12 Seasonal adjustment and trend-cycle estimation

The Seasonal Adjustment Guidelines for Statistics Canada's Methods and Standards Committee were written in March 2000. This is a proposal to update them following Statistics Canada's adoption of X-12-ARIMA (Findley et al., 1998) and to standardize them with those at the US Census Bureau (McDonal-Johnson et al., 2006a, 2006b) and EUROSTAT (Mazzi, 2008).

12.1 Scope and Purpose

12.1.1 Seasonal adjustment

A time series is a sequence of measurements of one variable observed through time. In most situations, the observations are dependent through time and it is this dependence in itself that is of interest. For the purpose of seasonal adjustment, the time series is assumed to be observed either monthly or quarterly and constituted of three distinct elements: the trend-cycle, the combined seasonal and calendar effects and the irregular. The objective of seasonal adjustment is to identify and estimate the combined seasonal and calendar effects, and to remove them from the time series. The resulting series is then called seasonally adjusted and consists of only the trend-cycle and irregular components.

Seasonal effects are the intra-year (monthly, quarterly) fluctuations which repeat more or less regularly from year to year. They result from composite effects of events related to the climate, institutional decisions or modes of operation which repeat with a certain regularity within the year. Calendar effects are related to the composition of the calendar. They include trading-day effects associated with the weekday composition of the month, moving holiday effects associated with non-fixed date holidays such as Easter, and other predictable events from the calendar. Trading-day effects are present when the level of activity varies with the days of the week. The Easter effect may be seen as the variation in level due to the displacement of a volume of activity from April to March when Easter falls in March instead of the usual April occurrence.

The seasonally adjusted series enables the assessment of the current trend-cycle direction with month-to-month or quarter-to-quarter comparisons.

The trend is the underlying long-term movement lasting many years. The cycle, also called business-cycle, is a quasi-periodic oscillation lasting for more than a year around the long-term trend. It is characterized by alternating periods of expansion and contraction. The trend and the cycle are difficult to estimate separately and thus are considered and analyzed as a whole as the trend-cycle.

The irregular component represents random variations that are unforeseeable movements related to events of all kinds and which cannot be attributed to the trend-cycle component, the seasonal component or the calendar effects.

12.1.2 Trend-cycle estimation

Seasonal adjustment of highly volatile series may not be enough to draw conclusion on the current trend-cycle direction. In those cases, further smoothing of the seasonally adjusted series is advisable to eliminate most of the irregular component. The resulting trend-cycle estimate is to be considered auxiliary information to the seasonally adjusted series.

12.1.3 X-12-ARIMA

The foundation of Statistics Canada's seasonal adjustment program is 1967's X-11 Variant of the Census Method II (Shiskin et al., 1967; Ladiray and Quenneville, 2001). In 1980, Statistics Canada incorporated the autoregressive integrated moving average (ARIMA) (Box and Jenkins, 1976) models to forecast and backcast the series before seasonal adjustment as well as several major modifications to improve the Census method. This new variant was called X-11-ARIMA (Dagum, 1980). Extending the series with ARIMA forecasts gave, on average, smaller revisions to the seasonally adjusted series. In 1988, Statistics Canada released an improved version of X-11-ARIMA (Dagum, 1988) available for microcomputers.

In 1998, the US Census Bureau released X-12-ARIMA (Findley et al., 1998). X-12-ARIMA uses linear regression with ARIMA errors (regARIMA modeling) to estimate calendar effects as well as additive outliers, level shifts and other predefined regression variables. Additionally, X-12-ARIMA permits user-defined regression for unusual or nonstandard calendar effects and includes a variant of the TRAMO algorithm (Gomez and Maravall, 1996) for automatic regARIMA modeling. Other features are described in the user guide (US Census Bureau, 2008). X-12-ARIMA is available for several computing platforms, including its raw FORTRAN executable, C for UNIX and one for FAME. The X12 procedure (SAS Institute Inc, 2007) in SAS® also implements the most important options of the method. X-12-ARIMA is the recommended seasonal adjustment method at Statistics Canada as X-11-ARIMA is being phased-out and will no longer be supported.

12.2 Principles of seasonal adjustment

As seasonal adjustment aims to filter out the combined seasonal and calendar effects, it should be applied when those effects can be properly identified and estimated. When seasonal and /or calendar effects cannot be identified in a time series, the series is considered de facto seasonally adjusted. Seasonally adjusted series should have no residual seasonality and are generally smoother than the corresponding raw series.

As new data becomes available, the various time series components can better be estimated. This results in revised and more accurate estimates for past seasonally adjusted values which should be acknowledged. However, too frequent revisions may hinder the usefulness of the seasonally adjusted data. Seasonally adjustment options should be selected to minimize the amplitude of the revisions without affecting the overall quality of the adjustment and a revision strategy should be implemented to minimize the frequency of the revisions to the published data.

Inappropriate seasonal adjustment options may lead to misleading results. As such proper time and effort should be put into the analysis of the series and on the initial selection and maintenance of options. Similarly, as various sets of options could lead to various results, collection of series which measure the same economic activity should be treated as a whole. This usually entails the use of similar adjustment options by the area involved for coherence purposes.

12.3 Principles of trend-cycle estimation

As a complement to the seasonally adjusted series, trend-cycle estimates may indicate the direction of the short-term trend (within the current year). When new data points are added to the series, past trend-cycle estimates can be estimated more accurately and are therefore subject to revisions. Trend-cycle estimates are sensitive to the current phase of the business cycle (turning point, recession, recovery or expansion); thus, the reliability of the current trend-cycle estimates depends on the proximity of a turning point as well as on the amplitude of the cycle.

