Enhancing seasonal adjustment using X13-ARIMA-SEATS: the case of production in the French quarterly accounts

Author: Suzanne Scott

University: Ecole nationale de la Statistique et de l'Analyse de l'Information (Ensai) and University Rennes 1

EMOS programme: Masters in Public Evaluation and Decision-making, specialisation in Methodology for Official Statistics

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1. Introduction

The national quarterly accounts describe the French economy's evolution over the recent past. One of the main aggregates published by the quarterly accounts division is the Gross Domestic Product (GDP) whose evolution follows rather closely that of the production account.

The production account, like all quarterly accounts, is computed by benchmarking indicators which are all processed using the same methods to ensure coherence. This preprocessing includes seasonally adjusting all indicators that present seasonality. A seasonally adjusted version of our aggregates can then be computed, allowing the publications to focus on the economically relevant part of the aggregates' evolution.

The issue with the way the accounts are currently adjusted resides in the current method used. Due to national accounting's need to minimise revisions, the quarterly accounts are still adjusted using the X12-ARIMA procedure, while several other Insee divisions use X13-ARIMA-SEATS to adjust their indicators following Eurostat's recommendations. This could be the source of differences in the evolutions published by the accounts and those published by the indicators.

Additionally, seasonal adjustment is the main source of revisions between publications: on average it accounts for 88% of publication to publication revisions for the total production of goods[1]. Minimising unnecessary revisions is important for the quarterly accounts, which makes reducing seasonal adjustment revisions essential. A good way to minimise them is to ensure that the adjustment model used is well fitted to the series, so that revisions correspond to a change in seasonality and not to noise in the series. A better fit comes from both a better understanding of the adjustment process, and from using the best suited method to compute the adjustment.

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1 The remaining 12% of revisions are due to revisions of the indicators, as such they represent a more accurate information and are welcome.

2. Objective

The intent of this paper was to compare the current method and the adjustments it produces to the latest methods available in order to see if changing the adjustment method is a viable option.

The first step of this analysis is to compare the quarterly accounts' current method to X13-ARIMA-SEATS. This comparison aims to identify each method's advantages and weaknesses, allowing us to ensure that changing methods could indeed lead to a better adjustment.

Each method will then be used to seasonally adjust the Industrial Production Index (IPI), the account's main indicator, and compute the production of manufactured goods' account. These adjusted indicators, and the corresponding accounts, will be compared in terms of:

- the overall quality of the seasonal adjustments,
- the amount of month to month revisions they produce,
- the amount of revision switching to the new method would produce,
- and the way they affect the differences between the accounts' evolution and the IPI's published evolution.

3. Methods

The current seasonal adjustment method relies on the X12-ARIMA procedure to adjust for seasonal and calendar effects. Two series of coefficients are computed to adjust for each effect individually in order to guarantee that the quarterly accounts are balanced with the annual accounts.

The quarterly accounts' method begins with a graphical analysis of the series in R to determine the period of adjustment and ensure that a seasonality is indeed present before running X12-ARIMA in SAS.

The calendar adjustment is then computed thanks to the Reg-ARIMA pre-processing step of X12. Reg-ARIMA consists in a regression of the series over the calendar effect regressors with ARIMA residuals. The tests for the significance of each effect in this step are sometimes followed directly, and sometimes overruled because of external economic information on the series. This difference in treatment creates some inconsistencies and can affect the final adjustment's quality.

