Chapter 7 - Seasonal and Calendar Adjustment

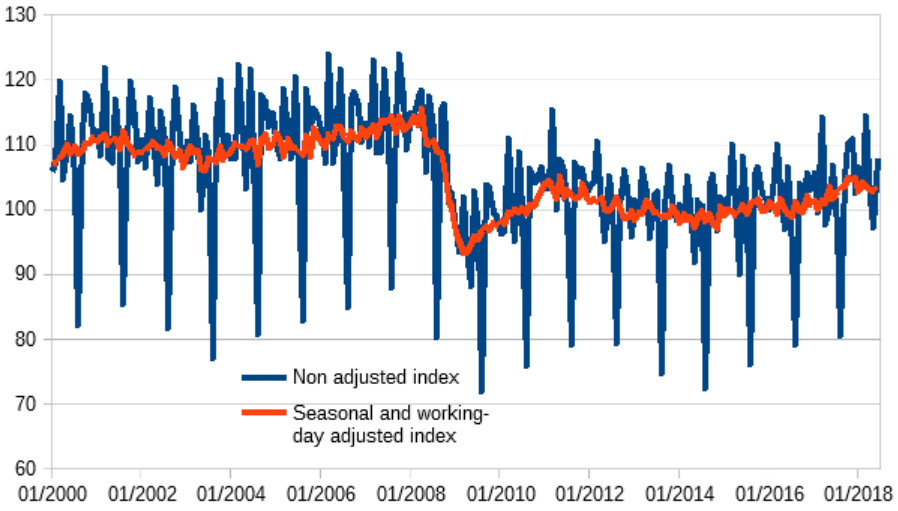
1- The Difficulty of Interpreting Gross Indices

The purpose of the IPI is to track the dynamics of production in France on a monthly basis. However, the month-to-month variations of the "gross" index are difficult to interpret because of the presence, as in most economic series, of seasonal and calendar (specifically, working-day) effects (in other words, the specific and changing calendar from one month to the next).

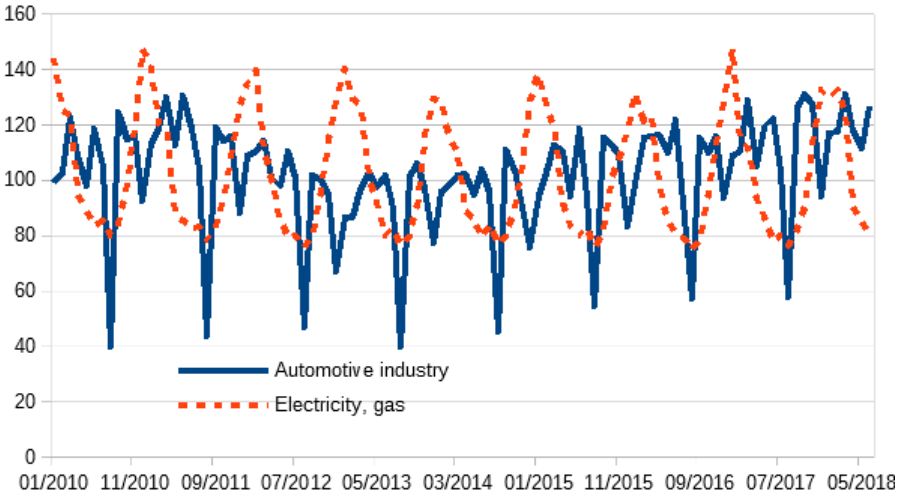
Industrial output follows a marked seasonal pattern (see Graph 1). Each year, it is characterised by a particularly low point in August, with many businesses reducing their activity during the summer holidays, making it difficult to interpret monthly trends. Seasonality can also vary considerably from one branch to another (e. g. automotive industry or electricity production with a high level in winter and a low level in summer), thus further complicating the comparison, with some series having even more pronounced profiles than industry as a whole (see Figure 2).

To analyse cyclical changes in industrial production, it is therefore necessary to adjust the series for seasonal and working-day effects, in the same way as many other economic series produced by INSEE. The methods used are updated regularly.

