Improving County-Level Earnings Estimates with a New Methodology for Assigning Geographic and Demographic Information to U.S. Workers

by Michael Compson*

This article describes a new methodology developed by the Office of Research, Evaluation, and Statistics (ORES) of the Social Security Administration (SSA) to assign a state and county of residence code and identify the date of birth and sex of nearly all workers for whom tax records provide earnings data in a given year. The current methodology assigns state and county codes and demographic information only to workers in SSA's 1-percent Continuous Work History Sample—fewer than 1.7 million workers in 2017. The new methodology assigns state and county codes and demographic information to more than 178 million workers for 2017. Applying these geographic and demographic indicators will enable ORES to use a vastly larger sample of workers to generate annual earnings estimates and mitigate the limitations associated with the current estimation process.

Introduction

The Office of Research, Evaluation, and Statistics (ORES) of the Social Security Administration (SSA) compiles earnings data from administrative records and provides them to internal staff for research and policy analysis, as well as to other federal agencies and outside research organizations via data exchange agreements. ORES also produces annual statistical publications containing approximately 140 tables presenting earnings data in the context of the Social Security and Medicare programs. The primary administrative data source for earnings tables used in research, policy analysis, and program evaluation is the Continuous Work History Sample (CWHS). In use since the 1930s, the CWHS is a system of files that contains annually updated earnings and benefits data, as well as demographic and geographic information for a random 1-percent sample of all Social Security numbers (SSNs) ever issued.[1]

One of ORES' key statistical publications is *Earnings and Employment Data for Workers Covered Under Social Security and Medicare, by State and County* (hereafter, *Earnings and Employment*; see https://www.ssa.gov/policy/docs/statcomps/eedata_sc/index.html). This annual publication presents the worker counts, earnings amounts, and Social Security and Medicare payroll-tax contribution amounts for all workers, wage and salary workers, and self-employed individuals for each county or county equivalent in the United States. ORES has identified three significant limitations associated with the current methodology for generating earnings estimates at the county level.

The first limitation is that many estimates are suppressed to comply with SSA's rigorous data protection rules, which prevent the direct or indirect disclosure of any information that could identify individuals.

Selected Abbreviations

10-CWHS-HE	Ten-percent CWHS with high earners subsample
CWHS	Continuous Work History Sample
EIN	employer identification number
FIPS	Federal Information Processing Standards
IRS	Internal Revenue Service

* *Michael Compson is a senior economist with the Office of Statistical Analysis and Support, Office of Research, Evaluation, and Statistics, Office of Retirement and Disability Policy, Social Security Administration.*

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Selected Abbreviations—*Continued*

MEF	Master Earnings File
MGD	Master Geographic-Demographic
OEIS	Office of Enterprise Information Systems
ORES	Office of Research, Evaluation, and Statistics
SCC	state and county code
SSA	Social Security Administration
SSN	Social Security number

In the *Earnings and Employment* 2017 edition, more than one-half of the county-level estimates were suppressed, primarily because the CWHS includes relatively few individuals with self-employment income. The current tabulation process, based on a 1-percent sample, allocates its sample of about 186,000 self-employed individuals across 3,215 counties in the United States and Puerto Rico, an average of only 58 self-employed persons per county.

The second limitation is that the current methodology occasionally produces relatively large year-to-year variances in some county-level earnings estimates, especially for Medicare-taxable earnings. In most cases, this problem emerges when relatively few workers reside in the affected county and one or several of them experience a large change in earnings. A single worker who experiences such a change in a given tax year can significantly affect the amount of aggregate earnings reported in a county because ORES assigns each worker a weight of 100 to reflect national estimates. Because all earnings are subject to the Medicare payroll tax, while earnings subject to the Social Security payroll tax are capped at an annual maximum amount ($127,200 in 2017), the year-to-year increase in an individual's Medicare-taxable earnings can be substantially larger than the increase in Social Security–taxable earnings.

The third limitation is that the state and county codes (SCCs) used in *Earnings and Employment* differ from the Federal Information Processing Standards (FIPS) SCCs that are used by ORES in other statistical publications and by other federal agencies.

The solution to the problems of county-level data suppression and the occasional large variance in the year-to-year earnings estimates is to expand the sample size that is used to generate the estimates. However, despite its limited sample size, only the CWHS currently provides the earnings, geographic, and demographic information necessary to generate the annual earnings tables ORES publishes. To enable the use of a larger sample, ORES has developed a systematic and automated process for assigning the SCC and demographic information (birth year and sex) for nearly all wage and salary workers and self-employed individuals in a given year. With the new methodology, ORES can assign a geographic location for nearly every worker based on the complete address reported each year on Internal Revenue Service (IRS) Forms W-2 and W-2c (filed by employers) and Form 1040 Schedule SE (filed by the self-employed).[2] ORES can then determine a worker's birth year and sex by cross-referencing SSA's Numerical Identification System (Numident) master file.[3] The new methodology enables ORES to assign a single SCC to 99.89 percent of the 178,863,694 workers whose earnings were reported on a W-2, W-2c, or Schedule SE for tax year 2017. It generates a standalone data file that contains the SSN, SCC, date of birth, and sex for nearly all wage and salary workers and self-employed individuals in a given tax year. ORES is developing a new process that will generate the annual earnings estimates by matching the data in the standalone file with a much larger sample of earnings records. That larger sample will replace the 1-percent CWHS that ORES currently uses for earnings estimation. SSA expects the new process and the expanded data set to be finalized and fully implemented within 2 years.

The effect of the new process for assigning geographic and demographic information and using the larger sample of workers extends well beyond improving the annual earnings estimates. The dramatic expansion of the number of workers with geographic and demographic information will open many new avenues, and improve existing ones, for using earnings data in research and policy analysis. For example, assigning SCCs to all workers will allow ORES to generate more accurate estimates of the size and characteristics of the U.S. workforce, identify and analyze worker migration patterns, evaluate SSA procedures for assigning SCCs to other administrative data, and provide valuable data and insights to other federal agencies that generate labor-force estimates.

This article discusses key aspects and limitations of the methodology SSA currently uses for generating county-level earnings estimates. Then it describes the new methodology for assigning SCCs and demographic information to records for workers who had earnings reported on a Form W-2, W-2c, or 1040 Schedule SE for a given tax year.

Limitations of the Current Methodology for Assigning Geographic Codes

ORES developed the current methodology for assigning SCCs to worker records in the CWHS file in the early 1990s and it became operational with the estimates using 1993 data.[4] Until then, ORES had used only the employer's location to assign worker SCCs. Now, ORES would shift to a hybrid approach, using the location of the worker's residence when that information was available, and the employer's location when it was not. In general, ORES used the employer's location only for workers whose employers submitted paper Forms W-2 and W-2c, which was still relatively common at the time. SSA would scan the paper forms to capture all the earnings information needed for program operations—information that did not include the employee's address. Beginning in the mid-1990s, however, the use of paper forms declined dramatically in favor of electronic filing, and basing a worker's SCC on employer location similarly declined. As a result, most of the SCCs assigned in the most recent versions of the CWHS reflect employee addresses.

In the early 1990s, computer storage capacity was limited. In developing the current methodology for assigning SCCs, ORES conserved storage space by using only the first five letters of a city's name and the 5-digit (rather than the 9-digit) ZIP Code to assign a county code to a worker in the CWHS. This approach saved storage space, but it limited the data available for assigning SCCs and may have led to occasional imprecision. For example, approximately 10 percent of 5-digit ZIP Codes lie in more than one county.[5]

The current methodology of assigning SCCs is prone to inaccuracy for other reasons as well. For example, the current SCCs, as noted earlier, are not the same as the FIPS-based codes used in other ORES statistical publications and by other federal agencies.[6] Additionally, some of the programming that assigns the current SCCs is hard-coded—that is, it is embedded in the source code, for which documentation may not exist. As a result, there is no way to verify the accuracy of these SCC assignments. Thus, a new methodology that uses the complete street addresses, city names, and 9-digit ZIP Codes reported on tax forms can only improve the accuracy of the SCCs assigned to each worker.

