3]

With our matching process, if two CPS ASEC records shared the same PIK but that PIK appeared on only one individual's record in the SNAP file, the one SNAP record would match to both CPS ASEC records on the CPS ASEC file, and the single SNAP record's data would be added to both CPS ASEC records. Although the information from the SNAP record was duplicated, the count of records on the CPS ASEC file was unchanged. On the SNAP file, however, duplicating the single SNAP record so that it could be matched to both CPS ASEC records increased the count of SNAP records by one. Therefore, when the matching process was complete, we deleted one of the duplicate records on the SNAP file. This eliminated a match, leaving the linked SNAP file with oner fewer match than the linked CPS ASEC file.

To prevent the same kind of duplication of records from occurring on the CPS ASEC file when the situation was reversed (that is, when a PIK that appeared on a single record in the CPS ASEC file appeared on two records in the SNAP file), we removed records with duplicate PIKs from the State SNAP files before we performed the match. That is, if two SNAP records had the same PIK, we removed one of the records, retaining the older one if there was an age difference. As a result, the CPS ASEC record with the PIK that was duplicated on the SNAP file would be matched to only one SNAP record. After the matching process was complete, we replaced the SNAP records we had removed from the SNAP file, restoring the original record count.

The estimates presented in all the tables in this memorandum have been rounded in accordance with the Census Bureau's rounding rules for disclosure of sample and administrative estimates. These rules are more restrictive for unweighted than weighted estimates, so their impact is most pronounced on the linked data sample counts, which are much smaller than the unweighted State SNAP administrative counts. Reported sample counts should be recognized as approximate.

Table 1 reports counts of State CPS sample households from which data were collected and the number of these households for which one or more members was matched to a SNAP administrative record. The years for which matches were performed were determined by the availability of that State's SNAP administrative data at the Census Bureau.

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[2] In Tennessee an average of 0.3 percent of the PIKs were duplicated while in Mississippi the fraction was 4.0 percent (DRB approval number CBDRB-FY21-CES014-018).

[3] A parent applying for SNAP may have repeated his or her own SSN for a child who had none, for example, and if PIK assignment were based solely on the SSN, both would have been assigned the same PIK. With the CPS ASEC, where name and date of birth are key elements in PIK assignment, parent-child combinations would seem much less likely.

Table 1. State CPS ASEC sample households with interviews and number with one or more members matched to a SNAP administrative record: three States, 2007-2017

Year	Sample households with interviews			Households with one or more members matched to a SNAP administrative record		
	Illinois	Mississippi	Tennessee	Illinois	Mississippi	Tennessee
2004			950			100
2005			1,000			150
2006			1,100			150
2007			1,000			150
2008			1,000			150
2009	2,300		1,000	250		150
2010	2,300	750	1,000	300	150	200
2011	2,300	750	1,000	300	200	200
2012	2,400	700	1,000	350	150	200
2013	2,300	750	1,000	350	150	200
2014	2,300	750	1,000	300	200	200
2015	2,200	1,300	1,200	350	300	200
2016	2,000	1,400	1,300	250	300	200
2017		1,300	1,300		250	200

DRB approval number: CBDRB-FY21-CES014-018.

Because of its population size, Illinois had the largest CPS ASEC household samples and, in all but one year, the most sample households with matches. Due to a sample design change implemented in 2015, Mississippi had a large sample increase and Tennessee had a small increase while Illinois had a small decrease. Comparing the counts of households with matches to the total households in each State, we see that matches were achieved with the highest fraction of households in Mississippi (between 19 and 27 percent; calculations not shown), followed by Tennessee (between 15 and 20 percent) and then Illinois (between 11 and 16 percent). Differences in SNAP eligibility and participation are probably the major determinant of these differences among the States, but as we will show below, differences in PIK rates may have played a role as well.

Table 2 presents more information on the match results for Illinois, including PIK rates for the State CPS ASEC sample and SNAP administrative records, counts of total matches, and figures expressing weighted estimates from the linked data as percentages of administrative totals of SNAP participants, units, and benefits. PIK rates for the State CPS ASEC records vary only slightly around 86 percent, while PIK rates for the State administrative records exceed 99 percent in every year. The number of CPS ASEC sample records matched to administrative records on PIK varies from a low of 550 in 2016 to a high of 800 in 2012. As a fraction of the State administrative totals, weighted estimates from the linked data range from 69.7 to 83.7 percent for participants, with half of the estimates below 71 percent. Estimates range from 64.7 to 86.8 percent for units and 76.6 to 98.7 percent for benefits. While the year with the most matches, 2012, yields the highest estimate of participants and nearly the highest estimate of units relative

to the respective administrative totals, the highest estimate of benefits occurs in 2010, a more average year in terms of matches.

Table 2. State CPS ASEC and SNAP PIK rates, sample matches, and weighted estimates from linked data compared to SNAP administrative totals: Illinois, 2009-2016

Year	CPS ASEC State PIK rate (percent)	State SNAP data PIK rate (percent)	Number of PIK matches	Weighted estimates from the linked data as a percentage of State SNAP administrative totals		
				Participants	Units	Benefits
2009	86.4	99.2	600	73.8	81.7	87.5
2010	86.7	99.1	700	80.3	86.8	98.7
2011	86.6	99.1	750	81.9	79.5	86.0
2012	86.3	99.2	800	83.7	86.7	93.5
2013	84.4	99.2	700	69.9	71.2	92.9
2014	84.2	99.3	700	70.5	70.3	77.7
2015	86.4	99.3	700	74.5	75.6	81.2
2016	84.9	99.6	550	69.7	64.7	76.6

DRB approval numbers: CBDRB-FY21-CES005-007 and CBDRB-FY21-CES014-014.

Table 3 presents the same statistics for Mississippi, whose CPS ASEC sample has higher PIK rates than Illinois and whose weighted estimates from the linked data compare more closely to the State administrative totals. PIK rates range from a low of 89.7 percent to a high of 94.7 percent, with half above 93.0 percent. With the sample size increase in 2015, the number of matches reaches 700 from levels of 350 to 450 in the preceding years. Weighted estimates of participants range from 79.3 to 99.8 percent of the administrative totals, but half of the estimates are at 93.9 percent or higher. Estimates of SNAP units range from 81.6 to 99.3 percent of the administrative totals while estimates of benefits range from 83.0 to 104.0 percent of the administrative totals, with half of the estimates in both cases well into the 90s.

Table 3. State CPS ASEC and SNAP PIK rates, sample matches, and weighted estimates from linked data compared to SNAP administrative totals: Mississippi, 2010-2017

Year	CPS ASEC State PIK rate (percent)	State SNAP data PIK rate (percent)	Number of PIK matches	Weighted estimates from the linked data as a percentage of State SNAP administrative totals		
				Participants	Units	Benefits
2010	89.3	99.5	450	99.8	99.3	104.0
2011	94.7	99.5	450	96.8	92.2	100.6
2012	94.0	99.4	350	79.3	81.6	83.0
2013	93.8	99.4	400	86.8	85.5	90.9
2014	93.9	99.4	400	88.2	87.6	84.2
2015	92.1	99.4	700	94.5	95.0	95.5
2016	92.0	99.4	700	93.9	93.5	99.0
2017	91.3	99.3	550	85.2	82.4	89.2

DRB approval numbers: CBDRB-FY21-CES005-007 and CBDRB-FY21-CES014-014.

Table 4 provides match statistics for Tennessee. The results begin with 2007 rather than 2004 because the full set of statistics was not produced for the earlier years. The CPS ASEC PIK rates fall between those of Illinois and Mississippi, with a range of 85.4 to 91.5, with all but two years (oddly the most recent) above 88 percent. The PIK rates for the State SNAP data are a percentage point lower than those for the other two States, however. Match counts are lowest in the first three years, then range from 450 to 550 between 2010 and 2017. Weighted estimates of participants range from 75.4 to 94.5 percent of the administrative totals, which is comparable to Mississippi in the width of the range but lower at both ends as well as overall, with half of the estimates below 80 percent. Nevertheless, these estimates are well above those for Tennessee. Estimates of SNAP units range from 77.6 to 100.0 percent of the administrative totals while estimates of benefits range from 84.0 to 111.4 percent of the administrative totals.

