This module is part of the

Memobust Handbook

on Methodology of Modern Business Statistics

26 March 2014

Theme: Seasonal Adjustment – Introduction and General Description

Contents

General section

1. Summary

A common practice nowadays for a National Statistical Institute (NSI), when dealing with systems of time series collected on sub-annual basis, is to perform seasonal adjustment (SA) in order to help users to interpret published statistics. By separating the non-seasonal part from the seasonal and calendar effects a user is likely to obtain a refined picture about the underlying movement from the time series observations. Hence, the SA-procedure eliminates the estimated seasonal and calendar effects from the original time series and obtain the SA estimates. Such estimates are likely to reveal what is new in a time series, which is a crucial issue related to seasonal adjustment. Hence, SA may be viewed as an aid in decision making, usually used for comparisons between different regular periods in time (month-to-month, quarter-to-quarter, etc.) but also for forecasting purposes and for model-building. For example, SA of macroeconomic indicators is useful for policy makers and other users because of the need for understanding repetitive fluctuations in economic activity (business-cycles) as well as the short-term and the long-term movements in time series. These effects are in a SA-procedure regularly expressed in terms of a unified trend-cycle component (see, e.g., Statistics Canada, 2009; ABS, 2008).

Since SA is a modelling procedure which transforms the original data in order to obtain the estimates a natural question is how reliable these estimates are. Further issues usually associated with SA are reliability and quality with respect to benefits and costs associated with the procedure in question. Some other issues, such as revisions, outlier treatment, aggregation and data presentation are also common to different domains of statistical production which necessitates standardised, coherent and consistent treatment of SA-procedures.

A NSI should also take care about the needs of both the internal and external users, which typically implies shifting focus from a pure methodological aspect to some other (perceived) quality aspects. Balancing between these two aspects is recommended since statistics should be of high quality but also easily interpretable for users.

A vast and very detailed literature about issues related to SA is already available to the public. See, e.g., IMF (2001), ECB (2003), Dagum and Cholette (2006), European Communities (2001) etc. The websites of some prominent statistical offices and developers of statistical software offer detailed information about the related procedures (e.g., Statistics Canada, 2009; ABS, 2008; U.S. Census Bureau, 2012; Bank of Spain, 2012; Koopman and Lee, 2010). Also, the European Statistical System (ESS) developed a set of guidelines on seasonal adjustment (Eurostat, 2009) and the new software Demetra+ (Eurostat, 2012). Although the ESS Guidelines provide a set of recommendations for the best practices, this document by its nature does not give a comprehensive introduction to seasonal adjustment for the non-specialists and typical users at a NSI.

Hence, in this and related modules the main focus is put on aggregating information about SA from different sources and experiences in order to assist the users at NSIs with relevant easy-to-read information and references to the more detailed technical and methodological description.

2. General description

2.1 Main objectives and general description

Intra-annual (monthly and quarterly) macroeconomic indicators represent a key tool for several people: policy makers, business managers, journalists, economists, statisticians, etc. Most of such indicators exhibit a (dominant) seasonal pattern obscuring and dwarfing other components of greater economic relevance to understand the economic phenomena. As a consequence, the seasonal fluctuations should be filtered out through the *seasonal adjustment*, a technique aimed at estimating the seasonal component and removing it from the observed time series. Figure 1 shows two examples of seasonal series (raw or unadjusted series) together with their corresponding SA series: the Italian industrial production index and the Italian labour force. Although both series are seasonal, the graphs reveal their different features. In particular industrial production shows more regular and larger seasonal fluctuations than labour force.

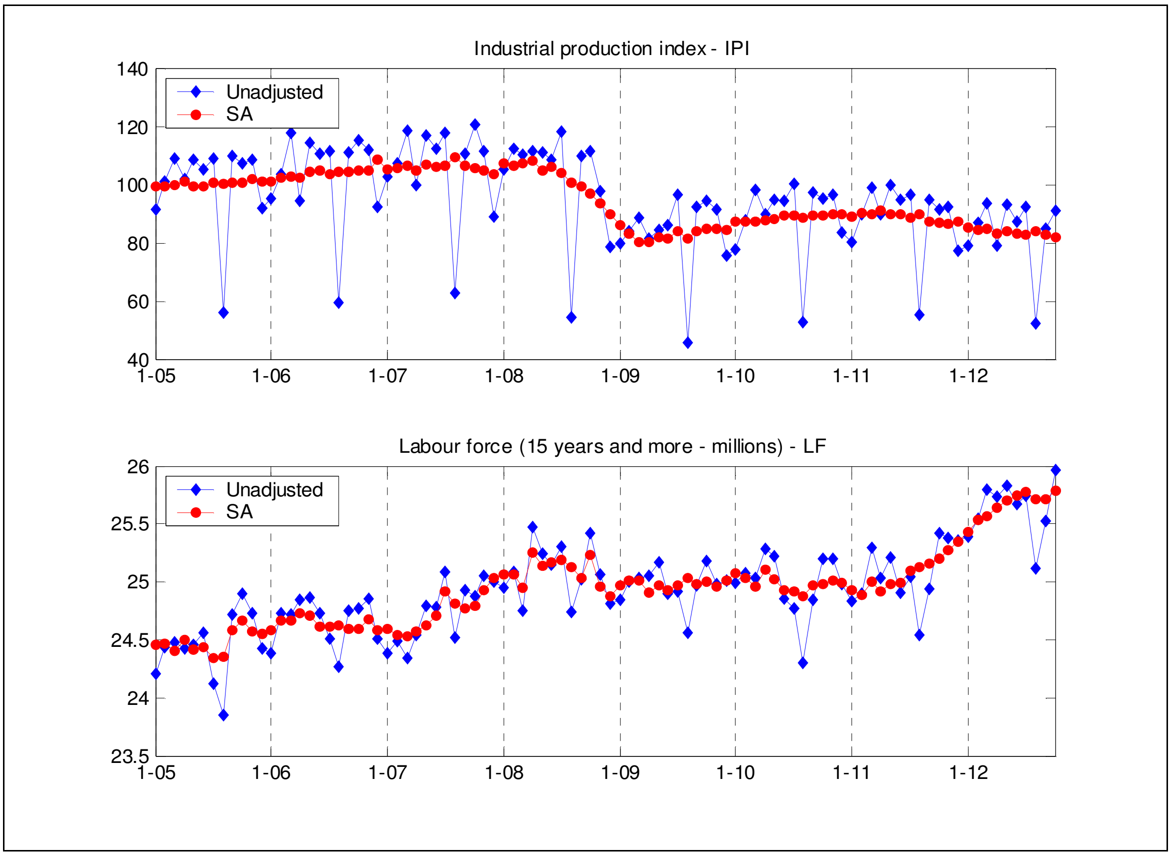

Figure 1: Italian industrial production index and labour force. Unadjusted and seasonally adjusted data (by Tramo-Seats for Linux).

