



State and Metro Area Employment, Hours, & Earnings

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Seasonal Adjustment

State industry employment time series published by the Current Employment Statistics State and Area program (CES State and Area) can exhibit regularly recurring seasonal movements. Seasonal adjustment eliminates the part of the change attributable to the normal seasonal variation and makes it possible to observe the cyclical and other nonseasonal movements in CES State and Area series. Seasonally adjusted series are published monthly for selected nonfarm payroll employment estimates.

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Technical information

X-13ARIMA-SEATS and special model adjustments

CES State and Area uses the X-13ARIMA-SEATS software, developed and maintained by the [U.S. Census Bureau](#), to seasonally adjust CES State and Area data on an annual and concurrent basis. The X-13ARIMA SEATS software is available on the U.S. Census Bureau web site at <https://www.census.gov/data/software/x13as/x13as-archive.html>.

CES State and Area defaults to using ten years of data as an input to X-13ARIMA-SEATS. If a historical correction prior to the default ten years was made during the annual benchmarking¹ process, the start year of the input universe time series will be the earliest corrected year. For newly published series, a minimum of three years of data is required before the series can be processed by X-13ARIMA-SEATS.

Variable survey interval adjustment. Due to the nature of the CES program, BLS controls for survey interval variations, sometimes referred to as the 4- versus 5-week effect, during seasonal adjustment. Although the CES survey is referenced to a consistent concept — the pay period including the 12th of each month — inconsistencies arise because there are sometimes 4 and sometimes 5 weeks between the weeks including the 12th in a given pair of months. In highly seasonal industries, these variations can be an important determinant of the magnitude of seasonal hires or layoffs that have occurred at the time the survey is taken, thereby complicating seasonal adjustment.

Standard seasonal adjustment methodology relies heavily on the experience of the most recent three years to determine the expected seasonal change in employment for each month of the current year. Prior to the implementation of the adjustment, the procedure did not distinguish between 4- and 5-week survey intervals, and the accuracy of the seasonal expectation depended in large measure on how well the current year's survey interval corresponded with those of the previous three years. All else the same, the greatest potential for distortion occurred when the current month being estimated had a 5-week interval but the three years preceding it were all 4-week intervals; or, conversely, when the current month had a 4-week interval but the three years preceding it were all 5-week intervals.

BLS adopted REGARIMA (regression with auto-correlated errors) modeling to identify the estimated size and significance of the calendar effect for each published series. REGARIMA combines standard regression analysis, which measures correlation among two or more variables, with ARIMA modeling, which describes and predicts the behavior of data series based on its own past history. For many economic time series, including nonfarm payroll employment, observations are auto-correlated over time; each month's value is significantly dependent on the observations that precede it. These series, therefore, usually can be successfully fit using ARIMA models. If auto-correlated time series are modeled through regression analysis alone, the measured relationships among other variables of interest may be distorted due to the influence of the auto-correlation. Thus, the REGARIMA technique is appropriate for measuring relationships among variables of interest in series that exhibit auto-correlation, such as nonfarm payroll employment.

In this application, the correlations of interest are those between employment levels in individual calendar months and the lengths of the survey intervals for those months. The REGARIMA models evaluate the variation in employment levels attributable to eleven separate survey interval variables, one specified for each month, except March. March is excluded because there are almost always 4 weeks between the February and March surveys. Models for individual basic series are fit with the most recent ten years of data available, the standard time span used for CES seasonal adjustment.

The REGARIMA procedure yields regression coefficients for each of the eleven months specified in the model. These coefficients provide estimates of the strength of the relationship between employment levels and the number of weeks between surveys for the eleven modeled months. The X-13ARIMA-SEATS software also produces diagnostic statistics that permit the assessment of the statistical significance of the regression coefficients, and all series are reviewed for model adequacy.

Because the eleven coefficients derived from the REGARIMA models provide an estimate of the magnitude of variation in employment levels associated with the length of the survey interval, these coefficients are used to adjust the CES data to remove the calendar effect. These "filtered" series are then seasonally adjusted using the standard X-13ARIMA-SEATS software.

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Two-step method

CES State and Area uses a two-step seasonal adjustment method to address the hybrid nature of CES State and Area time series. CES State and Area estimates state industry employment monthly and uses an annual benchmark process to revise the estimates to reflect the universe data from the Quarterly Census of Employment and Wages (QCEW). CES State and Area time series consist of universe data through the latest benchmark month followed by sample data up to the current month.² The seasonal variations of these two data sources can differ and cause distortions in the seasonally adjusted data unless adjusted separately.

Beginning with January 1994 data, the U.S. Bureau of Labor Statistics (BLS) implemented an alternative method that separately adjusts each part of the time series, an approach first carried out by Berger and Phillips (1994). This method uses the seasonal trends found in universe-derived employment counts to adjust historical benchmark employment data while also incorporating sample-based seasonal trends to adjust sample-based employment estimates. These two series are independently adjusted then spliced together at the October re-estimate point. By accounting for the differing seasonal patterns found in historical benchmark employment data and the sample-based employment estimates, this technique yields improved seasonally adjusted series with respect to analysis of month-to-month employment change.

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Concurrent seasonal adjustment

With the release of January 2018 data on March 12, 2018, CES State and Area converted to concurrent seasonal adjustment, which uses all available estimates, including those for the current month, in developing sample-based seasonal factors. Previously, CES State and Area projected sample-based seasonal factors once a year during the annual benchmark process and applied those projected seasonal factors to the not-seasonally adjusted monthly estimates over the following year. More information on CES State and Area's use of concurrent seasonal adjustment is available at <https://www.bls.gov/sae/seasonal-adjustment/implementation-of-concurrent-seasonal-adjustment-for-ces-state-and-area-estimates.htm>.

