Methodology for Seasonally Adjusting National Household Survey Labor Force Series with Revisions for 2015

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S hort-run movements in labor force time series are strongly influenced by seasonality—periodic fluctuations associated with recurring calendar-related events such as weather, holidays, and the opening and closing of schools. Seasonal adjustment eliminates the influence of these fluctuations and makes it easier for users to observe fundamental changes in the level of the series, particularly changes associated with general economic expansions and contractions.

While seasonal adjustment is feasible only if the seasonal effects are reasonably stable with respect to timing, direction, and magnitude, these effects are not necessarily fixed, but often evolve over time. The evolving patterns are estimated by X-13ARIMA-SEATS (X-13), with procedures based on moving averages, or "filters," that successively average a shifting timespan of data, thereby providing estimates of seasonal factors that change in a smooth fashion from year to year.

For observations in the middle of the series, a set of symmetric moving averages with fixed weights produces final seasonally adjusted estimates. A filter is *symmetric* if it is centered around the time point being adjusted, with an equal amount of data preceding and following that point. Standard seasonal adjustment options imply a symmetric filter that uses from 6 to 10 years of original data to produce a final seasonally adjusted estimate. Obviously, this final adjustment can be made only where there are enough data beyond the time point in question to adjust with the symmetric filter.

To seasonally adjust recent data, shorter filters with less desirable properties must be used. These filters are referred to as *asymmetric*, because they use fewer observations after the reference point than preceding it. The weights for such filters vary with the number of observations that are available beyond the time point for which estimates are to be adjusted. Seasonally adjusted data for the current year are produced with a technique known as *concurrent adjustment*. Under this practice, the current month's seasonally adjusted estimate is computed with the use of all relevant original data up to and including data for the current month. Revisions to estimates for previous months, however, are postponed until the end of the year. Revisions to a seasonally adjusted estimate for a given time point continue until enough future observations become available to use the symmetric weights. This effectively means waiting up to 5 years for a final adjustment when standard options are used.

At the end of each calendar year, BLS reestimates the seasonal factors for the Current Population Survey (CPS, or Household Survey) series by including another full year of data in

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the estimation process. On the basis of this annual reestimation, BLS revises the historical seasonally adjusted data for the previous 5 years. As a result, each year's data are generally subject to five revisions before the values are considered final. The fifth and final revisions to data for the earliest of the 5 years are usually quite small, while the first-time revisions to data for the most recent years are generally much larger. For the major aggregate labor force series, however, the first-time revisions rarely alter the essential trends observed in the initial estimates.

Changes in 2015

Revisions to 2014 estimates
This year's revisions incorporate data through December 2014 and provide revised estimates for January 2010 through November 2014 for all previous seasonally adjusted labor force series. Currently, there are 155 series that are directly seasonally adjusted and many more that are derived from these series. (See the subsequent section titled "Aggregation procedures.")

An important criterion for evaluating alternative methods of seasonal adjustment is how close initial estimates are to the results of subsequent revisions. Users of seasonally adjusted data are often most interested in current information. Thus, it is desirable that the initial seasonally adjusted estimates be as close as possible to the improved estimates made after more data become available. Even though the revisions currently being released for the 2014 seasonally adjusted data are not final, the first revisions are usually the largest and often indicate the direction of subsequent revisions.

Table 1 shows the civilian unemployment rates for January to November 2014, as first computed and as revised, and there were three revisions. Note that December 2014 is the final month of the series and has no revision.

Extension of seasonal adjustment to additional series
Beginning with the release of data for January 2015, "The Employment Situation" news release adds 6 directly seasonally adjusted series and 26 indirectly seasonally adjusted series. The directly adjusted series are the employment and unemployment levels for Asians (table A-2 of news release), and the employment and unemployment levels for Hispanic men age 20 and over and Hispanic women age 20 and over (table A-3). The new seasonally adjusted series mentioned above are adjusted with the SEATS procedure in X-13. (All other directly adjusted series are adjusted with X-11 in the X-13 program.) Historical data for these new series will be available back to 2003, when the CPS race and ethnicity questions were revised to comply with new OMB guidelines.