From an analytical point of view seasonally adjusting a time series, X_t, means to decompose it in four different components:

1. trend component T_t that shows the long-term tendency;
2. seasonal component S_t that represents intra-year fluctuations which recur every year to the same extent (short-term regular variations);

3. cyclical component C_t that indicates the medium and long term fluctuations containing the long-term irregular variations. The cyclical component is worth examining only in case of very long time series. As a general practice we assume that it is included in the trend component that it is referred to as cycle-trend;
4. irregular component I_t that contains the random effect that we cannot predict.

Depending on the relations among these components, different decomposition models can be considered:

a. the additive model

$$X_t = T_t + S_t + C_t + I_t$$

where the differences between the observed data and the cycle-trend (called seasonal differences) are supposed to be nearly constant in the same periods (months or quarters) of different years;

b. the multiplicative model

$$X_t = T_t \times S_t \times C_t \times I_t$$

where the ratios between the observed data and the cycle-trend (called seasonal-irregular ratios) are supposed nearly constant in similar periods of different years;

c. the log-additive model

$$ln(X_t) = ln(T_t \times S_t \times C_t \times I_t) = ln(T_t) + ln(S_t) + ln(C_t) + ln(I_t)$$

that can be used to specify an additive model on the logarithm of the time series.

There are some other decomposition models but these three are the most commonly used. Figure 2 shows two examples of deterministic time series built both summing up and multiplying a linear trend and a deterministic seasonality (both shown in the upper panels). Their sum is displayed in the lower left-hand panel, while their product is represented in the lower right-hand panel: in the former case the seasonal amplitude is constant around the trend, in the latter case the seasonality amplifies with the trend.

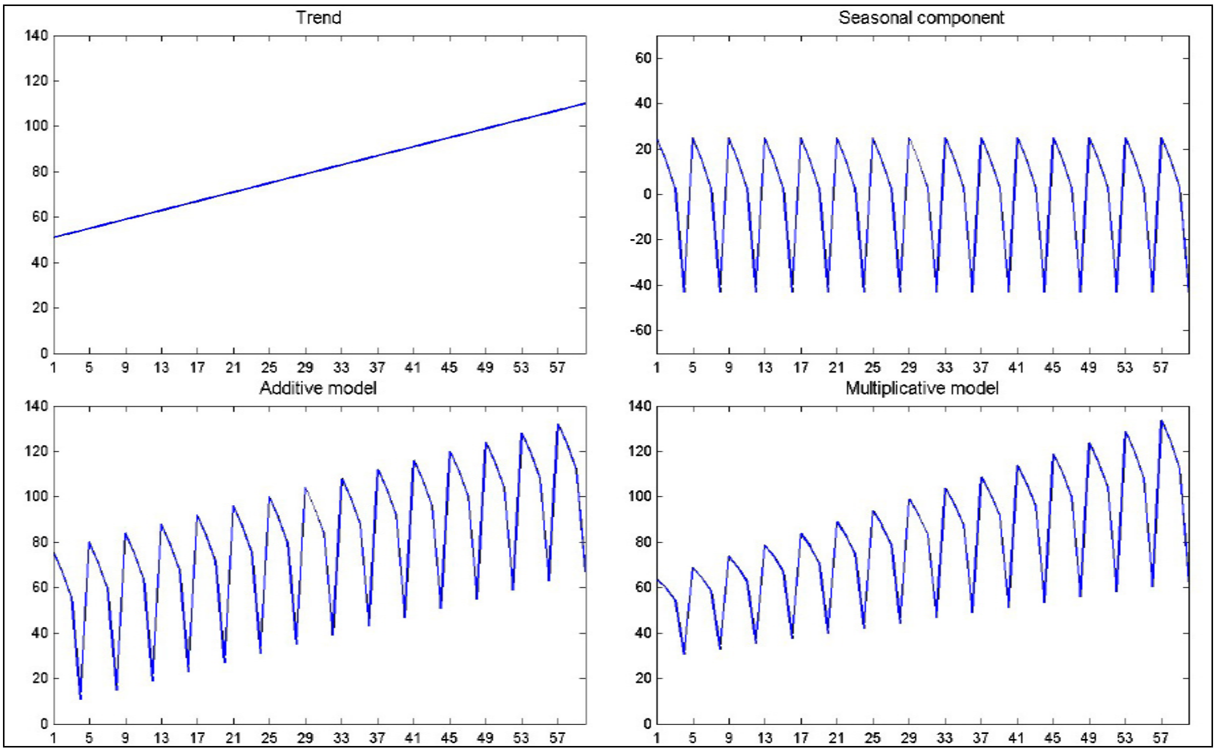

Figure 2: Additive and multiplicative models using a linear trend and a deterministic seasonal component.

According to the decomposition model used, the seasonally adjusted time series A_t, which contain neither calendar effects nor seasonal component, can be formulated in two alternative ways:

$$A_t = X_t - S_t = T_t + C_t + I_t \qquad \text{additive model}$$

$$A_t = X_t / S_t = T_t \times C_t \times I_t \qquad \text{multiplicative model}$$

It is worth noting that in the additive decomposition additive components have the same scale as the original series and the expected value of the irregular component is 0, while in the multiplicative or log-additive decompositions only the trend (and consequently the SA series) is expressed in the original scale and the expected value of the irregular component is 1.

Time series may be affected by the composition of calendar (*calendar effects*) or may contain atypical observations which do not follow the usual pattern of the time series (*outliers*). The former are always included in the seasonality and therefore removed from the SA series. As far as outliers are concerned, when they are assigned either to the irregular or to the trend, they are visible in the SA series, while when they are assigned to the seasonal component they are removed from the SA series.

Both calendar effects and outliers are generally dealt as deterministic components that are described below.

Calendar effects

The calendar effect component is a part of the time series which represents calendar variations, such as trading/working days, moving holidays and other calendar-related systematic effects that occur not the same way from year to year.

a) Trading/working day effect

Although the trading day and working day could be distinguished, we will use these as synonyms. Since the number of trading days may be different both in consecutive periods and in the same period of different years, it cannot be managed as an ordinary seasonal effect.

b) Holiday effect

The number of working days depends also on the holidays, which do not fall on weekends. As the national holidays vary from nation to nation, it is recommended to consider national calendar including national holidays to build country specific regression variables (or regressors), avoiding the use of standard regressors.

c) Easter effect and other moving holiday effect

There are some holidays which do not fall on a fix date. For example, Easter may be either in March or in April. Moreover, Easter may have one-week or more time duration before and/or after Sunday.

d) Bridging effect

Bridging days are days lying between a public holiday and a weekend. They are counted in purely calendar terms as full working days, but because of their particular date, they could be considered as holidays to offset overtime already worked or for long weekends.

e) Leap-year effect

There is an additional day in every four year which may affect the time series.

