Economics Bulletin

Volume 44, Issue 3

Implications of not controlling for known events in seasonal adjustment

Håvard Hungnes
Statistics Norway

Terje Skjerpen
Statistics Norway

Jørn Ivar Hamre
Statistics Norway

Xiaoming Chen Jansen
Statistics Norway

Abstract

Seasonal patterns in time series can change due to important events, such as legislative changes. If not taken into account, seasonal adjustment can produce misleading results. Two legal changes in Norway in 2022 and 2023 boosted house prices at the start of the year. If no adjustment is made for this, an enhanced seasonal pattern appears, which implies a slight increase in house prices in late 2023. This prompted the Norwegian central bank to raise the key interest rate in December 2023. But house prices adjusted for the legislative changes actually show a decline in the second half of 2023.

The views expressed are those of the authors and do not necessarily represent those of Statistics Norway.

Citation: Håvard Hungnes and Terje Skjerpen and Jørn Ivar Hamre and Xiaoming Chen Jansen, (2024) "Implications of not controlling for known events in seasonal adjustment", *Economics Bulletin*, Volume 44, Issue 3, pages 975-982

Contact: Håvard Hungnes - havard.hungnes@ssb.no, Terje Skjerpen - terje.skjerpen@ssb.no, Jørn Ivar Hamre - jorn.ivar.hamre@ssb.no, Xiaoming Chen Jansen - jansen.xiaoming.chen@ssb.no.

Submitted: February 19, 2024. **Published:** September 30, 2024.

1 Introduction

In December 2023, Norges Bank — the central bank of Norway — increased its key policy rate by 25 basis points. In its monetary policy assessment, the monetary policy committee states that prices in the resale homes market "have increased a little in recent months"; see Norges Bank (2023, p. 7). However, two recent legislative changes may have distorted the seasonally adjusted series for resale home prices. Had they been adjusted for these changes, house prices might actually have fallen in each of the last six months before Norges Bank raised the key policy rate.

In 2022, new requirements were introduced for housing sales reports for the resale homes market. The introduction of the stricter report — mandatory for the sale of resale homes in Norway — led to fewer homes coming on the market at the beginning of 2022. The number available for sale in the first 4 months of 2022 was 15 percent lower than in the same period the previous year. That probably contributed to the increase in the price of resale homes in early 2022.

With effect from 2023, the new lending regulations allowed more people to take up mortgages. Before 2023, borrowers had to be able to handle a 5 percentage point increase in the interest rate. From 2023, this was lowered to 3 percentage points, but borrowers still had to manage a 7 percent interest rate. The change enabled more people to secure mortgages large enough to buy a home and may have driven up house prices temporarily.

Norway maintains two series of house price statistics: a quarterly series by Statistics Norway and a monthly series by Real Estate Norway. They use different weighting methods: turnover for Real Estate Norway and housing value for Statistics Norway. Both use data from online marketplace finn.no that are based on the date of bid acceptance, not of property transfer. The present analysis uses the monthly statistics from Real Estate Norway.

House prices typically rise at the beginning of the year and fall at the end. In 2022 and 2023, this pattern was more pronounced than earlier, prompting the choice of a very short filter in the seasonal adjustment program for computing the seasonal components. Seasonal movements in 2022 and 2023 were, therefore, given large weights when the seasonal factors were calculated. This is problematic if the seasonal variation in the last two years was largely influenced by policy changes and only temporary.

Dagum and Morry (1985) point out the importance of controlling for extreme observations. There are various methods for dealing with periods of extreme observations so that they do not affect the seasonal factors severely. Findley *et al.* (1998) show how to control for extreme observations based on automatic outlier detection. This method, now included in standard seasonal adjustment programs, will only capture significant extreme observations and not necessarily influential observations that also can distort the seasonal pattern. Wright (2013) argues that in order to obtain more stable seasonal factors, one should not use the shortest seasonal filters in X12-ARIMA. In other seasonal adjustment methods, such as TRAMO-SEATS (Gómez and Maravall, 1996) or structural time series models (Harvey, 1989), periods of extreme observations may affect the seasonal factors less (see also Dagum and Bianconcini, 2016, ch. 5 and ch. 6).

In this paper, we illustrate the effect of extreme observations in 2022 and 2023 by handling these as outliers. This has also been done previously in other studies. Mehrhoff (2010) found only small revisions in seasonally adjusted figures for Argentine currency in circulation when variables capturing outliers were included during the Argentine crisis in 2001-2002, while the revisions were large if outliers were not accounted for. Both Evans and Tiller (2013) and Wright (2013) used a sequence of outlier variables during the financial crisis to investigate how much influence observations in this period had on the seasonal adjustment of labour market figures in the USA. While Evans and Tiller (2013) conclude that the observations during the financial crisis did not affect the seasonal adjustment after the crisis, Wright (2013) reaches the opposite conclusion. Variables capturing outliers have also been used during the COVID-19 pandemic to prevent the fluctuations from affecting the seasonal factors; see, e.g. Foley (2021). Eurostat (2015, 2024) recommends including outlier variables for extreme observations and for events where clear interpretations exist, such as changes in government policy. Statistics Norway (see Statistics Norway, 2020), advised to account for outliers throughout the COVID-19 pandemic unless one had a reason for why the particular time series would not be affected by the pandemic.

