

# Revision of Seasonally Adjusted Labor Force Series in 2004

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Short-run movements in labor force time series are strongly influenced by seasonality, which refers to periodic fluctuations that are associated with recurring calendar-related events such as weather, holidays, and the opening and closing of schools. Seasonal adjustment is the process of estimating and removing these fluctuations to yield a seasonally adjusted series. The reason for doing so is to make it easier for data users to observe fundamental changes in the level of the series, particularly those 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. These evolving patterns are estimated by the Bureau of Labor Statistics (BLS) using X-12, a procedure 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 one year to the next.

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 referred to as being 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 using 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 is enough data beyond the time point in question to adjust with the symmetric filter.

To seasonally adjust recent data, shorter, asymmetric 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 these filters vary depending on how many observations are available beyond the time point for which estimates are to be adjusted.

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 using standard options.

Beginning with the release of estimates for December 2003 in January 2004, BLS has adopted the practice of concurrent adjustment for seasonally adjusting current year labor force data from the Current Population Survey (CPS) data as it becomes available each month. Under this practice, the current month’s seasonally adjusted estimate is computed using all relevant original data up to and including those for the current month. Revisions to estimates for previous months, however, are postponed until the end of the year. Previously, seasonal factors for the CPS labor force data were projected twice a year. With the introduction of concurrent seasonal adjustment, BLS will no longer publish projected seasonal factors for CPS data. This procedure is discussed in more detail later in this article.

At the end of each calendar year, BLS reestimates the seasonal factors for the CPS series by including another full year of data in the estimation process. Based on this annual reestimation, BLS revises the historical seasonally adjusted data for the last 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 year are usually 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 2004

### Adoption of concurrent seasonal adjustment

As indicated above, the new seasonal adjustment methodology replaces the projected factor method, which updated seasonal factors only twice a year. Under the latter procedure, the seasonal adjustment program was run at the end of the year to update past estimates using all available data and produced a set of projected seasonal factors for the first 6 months of the upcoming year. These projected factors were subsequently 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.

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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, including data for the current month. While all previous-month seasonally adjusted estimates are revised in this process, BLS policy is not to revise previous months' official seasonally adjusted estimates as new data become available during the year. Revisions will continue to be introduced for the most recent 5 years of data at the end of each year.

Numerous studies, including that discussed in a 1987 paper on the CPS labor force series,<sup>1</sup> have indicated that the practice of concurrent adjustment generally produces initial seasonally adjusted estimates requiring smaller revisions than do those produced using projected factors. 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. Numerous revisions during the year, however, should be avoided, because they tend to confuse data users and substantially increase publication costs.

The case for revisions to previous-month seasonally adjusted estimates is less compelling for CPS series, because the original sample data are normally not revised. Moreover, an empirical investigation indicated that there were no substantial gains in estimating month-to-month change 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.)

### **Extension of seasonal adjustment to additional series**

Beginning in January 2004, seasonal adjustment has been extended to three series not previously adjusted. These are the U-4, U-5, and U-6 alternative measures of labor underutilization.<sup>2</sup> These measures were substantially revised after the redesign of the CPS in 1994 and were published on a not seasonally adjusted basis because there was not a time series sufficiently long to permit evaluation of the quality of the seasonal adjustment for key components of these measures. After careful study, BLS determined that the three labor underutilization measures could be adequately seasonally adjusted, even though some of their components could not.

<sup>1</sup> George R. Methee and Robert J. McIntire, "An Evaluation of Concurrent Seasonal Adjustment for the Major Labor Force Series," in the 1987 *Proceedings of the Business and Economic Statistics Section*, American Statistical Association.

<sup>2</sup> For a detailed discussion of these measures, see John E. Bregger and Steven E. Haugen, "BLS introduces new range of alternative unemployment measures," *Monthly Labor Review*, October 1995, pp. 19-26.

The U-4 measure is computed from the original CPS data as the total unemployed plus discouraged workers as a percent of the civilian labor force plus discouraged workers. Diagnostic testing indicated that the discouraged workers series is nonseasonal and therefore does not need to be seasonally adjusted. Thus, the seasonally adjusted U-4 is derived using the official adjustments for total employment and unemployment with the original (not seasonally adjusted) discouraged worker series added.

The U-5 measure adds all other marginally attached workers to both the numerator and denominator of the U-4 measure. Testing indicated that the all other marginally attached worker series has seasonality that is weak and hard to estimate. Therefore, BLS did not seasonally adjust this series, even though it is added to the seasonally adjusted components of U-4 to derive an adjusted U-5. Analysis of the seasonally adjusted U-5 series indicated that this approach was acceptable because no residual seasonality was present.

Finally, the U-6 measure extends the U-5 measure to include workers employed part time for economic reasons in the numerator. Because this latter series is already seasonally adjusted, the seasonally adjusted U-6 measure is easily derived.

### **Revisions to 2003 estimates**

This year's revisions incorporate data through December 2003 and provide revised estimates for January 1999 through December 2003 for all previously seasonally adjusted labor force series. A total of 116 series are directly seasonally adjusted and many more are indirectly adjusted. (See the section below on aggregation.)