The new indirectly seasonally adjusted series for Asians are derived from the directly seasonally adjusted employment and unemployment levels. These include the civilian labor force, the labor force participation rates, the employment-to-population ratios, and the unemployment rates for Asians (table A-2). The not in labor force seasonally adjusted series for Asians are also indirectly derived. (See the subsequent section titled "Aggregation procedures" for a brief discussion on indirect seasonal adjustment.)

Table 1. **Seasonally adjusted unemployment rates in 2014 and change due to revision**

Month	As first computed	As revised	Change
January	6.6	6.6	0.0
February	6.7	6.7	0.0
March	6.7	6.6	-0.1
April	6.3	6.2	-0.1
May	6.3	6.3	0.0
June	6.1	6.1	0.0
July	6.2	6.2	0.0
August	6.1	6.1	0.0
September	5.9	5.9	0.0
October	5.8	5.7	-0.1
November	5.8	5.8	0.0

For Hispanics, other than the four directly adjusted series for adult men and women, the series for adult men, adult women, and teenagers that appear in table A-3 are indirectly seasonally adjusted. Prior to 2015, the employment and unemployment series for total Hispanics were directly adjusted using the X-11 method, but starting with January 2015, these series will be indirectly adjusted. Historical data back to 2003 were revised using the SEATS method with the release of December 2014 data.

Adjustment Methods and Procedures

Beginning in 2003, BLS adopted the use of X-12-ARIMA (X-12) as the official seasonal adjustment procedure for CPS labor force series, replacing the X-11-ARIMA (X-11) program that had been used since 1980. Both X-12-ARIMA and X-11-ARIMA are based on earlier versions of the widely used X-11 method developed at the U.S. Census Bureau in the 1960s.[1] Statistics Canada added to X-11 the ability to extend the time series with forward and backward extrapolations from Auto-Regressive Integrated Moving Average (ARIMA) models, prior to seasonal adjustment. The X-11 algorithm for seasonal adjustment is then applied to the extended series. The use of forward and backward extensions results in initial seasonal adjustments that are subject to smaller revisions, on average, when the adjusted data are revised after future data become available.

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[1] For a detailed discussion of X-12-ARIMA, see David F. Findley, Brian C. Monsell, William R. Bell, Mark C. Otto, and Bor-Chung Chen, "New Capabilities and Methods of the X-12-ARIMA Seasonal Adjustment Program," *Journal of Business and Economics Statistics*, April 1998, pp. 127-152, http://www.census.gov/ts/papers/jbes98.pdf. For documentation on X-11-ARIMA, see Estela Bee Dagum, *The X-11 ARIMA Seasonal Adjustment Method*, catalogue no. 12-564E (Ottawa, Statistics Canada, January 1980), available on the U.S. Census Bureau's website at www.census.gov/srd/www/sapaper/historicpapers.html. The X-11 method is described in Julius Shiskin, Alan Young, and John Musgrave, "The X-11 Variant of the Census Method II Seasonal Adjustment Program," Technical Paper no. 15 (Bureau of the Census, 1967), also available at the link immediately above.

The enhancements in X-12 fall into three basic categories: (1) Enhanced ARIMA model selection and estimation, (2) detection and estimation of outlier, trading day, and holiday effects, and (3) new post adjustment diagnostics.

For 2015, BLS is moving to the X-13[2] program which was developed by the U.S. Census Bureau and the Bank of Spain. The X-13 program includes all of the capabilities of the X-12 program, while adding the SEATS[3] seasonal adjustment methodology.

X-11 and SEATS have strong similarities. The ARIMA model of the observed series is the starting point for both. They both also use the same basic estimator which is a weighted moving average of the series to produce the seasonally adjusted output. Their methods differ in the derivation of their moving average weights. (See the subsequent section titled "X-11 and SEATS decompositions.")

