

Revision of Seasonally Adjusted Labor Force Series in 2003

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Short-run movements in labor force time series are strongly influenced by seasonality, which refers to nearly periodic fluctuations of about 1 year in duration 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 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 produce 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. Obviously, this final adjustment can be made only when 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 5 years for a final adjustment when using standard seasonal adjustment options.

During the current year, limited use is made of new data to estimate seasonal factors. The seasonal factors are forecast

for the first 6 months of the year based on data ending in December of the last year. For the second half of the year, seasonal factor forecasts are prepared based on data through June of the current year. This limited use of current data tends to increase the size of the revision to the initial seasonally adjusted estimates compared with an alternative procedure, known as concurrent adjustment, which uses all available data to prepare a seasonally adjusted estimate of the most recent month's data.

A number of research studies, including a 1987 paper on the labor force series¹ derived from the Current Population Survey (CPS), have indicated that the alternative practice of concurrent adjustment generally produces initial seasonally adjusted estimates requiring smaller revisions than those produced using projected factors. BLS is continuing to compute and evaluate concurrent adjustment for the labor force series.

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 issues the projected factors for the first 6 months of the new year as well as revised estimates of historical seasonally adjusted data for the last 5 years. Each year's data are generally subject to five revisions before the values are considered final.

The fifth and final revisions in the earliest of the 5 years are usually quite small, while the first-time revisions in the most recent year are usually much larger, although even these rarely alter the essential trends observed in the initial estimates for the major aggregate labor force series.

Important Changes in 2003

Adoption of X-12 ARIMA, an improved seasonal adjustment program, and several major changes to the CPS affect how the seasonal adjustment of the labor force time series is conducted this year. As discussed below in more detail, these changes in the CPS will cause breaks in some of the labor force series, but in many cases they are adequately controlled for by using special options available in X-12.

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¹ G.R. Methee and R.I. 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.

Change in seasonal adjustment program

This year, the program used to seasonally adjust CPS data has been updated from X-11 ARIMA, used by BLS since 1980, to the X-12-ARIMA program. The adoption of X-12 has led to expanded use of a model-based approach to prior adjustments and the use of longer time series to develop ARIMA models and evaluate the quality of seasonal adjustment. The features and use of the program are discussed in more detail later in this article.

New industry and occupational classification systems

The CPS industry and occupational series are based on new industry and occupational classification systems derived respectively from the 2002 North American Industry Classification System and the 2000 Standard Occupational Classification system. These new classification systems result in breaks in the time series for industry and occupational data. As a result, seasonally adjusted detailed industry and occupational estimates from the household survey will not be presented until enough data classified under the new systems become available to make a determination, based on diagnostic testing, that these estimates meet minimum quality standards. Selected series for agriculture and nonagricultural industries will continue to be seasonally adjusted.

The procedure for seasonally adjusting the total CPS civilian labor force, employment, and the unemployment rate will be affected by the change in industrial classification. In the past, adding up the directly seasonally adjusted estimates for eight age-sex-industry series yielded the seasonally adjusted total employment level. (See the section on aggregation procedures later in this article.) These eight series consisted of teenagers and adults by sex in agriculture and nonagricultural industries. Under the new industrial classification system, there is a major decline in the size of the agricultural sector due to a less inclusive definition of that sector. This has a major effect on total agricultural employment, and an even larger effect when agricultural employment is disaggregated by age and sex. For this reason, BLS is dropping the industry, age, and sex detail for deriving the seasonally adjusted total employment series.

With the loss of industry detail, employment for only four age-sex groups (teenage men, teenage women, men aged 20 years and over, and women aged 20 years and over) will be directly seasonally adjusted and the sum of these four groups will constitute the seasonally adjusted total employment level. The change in the procedure for adjusting total employment also affects estimates of the total labor force and the unemployment rate. Total unemployment, however, will not be affected because industry detail has not been used to derive this total.

The change in procedure for deriving total seasonally adjusted employment, using only the four age-sex groups, has little effect on the adjusted labor force series. For this reason, it is not necessary to revise adjusted total

employment, labor force, and the unemployment rate back beyond the usual revision period of 5 years.