State-Level Estimates

Most of the earnings tables that ORES produces appear in two annual publications: the *Annual Statistical Supplement to the Social Security Bulletin* (with 21 earnings tables; see https://www.ssa.gov/policy/docs/statcomps/supplement/index.html) and *Earnings and Employment* (containing 106 tables). ORES also produces 11 earnings tables strictly for internal and interagency research.

Only two of the *Annual Statistical Supplement* tables present geographic detail for their earnings estimates, and both of them show data at the state level. Four of the 106 *Earnings and Employment* tables present earnings estimates at only the state level (the other 102 present estimates at both the state and county levels).

Errors in assigning state codes are rare because very few ZIP Codes cross state lines. Moreover, with only 53 geographic divisions (50 states, the District of Columbia, Puerto Rico, and a catch-all "other and unknown" category[7]) in which to allocate approximately 1.6 million wage and salary workers and 186,000 self-employed workers in the 2017 CWHS, no state-level earnings estimates require suppression.

County-Level Estimates

Earnings and Employment includes 102 tables with county-level data. Fifty-one tables (one for each state and one for Puerto Rico) contain estimates for Social Security–taxable earnings and 51 contain estimates for Medicare-taxable earnings.

The 50 states and Puerto Rico contain 3,215 counties or county equivalents. Each of the 51 county-level tables on Social Security–taxable earnings in *Earnings and Employment* also includes estimates that account for all residents of unknown locations within the state. Thus, these 51 tables together contain discrete estimates for 3,266 locations (3,215 counties + 51 unknown-location categories).[8] Each table includes nine columns of estimates (number of workers, taxable earnings, and Social Security contributions, each shown separately for wage and salary workers, self-employed workers, and total workers). For each location, those nine estimates are shown separately for all, male, and female workers: thus, three rows cross-tabulated by nine columns, for 27 estimates per location. Those 27 estimates multiplied by 3,266 locations yield 88,182 computations, or 9,798 estimates per column (88,182 ÷ 9). The 51 county-level tables on Medicare-taxable earnings likewise contain a total of 88,182 discrete county-level estimates, 9,798 for each type of computation.

Effect of Data Disclosure Standards on County-Level Estimates

In publishing earnings estimates, SSA follows strict data disclosure standards. If the unweighted count of workers in a county in the 1-percent CWHS is lower than 10, SSA suppresses the estimates for that county. Recall that the county-level tables show estimates broken down by sex, increasing the frequency of cell suppression, even if only one category has fewer than 10 workers (unweighted). *Primary cell suppression* refers to nondisclosure of a cell with fewer than 10 workers. *Secondary cell suppression* refers to the necessary suppression of the estimates for *both* male and female workers if the count of *either* is fewer than 10.

For example: For a county that has eight workers in the 1-percent CWHS file, ORES would suppress all estimates. For another county, with 17 workers, ORES would publish the "all workers" estimates but would suppress the estimates by sex, because one or both of the estimates would not have the requisite 10 workers to meet SSA disclosure standards. If 12 of this county's workers were women, and thus above the threshold for primary cell suppression, ORES would nevertheless suppress that estimate to prevent the number of male workers from being deduced. This example illustrates the principle of secondary cell suppression.

Secondary cell suppression may also be required for estimates broken down by type of worker (all, wage and salary, self-employed). Consider a county with 25 total workers, of whom 20 are wage and salary workers and 5 are self-employed. These categories are not necessarily mutually exclusive; a worker with both wage and salary earnings and self-employment income in a given year would be counted in both categories. Nevertheless, ORES would disclose only the estimate for that county's total workers and would suppress the estimates for self-employed individuals and for wage and salary workers.

Rigorous data disclosure requirements complicate the allocation of approximately 186,000 self-employed individuals in the 2017 CWHS across 3,215 counties (plus 51 state-level "unknown" locations). Table 1 reveals that in the county-level data of *Earnings and Employment* for 2017 (SSA 2019), 58.4 percent of the 9,798 estimates for the number of individuals with Social Security–taxable self-employment income required suppression. Secondary cell suppression required SSA to withhold the corresponding estimates for wage and salary workers. As a result, only 41.6 percent of the 19,596 county-level cells for the numbers of self-employed individuals and wage and salary workers with Social Security–taxable earnings contain estimates.

Table 2 shows the distribution of the 2017 *Earnings and Employment* county-level data cells for the number of self-employed individuals with Social Security–taxable income by the number of unweighted records that existed in the CWHS. The CWHS data for 53.2 percent of those cells had fewer than 10 unweighted records and an additional 39.1 percent of the cells contained estimates based on 10 to 99 unweighted records. This table underscores the problem of trying to allocate relatively few self-employed individuals across 3,215 counties while adhering to data disclosure standards: Only 7.6 percent of U.S. counties were represented by 100 or more self-employed individuals in the CWHS.

Table 1.
Suppression of *Earnings and Employment* county-level data cells to comply with data disclosure standards: Number of self-employed workers, tax year 2017

Status	Number	Percent
Total	9,798	100.0
Suppressed	5,726	58.4
Not suppressed	4,072	41.6

SOURCE: Author's calculations based on SSA (2019, Table 3).

Table 2.
Number and percentage of *Earnings and Employment* data cells showing county-level estimates of number of self-employed workers, by number of unweighted records for such workers in the underlying CWHS, tax year 2017

Number of unweighted records	Number	Percent	Cumulative	
			Number	Percent
Total	9,798	100.0	. . .	. . .
0	555	5.7	555	5.7
1–9	4,662	47.6	5,217	53.2
10–99	3,835	39.1	9,052	92.4
100–199	365	3.7	9,420	96.1
200–299	146	1.5	9,575	97.6
300–399	73	0.7	9,653	98.3
400–499	47	0.5	9,708	98.8
500 or more	115	1.2	9,798	100.0

SOURCE: Author's calculations based on SSA (2019, Table 3).

NOTES: Rounded components of percentage distribution do not all sum precisely to cumulative percentages.

. . . = not applicable.

Tables 3 and 4 repeat Tables 1 and 2 for all workers in the 2017 CWHS and they present a much different picture regarding the extent of cell suppression. Less than 9 percent of the estimates for all workers were suppressed (Table 3). In absolute terms, a 9-percent suppression rate is still high, but it is in stark contrast with the 58.4 percent of cells suppressed for self-employed workers (Table 1). In addition, only 6.9 percent of the estimates for all workers were based on fewer than 10 unweighted records (Table 4), compared with 53.2 percent of those for self-employed individuals (Table 2). More than 43 percent of the estimates of numbers of all workers were based on records for more than 100 workers in the CWHS, compared with only 7.6 percent for the estimates for self-employed individuals.

Table 3.
Suppression of *Earnings and Employment* county-level data cells to comply with data disclosure standards: Number of all workers, tax year 2017

Status	Number	Percent
Total	9,798	100.0
Suppressed	838	8.6
Not suppressed	8,960	91.4

SOURCE: Author's calculations based on SSA (2019, Table 3).