2 Seasonal adjustment of monthly house prices

The raw time series (Y_t) can be decomposed into a trend (T_t), a seasonal (S_t), and an irregular component (I_t). This decomposition is typically done additively or multiplicatively. Here, we use additive decomposition:

$$Y_t = T_t + S_t + I_t. \tag{1}$$

Real Estate Norway uses X11-ARIMA for seasonal adjustment, so we provide a brief overview of this method and its successors; see e.g. Dagum and Bianconcini (2016). The first step is to pre-adjust the series for extreme observations and generate forecasts for the later stages of the seasonal adjustment process. In X11-ARIMA, only simple adjustments of the original series are allowed, for example for trading day and Easter holiday effects. From X12-ARIMA on, extreme observations are included as a part of the ARIMA model; see Findley *et al.* (1998). We let the vector X_t include indicators for these effects. The general RegARIMA model is

$$\phi_p(L)\Phi_P(L^{12})(1-L)^d(1-L^{12})^D\left[Y_t - \beta X_t\right] = \theta_q(L)\Theta_Q(L^{12})\varepsilon_t, \tag{2}$$

where $\phi_p(L) = \left(1 + \sum_{l=1}^{p} \phi_p L^l\right)$, $\Phi_P(L^{12}) = \left(1 + \sum_{l=1}^{P} \Phi_l L^{l\times 12}\right)$, $\theta_q(L) = \left(1 + \sum_{l=1}^{q} \theta_l L^l\right)$, and $\Theta_Q(L^{12}) = \left(1 + \sum_{l=1}^{Q} \Theta_l L^{l\times 12}\right)$ are lag polynomials with $L^l Y_t = Y_{t-l}$, d and D are the number of times to difference for the non-seasonal and seasonal parts to become stationary, and $\varepsilon_t \sim NIID(0, \sigma^2)$.

This model enables us to forecast several periods ahead and estimate the preliminary effects of the included regressors in X_t. We can correct for these preliminary effects by defining

$$Z_t = Y_t - \hat{\beta} X_t,$$

where $\hat{\beta}$ is an estimate of β.

We apply the X11 algorithm to these corrected series to decompose into a trend, a seasonal, and an irregular component. The X11 algorithm (used in X11-ARIMA and its suc-

Table 1: Pre-processing results

	Published	Alternative
Transformation	None	None
ARIMA$(p,d,q)(P,D,Q)_{12}$	$(2,1,0)(0,1,1)_{12}$	$(1,1,1)(0,1,1)_{12}$
$\phi(L)$	$1-0.289L-0.210L^2$	$1-0.791L$
$\theta(L)$	1	$1-0.494L$
$\Phi(L)$	1	1
$\Theta(L)$	$1-0.660L^{12}$	$1-0.751L^{12}$
Easter effect	No	No
Trading days	No	No
Automatic outlier detection	No	No
Pre-specified outliers	No	Yes
Final seasonal filter	3×3	3×5
Final trend filter	9 terms Henderson MA	9 terms Henderson MA

cessors) involves multiple filters; see e.g. Wright (2013, appendix) or Dagum and Bianconcini (2016, ch. 4.1.1). The seasonal filters applied have the form

$$D_{a\times b}(L) = d_a(L)d_b(L), \tag{3}$$

where

$$d_i(L) = \frac{1}{i}\sum_{l=-\frac{i-1}{2}}^{\frac{i-1}{2}} L^{12l} \quad i = a, b. \tag{4}$$

The final seasonal filter in the algorithm, $a \times b$, is either 3×3, 3×5, or 3×9 (depending on the importance of the irregular component relative to the seasonal component). The seasonal component is constructed by means of

$$S_t = D_{a\times b}(L)\left(Z_t - \tilde{T}_t\right), \tag{5}$$

where $\tilde{T}$ is an estimate of the trend component. If the 3×3 filter is used, we have