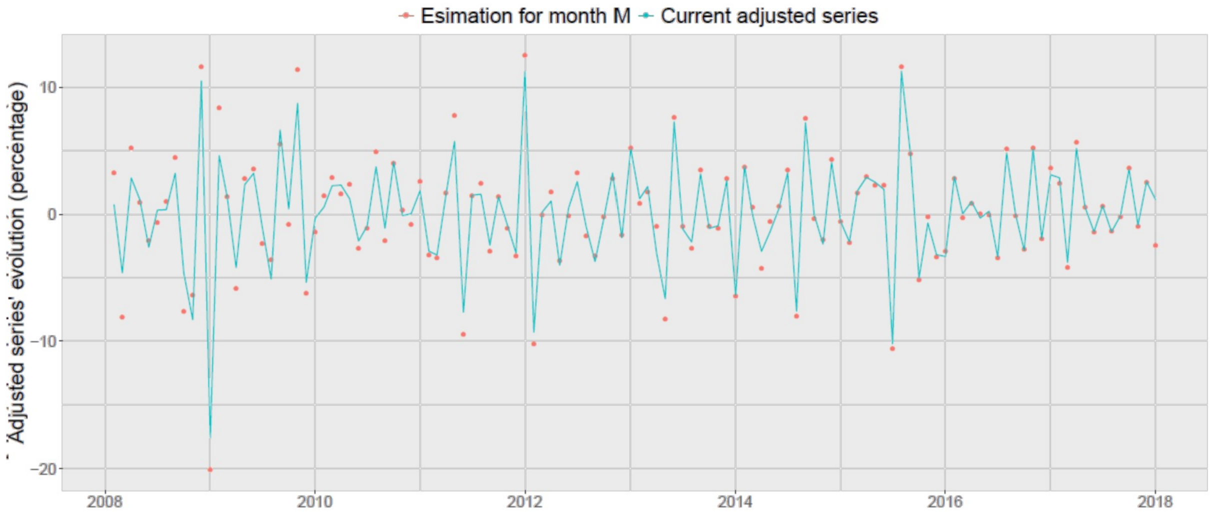
The seasonal adjustment is computed on the pre-processed series resulting from the Reg-ARIMA step. It is obtained thanks to the X11 procedure which decomposes the series into a trend-cycle component, an irregular component and a seasonal component using moving averages. Out of the many tests produced by the procedure, only those presented in the quarterly accounts' internal course are used in practice. This leads to some interesting diagnostics, such as the presence of seasonality in the residuals, being ignored to the detriment of the final adjustment.

These weaknesses accumulate and affect the quality of the seasonal adjustment, and as a consequence the quality of the accounts. They also provide unnecessary noise in the form of inconsistencies between accounts, as well as differences between the indicators and accounts. In particular, the published IPI series are adjusted in JDemetra+ using the X13-ARIMA method. For that reason the current adjustment was compared to the one we could reach by using JDemetra+ and the two methods it offers: X13-ARIMA, an updated version of X12-ARIMA, and

TRAMO-SEATS, an adjustment method which relies on signal analysis and extraction. As the quarterly accounts are currently in the process of switching from SAS to R, JDemetra+'s companion R package (RJDemetra) was also used for this comparison.

4. Results

X13-ARIMA and X13-SEATS lead to adjusted series similar to the current ones in quality, but both introduce more volatility in the adjusted series. This seems to provide little motivation to change the current method. However, the JDemetra+ softwares provide new diagnostics which allow a more thorough analysis of the series and of its adjustment.



