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SEASONAL ADJUSTMENT OF THE HARMONISED INDEX OF CONSUMER PRICES IN MALTA

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BOX 4: SEASONAL ADJUSTMENT OF THE HARMONISED INDEX OF CONSUMER PRICES IN MALTA[1]

The objective of this Box is to identify elements of seasonality in Malta's HICP index and explain the processes involved in the compilation of a seasonally adjusted series.

A prerequisite for the monitoring of the short-term development of economic statistics is the availability of seasonally adjusted data. The latter corrects for the seasonal fluctuations and calendar effects within the time series in order to provide a clearer understanding of the underlying economic trends. For instance, if the seasonal effect changes each month, it can be difficult to detect the general direction of monthly developments in a time series, such as turning points or consistency with other economic indicators. A key indicator that may require seasonal adjustment is the HICP, which is the official measure of price inflation used by the ECB to maintain price stability in the euro area over the medium term.

The annual growth rate in HICP inflation is not affected by seasonal patterns, as long as these patterns remain stable over time. However, it is sometimes useful to supplement the annual growth rates in inflation with shorter-term analysis, such as developments in the current month compared to the previous one. This is important because the year-on-year growth rate for a given month reflects price development over a period of 12 months and thereby could also be affected by so-called base effects stemming for instance, from changes in commodity prices.

Currently, the two most commonly used methods of seasonal adjustment within the European Statistical System (ESS) are the TRAMO-SEATS and X-12-ARIMA, which are supported by Banco de España and the Bureau of Census in the United States, respectively.[2] The ESS Guidelines on seasonal adjustment state that both methods are considered as "equally valuable as is reflected in their widespread use".[3]

Seasonal adjustment of HICP for Malta

In its analysis of price developments in the *Quarterly Review*, the Central Bank of Malta usually focuses on data for the overall HICP and a breakdown into five main components, namely energy, unprocessed food, processed food, non-energy industrial goods and services.

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[2] Gómez, V and Maravall, A. (2001), Seasonal Adjustment and Signal Extraction in Economic Time Series, A Course in Advanced Time Series Analysis, Peña, D., Tiao, G. C., and Tsay, R. S. (eds.), Wiley and Sons, New York, 202-246. Findley, D. F., Monsell, B. C., Bell, W. R., Otto, M. C. and Chen, B-C. (1998), New Capabilities and Methods of the X-12-ARIMA Seasonal-Adjustment Program, *Journal of Business and Economic Statistics*, 2, 16, 127-152.

[3] In the past, the Bank had already experimented with seasonally adjusting a range of monetary and economic statistics using the X-11 Variant of the Census Method II Seasonal Adjustment Program. Further details are available in Pule', J. (1995), Seasonal adjustment of economic time series, Central Bank of Malta, *Quarterly Review*, June 1995.

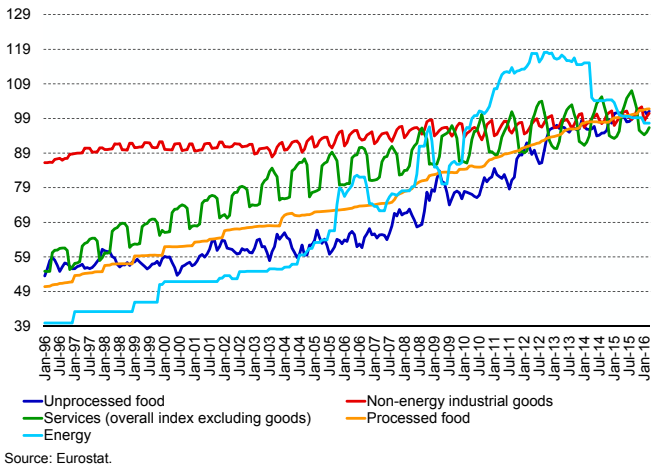
In this Box, the HICP index for Malta was seasonally adjusted using the TRAMO-SEATS approach through the application of the software package JDemetra+.[4] Following a recommendation by the Task Force on Seasonal Adjustment of National Harmonised Indices of Consumer Prices, it was decided to seasonally adjust the main components of the HICP directly, as opposed to the alternative of adjusting only the headline HICP index.[5]

The headline seasonally adjusted HICP is subsequently obtained by aggregating the adjusted main component series, namely unprocessed food, non-energy industrial goods and services with the unadjusted components for processed food and energy. The latter do not display elements of seasonality within their respective series. The main advantage of the indirect approach is a higher level of consistency between the adjusted aggregate HICP and the adjusted sub-component series. This approach is also warranted by the distinct seasonal pattern within each sub-index in order to avoid losing these component specific seasonal patterns during the aggregation process.

Chart 1 plots the unadjusted main components of the HICP over the period between 1996 and 2016. Seasonal patterns are clearly visible in the indices for unprocessed food, non-energy industrial goods and services.[6] On the contrary, the indices for processed food and energy do not exhibit seasonal variations over time.