Table 4. State CPS ASEC and SNAP PIK rates, sample matches, and weighted estimates from linked data compared to SNAP administrative totals: Tennessee, 2007-2017

Year	CPS ASEC State PIK rate (percent)	State SNAP data PIK rate (percent)	Number of PIK matches	Weighted estimates from the linked data as a percentage of State SNAP administrative totals		
				Participants	Units	Benefits
2007	89.0	98.5	300	76.7	79.1	88.2
2008	88.8	98.4	350	94.5	100.0	111.4
2009	90.4	98.3	400	82.7	84.5	92.9
2010	89.7	98.3	450	76.2	79.8	78.2
2011	90.0	98.3	450	80.3	84.6	88.2
2012	91.5	98.3	450	79.3	83.2	83.4
2013	90.7	98.2	550	91.5	92.8	94.6
2014	88.5	98.2	450	80.5	90.3	91.2
2015	88.4	98.1	450	75.4	83.3	84.0
2016	85.4	97.9	500	77.8	77.6	85.5
2017	85.7	98.0	450	78.7	80.6	84.2

DRB approval numbers: CBDRB-FY21-CES005-007 and CBDRB-FY21-CES014-014.

The linked data provide a closer approximation to the administrative data for total benefits than they do for either total participants or total units. This implies that units with higher benefits are better represented among the linked units than those with lower benefits, but this is not due to unit size. If larger units were better represented than smaller units, we would find that the linked data estimates of participants match the administrative counts more closely than do the linked data estimates of SNAP units. In fact, we do not observe this for any of the States, least of all Tennessee, where the linked data estimates of participants match the administrative counts less well than the estimates of units in every year but one. In Mississippi, the estimates for participants and units are in most years very close to each other.

A question left unresolved by the previous project was whether any of the unmatched SNAP unit members and survey household members could have been matched to each other if not for missing PIKs. In other words, did our results overstate the incidence of survey household members who were not participating in SNAP and of SNAP participants who were omitted from

survey rosters? A related question is whether missing PIKs resulted in the failure to achieve any matches at all in a subset of survey households and, if so, did such households differ from the matched households with respect to the composition of their SNAP units?

For a small subset of States and years, we searched for additional matches of two types. First, using age and gender as match variables, we identified additional linkages between unmatched State administrative records and unmatched CPS ASEC records within the same survey household. We limited this search to record pairs for which one or both records lacked a PIK, as this would have prevented a match in the third step described above. We also explored the potential for identifying additional matches between unmatched SNAP units in the administrative file and survey households at the same address, based on a common MAFID and survey month. Both applications made use of manual review to validate the results. While both approaches generated additional matches, as described below, fully automating the procedures and extending them to the full set of States and years would have required that we divert resources from the analytical tasks.[4]

Therefore, we did not extend the procedures beyond the test States and years; nor did we incorporate the results into the matched files for those States and years. However, we did assess the impact of the additional within-household matches on selected findings, and we report those results in the relevant sections below. We would recommend that at least the within-household matches be included in any future research that would benefit from maximizing within-household matches.

We searched for additional matches of both types in Illinois in 2015 and 2016 and in Tennessee in 2016. As reported above, the total number of sample households with one or more matches by PIK in these States and years was 800. We were able to find additional matches in 60 of these households, with the number of such matches totaling 100.[5] In our search for matches to additional households, we identified 250 SNAP units and survey households with the same MAFID and interview/benefit month. However, on reviewing these matches to identify potential matches between SNAP unit members and survey household members—based on age and sex as there could be no additional matches on PIK—we found only 70 such matches in 30 of the 250 households. We attribute the large number of false matches to duplicate MAFIDs within the administrative files, most likely arising from incomplete addresses (for example, missing apartment numbers, which would result in SNAP units in different apartments within the same building being assigned the same MAFID).

IV. Comparative Estimates of SNAP Unit Types

In this section, we compare estimates from the linked survey and administrative data to estimates from two alternative sources: State SNAP administrative data and SNAP Quality Control (QC) sample data. Both these latter sources represent the entire universe of SNAP participants whereas

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[4] That we did not expand this search to all three States and a larger set of years was also due to the pandemic-induced closing of Census Bureau headquarters, which resulted in our temporary loss of access to the linked data as we were beginning this work. When we were granted remote access several months later, we found it necessary to focus our attention on completing the PIK-based linkages and analyzing the resulting data.

[5] The statistics in this paragraph were released with DRB approval number CBDRB-FY21-CES014-018.

the linked survey and administrative data are limited to the household population. As defined by the U.S. Census Bureau, the household population excludes persons residing in most types of group quarters as well as persons without a fixed address (principally homeless people and those residing in shelters). Based on QC data, we estimate that about five percent of the SNAP population nationally is outside the CPS ASEC universe. In addition, another 10 to 15 percent of the CPS ASEC sample lacks the unique identifier—the PIK—that the Census Bureau assigns to enable linkage between the survey data and administrative records. It should be noted that PIK assignment utilizes data collected in applications for SSNs, so PIKs cannot be assigned to sample members who lack SSNs and for that reason would not be eligible for SNAP in most cases. For this reason, our inability to link these particular sample members to SNAP administrative data very likely does not diminish the fraction of the SNAP universe that the linked survey and administrative data represent. However, for most of those sample members who cannot be assigned PIKs, their lack of an SSN is not the reason. The inability to assign PIKs to these cases is due to issues with the quality of the data used to link their CPS ASEC records to the SSN database. These sample members constitute a potential shortfall in the extent to which the linked survey and State SNAP administrative records fully represent the universe of SNAP participants within the household population.

With a goal of improving SNAP eligibility simulation, this project identified subgroups of SNAP participants for which the simulation of SNAP eligibility has been especially problematic. Most of these subgroups were selected because Mathematica's CPS ASEC-based eligibility simulations tend to generate fewer estimated eligible subgroup members than QC sample-based estimates of SNAP participants, yielding SNAP participation rates in excess of 100 percent. Because of their obvious inaccuracy, such participation rates are of little value for policy analysis. The subgroups include six types of SNAP participants and six types of SNAP units. The participant subgroups are:

- All children
- Children 0 to 4
- Children 5 to 17
- Adults 60 and older (elderly adults)
- Adults with disabilities
- Nondisabled adults 18-49 in childless units

The SNAP unit subgroups include those with:

- One person only
- Children (with or without adult unit members)
- Children and only one adult
- Children only
- No earnings
- With children and no earnings

Adults 60 and older and adults with disabilities were included at the request of the Economic Research Service, a cosponsor of the overall project. Neither group is associated with estimated participation rates in excess of 100 percent, although the estimated participation rates for households including non-elderly persons with disabilities often approach 100 percent. Adults 60 and older have among the lowest estimated participation rates, which could be due in part to their eligibility being overestimated, although other reasons for their low participation in SNAP have been documented (see, for example, Levin et al. 2019).

The CPS ASEC data used in these estimates were collected from the monthly labor force survey respondents in March of each year and from a subset of February and April respondents who were not included in the March sample. The CPS ASEC estimates are weighted to March population estimates. The survey data were linked to SNAP administrative data in the same month as the survey in order to maximize the alignment of household composition between the two sources, but the SNAP administrative estimates presented in this memorandum are for March of each year. The QC estimates, by contrast, are for the fiscal year that includes the March survey sample and administrative estimates. The QC samples are too small to support State-specific estimates for a single month with the statistical precision desired for these comparisons.

Estimates for March 2016 are presented in Table 5 for Illinois, Table 6 for Mississippi, and Table 7 for Tennessee.[6] Generally, the results for 2016 for each State are consistent with what we see in the other years. Differences are due largely to sampling error in the estimates from the linked data. In addition, a CPS ASEC sample design change boosted the Mississippi sample substantially from 2015 forward. While we focus our discussion on the estimates for 2016 included here, we note any marked differences from the other years.

How do the subgroup estimates from the linked data compare to the administrative counts? For Illinois, the linked data estimates of all participants, all children, children by age, elderly adults, and units with children fall between 70 and 73 percent of the administrative counts. One-person units match the administrative counts much less well at 49 percent, and to a lesser extent so do units without earnings (54 percent for all such units and 57 percent for the subset with children) and units with children and a single adult (58 percent). However, child-only units match the administrative count nearly 20 percentage points better (at 84 percent) than do all SNAP units (at 65 percent). Moreover, in every other year (not shown in the table) the estimates of child-only units from the linked data exceed the administrative counts.