Table 4.
Number and percentage of *Earnings and Employment* data cells showing county-level estimates of total number of workers, by number of unweighted records for such workers in the underlying CWHS, tax year 2017

Number of unweighted records	Number	Percent	Cumulative	
			Number	Percent
Total	9,798	100.0	. . .	. . .
0	36	0.4	36	0.4
1–9	637	6.5	673	6.9
10–99	4,897	50.0	5,570	56.8
100–199	1,577	16.1	7,147	72.9
200–299	701	7.2	7,848	80.1
300–399	380	3.9	8,228	84.0
400–499	270	2.8	8,498	86.7
500 or more	1,300	13.3	9,798	100.0

SOURCE: Author's calculations based on SSA (2019, Table 3).

NOTES: Rounded components of percentage distribution do not sum to 100.0.

. . . = not applicable.

The reason for the dramatic differences in the number of estimates subject to cell suppression is the gulf between the numbers of wage and salary workers and self-employed individuals in the CWHS. For 2017, the CWHS contained almost 1.6 million wage and salary workers to allocate across the 3,215 counties, nearly nine times the number of self-employed individuals in the CWHS.[9]

Potential High Variance in Year-to-Year Estimates

ORES has investigated some very large differences in the estimates of taxable Social Security and Medicare earnings amounts from one year to the next and determined that they tend to result from large changes in the taxable earnings of one or two individuals in counties with a relatively small number of workers. Steep year-over-year changes in earnings are more prevalent for Medicare-taxable earnings because there is no cap on the amount of Medicare earnings subject to the payroll tax, and thus no ceiling on the countable amount by which an individual's earnings may increase.

In summary, ORES has identified several limitations associated with the current process for generating the annual earnings estimates at the county level:

- The relatively small number of self-employed individuals in the 1-percent CWHS combines with SSA's data disclosure rules to suppress more than one-half of the cells that would otherwise contain estimates at the county level.
- The limited number of self-employed individuals sometimes yields large variances in the year-to-year earnings estimates for counties with relatively few workers.
- *Employment and Earnings* uses SSA-developed SCCs instead of the standard FIPS-based SCCs; additionally, the current tabulation process truncates the address information used to assign its codes, which can diminish SCC accuracy.
- The process for assigning some of the SCCs via hard coding is not documented and cannot be verified as correct.

The New Methodology, Step by Step

As the first step in attempting to assign geographic and demographic codes to records for all wage and salary workers and all self-employed persons, ORES and SSA's Office of the Chief Actuary (OCACT) asked the SSA Office of Enterprise Information Systems (OEIS) to extract the address information

from Forms W-2, W-2c, and 1040 Schedule SE—or "the tax forms" for short. OEIS uses Pitney Bowes' Finalist software to assign a single SCC based on the address data shown in each of the tax forms processed in a given calendar year.[10]

ORES and OCACT also asked OEIS to develop a larger sample of earners for *Earnings and Employment* that would address many of the limitations imposed by using the 1-percent CWHS. After assigning SCCs and demographic information for all workers in a given tax year, ORES will match that information with the records for the larger sample of earners and thereby develop a new process for generating annual earnings estimates. The new process will dramatically reduce the need for cell suppression and the year-to-year variance in the county-level earnings estimates, improve the accuracy of the SCC assignments, and use SCCs that are consistent with those used in other ORES publications and by other agencies.

The new methodology consists of five steps:

1. Assigning a single SCC for *each job* held by each worker, as recorded on a worker's tax form(s) for a given year, using the Finalist software.
2. Extracting those results and housing them on tape files.
3. Using the Numident master file to identify valid and invalid SSNs and to provide each worker's demographic information (sex and date of birth).
4. Assigning a single SCC to *each worker* based on data in the tape file or, if needed, on various imputations, described below.
5. Merging the resulting SCC and demographic data files into a single standalone output file.

Preliminary Steps

Every year, SSA and the IRS share tax-form information for their respective programmatic needs. SSA receives and processes the earnings information contained in hundreds of millions of Forms W-2 and W-2c and millions of Schedules SE as part of the annual wage reporting process. This information is critical to ensure the proper tracking of workers' earnings histories for program operations.[11] To begin SSA's annual wage reporting process, OEIS extracts all of the information reported on the tax forms and stores it on an administrative data file. The ensuing steps of the wage reporting process include data cleaning and validating procedures. OEIS initiates a separate process for the more limited purpose of extracting only the address information for each job in that data file, which ORES can then use to assign SCCs.

In 2010, OEIS began using the Finalist software each year to extract the full address information reported on Forms W-2, W-2c, and 1040 Schedule SE. ORES then worked with a contractor to consolidate the thousands of OEIS data tapes containing the extracted data. However, developing a methodology for assigning a single SCC and attaching demographic information for each SSN in a given tax year was delayed until 2018. An unfortunate consequence of this delay was the loss of the data generated by the OEIS process for tax years 2009, 2010, and 2011, as file retention limits expired. However, ORES has retained the data for 2012–2019.

The new methodology enables ORES to extract state and county data either on a flow basis throughout the year or all at once at the end of the processing year. Extracting state and county data on a flow basis offers two key benefits. First, any problems with the data could be addressed in real time, without delays. Second, a flow basis would allow ORES to smooth out the uneven timing of the arrival of the tax forms, with the bulk of the previous year's wage data received early in the calendar year: ORES would simply adjust the processing schedule to account for the uneven distribution of incoming records throughout the calendar year. Presently, ORES is still processing a backlog of prior-year data, but upon completion, it expects to process the extracted data on a flow basis. In that scenario, ORES would run only the jobs that extract the state and county data from the thousands of data files that OEIS creates throughout the year. Once OEIS completed its processing for a given calendar year, ORES would begin the steps to assign a single SCC (as needed) and to attach date of birth and sex information to the record for each worker in the target tax year.

The discussion in the following subsections uses data from tax year 2017 to illustrate the steps ORES takes to extract, process, and merge the data it receives from OEIS.

The OEIS Process

OEIS uses the Finalist software to capture information from the complete address reported on the administrative data file that is derived from the individual's tax form(s). The software cross-references the address information with an underlying database that contains every U.S. postal delivery address and assigns the

FIPS SCCs. The software thereby enables ORES to improve the accuracy of its geographic coding and assign SCCs that are consistent with those used in other ORES publications and by other federal agencies.

As noted earlier, the data processed in a given calendar year are generally for earnings in the prior year. For example, in 2018, OEIS primarily processed tax-form data for 2017 earnings. At the end of each calendar year, OEIS provides ORES with a report that summarizes the processing results for each type of data source (W-2, W-2c, Schedule SE, W-3, W-3c, and SS-4). In 2018, OEIS processed 256,574,346 W-2 input records and generated 254,788,713 output records (Table 5). The difference—1,785,633—constitutes the 0.7 percent of all W-2 records processed in 2018 for which Finalist was unable to assign geographic information. OEIS also processed 3,682,466 W-2c input records and produced 3,452,217 output records in 2018. Finalist was unable to assign a geographic identifier to slightly more than 6 percent (230,249) of the W-2c records processed in 2018. OEIS processed 21,194,793 Schedule SE input records and generated the same number of output records. The records that OEIS processed in 2018 generated 1,055 tapes on SSA's mainframe computer.

In the next step, ORES separates the target-year records from the records for other tax years. Table 5 presents the number of earnings records extracted from the data tapes and identifies the number of output records OEIS processed for 2017 and non-2017 tax years. In 2018, ORES extracted 276,006,937 records for 2017 earnings. Of those, 90.7 percent were W-2s, 7.2 percent were Schedule SEs, and 0.9 percent were W-2cs. Table 5 also reveals that nearly 99 percent of the records processed in 2018 were for earnings in 2017. The 276,006,937 records for 2017 earnings represent 178,863,694 unique SSNs (workers).