X-11 is empirically based. It directly selects the seasonal moving averages from a pre-specified set. The weights are not designed for any specific series, but fit a wide variety of series. SEATS is model based and derives a moving average from the ARIMA model of the series. The moving averages are tailored to the specific modeled properties of the series. The SEATS methodology is flexible in that it can adjust some series that X-11 finds too variable. It also facilitates analysis with a variety of error measures produced within the system.

For almost all of the national labor force series that are seasonally adjusted by BLS, the main steps of the seasonal adjustment process proceed in the following order:

- Times series modeling—a REGARIMA model (a combined regression and ARIMA model) is developed to account for the normal evolutionary behavior of the time series and to control for outliers and other special external effects that may exist in the series;
- Prior adjustments—given an adequate REGARIMA model, the series is modified by prior adjustments for external effects estimated from the regression part of the model and extrapolated forward 12 months or more by the ARIMA part of the model;
- X-11 or SEATS decomposition—the modified and extrapolated series is decomposed into trend-cycle, seasonal, and irregular components by means of a series of moving averages, to produce seasonal factors for implementing seasonal adjustment; and
- Evaluation—a battery of diagnostic tests is produced to evaluate the quality of the final seasonal adjustment.

For two CPS series, the seasonal adjustment process begins with special user-defined prior adjustments for Easter effects. (See subsequent section titled "Aggregation procedures.")

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[2] For documentation on X-13ARIMA-SEATS, see *The X-13ARIMA-SEATS Reference Manual*, (Washington, Bureau of the Census, September 2013), http://www.census.gov/ts/x13as/docX13ASHTML.pdf.
[3] For documentation on the SEATS program which was developed by Victor Gomez and Agustin Maravall, see "Seasonal Adjustment and Signal Extraction in Economic Time Series," in in D. Peña, G.C. Tiao, and R.S. Tsay (eds.), *A Course in Time Series Analysis*, Ch.8, 202-247, New York: J. Wiley and Sons, 2001, http://www.bde.es/f/webbde/SES/servicio/software/tramo/sasex.pdf.

Time series modeling

Time series models play an important role in seasonal adjustment. They are used to identify and correct the series for aberrant observations and other external effects, as well as to extend the original series with backcasts and forecasts so that less asymmetric filters can be used at the beginning and end of the series.

ARIMA models[4] are designed to make forecasts of a time series based on only its past values. While these models can represent a wide class of evolving time series patterns, they do not account for the presence of occasional outliers and other special external effects. An outlier represents a sudden break in the normal evolutionary behavior of a time series. Ignoring the existence of outliers may lead to serious distortions in the seasonally adjusted series.

A common form of outlier that presents a special problem for seasonal adjustment is an abrupt shift in the level of the data that may be either transitory or permanent. Three types of outliers are usually distinguished: (1) An additive change that affects only a single observation, (2) a temporary change having an effect that diminishes to zero over several periods, and (3) a level shift or a break in the trend of the data, which represents a permanent increase or decrease in the underlying level of the series. These three main types of outliers, as well as other types of external effects, may be handled by the times series modeling component of X-13. This is done by adding to the ARIMA model appropriately defined regression variables based on intervention analysis originally proposed by George E.P. Box and George C. Tiao.[5]

The combined regression and ARIMA model is referred to as a REGARIMA model and is represented by

$$Y_t = \beta X_t + Z_t,$$

where, Y_t is the original series or a logarithmic transformation of it; X_t is a set of fixed regression variables; β represents the regression coefficients, and Z_t is a standard seasonal ARIMA model described by the notation (p,d,q)(P,D,Q), where p is the number of regular (nonseasonal) autoregressive parameters, d is the number of regular differences, q is the number of regular moving average parameters, P is the number of seasonal autoregressive parameters, D is the number of seasonal differences, and Q is the number of seasonal moving average parameters.

While the ARIMA model can be very complicated theoretically, in practice it takes a parsimonious form involving only a few estimated parameters. (See table 2.) There are well-developed methods for determining the number and types of parameters and the degree of differencing appropriate for a given series.