QC sample data include a measure of disability whereas the Illinois administrative data do not. The estimate of adults with disabilities from the linked data is 97.6 percent of the QC sample

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[6] Estimates for Illinois for the years 2009 through 2015, Mississippi for the years 2010 through 2015 plus 2017, and Tennessee for the years 2007 through 2015 plus 2017 were presented in the appendices of a memorandum submitted earlier in this project, "Counts of SNAP unit types (Task 4)." In addition, linked data estimates of SNAP participants, SNAP units, and SNAP benefits as a percentage of State administrative estimates were presented for all three States and years in Tables 2 through 4 above. While the linked data for Tennessee also include 2004 through 2006, we did not include estimates for these years in that memorandum because the unique identifier used in the linkage was less prevalent in 2004 and 2005 than in later years and because the QC data did not include an indicator of disability status prior to 2007. Only Mississippi included an indicator of disability status in its administrative data, and we wanted at least one source of such information for all three States.

estimate while the estimate of nondisabled adults 18-49 in childless units is only 56.6 percent of the QC sample estimate.[7] These strikingly discrepant results may have a common explanation. If the measure of disability in the CPS ASEC identifies more participants as disabled than the measure used in the QC data, which our results suggest, then fewer participants will be identified as nondisabled in the survey data.[8]

Table 5. Alternative estimates of 12 subgroups: Illinois, March 2016

Subgroup	Linked data sample count	Subgroup population estimates			Linked data as percentage of:	
		Linked data weighted estimate	State administrative data	QC data	State administrative data	QC data
Participants	**550**	**1,270,000**	**1,821,000**	**1,894,000**	**69.7**	**67.1**
Children	250	535,500	759,000	782,700	70.6	68.4
Children 0-4	70	157,600	219,000	235,900	72.0	66.8
Children 5-17	200	377,900	540,000	546,800	70.0	69.1
Adults 60 and older	60	155,600	214,000	201,500	72.7	77.2
Adults with disabilities	70	171,400		175,700		97.6
Nondisabled adults age 18-49 in childless units	60	129,200		228,100		56.6
SNAP units	**250**	**610,500**	**944,000**	**987,300**	**64.7**	**61.8**
One person only	100	261,700	532,000	553,100	49.2	47.3
With children	150	256,500	362,000	390,400	70.9	65.7
Children and only one adult	60	131,500	226,000	242,900	58.2	54.1
Children only	20	42,500	50,500	56,000	84.2	75.9
With no earnings	150	383,400	710,000	686,700	54.0	55.8
With children and no earnings	60	118,400	209,000	167,900	56.7	70.5
SNAP benefits ($1,000s)	**250**	**$175,700**	**$229,400**		**76.6**	

DRB approval number: CBDRB-FY2021-CES005-007.

While the Mississippi estimates from the linked data represent a much larger share of the corresponding administrative totals than do the estimates from Illinois, Mississippi resembles Illinois in that the estimates for all child participants, children by age, and elderly adults, which range between 92 and 98 percent of the administrative counts, are similar to the estimate for all participants (93.9 percent). Mississippi administrative data include an indicator of disability status, but only 8,000 participants are identified as having a disability. The estimate from the linked data, which is based on the CPS ASEC disability indicator, is nearly 12 times as high. The QC sample indicator of disability status shows far more participants with disabilities than the

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[7] Our estimates from the SNAP QC data were produced outside the Census Bureau, so they are not subject to the rounding rules. However, we rounded the QC estimates to four significant digits (three for estimates between 10,000 and 99,999 and two for estimates below 10,000) to be comparable to the estimates from the linked data.

[8] SNAP disability as reflected in the QC data is based on receipt of a government disability payment, which is a more stringent definition than the CPS ASEC measure used here, DIS_HP, which is based on the respondent's report of having had at any time in the prior year a disability or health problem that prevented or limited work, even for a short time.

administrative data (60,400 versus 8,000), but the estimate from the linked data is still 56 percent higher. Given that the administrative data underestimate disability, the administrative count of nondisabled adults 18-49 in childless units is higher than the QC sample estimate at 55,500 versus 44,800. Accordingly, the linked data estimate of nondisabled adults 18-49 in childless unit is 80 percent of the administrative data estimate but 98 percent of the QC sample estimate.

Mississippi shows less differentiation among the unit subgroups than does Illinois. One-person units and units with children are underestimated only slightly less than all units, and units without earnings are estimated equally well as all units while units with children and no earnings are estimated almost as well. Like Illinois, however, units with children and only one adult are estimated much less well than all units, but in a striking contrast to Illinois, childless units are overestimated—by 18 percentage points.[9] Comparisons with the QC data and administrative data are similar except that the QC data show barely half as many child-only units as the linked data, so the estimate from the linked data is nearly double the estimate from the QC data.

Table 6. Alternative estimates of 12 subgroups: Mississippi, March 2016

Subgroup	Linked data sample count	Subgroup population estimates			Linked data as percentage of:	
		Linked data weighted estimate	State administrative data	QC data	State administrative data	QC data
Participants	**700**	**540,100**	**575,000**	**578,800**	**93.9**	**93.3**
Children	350	249,700	265,000	259,900	94.2	96.1
Children 0-4	80	68,800	74,500	73,000	92.3	94.2
Children 5-17	250	180,800	191,000	186,900	94.7	96.7
Adults 60 and older	70	51,200	52,500	51,000	97.5	100.4
Adults with disabilities	100	94,000	8,000	60,400	1,180.0	156.0
Nondisabled adults 18-49 in childless units	50	44,100	55,500	44,800	79.5	98.4
SNAP units	**300**	**245,000**	**262,000**	**267,600**	**93.5**	**91.6**
One person only	150	110,700	125,000	128,200	88.6	86.3
With children	150	113,500	126,000	126,100	90.1	90.0
Children and only one adult	70	57,200	76,500	82,600	74.8	69.2
Children only	20	14,800	12,500	7,700	118.0	192.0
With no earnings	200	172,300	184,000	192,200	93.6	89.6
With children and no earnings	80	59,700	65,000	64,300	91.8	92.8
SNAP benefits ($1,000s)	**300**	**$65,360**	**$66,040**		**99.0**	

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As in both Illinois and Mississippi, the linked data in Tennessee estimate child participants as well as all participants. In 2016, there is a differentiation by age group, with the estimates of children 0 to 4 comparing less well to the administrative data than the estimates of children 5 to

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[9] Note, however, that the linked data sample of child-only units is very small, so the weighted estimate of child-only units is very imprecise. In fact, 2016 is the only year in which the Census Bureau's rounding rules allow us to report a sample count for Mississippi.

17, but this is not observed in most other years. Unlike the other two States, however, the Tennessee linked data overestimate elderly adults—by 9 percentage points, which is 31 percentage points higher than the rate for all participants. As in Mississippi, the estimate of persons with disabilities in the linked data is more than one-and-a-half times the estimate from the QC data. However, the linked data estimate of nondisabled adults 18-49 in childless households compares more closely to Illinois, being only 65 percent of the QC estimate (albeit higher in most other years).

Table 7. Alternative estimates of 12 subgroups: Tennessee, March 2016

	Linked data sample count	Subgroup population estimates			Linked data as percentage of:	
Subgroup		Linked data weighted estimate	State administrative data	QC data	State administrative data	QC data
Participants	**500**	**907,500**	**1,167,000**	**1,100,000**	**77.8**	**82.5**
Children	200	371,300	478,000	467,400	77.7	79.4
Children 0-4	50	91,700	143,000	133,400	64.1	68.7
Children 5-17	150	279,500	336,000	334,000	83.2	83.7
Adults 60 and older	50	110,800	102,000	107,300	109.0	103.0
Adults with disabilities	80	168,700		111,300		152.0
Nondisabled adults 18-49 in childless units	40	77,400		119,400		64.9
SNAP units	**200**	**431,700**	**556,000**	**542,600**	**77.6**	**79.6**
One person only	80	185,300	291,000	294,200	63.7	63.0
With children	100	186,300	231,000	221,100	80.6	84.3
Children and only one adult	50	89,700	146,000	141,600	61.4	63.3
Children only	20	22,800	450	14,700	5,070.0	155.0
With no earnings	150	284,300	416,000	398,600	68.3	71.3
With children and no earnings	50	85,000	124,000	119,200	68.5	71.3
SNAP benefits ($1,000s)	**200**	**$119,500**	**$139,700**		**85.5**	

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The most striking feature of the Tennessee unit estimates is the exceedingly small number of child-only units identified in the administrative data. While the linked data estimate is one-and-a-half times the QC sample estimate, it is more than 50 times the administrative data estimate.[10] With respect to the other unit subgroups, Tennessee resembles Illinois more closely than Mississippi in finding comparatively low estimates of units with only one person, units with children and only one adult, and units without earnings (including those with children).

What might account for some subgroups being estimated less well than other subgroups in the linked data, and what could cause the linked data to overestimate certain subgroups—sometimes by a large margin? There are a number of possible explanations, and some could be relevant to

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[10] The Task 8 memo under the project 50664 also noted the low incidence of child-only units in the administrative data for Tennessee compared to the other States and the Tennessee QC data.

understanding why the CPS ASEC-based simulations underestimate certain groups of SNAP-eligible participants and units. Possible explanations include the following:

- The CPS ASEC records of the members of some subgroups may be more likely than those of other subgroup members to be missing the unique identifier needed to link their survey records to State SNAP administrative records;

- Some subgroup members may be more likely than other subgroup members to be omitted from the CPS ASEC household rosters; we know, for example, that young children are undercounted in the census and in Census Bureau household surveys (Jensen 2019); and

- Variables used to identify subgroup members may be measured with differential accuracy in the CPS ASEC versus State SNAP administrative data or QC sample data; we find differences between the CPS ASEC and the administrative data in the recording of disability status, for example.