Validating SSNs

After ORES extracts the data resulting from the OEIS process, the task of assigning a single SCC and demographic data to worker-level earnings records begins. ORES merges the records from the three tax-form sources into a single data table to generate a "finder" file that contains all unique SSNs in the population of workers for a given year. The finder file is then compared with the Numident master file to identify valid and invalid SSNs (SSNs that exist in both the finder and the Numident are considered valid). For all valid SSNs, an algorithm extracts data identifying the worker's sex, date of birth, date of death, and the date when the death date was posted to the Numident.[12] ORES can assign SCCs, but cannot assign demographic information, for the invalid SSNs in the file. ORES creates a standalone data file to contain the linked SSN and demographic information. That file is ultimately merged with a file that contains the results of ORES' multistep process for assigning a single SCC for each worker in a given year.

The next step groups earners into one of the following mutually exclusive categories based on the tax forms that provide their geographic data:

- W-2 only
- W-2c only
- Schedule SE only
- W-2 and W-2c
- W-2 and Schedule SE
- W-2c and Schedule SE
- W-2, W-2c, and Schedule SE

Table 6 shows the distribution of earnings records and unique SSNs (workers) by source of geographic data. Nearly 89 percent of U.S. workers in 2017 had wage and salary income only (W-2, W-2c, or both).

Table 5.
Output records after OEIS processing in calendar year 2018, by tax year and tax-form data source

	Total		Tax year			
			2017		Other	
Source	Number	Percent	Number	Percent	Number	Percent
Total	279,435,723	100.0	276,006,937	98.8	3,428,786	1.2
W-2	254,788,713	91.2	253,365,171	90.7	1,423,542	0.5
W-2c	3,452,217	1.2	2,591,048	0.9	861,169	0.3
Schedule SE	21,194,793	7.6	20,050,718	7.2	1,144,075	0.4

SOURCE: Author's calculations based on SSA data processing audit reports.

Table 6.
Total and worker-level output records for 2017 processed in 2018, by type of tax-form data source

Source	Earnings records processed		Unique SSNs (workers) processed	
	Number	Percent	Number	Percent
Total	276,006,937	100.0	178,863,694	100.0
One form only				
W-2	234,677,110	85.0	156,748,520	87.6
W-2c	34,886	(L)	32,189	(L)
Schedule SE	10,720,522	3.9	10,720,024	6.0
Two forms only				
W-2 and W-2c	6,712,867	2.4	2,032,979	1.1
W-2 and Schedule SE	23,275,253	8.4	9,202,656	5.2
W-2c and Schedule SE	6,062	(L)	2,887	(L)
All three forms	580,237	0.2	124,439	0.1

SOURCE: Author's calculations based on SSA data processing audit reports.

NOTES: Rounded components of percentage distributions may not sum to 100.0.

(L) = less than 0.05 percent.

Slightly more than 5 percent had both wage and salary and self-employment income (Schedule SE and any combination of W-2 and/or W-2c), and 6 percent reported self-employment income only (Schedule SE).

The number of earnings records SSA processes always widely outnumbers the number of wage and salary and self-employed workers because some workers may have multiple tax forms for a single job, or forms for multiple jobs, in a given year. Therefore, some of the workers have multiple SCC fields populated for a given job (or for multiple jobs) in the OEIS process.[13] Note that "job" in this context is defined as one or more tax forms that report a specific worker/employer combination—indicated by the worker's SSN and the employer identification number (EIN). For tax year 2017, SSA processed an average of 1.54 earnings records for each of the 178,863,694 workers (SSNs) in the OEIS file.

Initial SCC Revisions

For any job, the presence of a W-2c presents ORES with an opportunity to improve the accuracy of the SCC assigned by the OEIS process if certain conditions are met. By definition, a Form W-2c corrects data reported on a prior Form W-2 for the same job. Therefore, if the SCCs assigned to a W-2 and a W-2c for a given job differ, it may be appropriate to assign the SCC associated with the W-2c for that job. The opportunity to revise the SCCs reported on a W-2 applies to two groups: the 2,032,979 workers whose earnings were reported on both a W-2 and a W-2c and the 124,439 workers whose earnings were reported all three tax forms.

Consider the workers who had earnings and geographic information for 2017 reported on both a Form W-2 and a W-2c (and not a Schedule SE). Table 7 presents the number of records and the number of jobs for these workers, broken out by the type of SCC information present in the data tape files after OEIS processing. In those tapes, a worker's earnings record may include SCC fields for each job or tax form, and, for various reasons, one or more of those SCC fields may be empty after the initial address extraction process. Note the different numbers of jobs associated with the Forms W-2 (3,669,556) and W-2c (2,092,796). From this information, we know that many (about 43 percent) of the jobs represented in a Form W-2 are not reflected in a corresponding W-2c.[14] For tax year 2017, the overwhelming majorities of both records and jobs have a single populated SCC field after OEIS processing.

In general, three conditions must be met to revise the SCC that the OEIS process assigns based on a W-2 with an SCC based on a W-2c. First, there must be a matching W-2c for the W-2 (that is, both forms must refer to the same job). Second, there must be a single SCC based on the Form W-2c that differs from the SCC based on the W-2. Third, if a W-2 has more than one matching W-2c, the SCCs based on the W-2cs must all be the same.

Table 8 illustrates the process using the 3,669,556 job-level W-2 records for 2017 shown in Table 7.[15] Approximately 55 percent of the job-level Forms W-2

Table 7.
OEIS process results for workers with both a W-2 and a W-2c (and no Schedule SE): Earnings records extracted, and number of jobs represented, by type of SCC information derived from the tax forms, tax year 2017

	Extracted records			Jobs [a]	
Type of information	Total	W-2	W-2c	W-2	W-2c
Total	6,712,867	4,326,838	2,386,029	3,669,556	2,092,796
Single SCC field					
Populated	6,513,097	4,205,939	2,307,158	3,630,751	2,019,478
Empty	26,079	23,331	2,748	7,130	1,151
Multiple SCC fields					
All empty	112,727	38,092	74,635	30,992	72,139
Mixed [b]	60,964	59,476	1,488	683	28

SOURCE: Author's calculations based on SSA data processing audit reports.

a. Because some jobs are reflected on both a W-2 and a W-2c and some are not, the unduplicated number of total jobs is unknown at this stage of the process.

b. At least one populated SCC field and at least one empty SCC field.

Table 8.
Updating SCC fields using address information on Form W-2c, if applicable, to OEIS-process results based on job-level Form W-2: Workers with both a W-2 and a W-2c (but no Schedule SE) in tax year 2017

Outcome	Number	Percent
Total	3,669,556	100.0
W-2 with a matching W-2c	2,010,274	54.8
SCC not updated using the W-2c because matching the forms resulted in—		
The same single populated SCC field (no update needed)	1,901,509	51.8
Other outcomes (a single SCC could not be identified)	69,008	1.9
SCC updated using the W-2c	39,757	1.1
W-2 without a matching W-2c	1,659,282	45.2
OEIS process resulted in—		
A single populated SCC field	1,639,733	44.7
Other outcomes	19,549	0.5

SOURCE: Author's calculations based on SSA data processing audit reports.

were also represented by a corresponding W-2c, with which SCC information can potentially be updated. The W-2s for the remaining 45 percent of the jobs did not have a matching W-2c and the SCCs assigned for those jobs remained unchanged. ORES updated the SCCs of only 39,757 of the 2,010,274 jobs represented by both a W-2 and a matching W-2c. The largest group of jobs that were not updated had the same address information reported on both the W-2 and the W-2c.

The same technique was applied for the 580,237 earnings records for which state and county data were provided on all three tax forms,[16] which enabled ORES to update the SCC based on the address reported on the W-2c for 2,237 additional jobs. In total, updating an assigned SCC using the address on a corresponding W-2c resulted in SCC changes for 41,994 jobs. Although the number of jobs for which ORES updated the SCC using W-2cs is very small relative to the full sample of almost 179 million workers for tax year 2017, this step illustrates the extent to which ORES strives to maximize the accuracy of the new methodology for assigning a single SCC to each SSN.