With respect to specifying the regression component to control for outliers, X-13 offers two approaches. First, major external events, such as breaks in trend, are usually associated with

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[4] For a more detailed discussion of ARIMA models, refer to George E.P. Box and Gwilym M. Jenkins, *Time Series Analysis: Forecasting and Control* (San Francisco, Holden Day, 1970); and Sir Maurice Kendall and J. Keith Ord, *Time Series* (New York, University Press, 1990).
[5] George E.P. Box and George C. Tiao, "Intervention Analysis with Applications to Economic and Environmental Problems," *Journal of the American Statistical Association*, vol. 70, no. 353, 1975, pp. 71-79.

known events. In such cases, the user has sufficient prior information to specify special regression variables to estimate and control for these effects.

Second, because it is rare that there is sufficient prior information to locate and identify all of the aberrant observations that may exist in a time series, as a second approach to specifying the regression component, REGARIMA offers automatic outlier detection based on work by I. Chang, G.C. Tiao, and C. Chen.[6] This approach is especially useful when a large number of series must be processed. Of course, both approaches may be combined so that readily available prior information can be used directly, while unknown substantial outliers may still be discovered.

Model adequacy and length of series. The preference is to use relatively long series in fitting times series models, but with some qualifications. Sometimes, the relevance of data in the distant past to seasonal adjustment is questionable, which may lead to using a shorter series.

Table 2. **REGARIMA models used for the eight major civilian labor force components**

Series	Model	Transformation	Series start date
Total employment:			
Men, 20 years and over	(0, 1, 2) (0, 1, 1)	LOG	1976
Women, 20 years and over	(0, 1, 0) (0, 1, 1)	LOG	1976
Men, 16 to 19 years	(3, 1, 0) (0, 1, 1)	LOG	1976
Women, 16 to 19 years	(0, 1, 1) (0, 1, 1)	LOG	1976
Total unemployment:			
Men, 20 years and over	(0, 1, 3) (0, 1, 1)	LOG	1990
Women, 20 years and over	(1, 1, 0) (0, 1, 1)	LOG	1990
Men, 16 to 19 years	(0, 1, 1) (0, 1, 1)	LOG	1976
Women, 16 to 19 years	(0, 1, 1) (0, 1, 1)	LOG	1976

Even though the filters have limited memory, there are reasons for using longer series. First, for homogenous time series, the more data used to identify and estimate a model, the more likely it is that the model will represent the structure of the data well and the more accurate the parameter estimates will be. The exact amount of data needed for time series modeling depends on the properties of the series involved. Arbitrarily truncating the series, however, may lead to more frequent changes in model identification and to large changes in estimated parameters, which in turn may lead to larger-than-necessary revisions in forecasts.

Second, although level shifts and other types of outliers tend to occur more often in longer series, X-13 has the capability of automatically controlling for these effects. Third, some very

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[6] I. Chang, G.C. Tiao, and C. Chen, "Estimation of Time Series Parameters in the Presence of Outliers," *Techonometrics*, 1988, pp. 193-204.

useful diagnostics available in X-13 typically require a minimum of 11 years of data and, in some cases, as much as 14 years of data. Fourth, attempting to fit longer series often provides useful insights into the properties of the series, including their overall quality and the effects of major changes in survey design.

On the basis of the foregoing considerations, REGARIMA models are initially estimated for series beginning in 1976, where data series of that length are available. Extensive use is made of intervention analysis to estimate the magnitude of known breaks in CPS series and of automatic outlier detection to identify and correct for the presence of additional aberrant observations.

Once a model is estimated, it is evaluated in terms of its adequacy for seasonal adjustment purposes. The criteria essentially require a model to fit the series well (there should be no systematic patterns in the residuals) and to have low average forecasting errors for the last 3 years of observed data. When there is a tradeoff between the length of the series and the adequacy of the model, a shorter series is selected. In this case, the identification of the model is not changed with the addition of new data, unless the model fails diagnostic testing.

Acceptable REGARIMA models have been developed for all of the labor force series that are directly adjusted. For each of the eight major civilian labor force components, table 2 presents the form of the ARIMA part of the model, the transformation selected, and the starting date of the series used to fit the model.