Figure 3 represents trading-day, leap-year and Easter effects drawn from an additive decomposition. The overall calendar effect is the sum of the represented effects, derived multiplying the regressors by their respective parameters of the regression model estimated on the unadjusted time series.

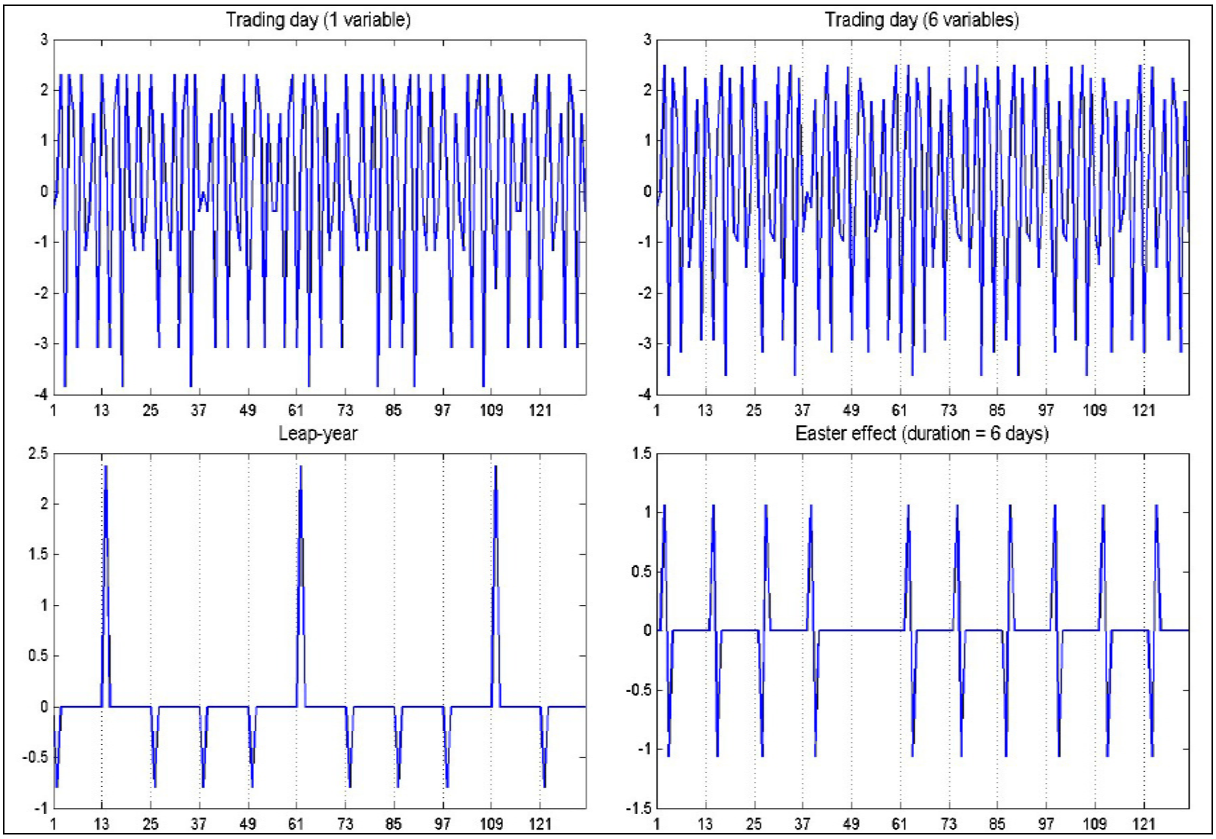

Figure 3: A representation of trading-day, leap-year and Easter effects in an additive decomposition.

Outliers

Outliers are data which differ greatly from the tendency. Typically these are caused by a one-off economic or social event. The most known type of outliers are:

1. the additive outlier which influences only one observation (it is included in the irregular component);
2. the transitory change that affects several observations, but reduces gradually (exponentially) until the time series returns to the initial level (it is included in the irregular component);
3. the level shift, which represents a step, that is a permanent change in the time series level (it is included in the trend component).

The left-hand panels of figure 4 represent the above outliers. Their effects on the time series are highlighted in the right-hand panels through red lines.