Seventeen employment series based on aggregate industry levels—that is, agriculture and nonagricultural—will continue to be seasonally adjusted. These series relate to class of worker and part-time workers for those industries. CPS industry data series from January 2000 to December 2002 have been recoded to reflect the new industrial classification system. This will cause the break in the agricultural series to appear as a large drop in level between December 1999 and January 2000.

New race and ethnicity classifications

The CPS questions on race and Hispanic origin have been modified to comply with the new standards for maintaining, collecting, and presenting Federal data on race and ethnicity. A major change is that respondents may select more than one race when answering the survey. Prior to January 2003, individuals who belonged to more than one race were forced to pick a single primary race. The CPS series for whites and blacks will now refer to persons who report, respectively, that they are white (and no other race) and black or African American (and no other race). Nationally, only 1.3 percent of the civilian noninstitutional population aged 16 years and older belonged to more than one race in May 2002, so this is not likely to have a major effect on the white and black series.

Unlike those for race, modifications to the questions for determining Hispanic status may have an effect on the Hispanic labor force series. Respondents will continue to be asked a separate question to determine if they are Hispanic, but this question has been altered in important ways. Prior to 2003, respondents were first asked about their race and then asked to designate their or their ancestors' country of origin. Persons were then designated as Hispanic if their, or their ancestors', origins lay in certain countries. Respondents are now asked directly if they are Spanish, Hispanic, or Latino before being asked about their race.

BLS will continue to seasonally adjust Hispanic total employment and unemployment but will not introduce seasonally adjusted data for detailed age and sex categories at this time. The reason is that the new ethnicity question may change the composition of those who identify themselves as Hispanic and this may alter the seasonal patterns, particularly for specific age and sex categories. As more data become available, BLS will make a determination as to the feasibility of seasonally adjusting more detailed Hispanic series.

New population controls

Also beginning in 2003, population controls based on Census 2000 will be used in the current monthly CPS estimation process. In addition, CPS data series from January 2000 through December 2002 have been revised to reflect the introduction of the Census 2000-based population controls. Revisions further back in time were not considered feasible, primarily because the 1990 census-based intercensal

population estimates were adjusted for the estimated undercount in the 1990 census, whereas the 2000 census-based estimates have no undercount adjustment. This will cause a break to occur in some of the historical series between December 1999 and January 2000. In particular, there is a net increase in total population, due to increases in the number of Hispanics, adults, and whites that more than offset decreases in the number of teenagers and blacks.

Effect of Changes

Normally, the only reason for making yearly revisions to seasonally adjusted series is to account for new information in the latest available data. This year, however, revisions also will be affected by the changes in the CPS and the adoption of the X-12 ARIMA seasonal adjustment program.

The changes introduced into the CPS this year affect the number of series that are directly seasonally adjusted. Prior to 2003, 182 series based on age, sex, industry, occupation, and other characteristics were directly seasonally adjusted; beginning in 2003, 116 series are directly seasonally adjusted. Eighty-one series have been eliminated: most of these were related to industry and occupation. Fifteen aggregate series, previously derived from detailed series that are no longer seasonally adjusted, are now directly seasonally adjusted at the aggregate level.

In another change, the length of many of the series used for time series modeling has been extended. Models for six of the eight major labor force series are estimated using data beginning in 1976. (See table 1.) The revisions to the seasonally adjusted estimates, however, do not need to extend beyond 5 years because of the limited memory of X-12 filters. The purpose of using a longer time series is to improve the quality of the time series models used to support the seasonal adjustment process. (See the section on time series models below for further discussion.)

Another change concerns the use of prior adjustments to correct a series for outliers. Previously, prior adjustments were confined to special events occurring in 1994, 1997, and 1999. Additional prior adjustments have been added to account for the changes in the data beginning in 2000, as well as for special events that occur in the part of the series that has been extended to earlier years.

This year's revisions incorporate data through December 2002 and provide revised estimates for January 1998 through December 2002 for all previously seasonally adjusted labor force series. Table 2 contains the prior adjustment factors and the new projected seasonal factors to be applied during the first 6 months of 2003 to the eight component series used in the computation of the seasonally adjusted civilian labor force and unemployment rate. (See the section on aggregation procedures later in this article.) Projected factors for the last 6 months of 2003 will be published in the July issue of this publication.