Prior adjustments
Prior adjustments are adjustments made to the original data prior to seasonal adjustment. Their purpose is to correct the original series for atypical observations and other external effects that otherwise would seriously distort the estimates of the seasonal factors. Prior adjustment factors are subtracted from or used as divisors for the original series, depending on whether the seasonal adjustment is additive or multiplicative.

Prior adjustment factors for CPS series may be based on special user-defined adjustments or handled more formally with REGARIMA modeling. Most of the prior adjustment factors for the labor force series are estimated directly from REGARIMA.

Level shifts. The most common type of outlier that occurs in CPS series is the permanent level shift. Most such shifts have been due to noneconomic methodological changes related to revisions in population controls and to major modifications to the CPS design.[7] One notable economic level shift was due to the 2001 terrorist attacks.

Population estimates extrapolated from the latest decennial census are used in the second-stage estimation procedure to control CPS sample estimates to more accurate levels. These intercensal population estimates are regularly revised to reflect the latest information on population change.

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[7] Further information on CPS population controls is available on the BLS website at http://www.bls.gov/cps/documentation.htm#pop for 1996 to present.

During the 1990s, three major breaks occurred in the intercensal population estimates. Population controls based on the 1990 census, adjusted for the estimated undercount, were introduced into the CPS series in 1994 and, in 1996, were extended back to 1990. In January 1997 and again in January 1999, the population controls were revised to reflect updated information on net international migration.

Population revisions, which reflected the results of Census 2000, were introduced with the release of data for January 2003 and were extended back to data beginning in January 2000. Since 2003, population controls also are updated in January to reflect new estimates of net international migration in the postcensus period, updated vital statistics and other information, and any methodological changes in the population estimation process. The population revisions introduced in January 2012 incorporated the results of the 2010 Census; those revisions were not extended back to January 2010.

In 1994, major changes to the CPS were introduced, including a redesigned and automated questionnaire and revisions to some of the labor force concepts and definitions. In January 2003, new industry and occupational classifications also were introduced and were extended back to data beginning in 2000.

To test for the possibility that revisions to the population controls or significant survey changes have important effects on those CPS series with large numerical revisions, each REGARIMA model is modified to include intervention variables for those years. The coefficients for these variables provide estimates of the direction and magnitude of the intervention effects.

Intervention effects for 2000 were necessary for selected employment series related primarily to Hispanic, adult, and agricultural categories. These effects mainly reflect increases in adult and Hispanic employment due to the introduction of Census 2000-based population controls and a decline in agricultural employment caused by the change in the industry classification system.[8]

Due to an unusual revision in the population controls in January 2000, the unadjusted employment level of Black or African American men 20 years or over had a strong upward shift in the first quarter of 2000. This temporary effect is permanently removed from the seasonally adjusted series with the use of the REGARIMA model.

Effect of September 2001. At the end of 2001, unemployed job losers were identified as having had substantial upward level shifts one month after the September 11, 2001, terrorist attacks on the World Trade Center in New York City.[9] Also, four additional series related to workers employed part time for economic reasons were identified as having substantial upward shifts at the time of the terrorist attacks.

Calendar effects. Calendar effects are transitory level shifts in a series that result from calendar events such as moving holidays or the differing composition of weekdays in a month between

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[8] See "Revisions to the Current Population Survey Effective in January 2003" at
http://www.bls.gov/cps/rvcps03.pdf.
[9] For more details, see http://www.bls.gov/cps/cpsrs2002.pdf.

years. These effects have different influences on the same month across years, thereby distorting the normal seasonal patterns for the given month.

Two CPS series related to persons at work exhibit significant effects in their April data due to the timing of Easter: "Persons at work on part-time schedules for noneconomic reasons who usually work part time in all industries" and "persons at work on part-time schedules for noneconomic reasons who usually work part time in nonagricultural industries." These series were seasonally adjusted with multiplicative models with a moving-holiday correction. A detailed discussion of the nature of the Easter effect in those series and of the procedure used to control for it was included in the January 1990 version of this article.