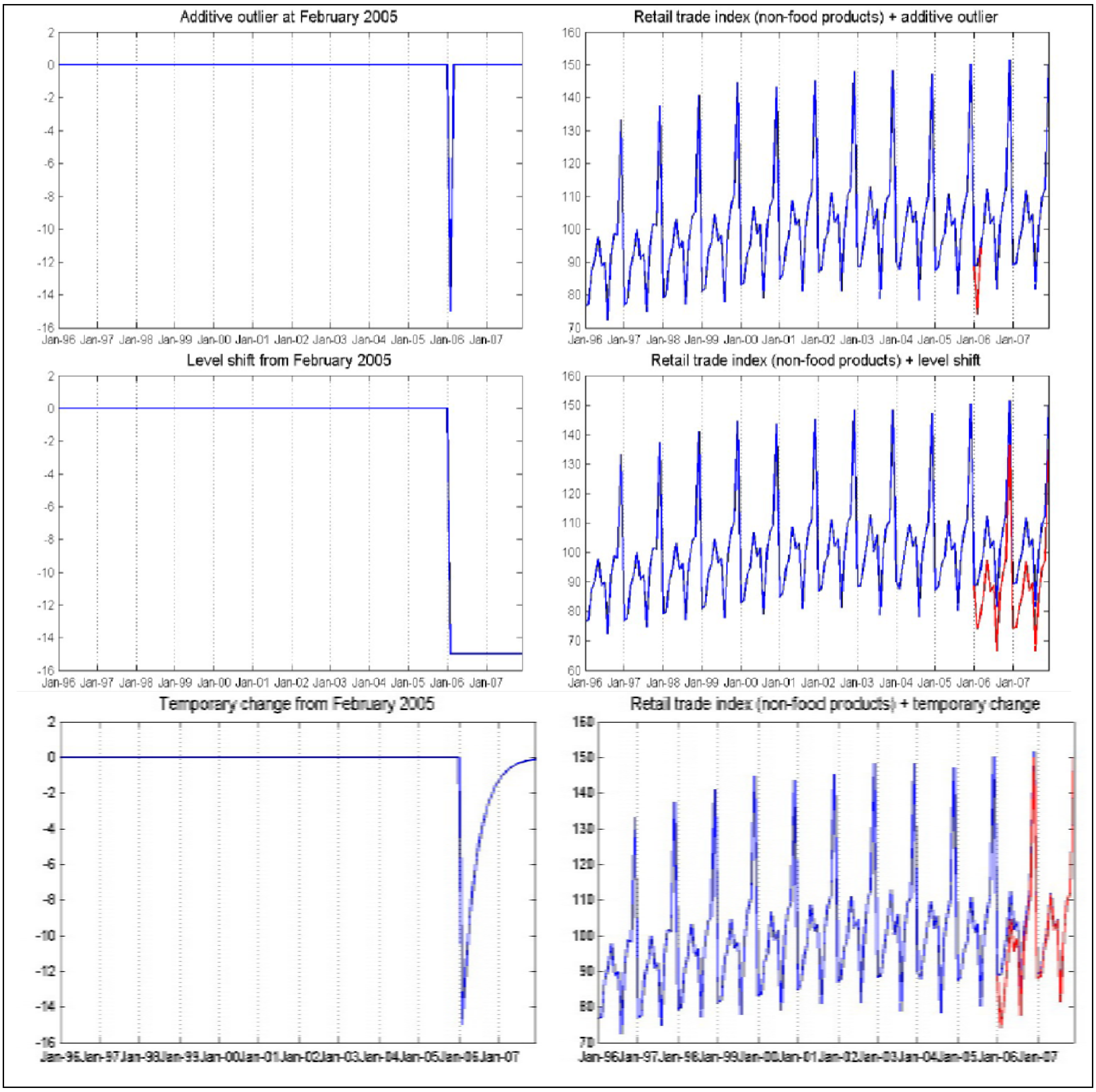

Figure 4: A representation of additive outlier, level shift and transitory change.

There are also other less known types of outliers which can be detected and treated: ramp outlier, innovational outlier and seasonal outlier.

More details on calendar effects and outliers can be found in the module "Seasonal Adjustment – Seasonal Adjustment of Economic Time Series".

2.2 Benefits and costs

From the previous section it has been seen that the main aim of seasonal adjustment is to filter out systematic seasonal fluctuations from time series, due to the noneconomic causes such as weather, calendar events and timing decisions. Generally SA data are preferred to unadjusted data since they are more easily interpreted because of their comparability between adjacent periods. Figure 3 confirms that, displaying month-on-month (m-o-m) growth rates calculated on both the unadjusted and the SA series of figure 1. Moreover, the two panels on the right-hand side, where m-o-m growth rates calculated on SA are represented, stress a typical feature of SA data: their volatile profile due to the presence of the irregular (and unpredictable) component overlapping the more smoothed trend-cycle component.

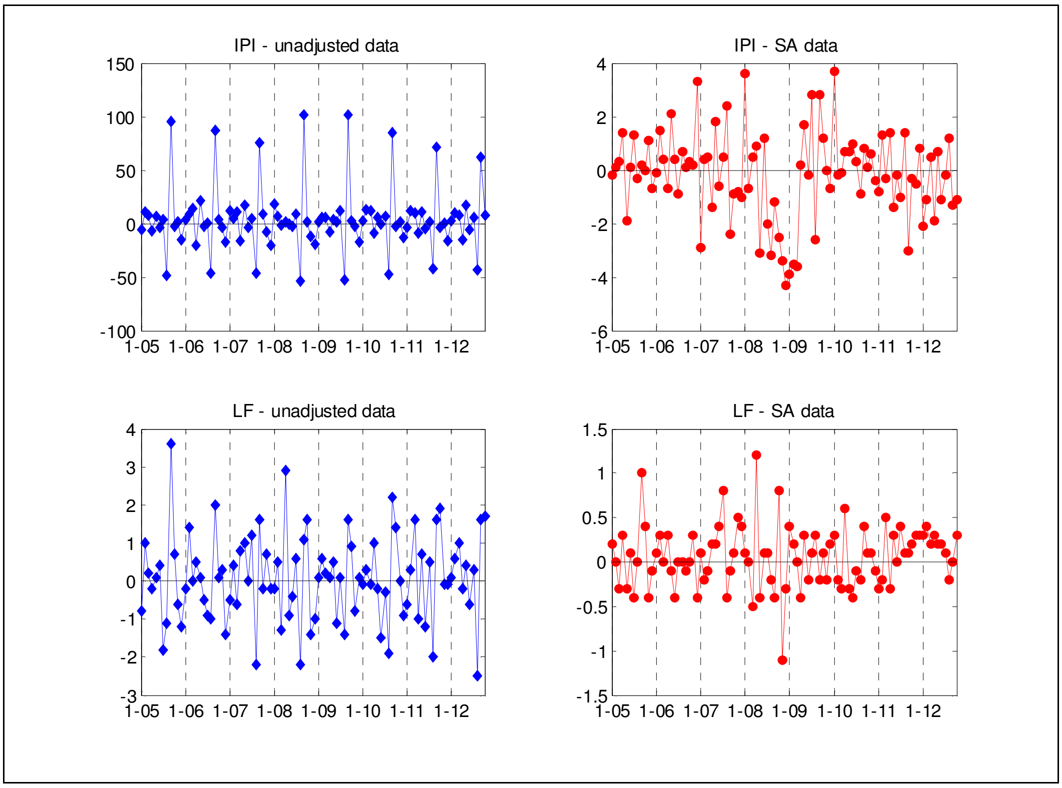

Figure 5: Month-on-month growth rates of Italian industrial production and labour force, calculated on unadjusted and SA data.

One simple way of removing seasonal fluctuations and understanding the recent movement of economic indicators is to calculate year-on-year (y-o-y) growth rates (i.e., applying seasonal differences on the log-transformed data) on the unadjusted data. However, inaccurate conclusions could be drawn utilising y-o-y growth rates on unadjusted data: firstly, time series do not show *regular* seasonal fluctuation, on the contrary they are often featured by a *moving* or an *evolutive* seasonality; secondly, y-o-y growth rates depend on the dynamic of two consecutive years and turning points in the data are shown up with some delay.[1] Seasonal adjustment allows to overcome both of these drawbacks: the first one is very intuitive, the second one needs some further details. To this end the example of the Italian index of industrial production is considered, both in calendar adjusted (i.e., unadjusted data with calendar effects removed) and SA form. Moreover, it is quarterly aggregated in order to have a smooth time series. Calendar adjusted data and SA data are presented in the upper

[1] It is worth noting that here the focus is not put on the debate concerning the calculation of y-o-y growth rates either on unadjusted data or on SA data. At this regards, useful references can be found on the handbook on data and metadata reporting and presentation (OECD, 2007). On the contrary, y-o-y growth rates on unadjusted data are presented as a very simple tool used to remove seasonality and to read the recent movement of economic indicators.

panel of figure 6, while the respective y-o-y and q-o-q growth rates are displayed in the lower panel. The main message conveyed by the latter is the two quarter delay in detecting the turning point of industrial production through the y-o-y growth rates, both at the third quarter 2009, the beginning of the expansion phase (highlighted through the grey area in the first panel), and at the second quarter 2011, that is the beginning of the new recession phase.