Determining a Single SCC

At this stage, the focus shifts from jobs to workers, as ORES aims to determine, wherever possible, the SCC of the worker's residence. Assigning the state and county data begins with sorting workers into three

mutually exclusive categories based on the number of SCCs that were assigned to them by the OEIS process: a single SCC, multiple SCCs, or no SCC (an empty SCC field or fields) assigned for any of their jobs. Table 9 presents the distribution of workers among these categories for tax year 2017. OEIS assigned a single SCC to 168.3 million workers, or 94.1 percent of the workers in the file. Another 9.3 million workers (5.2 percent) were assigned multiple SCCs, and the remaining 1.2 million workers (0.7 percent) were not assigned an SCC.

For geographic data, the objective of the new methodology is to assign a single SCC to the maximum number of workers. That process is complete for the 168.3 million workers with a single SCC assigned by OEIS using the Finalist software—hereafter, the "gold-standard file." Because this group represents an overwhelming majority of workers in 2017, it broadly reflects the geographic distribution of SCCs for the U.S. workforce in that year. For the 9.3 million workers to whom the software has assigned multiple SCCs, ORES imputes the one SCC that is deemed the most statistically likely to be accurate, and for the 1.2 million workers with no assigned SCC, ORES determines whether one can be imputed from other available data. The geographic distribution of the gold-standard file is used in imputing a single SCC for members of both the other groups; those processes are described below.

Imputing a Single SCC for Workers Outside the Gold-Standard File

ORES developed a multistep imputation process that uses the information in the extracted OEIS data to assign a single SCC to as many of the multiple-SCC and no-SCC workers as possible. The tax forms for some workers with no SCC assigned by the OEIS process nevertheless include a 5- or 9-digit ZIP Code.[17] In those cases, ORES uses the frequency distribution of ZIP Code/SCC combinations in the gold-standard file to impute an SCC. Table 10A shows the first step of the process. It presents frequency distributions for various hypothetical ZIP Code/SCC combinations to represent the actual distributions from the gold-standard file. Table 10B shows how a randomly generated number from 0 to 1, applied to each job with a ZIP Code but no assigned SCC, enables ORES to place the job within a frequency band (from Table 10A) and thereby assign SCCs in a pattern that follows the distribution in the gold-standard file.

Chart 1 diagrams the post-OEIS processing of all files with tax year 2017 earnings data. In Panel A, the records for the 178.9 million unique SSNs are grouped according to the number of SCCs that OEIS assigned using the Finalist software (one, two or more, none). The subsections that follow describe the methods with which ORES imputed a single SCC for most of the records to which OEIS assigned either zero or multiple SCCs.

Table 9.
Worker-level earnings records by number of SCCs assigned after the OEIS process and type of tax-form data source, tax year 2017

			Workers assigned—					
	Unique SSNs		A single SCC (gold-standard file)		Multiple SCCs		No SCC (empty field)	
Source	Number	Percent	Number	Share of unique SSNs	Number	Share of unique SSNs	Number	Share of unique SSNs
Total	178,863,694	100.0	168,338,342	94.1	9,304,745	5.2	1,220,607	0.7
One form only								
W-2	156,748,520	87.6	147,455,296	82.4	8,117,494	4.5	1,175,730	0.7
W-2c	32,189	(L)	29,241	(L)	520	(L)	2,428	(L)
Schedule SE	10,720,024	6.0	10,686,954	6.0	108	(L)	32,962	(L)
Two forms only								
W-2 and W-2c	2,032,979	1.1	1,851,438	1.0	173,632	0.1	7,909	(L)
W-2 and Schedule SE	9,202,656	5.2	8,206,088	4.6	995,008	0.6	1,560	(L)
W-2c and Schedule SE	2,887	(L)	2,489	(L)	397	(L)	1	(L)
All three forms	124,439	0.1	106,836	0.1	17,586	(L)	17	(L)

SOURCE: Author's calculations based on SSA data processing audit reports.

NOTE: (L) = less than 0.05 percent.

Table 10A.
Simulated SCC imputation, step 1: Applying the frequency distribution of ZIP Code/SCC combinations in the gold-standard (single-SCC) file

ZIP Code/SCC combination	Hypothetical instances of ZIP Code/SCC linkage in the gold-standard file		Frequency band	
	Number	Percent	Lower bound	Upper bound
ZIP Code 1 and—				
SCC A	10	100.0	0.0001	1.0000
ZIP Code 2 and—				
SCC B	20	66.7	0.0001	0.6667
SCC C	10	33.3	0.6668	1.0000
ZIP Code 3 and—				
SCC D	10	33.3	0.0001	0.3333
SCC E	10	33.3	0.3334	0.6667
SCC F	10	33.3	0.6668	1.0000

SOURCE: Author's illustration.

Table 10B.
Simulated SCC imputation, step 2: Applying a randomly generated number to the frequency bands to impute the SCC for four hypothetical workers

Scenario	Worker's ZIP Code on tax form	Randomly generated number	Imputed SCC
Worker W: ZIP Code not available on tax form	None	0.6395	Unknown
Worker X: Had one job and residential address appears on tax form	ZIP Code 1	0.9051	SCC A
Worker Y: Had two jobs and a different residential address associated with each job			
Job 1	ZIP Code 1	0.3654	SCC A
Job 2	ZIP Code 2	0.3816	SCC B
Worker Z: Had three jobs and the same residential address associated with each job			
Job 1	ZIP Code 3	0.1275	SCC D
Job 2	ZIP Code 3	0.2491	SCC D
Job 3	ZIP Code 3	0.8374	SCC F

SOURCE: Author's illustration.