Trend-cycle estimates should be fully consistent with the published seasonally adjusted series. If the seasonally adjusted values are frozen in a database, the trend-cycle should be estimated from the seasonally adjusted series as it appears in the frozen database. Similarly, if the seasonally adjusted series underwent further adjustments such as aggregation, balancing or reconciliation, the trend-cycle should be estimated from the aggregated, balanced or reconciled series.

12.4 Seasonal adjustment guidelines

- Before seasonally adjusting a series for the first time, one should assess if the seasonality is identifiable and if it can properly be estimated.
- If a series is neither seasonal or does not have calendar effects, no treatments are applied and the series is deemed de facto seasonally adjusted.
- Seasonally adjusted series should not have residual seasonality, nor residual calendar effects.
- For proper identification and estimation of seasonal and calendar effects, it is recommended to use a span of 10 to 15 years of data. The minimum is five (5) years to properly estimate a seasonal pattern and seven (7) years for calendar effects such as trading days and moving holidays.
- It is recommended to use regARIMA modeling to calculate calendar adjustment factors and temporary adjustments such as those from known additive outliers or level shifts. The same regARIMA model should usually be used to extrapolate the series in order to reduce revisions in the seasonally adjusted series.
- There are various seasonal adjustment options; the most important ones revolve around the selection of the decomposition model, the specification of a regARIMA model and the seasonal and trend-cycle filter lengths. X-12-ARIMA's automatic selection processes may be used for a preliminary setting of those options. When time permits or when quality expectation is high, the automatic selection should be reviewed using alternatives statistics, expert prior knowledge and graphical analysis.
- Seasonal adjustment options for each series should be reviewed periodically to verify their continued applicability and appropriateness, and to increase accuracy. The already selected seasonal adjustment options should not be changed between scheduled reviews without a right justification.
- Although the main seasonal adjustment options should usually be fixed between reviews, the adjustment factors and the regARIMA model parameters should be concurrent – that is, recomputed using all available data points. Exceptions may apply when the most recent observations have been historically subjected to large revisions. In this case, year-ahead (forecasted) factors may be more appropriate.
- For an aggregate (or composite) series comprising several component series, seasonal adjustment can be done indirectly – the seasonally adjusted components are aggregated to form the seasonally adjusted composite series – or directly –the aggregate is adjusted independently. With this last method, there can be discrepancies between the aggregate series and the aggregated components after seasonal adjustment. When required, apply a raking or a reconciliation method to reconcile the direct seasonally adjusted aggregate series with its seasonally adjusted components, without modifying the unadjusted components if possible.
- For either the indirect and direct approach, the aggregate should not contain residual seasonality and should be relatively smooth. The raked direct approach is preferred when more importance is given to the aggregate series than its components or when the components have very similar observed seasonal components. The indirect adjustment is usually appropriate when the component series have very different seasonal patterns and many of the series can be seasonally adjusted individually.
- Forcing the annual totals of the seasonally adjusted data to be equal to those of the original (or calendar adjusted original) series is rarely theoretically justified but could be used when there is a need for consistency with external benchmarks such as in the System of National Accounts or in reconciling an aggregate and its components.

12.4.1 Revisions to seasonally adjusted data

- Revisions to the seasonally adjusted data are to be published according to an officially stated revision policy and in alignment with the release calendar of the unadjusted data.
- When a concurrent seasonal factor is used, it is not necessary to revise the seasonally adjusted estimates more than one period back. Exceptions may apply when preliminary observations are used: it is recommended to revise the seasonal factors whenever the original figures are revised. On an annual basis, revise the seasonally adjusted values for the last three years when the first month (quarter) of the next year becomes available. When seasonally adjusted values are obtained with year-ahead (forecasted) seasonal adjustment factors, the annual revision applies to the last four years.

12.4.2 Trend-cycle estimation

- Apply the trend-cycle estimation method to the published seasonally adjusted series to ensure that the trend-line is centered on the seasonally adjusted series. The Dagum (1996) method or an appropriate adaptation/variant of it is the recommended methods for trend-cycle estimation.
- Inform the users that the last few trend-cycle estimates (and especially the very last estimate) are subject to revisions when one more data point is added. This higher variability associated with the estimates around the end can be indicated, for example, by a dashed line on the trend graph or by publishing an information note with the data.
- Revise trend estimates as far back as the seasonally adjusted estimates were revised, and in a typical monthly series add 3 more months (2 for quarterly) during the year, and 6 months (2 for quarterly) at the annual review.

12.4.3 Data presentation and data access

- Month-to-month (or quarter-to-quarter) growth rates and changes should be computed on seasonally adjusted data and should be used with caution if the time series has high volatility. Year on year same-month comparisons should be computed on calendar adjusted data, or, in absence of calendar effects, on raw data.
- Users should be given access to the full historical raw series, the seasonally adjusted and, upon request, to the seasonal adjustment options.

12.4.4 Implementation

Assistance with the interpretation and implementation of these guidelines can be obtained from the Time Series Research and Analysis Centre (TSRAC), Business Survey Methods Division.

12.5 Quality indicators

The following indicators may be used to assess if a series is seasonal:

- A simple time plots and a year-over-year graph to inspect the series for seasonal patterns and to visually find other perturbations.
- Various statistics such as the two Fisher tests for stable and moving seasonality and spectrum graphs described in (Ladiray and Quenneville, 2001; Findley et al., 1998).

Residual seasonality can be tested as above on the seasonally adjusted data or with other tests. (Ladiray and Quenneville, 2001)

Statistics to assess the significance of the estimated regARIMA components and the overall quality of the fitted model are described in many textbooks on the subject.

Simple summary statistics on the historical revisions of both the level and the period-to-period change in the seasonally adjusted data may be used to quantify the revisions. Revisions in the seasonal adjustment context usually improve accuracy because they come from using observations that were not initially available.

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