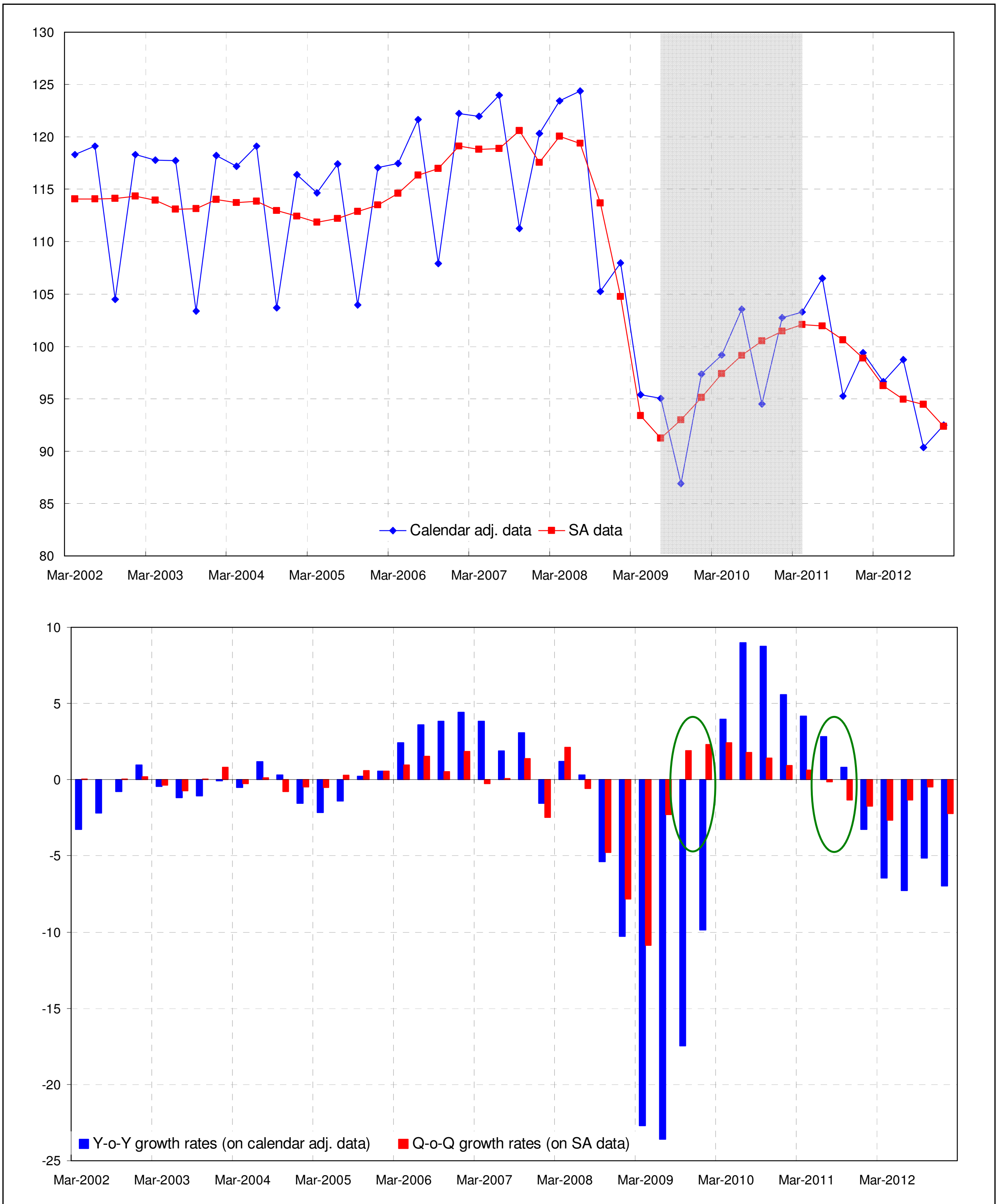

Figure 6: Italian industrial production index, quarterly aggregated.

It should be stressed that, although a time series is seasonally adjusted, unadjusted data remain useful. They represent the base to understand particular phenomena or events (introduction of a new classification, change of base year, introduction of new statistical methods, strikes, introduction of a new tax, …) and to take them into account in the model of seasonal adjustment.

As already sketched in the previous section, seasonal adjustment also includes the elimination of calendar effects. Data adjusted for calendar effects, generally achieved as a by-product of the seasonal adjustment, are often required by European regulations and reported in the press releases (useful information on reporting unadjusted, calendar adjusted and seasonally adjusted data, together with the corresponding growth rates can be found in OECD (2007)). Table 1 contains unadjusted and calendar adjusted index of industrial production, together with the number of working days (Monday to Friday) net of Italian holidays falling in working days and the y-o-y growth rates calculated on both unadjusted and calendar adjusted data. It can be seen that the calendar adjustment affects y-o-y growth rates only when the compared months have a different number of working days (light blue and yellow rows of the table).

Table 1: Italian industrial production index. Unadjusted and calendar adjusted data, number of working days and y-o-y growth rates.

Period	Unadjusted		Calendar adjusted		Working days		y-o-y (%)	
	2010	2011	2010	2011	2010	2011	Undjusted	Cal. adj.
Jan	77.8	80.4	81.7	81.9	19	20	3.3	0.2
Feb	87.6	89.8	88.0	90.2	20	20	2.5	2.5
Mar	98.1	99.0	94.7	97.7	23	22	0.9	3.2
Apr	89.8	89.8	86.7	90.1	21	20	0.0	3.9
May	94.6	99.6	95.6	97.6	21	22	5.3	2.1
Jun	94.4	94.8	93.3	93.7	21	21	0.4	0.4
Jul	100.4	96.3	100.6	99.4	22	21	-4.1	-1.2
Aug	52.7	55.2	51.6	54.1	22	22	4.7	4.8
Sep	97.4	94.8	95.4	92.9	22	22	-2.7	-2.6
Oct	95.1	91.5	98.2	94.5	21	21	-3.8	-3.8
Nov	96.3	92.4	95.2	91.3	21	21	-4.0	-4.1
Dec	83.4	77.1	78.3	76.9	22	20	-7.6	-1.8
Year	89.0	88.4	88.3	88.4	255	252	-0.7	-0.1

When the observed phenomenon depends on the number of worked days of each month (quarter), calendar effects have to be estimated and removed in order to improve both temporal comparisons and quality of seasonal adjustment. Calendar adjustment is part of the pre-treatment of the series performed before the decomposition and the seasonal adjustment.