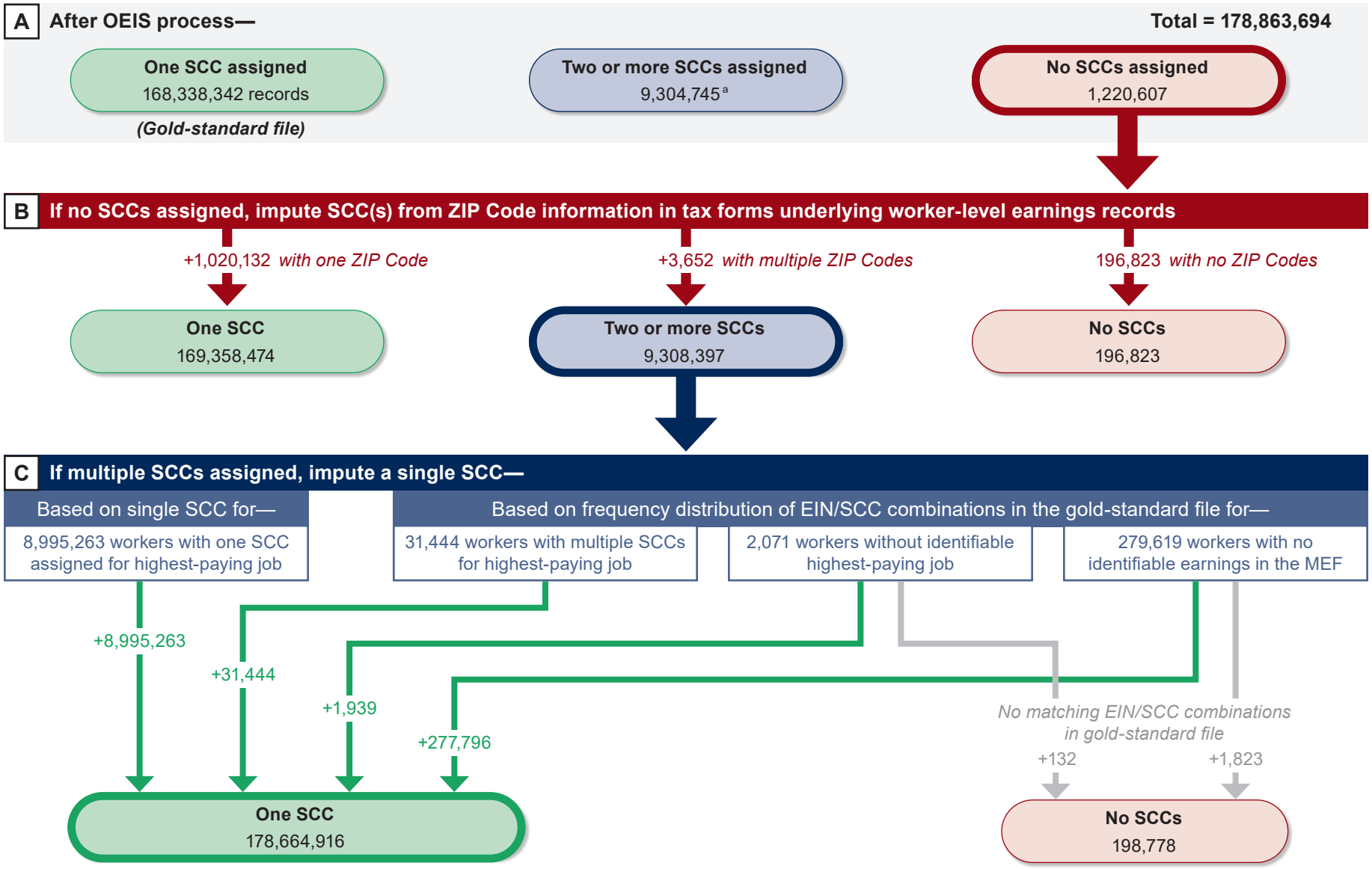
NOTE: SCC is imputed by identifying the randomly generated number's placement within the frequency bands shown in Table 10A.

Workers with No SCCs Assigned by the OEIS Process: ZIP Code Imputation

The OEIS process assigned no SCC to the records for 1.2 million workers. Using ZIP Code information on the tax forms, ORES imputed a single SCC for nearly 99 percent (1,020,132) of those workers (Chart 1, Panel B). For another 3,652 of those workers, the tax forms indicated multiple ZIP Codes and ORES therefore imputed multiple SCCs; those workers were added to the group to which OEIS assigned multiple SCCs. The remaining 196,823 records did not include ZIP Code information and could not be moved out of the "no SCC" group.

ORES uses the ZIP Code imputation method for the workers to whom OEIS assigns no SCCs and does not use it for workers to whom multiple SCCs are assigned—except for one subgroup. Of the 9,304,745 workers with multiple SCCs assigned for tax year 2017, 9,140,974 had no empty SCC fields associated with their jobs; but 163,771 had an empty SCC field for at least one job. ORES was able to impute a single SCC for 156,173 of the workers in the latter group using available ZIP Code information but could not impute an SCC for the other 7,598 workers based on ZIP Codes (Chart 2). Instead, ORES used EIN imputation, described below, for those workers.

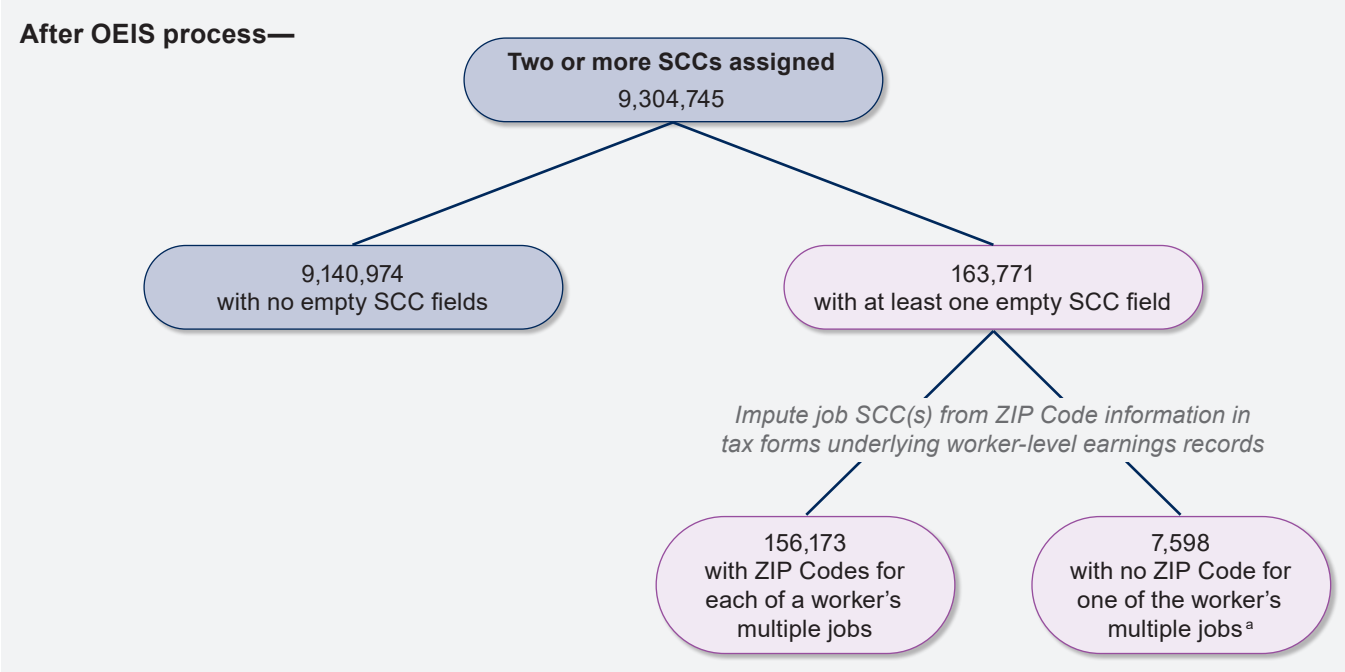
Chart 1.
New ORES methodology for assigning a single SCC to worker-level earnings (illustrated with tax year 2017 earnings records)



SOURCE: Author's calculations based on SSA data processing audit reports.

a. See Chart 2.

Chart 2.
Composition of worker-level earnings records with multiple SCCs assigned in the OEIS process, tax year 2017



SOURCE: Author's calculations based on SSA data processing audit reports.

a. ORES does not impute an SCC for the job with the missing ZIP Code but it imputes an SCC for that worker based on the ZIP Codes associated with the worker's other job(s).

Workers with Multiple SCCs Assigned by the OEIS Process: Imputing a Single SCC Based on Location of Highest-Paying Job

The next step is to determine which SCC to assign to a worker who was assigned multiple SCCs after the OEIS process or ZIP Code imputation. Using data from SSA's Master Earnings File (MEF),[18] ORES determines a worker's highest-paying job and assigns the SCC associated with the worker's address on the tax form for that job, with the rationale that the highest-paying job likely indicates where the worker resided for the longest time in that year. Chart 1, Panel C diagrams the process.

For the tax year 2017 records, ORES first examined the SSNs among the 9,308,397 workers whose records had multiple SCCs after the OEIS process and ZIP Code imputation and identified 9,250,150 that were valid and 58,247 that were not.[19] The MEF provided data on the earnings amount for each job these workers held in 2017. ORES assigned the single SCC corresponding with the location of the highest-paying job for 8,995,263 workers, or almost 97 percent of those with multiple SCCs assigned to their records by the OEIS process.