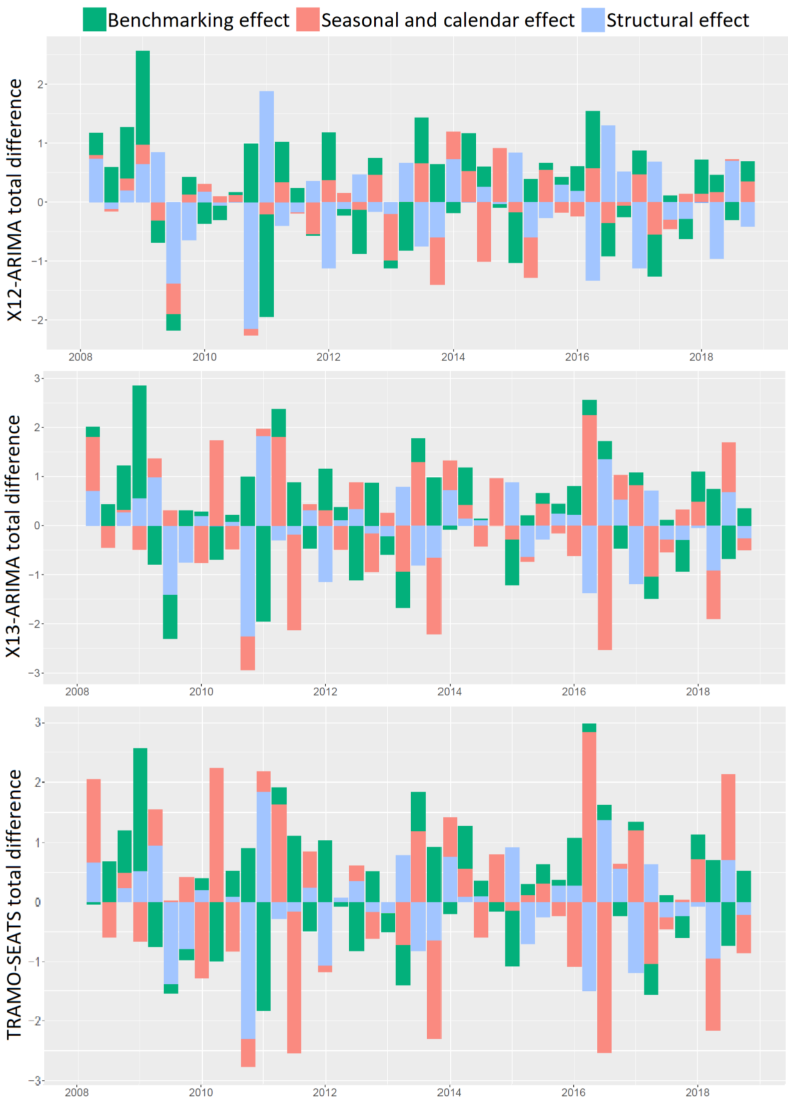
Note: The points correspond to the estimated evolution when computing the adjustment from the beginning of the series until that point, using the current model. The blue line is the estimated evolution when computing the adjustment over the entire series using the current model.

Figure 1: Revision diagnostic created in R for the evolution of the IPI of Computer, electronic and optical products adjusted with X13-ARIMA

These diagnostics include a revision analysis which is particularly interesting given the quarterly accounts' goal of reducing revisions. This graphical analysis compares the initial estimation of a month to its current estimation when computing the adjustment over the entire series. In order to see if this diagnostic could be adopted in our process I recreated it in R for the new methods (see figure 1 for the X13-ARIMA version). Unfortunately I could not produce the same result with the quarterly accounts' current method as it is run in SAS, which limits its use in this paper.

The new methods were also analysed with regards to how they affect the differences between indicator and account through analysis of the IPI (see figure 2). As expected, since the TRAMO-SEATS process is very different from both other methods, it is the one which creates the biggest differences between IPI and account. Surprisingly, X13-ARIMA also creates much bigger difference than the current adjustment.

As both methods amplify the differences significantly, part of the difference could be explained by their adjustments not being analysed for every series. Indeed, due to time constraints I only fine tuned the adjustments of the series with automatic adjustments of poor quality. This likely led to an accumulation of mistakes in the other adjustments which could influence the seasonal differences. Further attempts with more thorough adjustments would be necessary to conclude on this matter.



Note: The bars represents each effect's contribution to the difference in percentage points between the quarterly evolution of total production published by the IPI, and the one computed for the accounts after using each method.

Figure 2: Decomposition of the IPI-Account difference into Benchmarking effect, Seasonal and calendar effect and Structural effect for each method

Overall, X13-ARIMA-SEATS led to adjustments that are rather close to the current ones, both in the series they output and in their quality. They also do not appear to reduce the difference between the indicators they are used to adjust and the accounts. However, they offer a wider range of diagnostics than the current process. This could lead to a better understanding of the seasonality of quarterly accounts' indicators, and as consequence to better adjustment and an increase of the final aggregates' quality.

In the current process of switching the accounts' production process from SAS to R, it would seem possible to also change the adjustment process: either entirely by changing the method and using the official software, or partially by keeping the current method but incorporating some new diagnostics.

5. Contribution

This paper allowed me to better understand and transcribe the seasonal and calendar adjustment programs that the division will be using in R going forwards. This process also put into focus the lack of R packages implementing X12-ARIMA in a satisfactory way. Indeed most official and well maintained packages implemented X13-ARIMA-SEATS rather than X12-ARIMA.