Generally NSI and other official producers of SA data expend many efforts to produce carefully SA data and to make them available to the general public for several further purposes (modelling and forecasting, trend-cycle decomposition, turning points detection, business cycle analysis, …). This is due to several reasons.

a) A precise and rigorous definition of seasonality does not exist and, consequently, several methods and procedures have been developed to deal with seasonal macroeconomic indicators. Moreover, different procedures or different models/options, within the same procedure, give almost always different seasonally adjusted data.

b) Due to the specific *filters* used to remove the seasonal component (i.e., two-sided moving averages), when new unadjusted data become available, the seasonal adjustment performed on the longer series revises the seasonally adjusted data previously released, especially at the end of the series. Figure 7 shows the seasonally adjusted data of the Italian industrial production index released from July 2012 to December 2012.

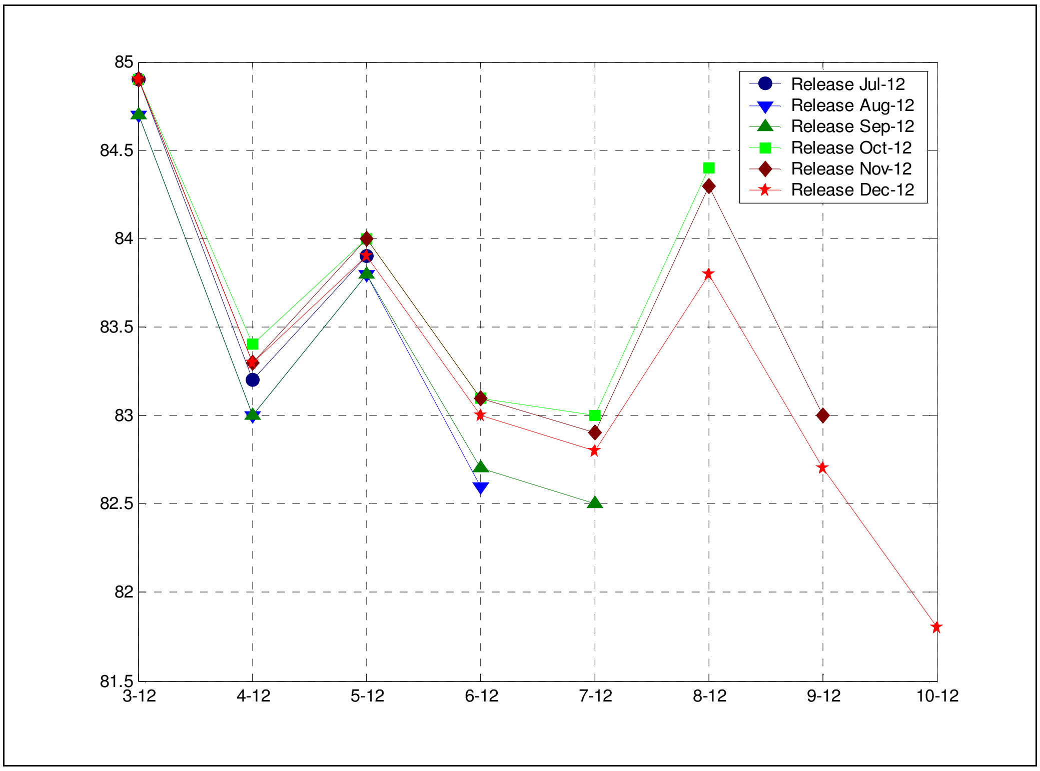

Figure 7: Italian industrial production index. Last releases of seasonally adjusted data.

c) Once a method and a procedure were chosen to approach the SA of a new domain, there are several issues that have to be dealt with:

- the number of time series to be treated (when not regulated by the European regulations): the whole domain or the most relevant indicators. Generally indicators at more disaggregated breakdown are more irregular and volatile and, therefore, more difficult to treat adequately;
- the choice between direct and indirect approach to seasonally adjust vertical/horizontal aggregates. In fact they may be seasonally adjusted through a seasonal adjustment procedure (direct approach) or aggregating the seasonally adjusted disaggregated components (indirect approach). Coherence is fulfilled by the latter, but problems of residual seasonality in the aggregates may arise;
- the treatment of outliers (breaks, unusual movements, extraordinary events) especially at the end of time series;
- the presentation of seasonally adjusted data and the respective metadata (procedure, model options, …).

d) Events affecting contemporaneously the domains of short-term business statistics, quarterly national accounts, business surveys, … (e.g., the 2008-2009 crisis) should require consistent treatments and solutions in order to release seasonally adjusted data of good quality, to avoid misleading results that may confuse users and undermine the credibility of the producer of seasonally adjusted data.

Dealing with all these issues is time and human resources consuming and requires a good knowledge of unadjusted data. As a consequence it is recommended that the statisticians who compile the indicators should also be in charge of the seasonal adjustment, with the assistance of specialists to handle important and/or crucial indicators.

2.3 Users' perspective

One of the main goals of the SA-procedures is to produce time series data which can relatively easily be interpreted by the users. Hence, the transparency should be a crucial issue for a NSI aiming to fulfil the users' needs. The term *user* might be interpreted in different ways in different offices. Thus, some distinction has to be made in this context to clarify what kind of users this module is considered with.

In the context of official statistics, the users of SA data and related procedures might be divided into the two main categories: internal users and external users. The internal users are usually employees in a NSI with certain level of responsibility in a process of production of business statistics but they are usually not specialists in SA. This module is mainly oriented to these users.

The external users, on the other hand, are typically researchers, business analysts, journalists or governmental policy makers. Common to all these users is that they are not involved in a process of production of seasonally adjusted data in official statistics. Some of the external users might have more or less influence on NSI with respect to certain quality aspects of seasonally adjusted data. However, the point of view of these external users will not be treated in this handbook except for very general remarks.

General to all these users is that they expect good quality of seasonally adjusted estimates. However, what some users may experience as a good quality might be different from the quality interpretation from the point of view of a specialist. Furthermore, different users put attention to certain aspects of data while others are more interested in economic interpretation of the results. Here, we summarise some of the most relevant issues related to the "perceived" quality and put those issues in a context of a NSI. The main idea is to bridge gaps between these two concepts by recommending strategies for satisfying the main users' needs while keeping *statistical* quality at a satisfactory level. More general aspects of statistical quality are discussed in some other modules in this handbook. Here, we focus on the specific topics concerned with seasonal adjustment and related issues.

The users of seasonally adjusted series are typically interested in the following issues:

e) Interpretability of seasonally adjusted time series:
    - Economic or other relevant interpretation.
    - Outlier interpretation.

f) Different aspects of consistency and coherence.

g) End-point analysis for forecasting purposes.

h) Business-cycle analysis and early detection of turning-points.

i) Revisions: nature of revisions- distinction between the natural source of revision (from the original unadjusted series) and the part of the revision due to specific SA-procedure.