Graph 1: Industrial Production Index (Base and Reference 100 in 2015)



Graph 2: Two Types of Characteristic Seasonality (Gross Indices, Base and Reference 100 in 2015)



2- Principle of Seasonal and Working Day Adjustments

Seasonal and working-day adjustment generally aims to break down the raw series, written X_t , into several components:

- the trend cycle: on the one hand, it includes the trend, which reflects the background variations in the series observed over a long period of time, and the cycle, which is the smooth and almost periodic movement around the trend component (this is characterised by an alternation of periods of expansion and recession, the length of which generally varies between three and ten years); it is written TC_t ;

- the seasonal component: this corresponds to the seasonal variations in the series occurring from one year to the next and requiring neutralisation. It is written S_t ;

- the component corresponding to calendar effects: this is used to take into account the different compositions of months or quarters in terms of working days; as with seasonality, the aim is to neutralise the calendar component since it generally provides no cyclical information; it is written WD_t ;

- the irregular component: this component is made up of residual and erratic fluctuations that cannot be attributed to one of the components described above. It is written I_t .

Two decomposition models are used to manage the seasonal/working-day adjustment of IPI series:

- the additive model: $X_t = TC_t + S_t + WD_t + I_t$;

- the multiplicative model: $X_t = TC_t \times S_t \times WD_t \times I_t$; this model can be converted into an additive model by applying the logarithm function to each member of the equality.

To seasonally adjust the series and correct it for calendar effects, it is therefore necessary to identify the two associated components S_t and WD_t and to remove them from the series studied. The seasonally and calendar-adjusted series is thus $X_t - S_t - WD_t$ in the case of the additive model and $X_t / (S_t \times WD_t)$ in the case of the multiplicative model.

The two main seasonal adjustment methods used in the European Statistical System are the TRAMO-SEATS method, a parametric method used for the IPI up to the 2005 base, and the non-parametric X13-ARIMA method.

3- Method Used for the Seasonal and Calendar Adjustment of the IPI

Since the shift to the 2010 base year, the seasonal adjustment of the IPI[37] has been based on the X13-ARIMA method, a method implemented using the JDemetra+ software provided by Eurostat[38] with the use of specific working-day regressors (see below). The X13-ARIMA method is based around two main modules[39].

A first module ("RegARIMA") allows for a pre-adjustment of the series: detection of outliers in the series, adjustment for "working days" effects, extension of the series to the edges and provision of diagnostics. Estimating seasonal coefficients is improved if the gross series is not overly disrupted by cyclical fluctuations.

Four types of disturbances can be detected and are then taken into account by adding regressors in a RegARIMA model:

- additive outliers are disruptions that occur in a given month and that cannot be attributed to seasonality. An example is a strike that can be assumed not to have any impact on production in the following months;

- transitory changes: an incident was significant enough to affect the level of production in the following months (e.g. a flood);

- level shifts: for example, the opening of a new plant or a major economic development such as the 2008 crisis;

- seasonal outliers: these allow for a sudden change in seasonality with a lasting impact to be taken into account, such as a change in the method of accounting for production.

For working-day adjustments (assuming such adjustment is necessary), the module uses regressors that reproduce the structure of the calendar (through the structure of months in terms of non-holiday trading days). To take into account the specificities of the national calendar (national holidays, public holidays), INSEE creates its own variables and then incorporates them into JDemetra+. The regressors are centred by removing the long-term averages for each month, allowing the seasonal component of the calendar to be removed. Finally, an automatic choice procedure is applied between different combinations of possible regressors (see below).

After detecting any effects, the RegARIMA module estimates them using a RegARIMA model to "linearise" the series and extend it to the edges for seasonal adjustment purposes.

In a second step, a second module (X11) performs the actual seasonal adjustment by iterative smoothing of moving averages and breaks down the linearised series in the first part into orthogonal components: the trend cycle, seasonality and the irregular component.

Seasonal adjustment is of an indirect type: it is conducted at a detailed level (at class level, i.e. NACE-4 level), and the seasonal and working-day aggregates are then calculated directly from these series[40] using the methods presented in Chapter 6.