Six nonagricultural "Average actual hours at work" seasonally adjusted series also have prior adjustments for holidays.[10] The holidays are Good Friday, Labor Day, Columbus Day, and Veterans Day. Whenever one of these holidays falls in the CPS reference week, the level of each series falls. A weighted regression variable is added to the REGARIMA models to estimate each holiday's effect by series. Since the effects are periodic (the sequence of dates for each holiday is not stable in annual timing but follows a longer cycle), the weights are necessary to maintain the level of the series over time. The estimate for each holiday is permanently removed from the series so as not to distort the level of the trend.

X-11 and SEATS decompositions
The X-11 and SEATS methods of seasonal adjustment contained within the X-13 program assume that the original series is composed of three components: trend-cycle, seasonal, and irregular. Depending on the relationship between the original series and each of the components, the mode of seasonal adjustment may be additive or multiplicative. Formal tests are conducted to determine the appropriate mode of adjustment.

The multiplicative mode assumes that the absolute magnitudes of the components of the series are dependent on each other, which implies that the size of the seasonal component increases and decreases with the level of the series. With this mode, the monthly seasonal factors are ratios, with all positive values centered around unity. The seasonally adjusted series values are computed by dividing each month's original value by the corresponding seasonal factor.

In contrast, the additive mode assumes that the absolute magnitudes of the components of the series are independent of each other, which implies that the size of the seasonal component is independent of the level of the series. In this case, the seasonal factors represent positive or negative deviations from the original series and are centered around zero. The seasonally adjusted series values are computed by subtracting the corresponding seasonal factor from each month's original value.

Given an appropriate choice for the mode of adjustment, the prior-adjusted, forecasted series is seasonally adjusted by the X-11 component of X-13. X-11 applies a sequence of moving average and smoothing calculations to estimate the trend-cycle, seasonal, and irregular components. The method takes either a ratio-to- or difference-from-moving-average approach, depending on whether the multiplicative or additive model is used. For observations in the

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[10] See the 2009 version of this article at http://www.bls.gov/cps/cpsrs2009.pdf for more information.

middle of the series, a set of fixed symmetric moving averages (filters) is used to produce final estimates. The implied length of the final filter under standard options is 72 time points for the 3 by 5 seasonal moving average or 120 time points for the 3 by 9 moving average. That is, to obtain a final seasonally adjusted estimate for a single time point requires up to 5 years of monthly data preceding and following that time point. For recent data, asymmetric filters, with less desirable properties than symmetric filters, must be used.

Like X-11, SEATS decomposes the observed series into trend, seasonal, and irregular components and its relationship between the components may be additive or multiplicative (via a log transformation). Both X-11 and SEATS use moving averages to decompose the series. The major difference between the two procedures is how the moving averages are constructed. X-11 selects from a set of predefined filters while SEATS derives its filters from a decomposition of the ARIMA model fit to the observed series into models for the trend, seasonal, and irregular components. The SEATS filters therefore are more tailored to the specific properties of the series as reflected in the ARIMA model fit while X-11 filters are nonparametric in that they can fit a wide variety of series without depending on a specific model.

Evaluation
A series should be seasonally adjusted if three conditions are satisfied: the series is seasonal, the seasonal effects can be estimated reliably, and no residual seasonality is left in the adjusted series. A variety of diagnostic tools is available for X-11 to test for these conditions. Among these tools are the F test from the original X-11, the more extensive M and Q tests from X-11-ARIMA, and a set of tests first available in X-12. The latter include sliding-span diagnostics, frequency-spectrum estimates, and revision-history statistics. X-13 provides some of the above diagnostics for SEATS analysis, but also provides a battery of model-based diagnostics. If diagnostic testing shows that any of the three conditions listed fails to hold for a given series, that series is deemed not suitable for seasonal adjustment.

Concurrent seasonal adjustment
Concurrent seasonal adjustment of national labor force data began at BLS with the release of estimates for December 2003 in January 2004. This practice replaced the projected-factor method, which updated seasonal factors only twice a year. Under the latter procedure, projected seasonal factors were used to seasonally adjust the new original data as they were collected. At midyear, the historical series were updated with data for January through June, and the seasonal adjustment program was rerun to produce projected seasonal factors for July through December of the current year.