An important criterion for evaluating alternative methods of seasonal adjustment is how close initial estimates are to 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 2002 seasonally adjusted data are not final, the first revisions are usually the largest, and often indicate the direction of subsequent revisions. This year, however, the revisions reflect both new observations and the changes in the CPS data discussed earlier.

Table 3 shows the civilian unemployment rates for 2002 as first computed and as revised. Rounded to one decimal place as published, the rates were unchanged in 4 of the 12 months, and changed by one-tenth of a percentage point in the remaining 8 months. Both the initial and revised series show the same overall rise in the rate from 5.6 percent in January to 6.0 percent in December.

Table 1. REGARIMA models used for the eight major civilian labor force components

Series	Model	Transformation	Length of series
Total employment:			
Men, 20 years and over	(0,1,2)(0,1,1)	LOG	1976-2002
Women, 20 years and over	(0,1,0)(0,1,1)	LOG	1976-2002
Men, 16 to 19 years	(3,1,0)(0,1,1)	LOG	1976-2002
Women, 16 to 19 years	(0,1,1)(0,1,1)	LOG	1976-2002
Total unemployment:			
Men, 20 years and over	(0,1,3)(0,1,1)	LOG	1990-2002
Women, 20 years and over	(1,1,0)(0,1,1)	LOG	1990-2002
Men, 16 to 19 years	(0,1,1)(0,1,1)	LOG	1976-2002
Women, 16 to 19 years	(0,1,1)(0,1,1)	LOG	1976-2002

Adjustment Methods and Procedures

As indicated earlier, the official seasonal adjustment procedure for the labor force series has been changed this year to X-12 ARIMA from the X-11 ARIMA program that had been in use by BLS since 1980.

Both X-12 and X-11 ARIMA are based on the widely used X-11 method developed at the U.S. Census Bureau in the 1960s.² X-11 ARIMA added to X-11 the ability to extend

² For a detailed discussion of X-12 ARIMA 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. For documentation on X-11 ARIMA, see *The X-11 ARIMA Seasonal Adjustment Method*, by Estela Bee Dagum (Statistics Canada Catalogue No. 12-564E, January 1983). The X-11 method is described in *The X-11 Variant of the Census Method II Seasonal Adjustment Program*, by Julius Shiskin, Alan Young, and John Musgrave (Technical Paper No. 15, Bureau of the Census, 1967).

Table 2. Prior adjustment and January-June 2003 seasonal adjustment factors for the eight major civilian labor force components

Series	Mode of adjustment	Prior adjustment factors			Projected seasonal adjustment factors					
		Pre-1990	Pre-1994	Pre-2000	January	February	March	April	May	June
Total employment:										
Men, 20 years and over	Multiplicative	.975		.982	.986	.989	.991	.999	1.003	1.006
Women, 20 years and over	Multiplicative			.987	.998	1.003	1.006	1.003	1.001	.993
Men, 16 to 19 years	Multiplicative	.939	.957		.897	.920	.947	.939	.985	1.133
Women, 16 to 19 years	Multiplicative				.935	.946	.944	.942	.954	1.115
Total unemployment:										
Men, 20 years and over	Multiplicative				1.216	1.183	1.148	1.009	.933	.938
Women, 20 years and over	Multiplicative				1.082	1.033	1.011	.947	.962	1.026
Men, 16 to 19 years	Multiplicative				1.033	1.024	.959	.881	.896	1.337
Women, 16 to 19 years	Multiplicative				.917	.928	.969	.894	.994	1.354

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 recalculated after future data become available.

Developed at the U.S. Census Bureau, the X-12 ARIMA program includes all 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 post-adjustment diagnostics.

For the majority of labor force series 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;
- 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.)