Lastly, a change made effective since the March 2019 campaign was implemented by estimating and applying the seasonal adjustment and working-day models over a reduced sub-period for recent data[41], the aim being to

37 Readers are referred to Eurostat's *'ESS guidelines on seasonal adjustment'* (2015) for a review of good practice in the area of seasonal adjustment.
38 The software can be used to apply the two main seasonal adjustment methods used within the European Statistical System: the TRAMO/SEATS method, a parametric method used previously in the 2005 IPI base, and the non-parametric method X-13-ARIMA.
39 For a complete presentation of the programme, see *'X-13ARIMA-SEATS Reference Manual'* (2017), U.S. Census Bureau. For a user-friendly presentation of how the X11 module works, the reader is referred to the following document: *'Comprendre la méthode X11'* (1999), D. Ladiray, B. Quenneville.
40 Another method, known as the "direct" method, involves making seasonal adjustments at each level of aggregation.
41 A decision was made to estimate models since 2005 and to fix the data before 2012.

adhere more closely to Eurostat's recommendations on the matter. The application of seasonal adjustment methods over 30 years (i.e. the time depth of the IPI series) can pose robustness problems on account of economic or behavioural changes. This approach also allows for changes in the past to be frozen, whereas seasonal adjustment methods by nature imply revisions over the entire series each time a new point is added (even if these revisions are very small beyond a few years in the past).

4- Monthly and Annual Campaigns

The seasonal and working-day adjustment process for IPI indices consists of applying the models identified series by series each month. These models are built and/or revised during annual campaigns (see below), which generally take place during the January-February period before the first campaign of the year (publication of the January indices in early March). The general form of the models (excluding parameter updates) is then determined at the end of the annual update for the entire coming year.

The monthly seasonal and working-day adjustment campaigns take into account the new data available each month, re-estimate the model coefficients, identify outliers over the recent period (last 12 months) and update the seasonal and working-day coefficients (thereby involving revisions to the past as new data become available).

This method of re-estimating models with the latest monthly data available but with an unchanged model, set of regressors and filters (known as the "partial concurrent/last outliers") is recommended by Eurostat.

Conduct of Annual Campaigns Conducted to Completely Update the Models

The overall approach of an annual campaign involves comparing the current modelling (i.e. the models currently used in production, considered as the reference) with an automatic model. If the automatic model is found to be of better quality (in terms of the quality assessment developed using the statistics and results provided by the programme) than the current modelling, the series is then examined in greater detail to determine whether the modelling needs to be changed. More specifically:

- For each series, automatic modelling is initiated by resetting all the parameters (working-day regressors, selected ARIMA model, additive outliers, etc.); the combinations tested for the working-day models are presented in Table 1;
- Current models (in production during monthly campaigns) are updated with the latest data by re-identifying outliers over the last year (refresh option used during monthly campaigns);

- For each series examined, a quality assessment[42] is published. The assessment is used to compare the quality of current and automatic modelling. A score is thus calculated for each series and only those series for which the score shows a better quality of automatic modelling than the current (reference) modelling are studied in depth; by way of illustration, there were 58 series in this case during the campaign implemented at the beginning of 2018 (out of a total of just over 200);

- To prioritise the processing of the series to be studied, the score also takes into account the weight (and therefore the economic weight) of the series. Thus, in the event that it is not possible to study all problematic series, the "weighted" score is used to detect as a priority those series whose poor quality is most likely to degrade the quality of the aggregate series;

- Once the model has been selected, the new seasonal and working-day adjusted series obtained are compared with the old series.

42The quality assessment uses diagnoses from JDemetra+ and creates synthetic indicators in the form of scores. The main diagnostic categories available in this file are as follows:
- *Overall quality of processing;*
- *Quality of the Reg-ARIMA model;*
- *Quality of the decomposition;*
- *Quality of the revisions* (covering the last two years available).

An overall quality score out of 20 is given, corresponding to the weighted average of the scores of each diagnostic family. This score can be used to compare the models (automatic processing/old model) and to identify "problematic" series, while giving priority to the series with the greatest weights.