With concurrent seasonal adjustment, the seasonal adjustment program is rerun each month as the latest CPS data become available. The seasonal factors for the most recent month are produced by applying a set of moving averages to the entire data set, extended by extrapolations, including data for the current month. While all previous-month seasonally adjusted estimates are recalculated in this process, BLS policy is not to revise previous months' official seasonally adjusted estimates as new data become available during the year. Instead, revisions are introduced for the most recent 5 years of data at the end of each year.

Numerous studies, including that discussed in a 1987 paper[11] on the CPS labor force series, have indicated that concurrent adjustment generally produces initial seasonally adjusted estimates requiring smaller revisions than do estimates produced with the projected-factor method. Revisions to data for previous months also may produce gains in accuracy, especially when the original data are themselves regularly revised on a monthly basis. Publishing numerous revisions during the year, however, can confuse data users.

The case for revisions to previous-month seasonally adjusted estimates is less compelling for CPS series, because the original sample data normally are not revised. Moreover, an empirical investigation indicated that there were no substantial gains in estimating month-to-month changes by introducing revisions to the data for the previous month. For example, it was found that if previous-month revisions were made to the labor force series, the overall unemployment rate would be different in only 2 months between January 2001 and November 2002, in each case by only one-tenth of a percentage point. (More detailed information about this study is available from the authors upon request.)

Aggregation procedures
BLS directly seasonally adjusts series on the basis of age, sex, industry, education, and other characteristics. BLS also provides seasonally adjusted totals, subtotals, and ratios of selected series. It is possible to seasonally adjust an aggregate series either directly or indirectly by seasonally adjusting its components and adding the results, or dividing in the case of ratios. Indirect and direct adjustments usually will not give identical results, because (1) seasonal patterns vary across series, (2) there are inherent nonlinearities in X-13, (3) many series are multiplicatively adjusted, and (4) some series are ratios.

BLS uses indirect seasonal adjustment for most of the major labor force aggregates. Besides retaining, so far as possible, the essential accounting relationships, the indirect approach is needed because many of the aggregates include components having different seasonal and trend characteristics that sometimes require different modes of adjustment.

Examples of indirectly seasonally adjusted series are the levels of total unemployment, employment, and the civilian labor force, as well as the unemployment rate for all civilian workers. These series are produced by the aggregation of some or all of the seasonally adjusted series for the eight major civilian labor force components. The seasonally adjusted level of total unemployment is the sum of the seasonally adjusted levels of unemployment for four age-sex groups: Men 16 to 19 years, women 16 to 19 years, men 20 years and over, and women 20 years and over. Likewise, seasonally adjusted civilian employment is the sum of employment in all industries for the same four age-sex groups. The seasonally adjusted civilian labor force is the sum of all eight components. The seasonally adjusted civilian unemployment rate is computed as the ratio of the total seasonally adjusted unemployment level to the total seasonally adjusted civilian labor force (expressed as a percentage).

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[11] See George R. Methee and Robert J. McIntire, "An Evaluation of Concurrent Seasonal Adjustment for the Major Labor Force Series," in *Proceedings of the Business and Economic Statistics Section* (Alexandria, VA, American Statistical Association, 1987) available at http://www.bls.gov/cps/methee_mcintire_asa_1987.pdf.

A problem with producing seasonally adjusted estimates for a series by aggregation is that seasonal adjustment factors cannot be directly computed for that series. Implicit seasonal adjustment factors, however, can be calculated after the fact by taking the ratio of the unadjusted aggregate to the seasonally adjusted aggregate or, for additive implicit factors, the difference between those two aggregates.

Availability of revised series
These revisions replace the seasonally adjusted estimates previously published. Revised historical seasonally adjusted labor force data are available in various forms on the BLS website at http://www.bls.gov/cps/data.htm, including text file access at http://download.bls.gov/pub/time.series/ln/ to all of the revised data. The seasonally adjusted data last published for 2009 and earlier years were not further revised.