Table 3. Seasonally adjusted unemployment rates in 2002 and change due to revision

Month	As first computed	As revised	Change
January	5.6	5.6	.0
February	5.5	5.6	0.1
March	5.7	5.7	.0
April	6.0	5.9	-.1
May	5.8	5.8	.0
June	5.9	5.8	-.1
July	5.9	5.8	-.1
August	5.7	5.8	.1
September	5.6	5.7	.1
October	5.7	5.8	.1
November	6.0	5.9	-.1
December	6.0	6.0	.0

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 models³ are designed to make forecasts of a time series based only on 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.

³ For a more detailed discussion of ARIMA models, refer to G.E.P. Box and G.M. Jenkins, *Time Series Analysis, Forecasting and Control* (San Francisco, Holden Day, 1970); and M. Kendall and J.K. Ord, *Time Series* (New York, University Press, 1990).

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, which 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 Box and Tiao⁴.

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} 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 theoretically be very complicated, in practice it takes a parsimonious form involving only a few estimated parameters. (See table 1.) There are well developed methods for determining the number and type 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 prior information is available 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 Chang, Tiao, and Chen.⁵ 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 directly used while unknown substantial outliers may still be discovered.

⁴ G.E.P. Box and G.C. Tiao, "Intervention Analysis with Applications to Economic and Environmental Problems," *Journal of the American Statistical Association*, vol. 70, 1975, pp. 71-79.

⁵ I. Chang, G.C. Tiao, and C. Chen, "Estimation of Time Series Parameters in the Presence of Outliers," *Technometrics*, vol. 30, 1988, pp. 193-204.

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 from the distant past for seasonal adjustment is questioned. 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 obtain 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 it 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 large changes to 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.

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 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 the observed data. When there is a tradeoff between 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 it 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 2002. For each of the eight major civilian labor force components, table 1 presents the form of the ARIMA part of the model, the transformation selected, and the length of the series used to fit the model.

Prior adjustments

The purpose of prior adjustments 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 the original series if the seasonal adjustment is additive. If the seasonal adjustment is multiplicative, the original series is divided by these values.

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.⁶ One notable economic level shift was due to the 2001 terrorist bombings. These 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 2000 census, were introduced with the release of data for January 2003 and were extended back to data beginning in January 2000. The nature and effect of these revisions have been discussed previously.

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. For data beginning in 2000, as discussed above, 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

⁶ 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; and "New Seasonal Adjustment Factors for Household Data Series" in the July 1999 issue.

estimates of the direction and magnitude of the intervention effects.

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 2000-based census population controls and the decline in agricultural employment caused by the change in the industry classification system.

A number of intervention effects previously identified in selected series for 1994, 1997, and 1999 were found to no longer be significant, and some additional interventions for 1990 and 1980 were added to account for the use of longer series.

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 eight major civilian labor force component series are shown in table 2, together with the seasonal factors. 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 and unemployed private wage and salary workers in the transportation and public utilities industry were identified as having had substantial upward level shifts 1 month after the September 11, 2001, terrorist bombings of the World Trade Center in New York City. (Because of the introduction of the new industry classification system, the seasonal adjustment of the second series was discontinued.) (See 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 bombings.

Calendar effects. Calendar effects refer to transitory level shifts in a series resulting from calendar events such as moving holidays or the differing composition of weekdays in a month between years. These effects have different influences on data for 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 initially seasonally adjusted with multiplicative models using the moving-holiday extension of X-11 ARIMA

developed at BLS. This procedure has been adapted to X-12 ARIMA. 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 uses 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 about 120 time points. That is, to obtain a final seasonally adjusted estimate for a single time point requires 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 tests 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 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 labor force, and the unemployment rate for all civilian workers. These are produced by 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 the same four age-sex groups for employment in all industries. 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 can not be directly computed and projected 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 data for the most recent 12 months 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), including ftp access (<ftp://ftp.bls.gov/pub/>

[special.requests/lf/](ftp://ftp.bls.gov/pub/)) to all of the revised data. The seasonally adjusted data last published for 1997 and earlier years were not further revised.

The January-June 2003 factors for any of the directly adjusted series beyond the eight major labor force components can be obtained from BLS upon request. Requests for the seasonal factors used for the labor force data should be addressed to the Division of Data Development and Publications, Office of Employment and Unemployment Statistics, Bureau of Labor Statistics, Washington, DC 20212.