We explore these alternative explanations below.

V. SNAP Subgroup Characteristics

To further explore potential reasons for the under- or over-estimation of SNAP eligibility among the 12 subgroups, we compare the subgroups and all participants with respect to four survey household characteristics that are relevant to eligibility unit construction or income eligibility. Each of the four characteristics is expressed as a binary variable. The first is whether or not the linked SNAP participants represent the entire survey household. The second is whether or not the survey household contains a related subfamily. The third is whether or not the survey household contains an unrelated individual/subfamily. The fourth characteristic, for participants, is whether or not the participant is in poverty and, for units, whether or not the unit head is in poverty.[11] Of note, the CPS ASEC is the official source of annual poverty estimates for the U.S.

Each of the next four tables below presents estimates of the distribution of the 12 subgroups, all participants, and all SNAP units with respect to one of the four characteristics for all three States for the years 2014-2016. We combined data for the years 2014-2016 because sample sizes are insufficient for annual State estimates, and differences over time are smaller than differences across the States. Tables with estimates for the years 2011-2013, which are broadly consistent with the findings for 2014-2016, were included in the appendix of an earlier memorandum, "Differences in the Characteristics of SNAP Subgroup Units (Task 5)."

Table 8 compares the 12 subgroups, all SNAP participants, and all SNAP units, by State, with respect to how often (expressed as the percentage of participants or units) the linked SNAP participants do not represent the entire survey household. Households in which the SNAP unit does not represent the entire household may provide alternative ways of determining unit composition for the purpose of assessing SNAP eligibility. If a subgroup is associated with a higher than average incidence of being in a household in which the SNAP unit does not include

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[11] The poverty status of the unit head is the poverty status of that individual as measured in the CPS ASEC, wherein poverty status is measured at the family level and then assigned to every member of the family. In the official poverty measure, related subfamilies are included in the householder's family. Unrelated families are assigned a poverty status based on their family membership. Unrelated individuals are treated as "families" of size one.

the entire household, this may contribute to the eligibility simulation understating the number of SNAP-eligible persons in that subgroup.

Table 8. Subgroup estimates of how often (percent) the SNAP unit does not include the entire survey household: three States, 2014-2016

Subgroup	Illinois	Mississippi	Tennessee
Participants	**55.3**	**45.7**	**48.3**
Children	59.1	42.1	49.0
Children 0-4	64.3	41.9	49.3
Children 5-17	57.0	42.2	48.9
Adults 60 and older	32.5	39.1	35.3
Adults with disabilities	37.8	46.3	39.4
Nondisabled adults 18-49 in childless units	71.6	66.5	71.8
SNAP units	**57.3**	**53.0**	**53.0**
One person only	57.0	61.6	50.1
With children	61.7	48.0	54.3
Children and only one adult	50.6	42.9	44.6
Children only	100.0	100.0	100.0
With no earnings	57.0	57.1	52.5
With children and no earnings	64.6	58.6	62.1

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In Illinois, children under 5 and nondisabled adults 18-49 in childless units show a higher than average likelihood of being in a household in which the SNAP unit is not the whole household at 64.3 and 71.6 percent, respectively, versus 55.3 percent on average. Elderly adults and adults with a disability have a much lower than average likelihood of being in a household in which the SNAP unit is not the whole household at 32.5 and 37.8 percent, respectively. With the exception of child-only units, which are always in households in which the SNAP unit is not the whole household, unit subgroups show comparatively little variation around the unit average of 57.3 percent. Units with children and no earnings are somewhat less likely than all units to be in households in which the SNAP unit is not the entire household (64.6 percent) while units with children and a single adult are somewhat less likely (50.6 percent).

In Mississippi, nondisabled adults 18-49 in childless units show a similarly high incidence of being in a household in which the SNAP unit is not the whole survey household at 66.5 percent versus the State average of 45.7 percent. Children under 5 are slightly below average in this regard. Elderly adults are only slightly less likely than all participants to be in a household in which the SNAP unit is not the whole household (at 39.1 percent), while adults with a disability are distinctly average in this regard. On the other hand, units show more variation than in Illinois. In addition to child-only units always being in households in which the SNAP unit does not include the entire household, one-person units are somewhat more likely than all units to be in households in which the SNAP unit is not the entire household at 61.6 versus 53.0 percent. Units with children and a single adult are less likely, at 42.9 percent.

Tennessee mirrors Illinois more closely than does Mississippi, except that children under 5 show only an average likelihood of being in a household in which the SNAP unit is not the entire household. Differences among units are also similar to Illinois but more pronounced. Units with children and no earnings are more likely to be in households in which the SNAP unit is not the entire household (62.1 versus 53.0 percent) while units with children and a single adult are less likely (44.6 percent) to be in such households.

Households that include a related subfamily may also provide alternative ways of determining unit composition for the purpose of assessing SNAP eligibility. Table 9 compares the 12 subgroups, all SNAP participants, and all SNAP units, by State with respect to how often the SNAP unit's survey household includes a related subfamily.

Table 9. Subgroup estimates of how often (percent) the SNAP unit's survey household includes a related subfamily: three States, 2014-2016

Subgroup	Illinois	Mississippi	Tennessee
Participants	**11.8**	**10.4**	**10.5**
Children	12.1	12.7	12.4
Children 0-4	17.9	18.5	11.6
Children 5-17	9.8	10.5	12.8
Adults 60 and older	5.8	5.7	7.9
Adults with disabilities	4.1	7.4	5.0
Nondisabled adults 18-49 in childless units	6.4	1.9	7.6
SNAP units	**10.3**	**8.0**	**7.5**
One person only	6.1	4.4	4.0
With children	16.0	13.9	11.5
Children and only one adult	19.5	17.7	13.7
Children only	9.3	9.6	9.9
With no earnings	9.3	8.3	7.1
With children and no earnings	18.3	16.8	12.0

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In two of the three States, children under 5 are more likely than all participants to live in a household with a related subfamily (17.9 versus 11.8 percent in Illinois, and 18.5 versus 10.4 percent in Mississippi). In all three States, elderly adults, adults with a disability, and nondisabled adults 18-49 in childless units are less likely than all participants to live in a household with a related subfamily (for example, in Illinois the three proportions are 5.8, 4.1, and 6.4 percent). Similarly, in all three States, units with children, units with children and a single adult, and units with children and no earnings are more likely than all units to be in a household with a related subfamily. One-person units are less likely to be in a household with a related subfamily (for example, in Illinois the proportions for the four subgroups are 16.0, 19.5, 18.3, and 6.1 percent versus 10.3 percent for all units).

Households that include an unrelated individual or subfamily may also provide alternative ways of determining unit composition for the purpose of assessing SNAP eligibility. Table 10

compares the 12 subgroups, all SNAP participants, and all SNAP units, by State, with respect to how often the SNAP unit's survey household includes an unrelated individual or subfamily.

Table 10. Subgroup estimates of how often (percent) the SNAP unit's survey household includes an unrelated individual or subfamily: three States, 2014-2016

Subgroup	Illinois	Mississippi	Tennessee
Participants	**16.0**	**15.1**	**15.4**
Children	16.9	15.8	17.1
Children 0-4	23.7	12.0	23.4
Children 5-17	14.1	17.2	14.3
Adults 60 and older	4.5	3.7	4.3
Adults with disabilities	13.4	11.6	10.9
Nondisabled adults 18-49 in childless units	20.0	18.0	24.1
SNAP units	**16.3**	**14.7**	**15.4**
One person only	14.7	13.3	15.1
With children	17.5	17.0	16.8
Children and only one adult	17.6	16.9	19.0
Children only	20.9	19.2	18.8
With no earnings	14.2	13.5	13.4
With children and no earnings	20.7	17.5	13.8

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In all three States, nondisabled adults 18-49 in childless units are more likely than all participants to be in a household that includes an unrelated individual or subfamily. This is most pronounced in Tennessee, where the subgroup fraction is 24.1 percent versus all participants at 15.4 percent. In Illinois and Tennessee, children under 5 are also more likely than all participants to be in a household with an unrelated individual or subfamily, but in Mississippi children under 5 are slightly less likely than all participants to be in such households. In Tennessee, for example, the likelihood among children under 5 is 23.4 percent. In all three States, elderly adults are far less likely than all participants to be in a household with an unrelated individual or subfamily. In Tennessee, for example, this fraction is only 4.3 percent. In all three States, there is very little differentiation among unit subgroups in the likelihood of being in a household that includes an unrelated individual or subfamily.