Table 1: Different Specifications for Working-Day Adjustment

Set of Regressors	Characteristics
Not applicable	No working-day (WDA) effects (= no WDA regressors)
Lpyear	Only a "leap year" effect and no effects according to the type of days (only one regressor)
Regwda 1 (+lpy), differentiated days (including Saturday)	6 regressors (Mondays, Tuesdays,..., working Saturdays) in contrast to Sundays and public holidays (+ possibly a "leap year" effect)
Regwda 2 (+lpy), week/weekend effect	1 regressor (week days, Monday to Friday, working days) in contrast to Sundays and public holidays (+ possibly a "leap year" effect)
Regwda 3 (+lpy), days differentiated relative to the weekend	5 regressors (Mondays, Tuesdays,..., working Fridays) in contrast to Sundays and public holidays (+ possibly a "leap year" effect)

Sequence of a Monthly Campaign

The monthly campaigns re-estimate the models by taking into account the new data made available:

- Update of the data file/launch of processing operations in JDemetra+;
- Verification of the quality of processing in JDemetra+;
- Interactive change of specifications if necessary (outliers in particular);
- Export and archiving of monthly processing.

5- Main Changes in the Treatment of Seasonal Adjustment since the 2010 Base

As noted above, since the move to the 2010 base year, the seasonal adjustment of IPI is now based on the X13-ARIMA method or later versions. Previously, seasonal and working-day adjustment was based on the TRAMO-SEATS method, another method recommended by Eurostat, particularly in the case of short-term statistics.

The change in the seasonal adjustment method[43] for the 2010 base was designed to improve consistency with the method used to compile the quarterly national accounts, which are partly based on the IPI series. The quarterly accounts have historically tended to use the X13-ARIMA method. Using different methods to compile the IPI and quarterly accounts could have led to discrepancies that were sometimes difficult to interpret. This change in method has led to revisions in the past.

In 2015, it was also decided to carry out the seasonal adjustment process and the adjustment of "working day" effects on the series at NACE-4 level (class level) and no longer on the series at NACE-3 level for practical reasons and to ensure consistency with the series published on the Eurostat website. New models for the class level therefore had to be developed. Although relevant for the reasons mentioned, this change may make it more difficult to identify robust models at a detailed NACE-4 level because of relatively significant fluctuations at this level of detail, whereas these fluctuations tend to be neutralised at a more aggregated level.

43In practice, there has been little impact on the main IPI aggregates, although significant discrepancies were sometimes found on more detailed series. For around a quarter of the series, the seasonal and working-day adjusted series from X13-ARIMA practically overlapped with the series produced using TRAMO-SEATS. By contrast, for around a third of the series, the results differed relatively significantly. These differences are not surprising since TRAMO-SEATS and X13-ARIMA are based on very different principles governing series decomposition. However, some discrepancies were found in the "pre-adjustment" phase: ARIMA modelling, the detection and correction of outliers and breaks, and possible transformation using the logarithm function. As for the adjustment for "working day" effects, it did not appear to be a cause of divergence since the working-day adjusted series obtained with the two methods were very similar when using the same working-day regressors.

Lastly, in early 2016, trend series were discontinued. Until December 2015, the calculation of the seasonally and working-day adjusted index of industrial production was based, in some industries, on trend series, and not on seasonally and working day-adjusted series. These series, numbering 18 in total (out of 203), accounted for around 12.5% of industrial output and were mainly found in the "Manufacture of machinery and equipment n.e.c. (CK)" (representing 73% of the branch) and in the "Manufacture of basic pharmaceutical products and pharmaceutical preparations (CF)" (representing the entire branch).

The purpose of changing methods was to ensure compliance with Eurostat guidelines (see above). The volatility of these series has increased but remains in the order of that of the automotive industry series (CL1) and other transport equipment (CL2), which have comparable weights. Graph 3 illustrates the impact of this change in 2010 on the indices for the CK branch.

Graph 3: CK Branch Indices - "Manufacture of machinery and equipment n.e.c." Before and After the Discontinuation of Trend Series (Base and Reference 100 in 2010)