The earnings records for the remaining 313,134 workers either indicated multiple SCCs for the highest-paying job, indicated multiple SCCs but no highest-paying job identified, or had no earnings recorded in the MEF. ORES imputed a single SCC for most of these workers by comparing their assigned SCCs with the geographic distribution of workers in the gold-standard file who had the same employer, according to the EIN on their tax forms. In other words, ORES uses the method, described above and illustrated in Tables 10A and 10B, of aligning the EIN/SCC combinations in the tax records for these workers with the frequency distribution of those combinations for workers in the gold-standard file. Specifically:

- The records for 31,444 workers indicated multiple SCCs for the highest-paying job.[20] Imputations based on EIN/SCC combinations enabled ORES to assign a single SCC for each of these workers.
- The records for 2,071 workers did not indicate a single highest-paying job. Most of these workers had two different jobs with the same amount of reported earnings. Imputations based on EIN/SCC combinations enabled ORES to assign a single SCC

for 1,939 of these workers. The reported EIN/SCC combination for the remaining 132 workers in this group had no matches in the gold-standard file and ORES moved the records for those workers into the no-SCC group.

- The records for the remaining 279,619 workers did not have a matching EIN/SSN combination in the MEF. Imputations based on EIN/SCC combinations enabled ORES to assign a single SCC for 277,796 of the workers in this group. The reported EIN/SCC combination for the remaining 1,823 workers in this group had no matches in the gold-standard file and ORES moved the records for these workers to the no-SCC group.

Chart 1, Panel C summarizes the redistributions resulting from each of these imputations and for each type of record reflecting multiple SCCs. It shows that ORES ultimately was able to assign a single SCC to 99.89 percent of the 178,863,694 workers in the tax year 2017 file.

After assigning a single SCC for as many workers as possible, ORES adds a data field to the earnings record that identifies how the single SCC was assigned to each worker. Table 11 shows the distribution of workers by the type of information or imputation that generated their assigned SCC. For example, the OEIS process assigned a single SCC to 94.1 percent of all workers (the gold-standard file). Using the location of the worker's highest-paying job during the tax year was the next most common method of assigning an SCC. Combined, these two methods accounted for 99.1 percent of all workers in tax year 2017.[21]

ORES then joins the data files containing the demographic and the geographic data into a single Master Geographic-Demographic (MGD) data file. Table 12 presents the distribution of workers by each combination of information in the four primary data fields of the MGD file.[22] Note that 99.1 percent of the workers in the 2017 file had a valid SSN. Although ORES could not attribute any demographic information to the 1,524,401 individuals with invalid SSNs, an SCC was assigned for 1,521,552 (99.8 percent) of them.

With its new process, ORES attached date of birth, sex, and SCC data to 176,254,369 worker-level earnings records, or 98.5 percent of all the individuals in the MGD file. ORES assigned a value for all three variables to 99.4 percent of individuals with a valid SSN.

Next Steps

The MGD file permits ORES to generate annual earnings estimates using a data file that is substantially larger than the 1-percent CWHS. As noted earlier, OEIS has been creating a larger sample (10-CWHS-HE) that includes a 10-percent version of the CWHS' sampling frame plus all "high earners," defined as those whose earnings exceeded the Social Security maximum taxable amount in any year from 1978 forward. ORES has been working with a contractor to develop a new process for generating the annual earnings estimates using the 10-CWHS-HE and MGD files. Expanding the underlying sample tenfold and

Table 11.
Number and percentage distribution of SCCs assigned for tax year 2017, by source of information or type of imputation

Source or type	Number	Percent
Total	178,863,694	100.0
Initial OEIS process generates—		
Single SCC (gold-standard file)	168,338,342	94.1
No SCCs; ORES imputes worker's SCC using ZIP Code information	1,020,132	0.6
Multiple SCCs		
A single SCC is associated with the highest-paying job	8,995,263	5.0
ORES imputes a single SCC based on the frequency distribution of matching EIN/SCC combinations in the gold-standard file for—		
Workers with multiple SCCs for highest-paying job	31,444	(L)
Workers without an identifiable highest-paying job	1,939	(L)
Workers without earnings data in the MEF	277,796	0.2
Missing data or SCC not assigned	198,778	0.1

SOURCE: Author's calculations based on SSA data processing audit reports.

NOTE: (L) = less than 0.05 percent.

Table 12.
Worker records for tax year 2017 in the MGD data file, for each combination of types of information contained

Combination	Type of information				All individuals		Valid SSNs	
	SSN status	Date of birth	Sex	FIPS SCC	Number	Percent	Number	Percent
Total	. . .	. . .	. . .	. . .	178,863,694	100.0	177,339,293	100.0
1	Invalid	Missing	Missing	Missing	2,849	(L)	. . .	. . .
2	Invalid	Missing	Missing	Provided	1,521,552	0.9	. . .	. . .
3	Valid	Missing	Missing	Missing	650	(L)	650	(L)
4	Valid	Missing	Missing	Provided	767,401	0.4	767,401	0.4
5	Valid	Missing	Unknown	Missing	4	(L)	4	(L)
6	Valid	Missing	Unknown	Provided	3,188	(L)	3,188	(L)
7	Valid	Missing	Male	Missing	14	(L)	14	(L)
8	Valid	Missing	Male	Provided	32,812	(L)	32,812	(L)
9	Valid	Missing	Female	Missing	19	(L)	19	(L)
10	Valid	Missing	Female	Provided	22,963	(L)	22,963	(L)
11	Valid	Provided	Unknown	Missing	56	(L)	56	(L)
12	Valid	Provided	Unknown	Provided	62,763	(L)	62,763	(L)
13	Valid	Provided	Male	Missing	123,756	0.1	123,756	0.1
14	Valid	Provided	Male	Provided	90,628,653	50.7	90,628,653	51.1
15	Valid	Provided	Female	Missing	71,298	(L)	71,298	(L)
16	Valid	Provided	Female	Provided	85,625,716	47.9	85,625,716	48.3

SOURCE: Author's calculations based on SSA data processing audit reports.

NOTE: (L) = less than 0.05 percent; . . . = not applicable.

including high earners will significantly reduce the number of estimates that must be suppressed under data disclosure standards. Including all high earners in the sample should also mitigate the large year-to-year earnings fluctuations in counties with relatively few workers.

ORES will evaluate the new process for generating its earnings estimates by comparing them with other estimates from its own statistical publications and those of other federal agencies. Specifically, ORES will evaluate worker counts by sex, age, and type of earnings (wage and salary, self-employment). The evaluation will also assess the results of the new process for assigning SCCs.

Caveats

Researchers wishing to use the MGD file generated using the new methodology should be mindful of several issues when using the data:

1. The data files ORES receives from OEIS contain only the geographic information produced by the software; they do not contain any of the earnings information reported on the tax forms.
2. The data files used to assign SCCs are not part of the annual wage reporting process and thus are not subject to the standard cleaning and validating procedures that SSA executes before posting records to the MEF. As a result, the data contain some SSNs that are assumed to be invalid because they are not present in the Numident file. The *Annual Statistical Supplement* and *Earnings and Employment* focus on workers covered under the Social Security or Medicare Hospital Insurance programs. As such, only workers with valid SSNs and earnings reported on the MEF are included in those publications' earnings estimates. However, the W-2, W-2c, and Schedule SE provide valuable geographic information about all U.S. workers. For this reason, ORES processes records for all SSNs (valid and invalid) to provide data for the U.S. workforce. ORES cannot assign demographic information for the invalid SSNs.
3. Some individuals have deferred-compensation distribution amounts rather than current-year earned wage and salary income reported in Box 1 ("Wages, tips, other compensation") on Form W-2.[23]

Individuals who receive deferred-compensation distributions as their only earnings in a given tax year are not considered to be workers in the traditional sense. This situation applies to very few earners. For now, ORES includes these individuals in the MGD file and will reexamine these instances as it refines the new SCC-assignment methodology.