Each time series is decomposed into four separate parts: the trend and cyclical elements, the seasonal effect and the irregular component. The process of seasonal treatment involves the setting up of a seasonal ARIMA model for each time series that needs to be adjusted. The seasonal part of an ARIMA model has the same structure as the non-seasonal part, that is, it may have an autoregressive (AR) term, an order of differencing (I) and a moving average (MA) component. In the seasonal part of the model, all of these factors operate across multiples of lag 's', where s refers to the number of periods in a season. Hence, a seasonal ARIMA model is

Chart 1
HICP SUB-INDICES FOR MALTA
(2015=100)



Source: Eurostat.

[4] Official program JDemetra+ v2.0.0 is publicly available from the CROS portal at: https://ec.europa.eu/eurostat/cros/content/download_en.

[5] The Task Force on Seasonal Adjustment of National Harmonised Indices of Consumer Prices is an ECB Task force set up to consider technical aspects of seasonal adjustments. Further details are available in Eiglsperger, M. (2011), Seasonal adjustment of harmonised indices of consumer prices – main findings of an ESCB task force, *European Central Bank* paper presented to the Ottawa Group, March 2011.

[6] In 2016, the weights for each sub-index in the overall HICP were as follows: services (43.7%), non-energy industrial goods (28.7%), unprocessed food (7.4%), processed food (13.0%) and energy (7.2%). These weights are updated annually.

classified as an ARIMA(p,d,q)(P,D,Q) model, where P refers to the number of seasonal autoregressive terms, D is the number of seasonal differences and Q is the number of seasonal moving average components. If the seasonal pattern changes over time, the time series is split accordingly and a unique ARIMA model is applied to each sub-sample. Table 1 lists the different ARIMA models for the different sub-samples of each treated HICP sub-index.

In each case, the changes in the seasonal pattern were traced back to changes in policy or the introduction of methodological changes in the data collection process. For instance, the difference in the seasonality pattern of unprocessed food was due to a change in methodology following the introduction of the HICP Regulation on the treatment of seasonal products, including fruit and vegetables, in 2011.[7]

The non-energy industrial goods series was split into three segments: up to December 2002, from January 2003 to December 2010 and from January 2011 onwards. The latter split was due to the same HICP Regulation in 2011, which also dealt with clothing and footwear, while the former relates to the elimination of an import levy on industrial goods implemented in January 2003. Differences in the seasonal pattern of services were due to a change in methodology of collecting hotel accommodation rates by the National Statistics Office (NSO) in March 2010.[8]

The seasonal adjustment of the three sub-indices – unprocessed food, non-energy industrial goods and services – is followed by diagnostic tests to ensure the successful removal of the seasonality pattern within the original series.[9] Following an analysis of the auto-correlation and partial auto-correlation functions of each series, the ARIMA models selected proved to be the best fitting for each respective adjustment. A number of tests were also

Table 1
HICP SUB-INDICES: ARIMA MODELS

HICP sub-indices (series span)	ARIMA Model
Unprocessed food (Jan. 96 – Dec. 10)	(0 1 0) (0 1 1)
Unprocessed food (Jan. 11 – Mar. 16)	(0 1 1) (0 1 1)
Industrial goods excluding energy (Jan. 96 – Dec. 02)	(0 1 0) (1 0 1)
Industrial goods excluding energy (Jan. 03 – Dec. 10)	(0 1 0) (0 1 1)
Industrial goods excluding energy (Jan. 11 – Mar. 16)	(1 0 0) (0 1 1)
Services (Jan. 96 – Feb. 10)	(0 1 1) (0 1 1)
Services (Mar. 10 – Mar. 16)	(1 0 0) (1 1 0)

Source: Author's calculations.

[7] HICP Regulation No. 33/2009 on the treatment of seasonal products. For details, see the Box entitled "Methodological changes in the compilation of the HICP and their impact on recent data", *European Central Bank Monthly Bulletin*, April 2011.

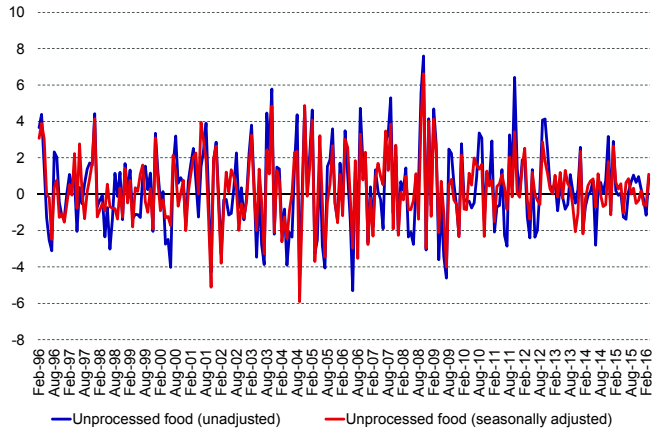
[8] In March 2010, the NSO started to collect statistics on hotel accommodation from a popular booking website rather than using hotel rack rates which led to this change in the seasonal pattern.