Research data provided with the implementation of concurrent seasonal adjustment by state and benchmark year is available at <https://www.bls.gov/sae/seasonal-adjustment/research-data-on-concurrent-seasonal-adjustment-by-state-and-benchmark-year.htm>.

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Outliers identified during concurrent seasonal adjustment

With the release of March 2020 data on April 17, 2020, the Current Employment Statistics (CES) State and Area program began providing a list of series identified as outliers during concurrent seasonal adjustment.

The file contains outliers from the January following the most recent benchmark and is updated with each preliminary release to include the most recent data. No changes have been made to the seasonal adjustment methodology. Outliers made in previous benchmark years, beginning in March 2020, are available upon request by contacting the Current Employment Statistics State and Area program via [email](#) or calling (202) 691-6559.

A spreadsheet with the outliers identified during concurrent seasonal adjustment is available below.

[Outliers-identified-during-concurrent-seasonal-adjustment.xlsx](#)

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Prior adjustments

With the release of June 2020 data on July 17, 2020, CES State and Area began incorporating prior adjustments as part of the seasonal adjustment process.

Unlike the use of seasonal outliers, prior adjustments remove the effect (rounded to the hundreds) of a known nonseasonal event from the not seasonally adjusted data before running X-13 ARIMA-SEATS. This is done to ensure that nonseasonal events such as Census hiring and strikes are not included in the calculation of the seasonal factors. Once the seasonal factors are calculated, they are applied to the not seasonally adjusted data used as inputs. Then the prior adjustments that were removed before running X-13 ARIMA-SEATS are incorporated to create the seasonally adjusted estimates.

Seasonal outliers will continue to be made where there is insufficient information to determine a prior adjustment.

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Seasonally adjusting CES State and Area data

CES State and Area publishes seasonally adjusted data for nonfarm payroll employment series at the supersector and sector levels, as well as total nonfarm (TNF) for published metropolitan statistical areas (MSAs) that have sufficient sample history and satisfy criteria for seasonal adjustment. Revisions of historical data for the most recent five years, where available, are made once a year, coincident with annual benchmark adjustments. If a historical correction is issued to the unadjusted supersector or sector series prior to the standard five year replacement period, seasonally adjusted data will be revised back to the earliest historically corrected year.

The aggregation method of seasonally adjusted data is based upon the availability of underlying industry data. For all 50 states, the District of Columbia, and Puerto Rico, the following series are sums of underlying industry data: total private, goods-producing, service-providing, and private service-providing. The same method is applied for the U.S. Virgin Islands with the exception of goods-producing, which is independently seasonally adjusted because of data limitations. For all 50 states, the District of Columbia, Puerto Rico, and the U.S. Virgin Islands, seasonally adjusted data for manufacturing, trade, transportation, and utilities, financial activities, education and health services, leisure and hospitality, and government are aggregates wherever exhaustive industry components are available seasonally adjusted; otherwise these industries' employment data are directly seasonally adjusted. In a very limited number of cases, the not seasonally adjusted data for mining, construction, manufacturing, trade, transportation, and utilities, financial activities, education and health services, leisure and hospitality, and government do not exhibit enough seasonality to be adjusted; in those cases the not seasonally adjusted data are used to sum to higher level industries. The seasonally adjusted total

nonfarm data for all MSAs and metropolitan divisions are not an aggregation but are derived directly by applying the seasonal adjustment procedure to the not seasonally adjusted total nonfarm level.

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Research

Technical research related to seasonal adjustment in the CES program is outlined in the papers below:

- Franklin D. Berger and Keith R. Phillips, “ Solving the mystery of the disappearing January blip in state employment data,” *Economic Review* (Dallas, TX: Federal Reserve Bank of Dallas), April 1994, pp.53-62, <https://www.dallasfed.org/~media/documents/research/er/1994/er9402d.pdf>.
- Jonathan Creem, “ Outlier Review during Concurrent Seasonal Adjustment of CES State and Area Series,” Joint Statistical Meetings (Baltimore, Maryland), November 2017, <https://www.bls.gov/osmr/research-papers/2017/pdf/st170110.pdf>.
- Jurgen Kropf, Christopher Manning, Kirk Mueller, and Stuart Scott, “ Concurrent Seasonal Adjustment for Industry Employment Statistics,” *Proceedings of the Business and Economic Statistics Section*, American Statistical Association, 2002, <https://www.bls.gov/ces/additional-resources/cescsapdf.pdf>.
- Stephanie Cano, Patricia Getz, Jurgen Kropf, Stuart Scott, and George Stamas, “ Adjusting for a Calendar Effect in Employment Time Series,” *Proceedings of the Business and Economic Statistics Section*, American Statistical Association, 1996, <https://www.bls.gov/osmr/research-papers/1996/pdf/st960190.pdf>.
- Steve Mance, “ Concurrent Seasonal Adjustment of State and Metro Payroll Employment Series,” Joint Statistical Meetings (Seattle, Washington), October 2015, <https://www.bls.gov/osmr/research-papers/2015/pdf/st150110.pdf>.
- Stuart Scott, George Stamas, Thomas Sullivan, and Paul Chester, “ Seasonal adjustment of hybrid economic time series,” *Proceedings of the Section on Survey Research Methods*, American Statistical Association, 1994, <https://www.bls.gov/osmr/research-papers/1994/pdf/st940350.pdf>.

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END NOTES

¹ More information on the annual benchmark process is available at <https://www.bls.gov/sae/publications/benchmark-article/annual-benchmark-article.htm>.

² For more information, see <https://www.bls.gov/sae/questions-and-answers.htm#Benchmarking>.

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