The French quarterly accounts' division is usually rather conservative with regards to its methodology in order to allow the series' users to study it without dealing with major revisions. However, this paper came at a time where it was open to methodological changes as the ongoing process of a software change from SAS to R is likely to cause revisions. As such, although the conclusion of this paper defined the next step as implementing new diagnostics for seasonal adjustment without changing the method, practise led to the decision to also implement the switch to X13-ARIMA.

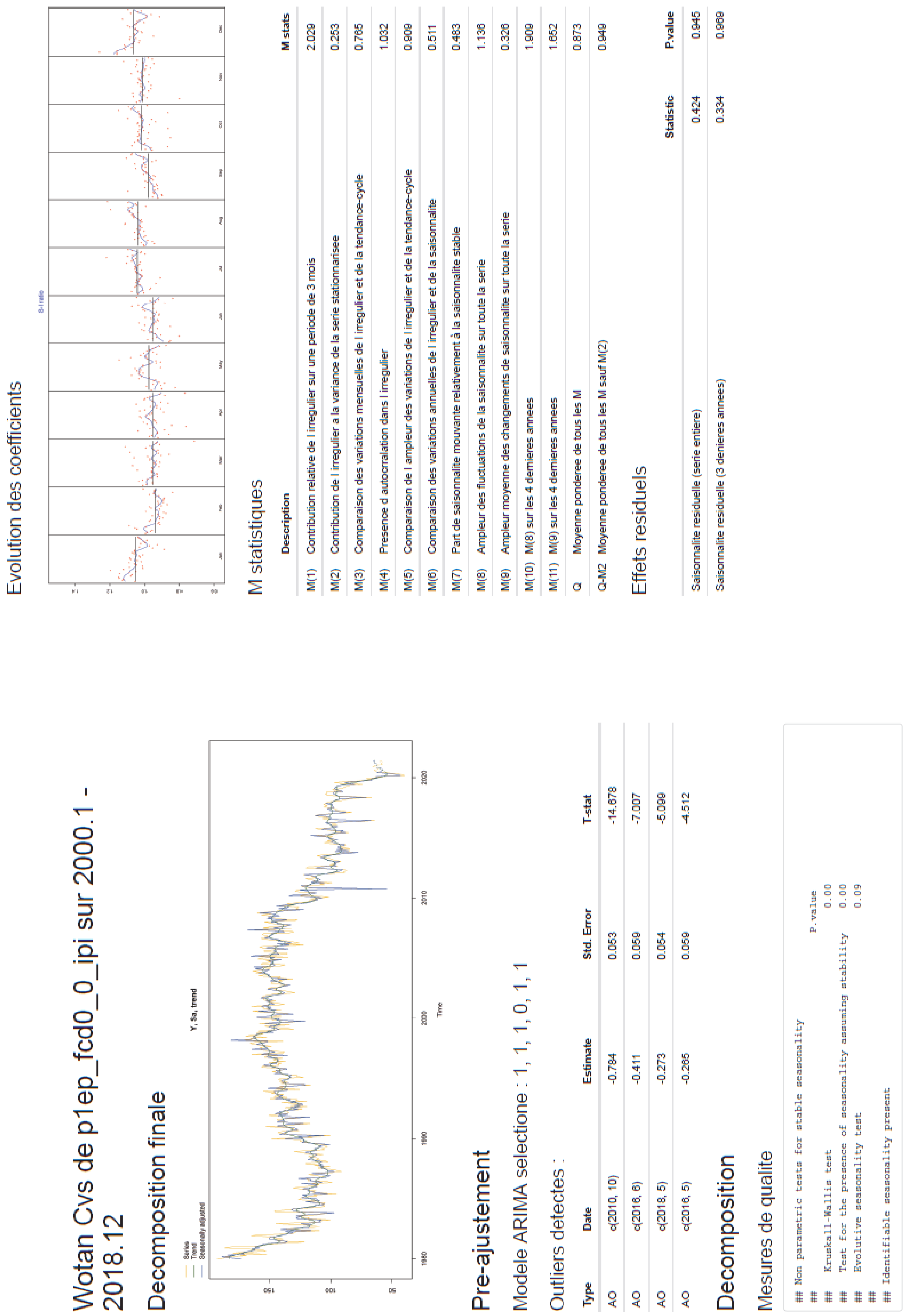
While I was able to implement the calendar and seasonal effect adjustment and their diagnostics (see figure 3 for the seasonal adjustment diagnostics[2]), I unfortunately only had time to properly analyse the revisions linked to the calendar effect adjustment[3].