2.3.1 Interpretability

Seasonally adjusted time series are expected to reflect basic properties of the original time series. Hence, the users would like to have seasonally adjusted estimates that reveal the “true” development in an economic variable. An informed user may have an *internal* knowledge about the “true” properties of a certain time series variable. This knowledge (read: information) may imply the expected future development in a specific direction. Furthermore, this user might have strong reason to believe that the future development of the corresponding seasonally adjusted estimates would follow the expectations and preferably lie within an expected (prediction) interval. Any strong divergence from these expectations would imply questioning the quality of SA.

From a point of view of a producer of official statistics, this kind of situation would lead to a thorough investigation about the source of such a deviation from the expected results. Sometimes, the estimation process within a seasonal adjustment procedure produces results that are not wrong from the statistical point of view but the same results might be interpreted as erroneous by the users. It is well-known that SA might induce some spurious marginal effects on a seasonally adjusted estimate, especially at the end of time series.

A transparent communication between specialists, internal users and external users is important in any case. The recommended action for a producer is to make an attempt to meet the external users’ requirements if this would not result in a significant departure from the quality requirements. Otherwise, if there is no possibility to make any changes, it is important to clarify the actual cause of the discrepancy between the expected results and the actual outcome. Also, motivation for further actions has to be understandable from the users’ point of view.

2.3.2 Consistency and coherence

The term consistency is usually related to the users’ needs for internal coherence within a system of seasonally adjusted time series where some pre-defined inter-relationships have to be preserved. The nature of these relationships naturally originates from the raw data. The systems of time series are usually classified by certain attributes based on, e.g., artificial accounting constraints as in the systems of national accounts or by trade-group classifications as in the retail trade. In addition, there are natural classifications due to the different categories such as gender, regions or provinces, part-time or full-time employment in the system of labour force series. All sub-categories must add up to the marginal totals which in turn aggregates to the grand totals. These constraints are called the *cross-sectional aggregation* constraints meaning that all the original relationships between different categories are preserved for each period of time.

Quite often there are also *temporal constraints* that some or all series in a system are required to satisfy. This means that the seasonally adjusted yearly totals created from the aggregated higher frequency (monthly or quarterly) seasonally adjusted series, must add up to the corresponding annual benchmark. This annual benchmark is usually formed as a yearly total from the higher frequency unadjusted series.

The users would like to have consistencies in all directions in such systems of seasonally adjusted time series. This is important because of the necessity to explain the results in an easy way when communicating with external users and the public. Thus, in order to satisfy consistency restrictions the experts usually implement some kind of *reconciliation* or *benchmarking* technique. These techniques are mathematical tools to achieve aggregation consistency (summability) and the temporal consistency (benchmarking). See, e.g., Dagum and Cholette (2006) for more details about the reconciliation and benchmarking issues.

In some cases the users are interested in consistency in terms of coherence which is not as straightforward as aggregation. Coherence might be loosely interpreted as a more general form of relative correspondence between a set of mutually connected time series from different sources. This requirement is often more difficult to satisfy than consistency within a system of time series from one source. The internal users have to be aware of limitations of the SA methods and hence be able to explain nature of inconsistencies to the external users.

2.3.3 End-point analysis and forecasting

Seasonally adjusted time series are generally used by economic agents, policy makers, researchers and others who are interested in extracting information from the data. Usually, the main interest is in short-term prediction because of the nature of seasonally adjusted time series. Seasonal effects have impact on the higher frequency time series (within a year, usually monthly or quarterly frequency). This implies that the growth rates of seasonally adjusted estimates from one year to another should coincide with the corresponding growth rates from the original time series. Any discrepancy should be addressed to changes in seasonal variation from year to year (*moving seasonality*) or to the issues related to modelling.

Consequently, the users are likely to prefer stable seasonal patterns in order to extract other relevant information which is generally not stable and hence not repetitive. The main idea is to use seasonally adjusted data to reveal the news in time series in order to understand "where we are now" and "where we are going to". According to ESS Guidelines (Mazzi and Calizzani, 2009, p. 6), this is the ultimate goal of SA. The extraction of the news in time series is closely connected to short-term forecasting purposes.

However, the most common SA-procedures are by default very sensitive to any instability at the end points. As a consequence, they actually fail to make reliable forecasts unless very strong assumptions are fulfilled. For example, the presence of outliers at the end of time series is likely to magnify uncertainty in the forecasts. However, there is no reliable statistical technique to identify presence and nature of these outliers. See, e.g., IMF (2001, p. 135) for a discussion about end-point problems.

Hence, the users of SA have to have enough knowledge about the end-point problems in order to communicate with the users of official statistics.

2.3.4 Business cycle analysis and detection of turning points

This issue is closely connected to the previous topic and the concept of "news". Changes in trend or in the business cycle are related to the needs for understanding the past and the future. For example, the economic agents and policy makers try to explain effects of some political measures in the past using the trend-cycle analysis. They are interested in timing of business-cycles, i.e., in locating periods of recessions and expansions in economy. They are indeed focused on identifying the turning points in the future too in order to modify course of future actions.

Hence, the users who run business statistics in a NSI would like to understand the nature of results from a SA-procedure in order to be able to explain their effects when necessary. In the case when a deep technical explanation is needed it is advisable to contact a SA expert.

2.3.5 Revisions

Small revisions in seasonally adjusted time series are of particular interest to the users. Large revisions usually imply questioning the data quality and relevance of the chosen seasonal adjustment methods. For an official statistics producer it is important to put effort to identify sources of revisions. In some cases revisions may be reduced by certain strategies which focus on increasing stability of the estimates. This is especially important if revisions do not originate from the actual revisions in published raw data. This issue is rather technical and requires a good communication between the users and the experts.

3. Design issues

4. Available software tools

The users of official statistics usually prefer a software tool which is user-friendly and stable. Furthermore, the use of some of the conventional and internationally accepted software tools and methods is typically favoured by the users. Recommendations from Eurostat are also important to the users since the NSIs usually distribute some seasonally adjusted data to this statistical institution.

In the ESS Guidelines for Seasonal Adjustment (Eurostat, 2009) two main (A-classified) methods are proposed, TRAMO-SEATS (Gomez and Maravall, 1996, 2001a, 2001b), X-12-ARIMA/X-13-ARIMA-SEATS (USCB 2011, 2012a, 2012b, 2013). The National Bank of Belgium in cooperation with Eurostat has recently developed two open source software platforms Demetra+ and JDemetra+. These platforms are based on the two leading algorithms mentioned above, TRAMO-SEATS and X-13-ARIMA-SEATS. Demetra+ and JDemetra+ are freely downloadable from the Eurostat's home page (Eurostat, 2012).

The Structural Time Series Models (B-classified) are also recommended as an alternative to the previous two methods, under certain conditions. Hence, the users are likely to favour one of the proposed methods, typically TRAMO-SEATS or X-12-ARIMA.

Some other preferences, e.g., those related to the chosen software platform, might occur depending on the available IT-architecture or specific subject-matter issues, which may vary from one NSI to another.