The income of an eligibility unit will affect its eligibility for SNAP, and the income measured in the CPS ASEC does not necessarily match the income reported and verified in the SNAP eligibility process. If the CPS ASEC measures higher income than would be measured in the SNAP eligibility process, the eligibility simulation may determine that a unit was ineligible when it would have been found eligible otherwise. If a subgroup tends to have higher CPS ASEC income than all SNAP participants, this may help to explain why eligibility among the subgroup members is underestimated.

Table 11 compares the 12 subgroups, all SNAP participants, and all SNAP units, by State, with respect to the CPS ASEC poverty rate. In all three States, elderly adults and nondisabled adults

18-49 in childless units have lower poverty rates than all participants. For example, in Mississippi the poverty rates for the two subgroups are 47.7 and 45.3 percent, respectively, compared to 57.1 percent for all participants. Children, on the other hand, tend to have higher poverty rates than all participants, although the results by age group differ across the three States.

Table 11. Subgroup estimates of how often (percent) the SNAP participant or unit head is in poverty: three States, 2014-2016

Subgroup	Illinois	Mississippi	Tennessee
Participants	**46.9**	**57.1**	**52.6**
Children	50.8	62.0	58.3
Children 0-4	46.1	69.1	59.2
Children 5-17	52.7	59.3	57.9
Adults 60 and older	38.9	47.7	41.0
Adults with disabilities	52.6	60.3	53.1
Nondisabled adults 18-49 in childless units	32.2	45.3	43.4
SNAP units	**44.7**	**55.2**	**49.8**
One person only	42.6	51.0	48.2
With children	48.9	58.7	53.6
Children and only one adult	47.9	69.1	61.1
Children only	48.7	49.0	43.7
With no earnings	49.1	58.1	52.5
With children and no earnings	70.6	61.5	59.3

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Unit differences in poverty rates vary across the three States. For example, while units with children and no earnings have higher poverty rates than all units in all three States, the difference in Illinois is much larger than in Mississippi or Tennessee. In Illinois, 70.6 percent of these units are in poverty compared to 44.7 percent for all units, but in Mississippi the difference between the subgroup and all units is only 6.3 percentage points (61.5 versus 55.2 percent). In Illinois, the remaining unit subgroups and all units have similar poverty rates, but, in Mississippi, the poverty rate for units with children and a single adult is 14 percentage points higher than the poverty rate for all units (69.1 versus 55.2 percent). In Tennessee, the difference is 11 percentage points (61.1 versus 49.8 percent).

No participant nor unit subgroup scores consistently high across all four measures in a direction that implies potential difficulty in simulating eligibility, but some groups deviate from all participants or all units on at least two measures in all three States. Among participant subgroups, nondisabled adults 18-49 in childless units show by far the highest likelihood of being in a unit that does not include the whole household and have the lowest poverty rate in two of the three States. Elderly adults have the lowest poverty rate in Tennessee and the second lowest in the other two, but, on all three household composition measures, they score low with respect to complexity, implying relative ease in simulating SNAP eligibility. Adults with a disability also tend to score low or average on the measures of household complexity. Children under 5 do not score consistently across the three States on any of the four measures.

Among unit subgroups, child-only units are always less than the entire household for obvious reasons, and this does complicate simulation of their SNAP eligibility, but they are also very rare, as documented above. They are also the most likely to be in a household with an unrelated individual or subfamily although only by a small margin, and they are not distinctive on the other two measures. Units with children and no earnings are consistently more likely to be in units that do not include the whole household and in households that include a related subfamily, and they also have the highest or second highest poverty rate in all three States. This combination of characteristics suggests that the identification of such units within the larger household may be critical in establishing their eligibility. Units with children and a single adult stand out with respect to the relatively high frequency with which their households include a related subfamily, but in every State they are most likely to be the entire household. Given that, their high poverty rates in two States would not appear to derive from subsetting the household. One-person units in all three States are least likely to be in a household that includes a related subfamily, and they are undistinguished in other respects.

VI. Multiple SNAP Units, Nonparticipating Household Members, and Nonmatched SNAP Participants

In this section we provide information on two aspects of the composition of SNAP households that are relevant to eligibility simulation: (1) the occurrence of multiple SNAP units within the same household and (2) the occurrence of nonparticipating household members within SNAP households. We also document instances in which not all members of a SNAP unit could be linked to survey household members, implying that the nonmatched SNAP unit members were not members of the survey household. To assess the potential implications of unmatched SNAP unit members on estimated SNAP participation rates, we examine their distribution by age.

Estimates of the distribution of the number of SNAP units per SNAP household were produced for all three States in the preceding task order. These estimates based on State administrative data are more precise than what we can produce with linked survey and administrative data, but their accuracy is uncertain. The principal reason to repeat these estimates with the linked data, therefore, is to compare the results and, in so doing, assess the accuracy of the estimates from the State administrative data. Another reason is to examine characteristics that may differentiate households with one versus multiple SNAP units. Such characteristics include the presence of household members who are outside of the householder's nuclear family. The characteristics that we examine are whether or not a household includes: (1) a subfamily that is related to the householder, such as a child and his or her spouse or own child, (2) an individual who is unrelated to the householder, such as a roommate or boarder, (3) a parent of the householder, (4) a grandchild of the householder, (5) an unmarried partner of the householder, and (6) a non-citizen.[12] Non-citizens could include the householder.

Table 12 provides estimates of the frequency of these six characteristics among CPS ASEC households with linked SNAP administrative records in each of the three States. With the exception of non-citizens, the estimated frequencies of these characteristics are similar across the three States. Among the relationships considered, individuals unrelated to the householder were

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[12] We had intended to examine unrelated subfamilies as well, but they proved too rare to include in our estimates.

the most common, being found in 14 percent of the households in all three States. Unmarried partners were found among 9 to 11 percent of the households, and grandchildren were included in 8 to 11 percent of the households. Related subfamilies (between 7 and 9 percent) and parents of the householder (around 6 percent) were the least common.

Table 12. Weighted percentage of survey households with selected characteristics: CPS ASEC households with linked SNAP administrative records, by State, 2011-2016

Household characteristic	Illinois	Mississippi	Tennessee
Household includes:			
A related subfamily	8.6	8.4	7.2
An unrelated individual	14.6	14.3	14.0
A parent of the householder	6.4	5.8	5.7
A grandchild of the householder	8.4	10.8	8.4
An unmarried partner of the householder	10.8	9.3	9.2
A non-citizen	13.1	S	5.1

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S indicates that the value was suppressed because of small numerator.

As noted, the frequency of non-citizens varied markedly across the three States. Non-citizens were found in 13 percent of the SNAP households in Illinois but only 5 percent of the households in Tennessee, and they were too rare to report in Mississippi. While these differences undoubtedly reflect variation in the relative frequency of non-citizens in the populations of the three States, differential assessment of SNAP eligibility could be a factor as well.

For the presence versus absence of five of these household characteristics (all except non-citizen), Table 13 reports the percentage of SNAP households with multiple SNAP units by State. For each State, between 8.2 and 8.8 percent of all SNAP households included multiple SNAP units.[13] Multiple SNAP units were more common in the presence versus the absence of each of the five household characteristics although the strength of this relationship varied across the five characteristics and, for some, across States. This relationship between specific features of household composition and the occurrence of multiple SNAP units was strongest and most consistent across States for related subfamilies, parents of the householder, and grandchildren of the householder. For example, a SNAP household with a related subfamily was nearly three times as likely to have multiple SNAP units as a SNAP household without a related family.

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[13] These estimates contrast sharply with the estimates obtained from State administrative data, which represent SNAP units per "dwelling." Over the years 2011-2016, the average percentage of dwellings with multiple SNAP units was 16 percent in Illinois, 13 percent in Mississippi, and 0 percent in Tennessee (these estimates were assigned DRB Delegated Authority Approval Number CBDRB-FY21-CES014-003). We attribute the high rates in Illinois and Mississippi to inadequate differentiation among distinct Census households in the identification of dwellings. That is, multiple Census households may be treated as a single dwelling in many instances in the administrative data. Conversely, the absence of multi-unit dwellings in Tennessee suggests that dwellings in the State administrative data were identified uniquely with SNAP units. For all three States these issues most likely stem from the quality of the address information included in the State administrative data—or, more specifically, in the address fields provided to the Census Bureau.