4. The OEIS process assigns multiple SCCs to a single worker in millions of instances, raising the critical question of how to determine a single correct SCC. As described above, ORES uses earnings data from the detailed segment of the MEF (containing job-level data) to determine the individual's highest-paying job during the year and assigns the SCC corresponding with the worker's address on the tax form submitted by that employer. This method reflects the assumption that the year's highest paying job indicates where the worker resided for the longest time during the year. However, the resulting SCC assignment may not necessarily reflect the current location of a worker who relocated during the earnings year, as the tax records do not specify a worker's most recent address.
5. The overwhelming majority, but not quite all, of the data SSA processes in a given calendar year are for earnings in the previous calendar year. For the time being, the new methodology does not use data received in a calendar year that are not for the previous calendar year's earnings. If the timing of the earnings data is unknown, those data may reflect earnings from before the previous calendar year, and the worker may have relocated at some point in the interim. Once ORES has processed all available historical geographic data, it will reassess whether these "off-year" data can be used.

Summary

This article identifies several limitations of ORES' current process for generating annual earnings estimates at the county level. A primary concern is the relatively small number of self-employed individuals in the 1-percent CWHS used to generate county-level estimates. ORES currently suppresses more than one-half of the county-level estimates for self-employed individuals to comply with data disclosure standards. Attempting to allocate approximately 186,000 self-employed individuals across 3,215 U.S. counties is problematic under the strict standards of primary and secondary cell suppression that are required to maintain confidentiality. In addition, reported earnings may vary widely from year to year in counties with small workforces.

The current methodology also truncates available address information to accommodate data storage restrictions dating from the 1990s, compromising the accuracy of some assigned SCCs. Additionally, the SCCs currently assigned for the earnings estimates are not compatible with the standard FIPS-based codes used in other ORES statistical publications and by other federal agencies. Further, the current process for assigning SCCs employs some hard-coded instructions that were never fully documented, meaning that their validity cannot be confirmed.

ORES is working toward replacing the 1-percent CWHS with the 10-CWHS-HE data file. The larger sample will reduce the incidence of cell suppression and the frequency of large year-over-year changes in earnings reported in counties with small workforces. Until then, the 1-percent CWHS is the only data set available for policy analysis and research that contains the earnings, geographic, and demographic data necessary to produce statistical publications containing earnings estimates.

This article describes the new process for assigning SCCs and demographic information for nearly all individuals with earnings reported on a Form W-2, Form W-2c, or Form 1040 Schedule SE in a given tax year. Testing the new methodology with records for tax year 2017, ORES increased the number of workers with SCC, date of birth, and sex information from the 1.5 million represented in the CWHS to more than 178 million, representing essentially the entire U.S. labor force. In addition to expanding the number of workers with geographic and demographic data assigned, the new methodology makes three other key changes: (1) SCCs are based on the complete address information reported in the W-2, W-2c, or Schedule SE; (2) standard FIPS-based SCCs are assigned; and (3) SCCs determined by information on the tax forms replace hard-coded SCC assignments.

With the ability to assign SCCs and demographic information for nearly all workers in a given tax year, ORES can develop a process to use the 10-CWHS-HE and MGD files to generate annual county-level earnings estimates. This work is ongoing and will mitigate or eliminate the problems identified with the current process for generating those estimates.

Notes

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[1] Smith (1989) describes the CWHS.

[2] IRS Form W-2 is the annual wage and tax statement that employers file on behalf of employees. Form W-2c, "Corrected Wage and Tax Statement," is filed when a worker's original W-2 contained any errors or needs to be updated.

[3] The Numident contains records for all SSNs ever issued. The information is derived from SSA Form SS-5, the application for an SSN, which contains the individual's name, place and date of birth, and sex.

[4] The need to develop the current methodology for assigning geographic codes is discussed in Dill, Enis, and Williams (1991). The methodology is described in Dill, Bye, and Williams (1994).

[5] The purpose of ZIP Codes is to speed the flow of mail, not to designate county location.

[6] The SCCs currently used for the *Earnings and Employment* county-level earnings estimates predate the development of the FIPS codes.

[7] "Other and unknown" includes persons employed in American Samoa, Guam, the Northern Mariana Islands, and the U.S. Virgin Islands; U.S. citizens employed abroad by U.S. employers; persons employed on U.S. oceanborne vessels; and workers with unknown residence.

[8] Each of the county-level tables also includes estimates for the entire state and for the entire United States (including Puerto Rico). Those estimates duplicate figures shown in the state-level tables. This discussion disregards the duplicative state and U.S. totals to focus on the unique county-level estimates.

[9] Note that approximately 80,000 workers had both wage and salary earnings and self-employment income in the CWHS for 2017. These individuals are counted in both worker categories. The unduplicated count of total workers in the 2017 CWHS is slightly less than 1.7 million.

[10] There is a 1-year lag between the tax year (which is essentially equivalent to the earnings year) and the calendar year in which OEIS processes the data. For example, OEIS processed most of the tax year 2017 data in calendar year 2018.

[11] Although SSA also receives employer addresses from IRS Form W-3 ("Transmittal of Wage and Tax Statements"), IRS Form W-3c ("Transmittal of Corrected Wage and Tax Statements"), and SSA Form SS-4 ("Application for Employer Identification Number"), that information is not used in assigning SCCs.

[12] The algorithm was developed for the CWHS.

[13] Having more than one job during a given year is the most common reason the OEIS process assigns multiple SCCs to a worker based on that year's tax forms. Other reasons include the worker relocating while retaining a job, resulting in tax forms potentially indicating different addresses for the same job; errors in filing or processing the tax forms; and OEIS' use of address data that have not been subjected to the data cleaning procedures associated with SSA's annual wage reporting process.

[14] It may seem counterintuitive that the numbers of W-2s and W-2cs for workers who have both tax forms differ so widely. The numbers differ for several reasons; for example, a worker who holds a job that generates both a W-2 and a W-2c may also hold one or more jobs that generate only W-2s in that year.

[15] Technically, all W-2s are "job-level." Table 7 distinguishes between the W-2 records extracted in the OEIS process, which may include multiple jobs for a single worker or multiple forms for a single job, and the unduplicated number of discrete SSN/EIN combinations reported on the W-2s (labeled "jobs" in the table).

[16] The unduplicated number of jobs with records from all three types of tax forms is unavailable.

[17] The Finalist software attempts to assign SCCs using full addresses rather than relying only on ZIP Codes (which sometimes cross county lines). Therefore, after OEIS processing, some records may have an empty SCC field—for various reasons—even if a ZIP Code appears on the tax form.

[18] Olsen and Hudson (2009) describe the MEF.

[19] As noted earlier, ORES cannot assign demographic information to the records for workers with an invalid SSN but it can impute an SCC for them.

[20] For most of these workers, multiple W-2s (with differing addresses and ZIP Codes) were associated with the highest-paying job.

[21] Researchers who use the resulting data file and have concerns about any of the ORES imputation methods can identify the workers whose SCCs were based on each of these techniques and substitute "unknown" for the imputed values.

[22] Although the MGD file also includes information on date of death and date of death posting, Table 12 omits those fields to focus on the demographic data needed for the published SSA earnings estimates.

[23] Some deferred-compensation plans consider the distributions to be taxable as self-employment income. In these cases, the distributions may be subject to income tax as well as to Social Security and Medicare taxes under the Self-Employment Contributions Act.

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