[9] A detailed description of the diagnostic tests is available in Grudkowska, S. (2013), JDemetra+ User Manual, *Nardowy Bank Polski* publication, October 2013.

carried out to ensure the absence of seasonality in the residuals and from the final seasonally-adjusted series. Outliers were found within the services series and the non-energy industrial goods series. These were corrected for by TRAMO-SEATS. Also, a significant Easter effect was found within the services series and was removed.

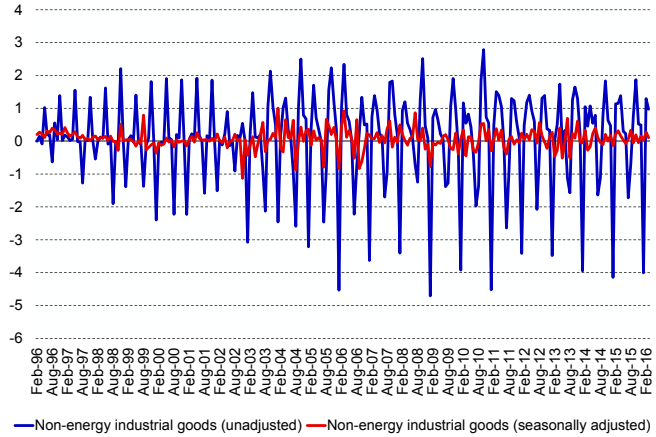
Charts 2, 3 and 4 depict the month-on-month growth rates of the seasonally adjusted series for each sub-index in comparison to the unadjusted series. As expected, each series portrays lower month-on-month volatility over time indicating a successful removal of both seasonal and calendar factors within the data. While the seasonal component was successfully removed, the series for unprocessed food shows persistently strong volatility due to its irregular component. However, the relatively low weight of this index does not raise concern for the aggregation of the overall HICP index.

Chart 2
UNPROCESSED FOOD
(month-on-month growth rates)



Source: Author's calculations.

Chart 3
NON-ENERGY INDUSTRIAL GOODS
(month-on-month growth rates)



Source: Author's calculations.

Due to the fact that the HICP is a monthly chained Laspeyres price index with annually updated weights, one cannot simply aggregate the sub-indices to obtain the headline index. Instead, the process of aggregation involves unchaining the sub-indices, aggregating these unchained series as a weighted sum, chain-linking the series in order to compile an overall index and finally normalising this final time series to match a reference year.[10] A tool created by the Deutsche Bundesbank to conduct this aggregation exercise to obtain the overall HICP seasonally adjusted

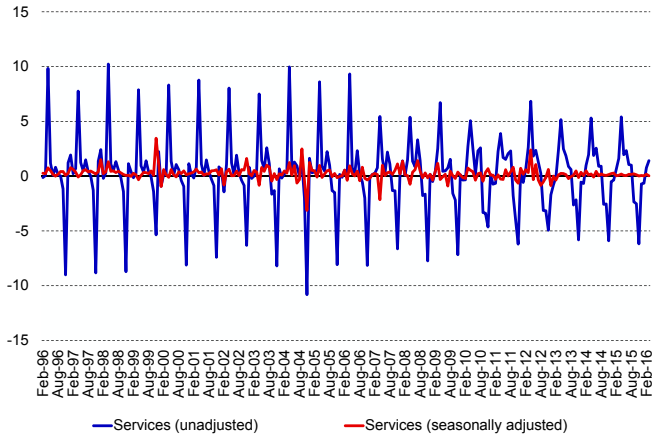
[10] Reference year used was 2015.

series was used for this purpose.

Chart 5 plots the final seasonally adjusted overall HICP index results for Malta. As can be seen, the monthly growth rates of the seasonally adjusted series portray a much lower volatility in comparison to the original unadjusted series. This newly adjusted series can provide a useful tool for analysts and policy makers as underlying trends within the series are no longer masked by seasonal factors.

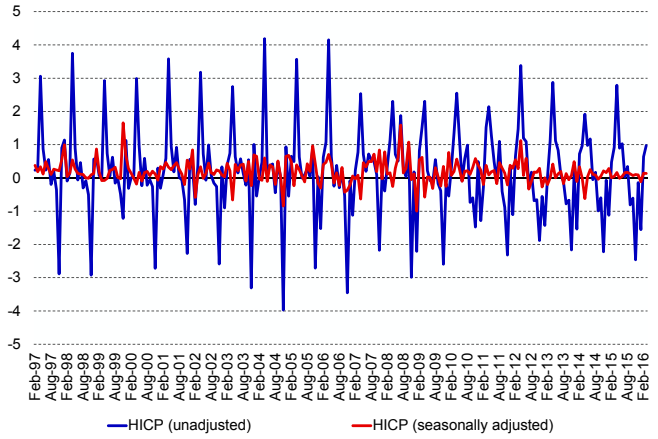
The Central Bank of Malta will be compiling a monthly time series of seasonally adjusted HICP data for internal analysis and research purposes. It also intends to start releasing such statistics on a regular basis on its website for use by the general public.

Chart 4
SERVICES
(month-on-month growth rates)



Source: Author's calculations.

Chart 5
OVERALL HICP INDEX
(month-on-month growth rates)



Source: Author's calculations.