Table 13. Weighted percentage of survey households with multiple SNAP units by household characteristics: CPS ASEC households with linked SNAP administrative records, by State, 2011-2016

Household characteristic	Illinois	Mississippi	Tennessee
All households with SNAP units	8.3	8.8	8.2
Household includes:			
A related subfamily			
With	19.9	20.6	21.6
Without	7.2	7.8	7.2
An unrelated individual			
With	16.2	11.4	17.1
Without	6.9	8.4	6.8
A parent of the householder			
With	22.6	18.1	14.0
Without	7.3	8.3	7.9
A grandchild of the householder			
With	23.9	21.9	18.0
Without	6.8	7.3	7.3
An unmarried partner of the householder			
With	16.0	10.2	10.2
Without	7.3	8.7	8.0

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Given the low frequency of multiple SNAP units, however, only one in five SNAP households with a related subfamily had more than one SNAP unit, meaning that most related subfamilies, if they were participating in SNAP, were either included in the same SNAP unit as the householder's (primary) family or constituted the sole SNAP unit in the household.[14]

Reflecting weaker relationships, multiple SNAP units were more than twice as common in the presence versus the absence of unrelated individuals in Illinois and Tennessee but only marginally so in Mississippi. Multiple SNAP units were also more than twice as common in the presence versus the absence of unmarried partners in Illinois but only narrowly more common in Mississippi and Tennessee.

Similarly, the survey household was more likely to include at least one member who was not a SNAP participant in the presence versus absence of each of the six characteristics in all three States (Table 14). Overall, 50 percent of SNAP households in Illinois and 42 percent in Mississippi and Tennessee included a nonparticipant. Having one of the types of household members represented in the six characteristics nearly doubled the probability of having a nonparticipant compared to not having that type of member. For example, 91 percent of the Illinois SNAP households with a related subfamily had a nonparticipating member compared to

[14] Small sample sizes limited our ability to explore this further, but future research with larger samples could potentially enhance our ability to use this information in constructing eligibility units.

46 percent of the SNAP households without a related subfamily. In Mississippi, these figures were 80 percent and 39 percent, respectively; in Tennessee, they were 72 percent and 40 percent. As noted, non-citizens were too rare in Mississippi SNAP households to estimate their impact on the incidence of nonparticipants. However, in Illinois, where non-citizens in SNAP households were most common, 87 percent of the households with non-citizens had nonparticipating members compared to 45 percent among households without non-citizens. Even though Tennessee had a much lower frequency of non-citizens in their SNAP households than Illinois, their impact was similar: 79 percent of the households with non-citizens had nonparticipating members compared to only 40 percent of those without non-citizens.

Table 14. Weighted percentage of survey households with nonparticipating members by household characteristics: CPS ASEC households with linked SNAP administrative records, by State, 2011-2016

Household characteristic	Illinois	Mississippi	Tennessee
All households with SNAP units	50.1	42.4	41.8
Household includes:			
A related subfamily			
With	91.0	80.1	72.3
Without	46.2	38.9	39.5
An unrelated individual			
With	81.9	76.5	75.0
Without	44.6	36.7	36.4
A parent of the householder			
With	88.6	79.0	69.8
Without	47.4	40.1	40.2
A grandchild of the householder			
With	87.1	77.3	72.1
Without	46.7	38.1	39.1
An unmarried partner of the householder			
With	79.3	72.8	69.8
Without	46.6	39.2	39.0
A non-citizen			
With	86.6	S	79.0
Without	44.6	S	39.9

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S indicates suppressed because of small denominator.

When only some of the members of a CPS ASEC household link to SNAP administrative records, the unmatched members reflect a major challenge in simulating SNAP eligibility—determining how to divide the survey household membership into prospective SNAP units. Table 15 reports cross-tabulations of the number of matches (participating members) and nonmatches (nonparticipating members) among CPS ASEC households with one or more matches to SNAP administrative records. Because the cross-tabulations include progressively fewer sample

households as the numbers of matches and nonmatches increase, we have combined six years of data (2011 through 2016) for each of the three States. We have also capped the number of matches at four or more and the number of nonmatches at three or more.

Table 15. Weighted percentage distribution of linked survey households by number of participating and nonparticipating members, by State, 2011-2016

Number of participating members (matches)	Number of nonparticipating members (nonmatches)				
	0	1	2	3+	Total
Illinois					
1	22.79	10.84	6.32	6.92	46.87
2	10.46	5.39	2.97	3.36	22.18
3	6.04	4.04	2.42	1.48	13.98
4+	10.62	4.27	1.35	0.72	16.96
Total	49.91	24.54	13.06	12.48	100.00
Mississippi					
1	20.24	12.54	6.16	4.48	43.42
2	11.40	4.83	1.75	1.08	19.06
3	10.25	3.32	1.09	0.86	15.52
4+	15.75	3.56	1.67	1.01	21.99
Total	57.64	24.25	10.67	7.43	100.00
Tennessee					
1	24.99	9.59	7.31	4.51	46.40
2	11.28	5.54	2.37	1.56	20.75
3	9.64	3.86	1.79	0.50	15.79
4+	12.25	3.00	1.06	0.75	17.06
Total	58.16	21.99	12.53	7.32	100.00

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The row totals in the right-hand column provide a distribution of the number of matches per household while the column totals beneath each cross-tabulation provide a distribution of the number of nonmatches. Mississippi has somewhat more matches per household than Illinois or Tennessee, with 43 percent of the households having a single match and 22 percent having four or more matches. In the other two States, between 46 and 47 percent of the households have a single match, while 17 percent have four or more. In both Mississippi and Tennessee, around 58 percent of the survey households have no nonmatches—that is, every member of the household links to a SNAP record. In Illinois, 50 percent of the households have no nonmatches.

Most of the difference between Illinois and the other two States with respect to nonmatches lies in the fraction of households with three or more nonmatches: 12.5 percent for Illinois versus fewer than 7.5 percent for Mississippi and Tennessee. A large number of nonmatches in a household suggests that an entire subfamily or group of unrelated individuals was not participating in SNAP, but when the number of matches is small, we have to consider the possibility that the matches may be erroneous. In Illinois, nearly 7 percent of households had a single match and three or more nonmatches, and 3.4 percent of households had two matches with

three or more nonmatches. Both fractions were lower in the other two States, with 4.5 percent of the households in both States having a single match combined with three or more nonmatches, and only 1.1 percent in Mississippi and 1.6 percent in Tennessee having two matches with three or more nonmatches.

Nonmatches can occur among the members of matching SNAP administrative units as well. When these represent true nonmatches as opposed to matches that failed because of missing link keys, they imply either of two scenarios: (1) a member of the SNAP unit was omitted from the survey household roster or (2) a member of the SNAP unit does not actually live with the other members of the unit. Surveys and even censuses do miss household members on occasion. In particular, the 2010 census undercount of young children has been a focus of recent research at the Census Bureau.[15] Furthermore, surveys and administrative data may define household membership differently, so a discrepancy between the two sources is not necessarily an error in either source.

Table 16 reports the weighted percentage distribution of linked survey households by the number of unmatched survey household members and unmatched SNAP unit members. As with the previous table, the estimates are presented by State, aggregated over the years 2011 through 2016.[16] We note, first, that nonmatches are much less common among the SNAP units than the survey households and, second, that their occurrence is more similar across States. The proportion of households with no SNAP nonmatches ranges from 79.2 percent for Illinois to 82.9 percent for Mississippi. These estimates are 20 to 30 percentage points higher than the proportion of households with no survey nonmatches, which, as shown in Table 15, ranges from 49.9 percent in Illinois to 58.2 percent in Tennessee. We note as well that roughly half of the households have no unmatched members in either the household or SNAP unit. This fraction ranges from a low of 45.3 percent for Illinois to a high of 53.5 percent for Tennessee.

When there is an unmatched member of the household or the SNAP unit, about half the time there is just a single unmatched individual. In Illinois and Mississippi, the instances of a single unmatched SNAP unit member outnumber the instances of two or more unmatched SNAP members; in Tennessee the numbers are nearly equal. In Mississippi and Tennessee, the instances of a single unmatched survey household member outnumber the instances of two or more—to a greater degree in Mississippi. In Illinois, the instances of two or more unmatched survey household members outnumber by a slight margin the instances of a single unmatched member.

Instances where there are unmatched members in both the survey household and the SNAP unit suggest the possibility of match failures. This is particularly true when the number of unmatched members from each source is identical. We have footnoted the cells on the diagonal where the number of nonmatches is identical (including the cell representing no nonmatches in either source). Excluding the 0,0 cell and treating three or more survey nonmatches as identical to three

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[15] See, for example, Jensen (2019), which examines coverage in the CPS ASEC and two other Census Bureau surveys. Weighting adjustments correct for any undercount at an aggregate level but do not address underreporting at the household level.