From the quick comparison that was possible, the revisions obtained after fully transcribing the adjustment process in R were smaller than anticipated in this paper. This is partly because further study of both the current programs and RJDemetra's parameters showed that some relevant parameters had not been taken into account for this papers' analysis. The final adjustment program I produced in R is thus more faithful to the SAS one, and as such leads to smaller revisions.

Overall this paper is of great help to guide the methodological changes taking place in the French quarterly accounts at the moment. It also constitutes a reference and guideline for new accounts manager wishing to better understand seasonal and calendar adjustment and has allowed me to update the division's internal course on the subject. All in all, while this paper does not introduce a new concept, it does constitute a useful toolkit for the checks to put in place when considering a change of seasonal adjustment method.

2The revision diagnostic discussed previously is not included in this output as it impact the computation speed. It is only computed, and included in an other output, when requested.

3The automatic selection arrived at the same overall significant effects for the majority of series. The adjustment coefficients and calendar adjusted series were thus quite similar.



Wotan Cvs de p1ep_fcd0_0_ipi sur 2000.1 - 2018.12

Decomposition finale

Pre-ajustement

Modele ARIMA selectione : 1, 1, 1, 0, 1, 1

Outliers detectes :

Type	Date	Estimate	Std. Error	T-stat
AO	c(2010, 10)	-0.784	0.053	-14.678
AO	c(2016, 6)	-0.411	0.059	-7.007
AO	c(2018, 5)	-0.273	0.054	-5.099
AO	c(2016, 5)	-0.265	0.059	-4.512

Decomposition

Mesures de qualite

```
## Non parametric tests for stable seasonality
##                                                          P.value
##   Kruskall-Wallis test                                      0.00
##   Test for the presence of seasonality assuming stability   0.00
##   Evolutive seasonality test                                0.09
##
## Identifiable seasonality present
```

Evolution des coefficients

M statistiques

	Description	M stats
M(1)	Contribution relative de l irregulier sur une periode de 3 mois	2.029
M(2)	Contribution de l irregulier a la variance de la serie stationnarisee	0.253
M(3)	Comparaison des variations mensuelles de l irregulier et de la tendance-cycle	0.765
M(4)	Presence d autocorralation dans l irregulier	1.032
M(5)	Comparaison de l ampleur des variations de l irregulier et de la tendance-cycle	0.909
M(6)	Comparaison des variations annuelles de l irregulier et de la saisonnalite	0.511
M(7)	Part de saisonnalite mouvante relativement à la saisonnalite stable	0.483
M(8)	Ampleur des fluctuations de la saisonnalite sur toute la serie	1.136
M(9)	Ampleur moyenne des changements de saisonnalite sur toute la serie	0.326
M(10)	M(8) sur les 4 dernieres annees	1.909
M(11)	M(9) sur les 4 dernieres annees	1.652
Q	Moyenne ponderee de tous les M	0.873
Q-M2	Moyenne ponderee de tous les M sauf M(2)	0.949

Effets residuels

	Statistic	P.value
Saisonnalite residuelle (serie entiere)	0.424	0.945
Saisonnalite residuelle (3 denieres annees)	0.334	0.969

Figure 3: *Diagnostic output created by the quarterly accounts' new method in for the IPI of Coke and refined petroleum*

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Contact information:

University: Ecole nationale de la Statistique et de l'Analyse de l'Information (Ensai) and University Rennes 1

EMOS programme: Masters in Public Evaluation and Decision-making, specialisation in Methodology for Official Statistics

Applying student:

Mr/Ms	Ms
Surname	Scott
First name	Suzanne
E-mail address 1	suzanne.scott@insee.fr
E-mail address 2	suzascott@yahoo.fr
Telephone number	01 87 69 56 79
Mobile number	06 46 42 12 76

EMOS Programme responsible supporting the application:

Surname	
First name	
E-mail address 1	
E-mail address 2	
Telephone number	
Mobile number	
Qualitative assessment for the selection Max. 2000 words	