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Seasonal Adjustment

Over the course of a year, the size of the Nation's labor force, the levels of employment and unemployment, and other measures of labor market activity undergo sharp fluctuations due to such seasonal events as changes in weather, reduced or expanded production, harvests, major holidays, and the opening and closing of schools. Because these seasonal events follow a more or less regular pattern each year, their influence on statistical trends can be eliminated by adjusting the statistics from month to month. These adjustments make it easier to observe the cyclical and other nonseasonal movements in the series. Seasonally adjusted series for selected labor force and establishment-based data are published monthly in *Employment and Earnings.*

Household data

Beginning in January 2003, BLS started using the X-12-ARIMA (Auto-Regressive Integrated Moving Average) seasonal adjustment program to seasonally adjust national labor force data from the Current Population Survey (CPS), or household survey. This program replaced the X-11 ARIMA program which had been used since January 1980. For a detailed description of the X-12-ARIMA program and its features, see D.F. Findley, B.C. Monsell, W.R. Bell, M.C. Otto, and B.C. Chen, "New Capabilities and Methods of the X-12-ARIMA Seasonal Adjustment Program," *Journal of Business and Economic Statistics,* April 1998, Vol. 16, No. 2, pp. 127-152. See "Revision of Seasonally Adjusted Labor Force Series in 2003," in the February 2003 issue of this publication for a discussion of the introduction of the use of X-12 ARIMA for seasonal adjustment of the labor force data and the effects that it had on the data.

Beginning in January 2004, BLS converted to the use of concurrent seasonal adjustment to produce seasonally adjusted labor force estimates from the household survey. Concurrent seasonal adjustment uses all available monthly estimates, including those for the current month, in developing seasonal factors. Previously, seasonal factors for the CPS data had been projected twice a year. As a result of this change in methodology, BLS no longer publishes seasonal factors for the labor force data. For more information on the adoption of concurrent seasonal adjustment for the labor force data, see "Revision of Seasonally Adjusted Labor Force Series in 2004," in the January 2004 issue of this publication available on the Internet at **http://www.bls.gov/cps/cpsrs2004.pdf.**

Revisions of historical data, usually for the most recent 5 years, are made only at the beginning of each calendar year. However, as a result of the revisions to the estimates for 1970-81 based on 1980 census population counts, revisions to seasonally adjusted series in early 1982 were carried back to 1970. In 1994, data were revised only for that year because of the major survey redesign and the introduction of 1990 census-based population controls, adjusted for the estimated undercount, into the Current Population Survey. In 1996, 1990-93 data also were revised to incorporate these 1990 census-based population controls and seasonally adjusted series were revised back to 1990. Subsequent revisions were carried back only to 1994 through 1998, when the standard 5-year revision period was reinstated.

All labor force and unemployment rate statistics, as well as the major employment and unemployment estimates, are computed by aggregating independently adjusted series. For example, for each of the major labor force components— employment, and unemployment—data for four sex-age groups (men and women under and over 20 years of age) are separately adjusted for seasonal variation and are then added to derive seasonally adjusted total figures. The seasonally adjusted figure for the labor force is a sum of four seasonally adjusted civilian employment components and four seasonally adjusted unemployment components. The total for unemployment is the sum of the four unemployment components, and the unemployment rate is derived by dividing the resulting estimate of total unemployment by the estimate of the labor force. Because of the independent seasonal adjustment of various series, components will not necessarily add to totals.

Each January issue (March issue in 1996 and February issue in 2003) of *Employment and Earnings* contains revised seasonally adjusted data for selected labor force series based on the experience through December and a description of the current seasonal adjustment procedure.

National establishment data

BLS also uses the X-12-ARIMA seasonal adjustment program to seasonally adjust national establishment-based employment, hours, and earnings series derived from the Current Employment Statistics (CES) program. (Use of X-12 ARIMA to seasonally adjust the CES data began in June 1996, with the release of the March 1995 benchmark revisions.) Individual series are seasonally adjusted using either a multiplicative or an additive model. For employment, seasonal adjustment factors are directly applied to the component levels. Individual 3-digit NAICS levels are seasonally adjusted, and higher-level aggregates are formed by the summation of these components. Seasonally adjusted totals for hours and earnings are obtained by taking weighted averages of the seasonally adjusted data for the component series.

Revised seasonally adjusted national establishment-based series based on the experience through January 2004 and a detailed description of the current seasonal adjustment

procedure appear in the February 2004 issue of *Employment and Earnings.*

Concurrent seasonal adjustment. Beginning in June 2003 with the May 2003 first preliminary estimates, BLS began computing seasonal factors concurrently with the monthly estimate production. Previously, the factors were forecasted twice a year. Concurrent seasonal adjustment is expected to provide a more accurate seasonal adjustment, and smaller revisions from the first preliminary estimates to the final benchmarked estimates, than the semiannual updates. As a result of the adoption of concurrent seasonal adjustment, the CES program has discontinued the publication of projected seasonal factors.

Additive and multiplicative models. Prior to the March 2002 benchmark release in June 2003, all CES series were adjusted using multiplicative seasonal adjustment models. Although the X-12-ARIMA seasonal adjustment program provides for either an additive or a multiplicative adjustment depending on which model best fits the individual series, the previous CES processing system was unable to utilize additive seasonal adjustments. A new processing system, introduced simultaneously with the conversion to NAICS in June 2003, is able to utilize both additive and multiplicative adjustments. The article, "Revisions to the Current Employment Statistics National Estimates Effective May 2003," published in the June 2003 issue of this publication contains a list of which series are adjusted with additive seasonal adjustment models and which series are adjusted with multiplicative models. The article also lists which series are subject to the calendar-effects modeling described below.