[16] Slight differences in the marginal distributions of survey nonmatches are due to rounding in the interior cells.

or more SNAP nonmatches, the fraction of households with an equal, nonzero number of survey and SNAP nonmatches ranges from 4.4 percent for Mississippi to 9.0 percent for Tennessee, with Illinois at 7.4 percent (calculation not shown). The larger fraction of households missing one or more members from both the survey household and the SNAP unit ranges from 10.8 percent for Mississippi to 16.1 percent for Illinois, with Tennessee at 15.8 percent.

Table 16. Weighted percentage distribution of linked survey households by number of unmatched survey household and SNAP unit members, by State, 2011-2016

Number of unmatched survey household members	Number of unmatched SNAP unit members				
	0	**1**	**2**	**3+**	**Total**
Illinois					
0	45.25[a]	2.45	0.90	1.32	49.92
1	18.20	4.44[a]	1.09	0.82	24.55
2	9.25	2.16	0.93[a]	0.71	13.05
3+	6.48	2.55	1.41	2.03[a]	12.47
Total	79.18	11.60	4.33	4.88	100.00
Mississippi					
0	51.42[a]	3.22	1.57	1.44	57.65
1	19.55	2.68[a]	1.03	0.98	24.24
2	7.08	1.74	1.01[a]	0.84	10.67
3+	4.86	1.29	0.52	0.75[a]	7.42
Total	82.91	8.93	4.13	4.01	100.00
Tennessee					
0	53.48[a]	2.55	1.04	1.07	58.14
1	16.07	4.40[a]	0.84	0.67	21.98
2	7.22	2.07	1.80[a]	1.46	12.55
3+	2.79	10.03	4.42	2.77[a]	7.31
Total	79.56	10.03	4.42	5.97	100.00

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[a] Number of unmatched survey household and SNAP unit members is identical.

The estimated frequency of nonmatches in both the survey household and the SNAP unit would be reduced by identifying additional matches between unmatched members associated with the same household. As described earlier, we searched for additional matches by age and sex among pairs of members within the same household in Illinois in 2015 and 2016 and Tennessee in 2016. At least one member of each pair that we matched lacked a PIK, preventing a match on that unique identifier.

Table 17 shows the weighted percentage of survey households containing such matches and how much they reduced the weighted percentage of households with unmatched household members and unmatched SNAP unit members. The fraction of households with additional matches identified ranged from 4.5 percent in Illinois in 2015 to 9.7 percent in Tennessee in 2016. In some but not all cases, these additional matches eliminated all of the unmatched survey

household or SNAP unit members within a household.[17] The average share of households with unmatched survey household members in Illinois over the period 2011 to 2016 was 50.1 percent (calculated from Table 16). The additional matches would reduce this to about 48 percent, assuming the average reduction in 2015 and 2016 applied to all six years. In Tennessee, the additional matches reduced the weighted estimate of households with unmatched survey household members by 6.3 percentage points, which compares to a 2011 to 2016 average of 41.8 percent. If this same reduction applied to all six years, the fraction of SNAP households with non-participating members fall to 35.5 percent.

Table 17. Estimated impact of additional matches on the relative frequency of unmatched survey household and SNAP unit members: Illinois, 2015 and 2016 and Tennessee, 2016

State and year	Sample count of matched households	Weighted percentage of households with additional matches identified	Weighted percentage point reduction in households with unmatched:	
			Survey household members	SNAP unit members
Illinois, 2015	350	4.5	1.5	4.0
Illinois, 2016	250	7.0	3.2	5.3
Tennessee, 2016	200	9.7	6.3	6.3

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The additional matches also reduced the weighted estimate of households with unmatched SNAP unit members in Illinois by 4.0 and 5.3 percentage points in 2015 and 2016, respectively. For comparison, the average share of households with unmatched SNAP unit members in Illinois over the period 2011 to 2016 was 20.8 percent. If the 2015 and 2016 results applied to all six years, the fraction of SNAP households with unmatched SNAP unit members would fall to just above 16 percent. In Tennessee, however, the additional matches reduced the weighted estimate of households with unmatched SNAP unit and survey household members by the same degree (6.3 percentage points). This reduction compares to a six-year average of 20.4 percent of Tennessee households with unmatched SNAP unit members. If the 2016 findings applied to all six years, the fraction of SNAP households with unmatched SNAP unit members would fall to about 14 percent.

Nonmatches in the survey household—especially when they outnumber the unmatched SNAP unit members—indicate SNAP units that encompass only part of the household. Nonmatches in the SNAP unit—especially when they outnumber the unmatched survey household members— indicate persons who may have been omitted from the survey household roster and, therefore, cannot be included in a simulated SNAP unit.

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[17] If the number of unmatched survey household members were identical to the number of unmatched SNAP unit members, the additional matches could potentially eliminate all unmatched members of both types. If one number were larger than the other, the additional matches could at most eliminate all unmatched members of one type. Given that unmatched survey household members were more than twice as numerous as unmatched SNAP unit members, the additional matches were more likely to eliminate all unmatched SNAP unit members than all of the unmatched survey household members.

Picking up on this last point, we estimated the age distribution of the unmatched SNAP unit members. We did so for each State, combining the estimates over the six years, 2011 to 2016. Table 18 presents, for each age group, weighted estimates of matched SNAP records, matched plus unmatched SNAP records, and the percentage increase due to the addition of the unmatched SNAP records.[18]

Table 18. Weighted estimates of the addition of unmatched SNAP unit members to matched unit members, by age group and State, 2011-2016

Age group	Estimate from matched records	Adding unmatched SNAP records	Percentage increase
Illinois			
All Participants	8,510,000	10,080,000	18.5
Children	3,730,000	4,803,000	28.8
Children 0-4	1,079,000	1,399,000	29.6
Children 5-17	2,651,000	3,404,000	28.4
Adults 18 to 59	3,982,000	4,466,000	12.2
Adults 60 and older	798,100	813,000	1.9
SNAP units with children	1,854,000	2,145,000	15.7
Mississippi			
All Participants	3,413,000	4,084,000	19.7
Children	1,465,000	1,828,000	24.8
Children 0-4	423,300	569,000	34.3
Children 5-17	1,042,000	1,260,000	20.9
Adults 18 to 59	1,691,000	1,990,000	17.7
Adults 60 and older	257,500	265,700	3.2
SNAP units with children	678,200	777,600	14.7
Tennessee			
All Participants	6,387,000	7,687,000	20.4
Children	2,481,000	3,236,000	30.4
Children 0-4	778,200	1,015,000	30.4
Children 5-17	1,702,000	2,220,000	30.4
Adults 18 to 59	3,266,000	3,786,000	15.9
Adults 60 and older	640,200	665,500	4.0
SNAP units with children	1,358,000	1,585,000	16.7

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The unmatched SNAP unit members are disproportionately children, as evidenced by the greater percentage increase among children than among nonelderly adults and especially elderly adults. In Illinois, adding the unmatched SNAP unit members increases the number of SNAP children

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[18] The matched records are weighted by their CPS ASEC person weights, which were used for the annual tabulations that we summed to obtain the estimates of matched records presented here. The unmatched SNAP records have no person weights, so they are weighted by the CPS ASEC household weights of the households to which their SNAP units are matched. The household weight for a given household equals the person weight of the householder. Children's person weights tend to be somewhat larger than their household weights because children are underrepresented in the survey relative to adults. If we had used household weights for the matched records, the estimates of the percentage increase for children would be somewhat larger.

by 29 percent compared to 12 percent for nonelderly adults and just 2 percent for elderly adults. Furthermore, while many of the unmatched children in Illinois are in SNAP units with one or more matched children, the additional children nevertheless increase the estimated number of SNAP units with children by 16 percent. Mississippi is the only State in which the percentage increase for children under 5 is markedly greater than the increase for older children: 34 percent versus 21 percent. Tennessee falls between the other two States in the relative impact of the additional SNAP unit members on children versus nonelderly adults. Adding the unmatched SNAP unit members increases the number of children by 30 percent, the number of nonelderly adults by 16 percent, and the number of elderly adults by 4 percent.

The additional matches that we identified between unmatched survey household members and SNAP unit members in Illinois and Tennessee have implications for the findings presented in Table 18. Table 19 shows the results of incorporating these edits into the estimates for Illinois for the combined years 2015 and 2016.[19] The top panel reports the original estimates while the lower panel reports the revised estimates. The revised estimates are obtained by adding the number of additional matches to the original estimate of SNAP participants by subgroup and subtracting the additional matches from the original estimate of unmatched SNAP unit members.