5. Decision tree of methods

6. Glossary

For definitions of terms used in this module, please refer to the separate "Glossary" provided as part of the handbook.

7. References

ABS (2008), *Time Series Analysis: Seasonal Adjustment Methods*. Australian Bureau of Statistics. Available from: http://www.abs.gov.au/websitedbs/d3310114.nsf/51c9a3d36edfd0dfca256acb00118404/c890aa8e65957397ca256ce10018c9d8!opendocument/ [Accessed 20 March 2013]

Bell, W. R. and Hillmer, S. C. (1984), Issues Involved with the Seasonal Adjustment of Economic Time Series. *Journal of Business and Economic Statistics* **4**, 291–320.

Bank of Spain (2012), *Statistical and Econometrics Software*. Banco de España. Available from: http://www.bde.es/bde/en/secciones/servicios/Profesionales/Programas_estadi/Programas_estad_d9fa7f3710fd821.html/ [Accessed 20 March 2013]

Dagum, E. B. and Cholette, P. A. (2006), *Benchmarking, Temporal Distribution, and Reconciliation Methods for Time Series*. Springer.

ECB (2003), *Seasonal adjustment*. European Central Bank publication. Available from: http://www.ecb.int/pub/pdf/other/statseasonaladjustmenten.pdf/ [Accessed 20 March 2013].

European Communities (2001), *Seasonal Adjustment of European Aggregates: Direct versus Indirect Approach*. Office for Official Publication of the European Communities, Luxembourg.

Eurostat (2009), *ESS Guidelines on Seasonal Adjustment*. European Commission, Luxembourg. Available from: http://epp.eurostat.ec.europa.eu/portal/page/portal/product_details/publication?p_product_code=KS-RA-09-006/ [Accessed 20 March 2013].

Eurostat (2012), *Demetra+*. Available from: http://www.cros-portal.eu/content/demetra/ [Accessed 20 March 2013].

Gomez, V. and Maravall, A. (1996), *Programs TRAMO and SEATS: Instructions for the user* (beta version: June 1997). Banco de Espana, Servicio de Estudios, DT 9628.

Gomez, V. and Maravall, A. (2001a), Automatic modeling methods for univariate series. In: D. Peña, G. C. Tiao, and R. S. Tsay (eds.), *A Course in Time Series Analysis*. John Wiley and Sons, New York, NY.

Gomez, V. and Maravall, A. (2001b), Seasonal adjustment and signal extraction in economic time series. In: D. Peña, G. C. Tiao, and R. S. Tsay (eds.), *A Course in Time Series Analysis*. John Wiley and Sons, New York, NY.

Granger, C. W. J. (1978), Seasonality: causation, interpretation and implications. In: Zellner, A. (ed.), *Seasonal Analysis of Economic Time Series*, U.S. Department of Commerce, U.S. Bureau of the Census, Washington D.C., 33–46.

Hylleberg, S. (ed.) (1992), *Modelling Seasonality*. Oxford University Press, Oxford, New York, Toronto.

IMF (2001), Seasonal Adjustment and Estimation of Trend-Cycles. *Quarterly National Accounts Manual— Concepts, Data Sources, and Compilation*, International Monetary Fund Publication, Ch. VIII. http://www.imf.org/external/pubs/ft/qna/2000/textbook/ [Accessed 20 March 2013]

Koopman, S. J. and Lee, K. M. (2010), *STAMP*. http://www.stamp-software.com/ [Accessed 20 March 2013]

OECD (2006), *Glossary of statistical terms*. http://stats.oecd.org/glossary/detail.asp?ID=2398/ [Accessed 20 March 2013].

OECD (2007), *Data and Metadata Reporting and Presentation Handbook*.

Stuckey, A., Zhang, X. M., and McLaren, C. H. (2004), *Aggregation of Seasonally Adjusted Estimates by a Post-Adjustment*. Methodological Advisory Committee, November 2004, Australian Bureau of Statistics. Available from: http://www.uow.edu.au/~craigmc/abs_agg_2004.pdf [Accessed 21 March 2013]

Statistics Canada (2009), *Seasonal adjustment and trend-cycle estimation*. http://www.statcan.gc.ca/pub/12-539-x/2009001/seasonal-saisonnal-eng.htm/ [Accessed 20 March 2013].

U.S. Census Bureau (2011), *X-12-ARIMA Reference Manual (Version 0.3)*.

U.S. Census Bureau (2012a), *X-12-Arima Seasonal Adjustment Program*. United States Census Bureau. http://www.census.gov/srd/www/x12a/ [Accessed 20 March 2013]

U.S. Census Bureau (2012b), *X-13-Arima-Seats Seasonal Adjustment Program*. United States Census Bureau. Available from: http://www.census.gov/srd/www/x12a/ [Accessed 20 March 2013]

U.S. Census Bureau (2013), *X-13ARIMA-SEATS Reference Manual (Version 1.1)*. http://www.census.gov/srd/www/x13as/

Willeboordse, A. (ed.) (1998), *Handbook on the Design and Implementation of Business Surveys*. Office for Official Publications of the European Communities, Luxembourg.

Interconnections with other modules

8. Related themes described in other modules

1.

9. Methods explicitly referred to in this module

1. Seasonal Adjustment – Seasonal Adjustment of Economic Time Series

10. Mathematical techniques explicitly referred to in this module

1.

11. GSBPM phases explicitly referred to in this module

1. 6. Analyse - 6.1 Prepare draft outputs

12. Tools explicitly referred to in this module

1.

13. Process steps explicitly referred to in this module

1.

Administrative section

14. Module code

Seasonal Adjustment-T-Introduction

15. Version history

Version	Date	Description of changes	Author	Institute
0.0.1	26-11-2012	first draft: Module 1.3.User's perspective	Suad Elezović	SCB (Sweden)
0.0.2	01-02-2013	second draft: module chapters compiled by HU	Anna Ciammola, Attila Lukacs, Suad Elezović	ISTAT (Italy), KSH (Hungary), SCB (Sweden)
0.0.3	19-03-2013	changes according to reviewers' comments; glossary included	Suad Elezović	SCB (Sweden)
0.0.4	13-06-2013		Anna Ciammola	ISTAT (Italy)
0.0.5	20-09-2013	changes according to reviewers' comments	Suad Elezović	SCB (Sweden)
0.0.6	04-10-2013	updated ch. 4 + minor changes in references	Suad Elezović	SCB (Sweden)
0.1	22-11-2013	version submitted to Editorial Board	Suad Elezović	SCB (Sweden)
0.1.1	10-12-2013	preliminary release		
1.0	26-03-2014	final version within the Memobust project		

16. Template version and print date

Template version used	1.0 p 4 d.d. 22-11-2012
Print date	26-3-2014 13:28