Variable survey intervals. Beginning with the release of the 1995 benchmark, BLS refined the seasonal adjustment procedures to control for survey interval variations, sometimes referred to as the 4- versus 5-week effect. 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 week 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 3 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 from the previous 3 years. All else being the same, the greatest potential for distortion occurred when the current month being estimated had a 5-week interval but the 3 years preceding it were all 4-week intervals, or conversely, when the current month had a 4-week interval but the 3 years preceding it were all 5-week intervals.

BLS uses REGARIMA (regression with autocorrelated 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 autocorrelated over time. That is, each month's value is significantly dependent on the observations that precede it; these series, thus, usually can be successfully fit using ARIMA models. If autocorrelated 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 autocorrelation. Thus, the REGARIMA technique is appropriate to measuring relationships among variables of interest in series that exhibit autocorrelation, 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 11 separate survey interval variables, one specified for each month, except March. March is excluded because there is almost always 4 weeks between the February and March surveys. Models for individual basic series are fitted with the most recent 10 years of data available, the standard time span used for CES seasonal adjustment.

The REGARIMA procedure yields regression coefficients for each of the 11 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 11 modeled months. The X-12-ARIMA 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 11 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 then are seasonally adjusted using the standard X-12-ARIMA software previously used.

For a few series, REGARIMA models did not fit well; these series are seasonally adjusted with the X-12 software but without the interval-effect adjustment. There are several additional special effects modeled through the REGARIMA process which are described below.

Construction series. BLS continues its special treatment in seasonally adjusting the construction industry series, which began with the 1996 benchmark revision. In the application of the interval-effect modeling process to the construction series, there initially was difficulty in accurately identifying and measuring the effect because of the strong influence of variable weather patterns on employment movements in the industry. Further research allowed BLS to incorporate interval-effect modeling for the construction industry by disaggregating the construction series into its finer industry and geographic estimating cells and tightening outlier designation parameters. This allowed a more precise identification of weather-related outliers that had masked the interval effect and clouded the seasonal adjustment patterns in general. With these outliers removed, interval-effect modeling became feasible. The result is a seasonally adjusted series for construction that is improved because it is controlled for two potential distortions, unusual weather events and the 4- versus 5-week effect.

Floating holidays. BLS also makes special adjustments for average weekly hours and average weekly overtime series to account for the presence or absence of religious holidays in the April survey reference period and the occurrence of Labor Day in the September reference period.

Local government series. A special adjustment also is made in the local government, excluding education series in November each year to account for variations in employment due to the presence or absence of poll workers.

Refinements in hours and earnings seasonal adjustment. With the release of the 1997 benchmark, BLS implemented refinements to the seasonal adjustment process for the hours and earnings series to correct for distortions related to the method of accounting for the varying length of payroll periods across months. There is a significant correlation between over-the-month changes in both the average weekly hour (AWH) and the average hourly earnings (AHE) series and the number of weekdays in a month, resulting in noneconomic fluctuations in these two series. Both AWH and AHE show more growth in "short" months (20 or 21 weekdays) than in "long" months (22 or 23 weekdays). The effect is stronger for the AWH than for the AHE series.

The calendar effect is traceable to response and processing errors associated with converting payroll and hours information from sample respondents with semimonthly or monthly pay periods to a weekly equivalent. The response error comes from sample respondents reporting a fixed number of total hours for workers regardless of the length of the reference month, while the CES conversion process assumes that the hours reporting will be variable. A constant level of hours reporting most likely occurs when employees are salaried rather than paid by the hour, as employers are less likely to keep actual detailed hours records for such employees. This causes artificial peaks in the AWH series in shorter months that are reversed in longer months.

The processing error occurs when respondents with salaried workers report hours correctly (vary them according to the length of the month), which dictates that different conversion factors be applied to payroll and hours. The CES processing system uses the hours conversion factor for both fields, resulting in peaks in the AHE series in short months and reversals in long months. Currently, the CES processing system can accommodate only one conversion factor per reporter.

The series to which the length-of-pay-period adjustment is applied are not subject to the 4- versus 5-week adjustment, because the modeling cannot support the number of variables that would be required in the regression equation to make both adjustments.

State establishment data

Seasonally adjusted nonfarm payroll employment data by selected industry supersectors for all States and the District of Columbia are presented in table B-7 of this publication. As with the national establishment data, the State establishment data are seasonally adjusted with the X-12-ARIMA seasonal adjustment program. Seasonal adjustment factors are applied directly to the employment estimates at the supersector level and then aggregated to the State totals for most States. For a few States that do not have many publishable seasonally adjusted supersectors, however, total nonfarm data are seasonally adjusted directly at the aggregate level. The recomputation of seasonal factors and historical revisions are made coincident with the annual benchmark adjustments.

Region and State labor force data

Beginning in 1992, BLS introduced publication of seasonally adjusted labor force data for the census regions and divisions, the 50 States, and the District of Columbia (tables C-1 and C-2). Beginning in 1998, regional aggregations are derived by summing the State estimates.

Seasonal adjustment of the State labor force data is done in two steps. First, a signal plus noise model is fit to the data series to filter out the effects of sampling errors that result from the small sample size of the State estimates. In the second step, the error-corrected labor force series is then seasonally adjusted with the X-12-ARIMA seasonal adjustment program.

Seasonal adjustment factors are computed and applied independently to the component employment and unemployment levels and then aggregated to regional or State totals. Current seasonal adjustment factors are produced for 6-month periods twice a year. Historical revisions usually are made at the beginning of each calendar year. Because of the separate processing procedures, totals for the Nation, as a whole, differ from the results obtained by aggregating regional or State data.