Table 19. Estimated impact of additional matches on the frequency of unmatched SNAP unit members by age: Illinois, 2015-2016

Age group	Weighted estimate of participants from linked survey and administrative data	Weighted estimate of unmatched SNAP unit members	Percentage increase from adding unmatched SNAP unit members	Additional weighted matches among original unmatched SNAP unit members
Original Estimates				
All Participants	2,792,000	538,300	19.3	113,700
Children	1,154,000	350,200	30.3	96,800
Children 0-4	351,500	91,900	26.1	30,000
Children 5-17	803,000	258,200	32.2	66,700
Adults	1,638,000	188,100	11.5	16,900
Revised Estimates				
All Participants	2,906,000	424,600	14.6	--
Children	1,251,000	253,400	20.3	--
Children 0-4	381,500	61,900	16.2	--
Children 5-17	869,700	191,500	22.0	--
Adults	1,655,000	171,200	10.3	--

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For example, the original estimate of all participants based on the PIK matches was 2,792,000 with another 538,300 unmatched SNAP unit members. With our additional matching, we identified 113,700 matches among the 538,300 unmatched SNAP unit members. Adding these to the estimated participants based on PIK matches and subtracting them from the unmatched SNAP unit members yielded the revised estimates of 2,906,000 matched participants and

[19] With just a single year of data, Tennessee provided too small a sample of unmatched SNAP unit members and edits by subgroup to yield meaningful results.

424,600 unmatched SNAP unit members. With these changes, the estimated increase in participants due to unmatched SNAP unit members is reduced from 19.3 percent to 14.6 percent. The impact of the additional matches is much greater for children than adults. For all children and for children 0 to 4 and 5 to 17, the reduction is 10 percentage points compared to only 1.2 percentage points for adults.[20]

That the unmatched SNAP unit members should include more children than adults, even after the additional matches, is not surprising, given that surveys and the decennial census tend to undercount children (Jensen 2019). The implication for SNAP eligibility simulation is clear. Unless the uncounted SNAP participants appear in eligible but not participating survey households, they may help to explain the shortfall in estimated eligible children and units with children.

VII.   Implications for SNAP Unit Simulation

To fully explore the reasons why the CPS ASEC-based simulations under- or overestimate the number of SNAP-eligible persons and households within specific subgroups, and what this may imply about simulation of the SNAP eligibility unit, it would have been necessary to implement the simulations on the linked survey and administrative data. While we were not able to do so within the scope of this project, our findings do bear a number of implications for SNAP unit simulation.

As reported above, Czajka, Cunnyngham and Rosso (2015) using linked survey and SNAP administrative data from New York and Colorado found that roughly half of SNAP households included non-participants and about 10 percent had SNAP participants who were not counted in the survey. Using the same methodology, here we found that 50 percent of SNAP households in Illinois and 42 percent in Mississippi and Tennessee had non-participating members, but around 20 percent in Illinois and Tennessee and 17 percent in Mississippi had SNAP participants who were not counted in the CPS ASEC.

Participation rates for children in both age groups were estimated at around 102 percent in 2015, and the participation rate for SNAP units with children was estimated at 100 percent (Gray and Cunnyngham 2017, supplemental tables). We found no evidence from the linked data that children and units with children were differentially underestimated relative to the administrative totals. However, children dominate the SNAP participants we identified as being omitted from CPS ASEC household rosters. To obtain a more complete simulation of eligible children and units with children would require an adjustment to the estimated number of simulated eligible children and units with children. Ideally, this should be based on a larger sample of States and multiple years of linked data. With such data, the probability of omitted children could be modeled as a function of household characteristics. Assumptions about the underreporting of eligible children in non-participating households would be required, as the linked data are informative only about participating households.

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[20] It was necessary to combine non-elderly and elderly adults because the additional matches among the latter were too few to report.

Adults with disabilities were added to the analysis at the request of ERS and not because the Mathematica simulations yield a participation rate at or above 100 percent. Our findings suggest that the CPS ASEC identifies more instances of disability among adult SNAP participants than the QC data.[21] This discrepancy would tend to depress estimated participation rates among adults with disabilities, other things being equal.

This difference in the identification of disability may also contribute to the underestimation of eligible nondisabled adults 18-49 in childless units, whose participation rate was estimated at 101 percent in 2015, while the participation rate for households containing such individuals was estimated at 123 percent. If disability is measured at a higher rate in the CPS ASEC than the QC data, persons without disabilities will be underestimated. Indeed, estimates of this subgroup compared less well to QC sample totals than most other participant subgroups.

We find evidence as well of other factors that make eligibility simulation for this subgroup challenging. Nondisabled adults 18-49 in childless units show the highest likelihood—66 to 72 percent—that their SNAP unit does not include the entire household. In addition, nondisabled adults 18-49 in childless households are subject to special eligibility restrictions, which are difficult to simulate. Nevertheless, one inference from our findings is that the underestimation of nondisabled adults themselves can be reduced by employing a narrower definition of disability in the simulation.

Elderly adults, which were added to the analysis on the recommendation of ERS, differ from the other subgroups in having a historically low participation rate (42 percent in 2015). Low benefits are a significant factor in their low participation, but it is possible that their eligibility is overestimated. We find from our linked data that elderly SNAP participants have among the lowest poverty rates, which is consistent with the low benefits. They score low on the three measures of household complexity, which suggests that alternative ways of constructing SNAP eligibility units in complex households is a relatively minor factor in determining elderly adult eligibility.

One-person units, which had an estimated participation rate of 101 percent in 2015, were underestimated in the linked data relative to all units and most other subgroups. We speculate that this may be a function of their reliance on a single person having a PIK for a match to occur. However, we note as well that if a larger SNAP unit had only a single survey sample member with a PIK, that unit would have been counted as a one-person unit. Beyond this, one-person units were not distinctive in our analysis. In fact, in only Mississippi were they more likely than all SNAP units to be only part of the survey household.

Units with children and a single adult, which had an estimated participation rate of 131 percent in 2015, were underestimated in the linked data in all three States relative to all units and most of the unit subgroups. However, of all the unit subgroups they were most likely to constitute the

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[21] Only Mississippi among the three States included a measure of disability in the administrative data provided to the Census Bureau, and it grossly underestimated the incidence of disability relative to the QC data. In addition, our analysis employed a narrower definition of disability, based on a single indicator referencing the respondent's condition at the time of the interview, compared to Mathematica's simulations, which employ multiple indicators referencing the prior calendar year.

entire household in all three States although they were also most likely to be in a household with a related subfamily. These seemingly contradictory findings offer no guidance for improving their eligibility simulation. One can imagine that units with children and a single adult often *are* the related subfamily, living with the adult's parents, so the latter finding is not surprising, but that situation implies the presence of others in the household.

Child-only units had an estimated participation rate of 135 percent in 2016 (Lauffer 2020, supplemental tables).[22] Since households without adults are virtually non-existent in the CPS ASEC, child-only units are ones in which the adults are not eligible for SNAP. Because simulated child-only units are underestimated at a far higher rate than simulated units with children, the underestimation of this subgroup in SNAP eligibility simulations is likely due primarily to the underestimation of ineligible parents. Beyond confirming the obvious, that child-only units are never the entire household, our analysis did not produce any insights to help improve their eligibility simulation. In fact, the estimates of child-only units from the linked data exceeded the administrative counts and QC sample estimates in two of the three States and outperformed all units and all other subgroups in the third. We caution, however, that the linked samples of child-only units were very small, so the comparisons involving this subgroup should be interpreted with caution.

Units with no earnings, which had an estimated participation rate of 97 percent in 2015, were estimated less well than all units in Illinois and Tennessee. A possible explanation is that the CPS ASEC captures earnings for units that have no reported earnings in the administrative data. This proposition could be assessed directly by comparing the two sources of income on all linked records. It could also be that CPS respondents without earnings were less likely to have PIKs and, as a result, less likely to be linked. In other words, the linked records may under-represent SNAP participants without earnings. On the household composition measures, units without earnings were not differentiated from all units, so we find no evidence pointing to particular issues in how units without earnings are constructed.

Our findings also point to elements of household composition that are strongly associated with the incidence of nonparticipating members. We found a markedly higher incidence of nonparticipating members when a household included a related subfamily; an unrelated individual; a parent, grandchild, or unmarried partner of the householder; or a non-citizen. This provides potentially useful information in determining when to define simulated eligibility units that exclude some household members.

Creating multiple eligible units within a household has also been viewed as a way of improving eligibility simulations—particularly by increasing the number of one-person units (Czajka, Cunnyngham, and Rosso 2015). However, we find a low incidence of multiple SNAP units within the same household (between 8 and 9 percent), suggesting the limitations of this strategy. When multiple eligibility units are created, it may be best that this be done in such a way that, except in rare cases, only one unit is deemed eligible.

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[22] An estimated participation rate for this subgroup was not produced for 2015.

VIII. References

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