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 2003 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 2003 as first computed and as revised. Rounded to one decimal place as published, the rates were unchanged in 9 of the 12 months, and changed by one-tenth of a percentage point in the remaining 3 months.

## **Adjustment Methods and Procedures**

Beginning in 2003, BLS adopted the use of X-12-ARIMA as the official seasonal adjustment procedure for CPS labor force series, replacing the X-11-ARIMA program that had been used since 1980. Both X-12- and X-11-ARIMA are based on earlier versions of the widely used X-11 method

Table 1. **Seasonally adjusted unemployment rates in 2003 and change due to revision**

Month	As first computed	As revised	Change
January .....	5.7	5.8	0.1
February .....	5.8	5.9	.1
March .....	5.8	5.8	.0
April .....	6.0	6.0	.0
May .....	6.1	6.1	.0
June .....	6.4	6.3	-.1
July .....	6.2	6.2	.0
August .....	6.1	6.1	.0
September .....	6.1	6.1	.0
October .....	6.0	6.0	.0
November .....	5.9	5.9	.0
December .....	<sup>1</sup> 5.7	5.7	.0

<sup>1</sup> This rate reflects the use of seasonal factors projected for December 2003 as published in the July 2003 issue of *Employment and Earnings* and was subject to revision before regular publication of December data.

developed at the U.S. Census Bureau in the 1960s.<sup>3</sup> X-11-ARIMA 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 they are revised after future data become available.

Also developed at the U.S. Census Bureau, the X-12-ARIMA program includes all of the capabilities of the X-11-ARIMA program while also introducing major enhancements. These enhancements 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 postadjustment diagnostics.

For the majority of 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 by the ARIMA part of the model;
- X-11 decomposition—the modified and extrapolated series is decomposed into trend, seasonal, and irregular components using a series of moving averages, developed in the X-11 part of the program, 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 series, the seasonal adjustment process begins with special user-defined prior adjustments for Easter effects. (See section below on calendar adjustments.)

### 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<sup>4</sup> 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 level that may be either transitory or permanent. Three types 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 break in trend, which is 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 time series modeling component of X-12. 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.<sup>5</sup>

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

$$Y_t = \mathbf{b}X_t + Z_t$$

where  $Y_t$  is the original series or a log transformation of it,  $X_t$  is a set of fixed regression variables,  $\mathbf{b}$  represents the

<sup>3</sup> 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 Economic Statistics*, April 1998, pp. 127-52. 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 1983). 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).

<sup>4</sup> 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).

<sup>5</sup> George E.P. Box and George C. Tiao, "Intervention Analysis with Applications to Economic and Environmental Problems," *Journal of the American Statistical Association*, 1975, pp. 71-79.

regression coefficients, and  $Z$  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 theoretically be very complicated, 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-12 offers two approaches. Major external events, such as breaks in trend, are usually associated with known events. In such cases, the user has sufficient prior information to specify special regression variables to estimate and control for these effects.

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.<sup>6</sup> This is especially useful when a large number of series must be processed. Of course, both of these 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 time series models, but with some qualifications. Sometimes, the relevance of data in the distant past for seasonal adjustment is questionable. The implied X-11 moving average does not use much more than 5 years of data before and after the central observation being adjusted. Using a sliding span of 10 years in length, never revising back more than 5 years at any point, is sufficient to produce final revised seasonal factors.

Even though the X-12 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 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-12 has the capability of automatically controlling for these effects.

<sup>6</sup> I. Chang, G.C. Tiao, and C. Chen, "Estimation of Time Series Parameters in the Presence of Outliers," *Technometrics*, 1988, pp. 193-204.

Third, some very useful diagnostics available in X-12 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 its overall quality and the effects of major changes in survey design.

Based on the above considerations, REGARIMA models are initially estimated for series beginning in 1976 where data series of this 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 (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. If a shorter series is selected, 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 116 labor force series that were directly adjusted at the end of 2003. 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 refer to 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. These corrections, or prior adjustment factors, are subtracted from or used as divisors for the original series, depending on whether the seasonal adjustment is additive or multiplicative.

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

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 of these shifts have been due to noneconomic methodological changes related to revisions in population controls and major modifications to the CPS design.<sup>7</sup> One notable economic level shift was due to the 2001 terrorist attacks. These level shifts are discussed briefly below.

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 every 10 years to reflect the latest census data and, less frequently, on other occasions.

During the 1990s, three 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 international migration.

The most recent population revisions, which reflect the results of the 2000 census, were introduced with the release of data for January 2003 and were extended back to data beginning in January 2000. Specifically, there was a net increase in the total population, in large part due to growth in the numbers of Hispanics.

In 1994, major changes to the CPS were introduced, which included a redesigned and automated questionnaire and revisions to some of the labor force concepts and definitions. For data beginning in 2000, new industry and occupational classifications were introduced into the CPS.

To test for the possibility that revisions to the population controls had important effects on those CPS series with large numerical revisions in 1990, 1997, 1999, or 2000, as well as to test for effects due to the 1994 redesign, each REGARIMA model was modified to include intervention variables for those years. The coefficients for these variables provide estimates of the direction and magnitude of the intervention effects.

<sup>7</sup> For further discussion of these changes, see the following articles in previous issues of this publication: "Revisions in the Current Population Survey Effective January 1994" in the February 1994 issue; "Revisions in Household Survey Data Effective February 1996" in the March 1996 issue; "Revisions in the Current Population Survey Effective January 1997" in the February 1997 issue; "Revision of Seasonally Adjusted Labor Force Series" in the January 1998 issue; "Revisions in the Current Population Survey Effective January 1999" in the February 1999 issue; "New Seasonal Adjustment Factors for Household Data Series" in the July 1999 issue; and "Revisions to the Current Population Survey Effective in January 2003" in the February 2003 issue, available on the Internet at <http://www.bls.gov/cps/rvcps03.pdf>.

Intervention effects for 2000 were necessary for selected employment series primarily related 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 the decline in agricultural employment caused by the change in the industry classification system. (See the article, "Revisions to the Current Population Survey Effective in January 2003" in the February 2003 issue of this publication.)

For those series with significant intervention effects, the estimated level shifts were removed prior to seasonal adjustment, thereby providing a smooth link to the pre-1990, pre-1994, pre-1997, pre-1999, and pre-2000 data. The resulting "prior adjusted" series were then used to estimate the seasonal factors. These factors were applied to the original series, without prior adjustment, to obtain the seasonally adjusted series.

The prior adjustment factors used for all of the eight major civilian labor force component series are shown in table 3. Because all eight series are seasonally adjusted with the multiplicative mode, the prior adjustments also are multiplicative. That is, the original series is modified prior to seasonal adjustment by dividing it by its prior adjustment factor.

*September 2001 effect.* At the end of 2001, unemployed job losers were identified as having had substantial upward level shifts 1 month after the September 11, 2001, terrorist attacks on the World Trade Center in New York City. (See the seasonal adjustment article in the January 2002 issue of this publication for more details.) 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 in September 2001.

*Calendar effects.* Calendar effects refer to transitory level shifts in a series resulting from calendar events such as

Table 3. **Prior adjustment factors for the eight major civilian labor force components**

Series	Mode of adjustment	Prior adjustment factors		
		Pre-1990	Pre-1994	Pre-2000
Total employment:				
Men, 20 years and over .....	Multiplicative	.992		.983
Women, 20 years and over .....	Multiplicative			.988
Men, 16 to 19 years .....	Multiplicative	.940	.957	
Women, 16 to 19 years .....	Multiplicative			
Total unemployment:				
Men, 20 years and over .....	Multiplicative			
Women, 20 years and over .....	Multiplicative			
Men, 16 to 19 years .....	Multiplicative			
Women, 16 to 19 years .....	Multiplicative			

moving holidays or the differing composition of weekdays in a month between 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 have significant effects in their April data due to the timing of Easter. These series are persons at work on part-time schedules for noneconomic reasons who usually work part time in all industries and in nonagricultural industries. These series were seasonally adjusted with multiplicative models using a moving-holiday correction. A detailed discussion of the nature of the Easter effect in these series and of the procedure used to control for it was included in the January 1990 version of this article.

### **X-11 decomposition**

The X-11 method of seasonal adjustment contained within the X-12-ARIMA procedure assumes 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 1. 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 from each month's original value the corresponding seasonal factor.

Given an appropriate choice for the mode of adjustment, the prior-adjusted and forecasted series is seasonally adjusted by the X-11 component of X-12. X-11 applies a sequence of moving average and smoothing calculations to estimate the trend, 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 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.

All of the civilian labor force component series were adjusted using the multiplicative mode. In previous years, unemployed teenagers, nonagricultural employment, and some other series were additively adjusted. Formal testing for the mode of seasonal adjustment with REGARIMA resulted in the rejection of all additive adjustments in favor of multiplicative adjustments.

### **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 in X-12 to test for these conditions. These include 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. These X-12 tests include sliding-span diagnostics, frequency-spectrum estimates, and revision-history statistics. If diagnostic testing shows that any of the three conditions fails to hold, a series is deemed not suitable for seasonal adjustment.

### **Aggregation procedures**

BLS directly seasonally adjusts 116 series based on age, sex, industry, occupation, 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. This is so because seasonal patterns vary across series, there are inherent nonlinearities in X-12, many series are multiplicatively adjusted, and 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, and the unemployment rate for all civilian workers. These 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 and women 16 to 19, and men 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 in percentage form).

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**

This issue of *Employment and Earnings* contains revised monthly and quarterly data for the most recent months and quarters for many seasonally adjusted labor force series. These revisions replace the seasonally adjusted estimates previously published. Revised historical seasonally adjusted labor force data also are available in various forms on the BLS Internet site ([www.bls.gov](http://www.bls.gov)), including ftp access (<ftp://ftp.bls.gov/pub/special.requests/lf/>) to all of the revised data. The seasonally adjusted data last published for 1998 and earlier years were not further revised.