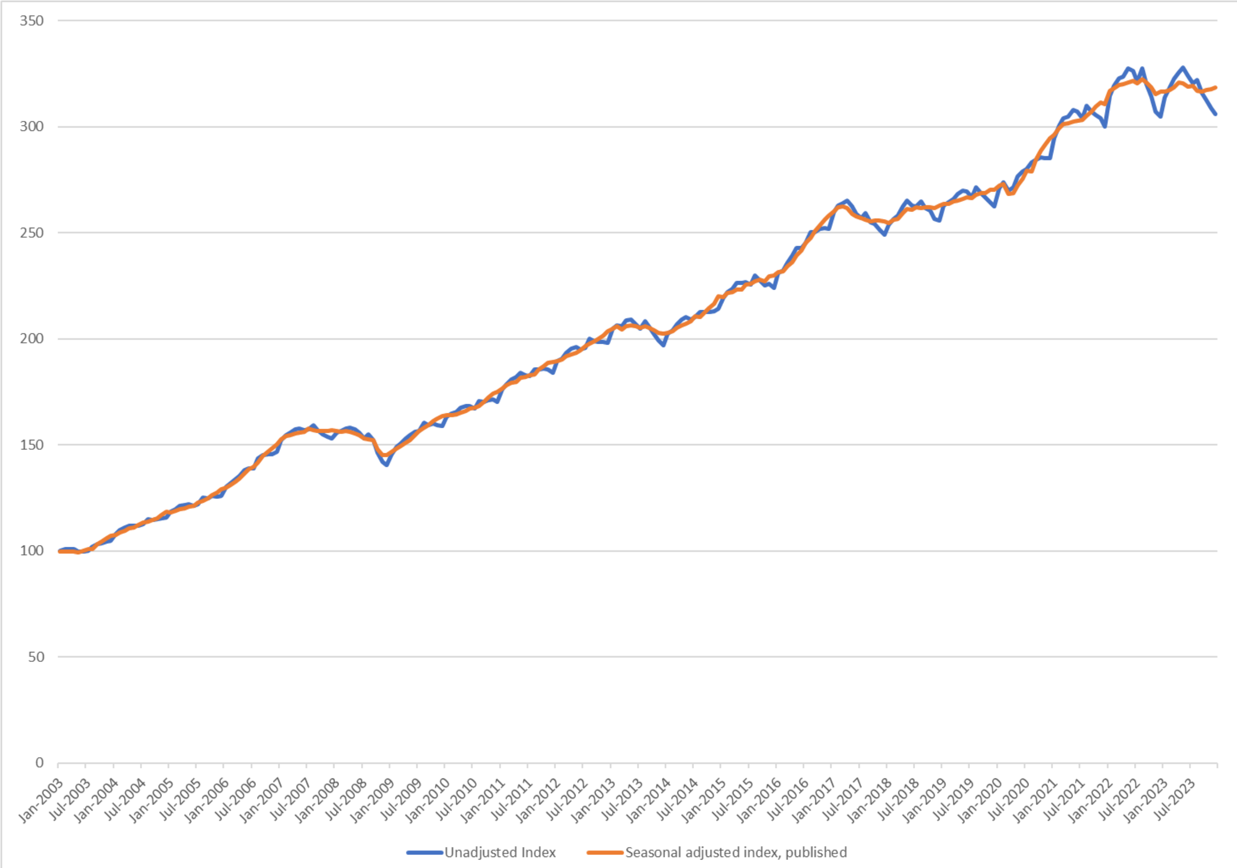
$$D_{3\times 3}(L) = \left(\frac{1}{9}L^{-24} + \frac{2}{9}L^{-12} + \frac{3}{9} + \frac{2}{9}L^{12} + \frac{1}{9}L^{24}\right), \tag{6}$$

implying that the seasonal component is based on a five-year weighted average of deviations between Z_t and its estimated trend. At the beginning and end of the series, we apply the forecasts (12 months) for Z_t and asymmetric versions of the filter.

2.1 Replication of published seasonally adjusted series

We have replicated the published seasonally adjusted series in both JDemetra+ (JDemetra, 2023) and in X-13ARIMA-SEATS (U.S. Census Bureau, 2023). Since Real Estate Norway uses X11-ARIMA for the seasonal adjustment, we did not allow for any type of outliers. Easter and trading day effects were insignificant and are, therefore, not included. This

Figure 1: House prices in Norway 2003-2023, seasonally unadjusted and published seasonally adjusted index



Source: Real Estate Norway, January 4, 2024.

implies that $Z_t = Y_t$, and (2) is only used for forecasting 12 months ahead.

In Table 1, the column "Published" reports results for the selected model. Additive decomposition as in (1) is selected. The non-seasonal part is modelled as an ARIMA(2,1,0) process, and the seasonal part is modelled as an ARIMA(0,1,1) process.

Figure 1 shows the unadjusted price index together with the published seasonally adjusted series. The deviation between the two series is not very large, except in recent years. At the beginning of both 2022 and 2023, unadjusted house prices rose considerably, before falling back for the remainder of both years. The seasonally adjusted index clearly shows smaller fluctuations. Thus, the seasonal component became more important in these two years.

In Table 2, the row "Published" reports quality assessment statistics for the model. The first nine statistics (M1-M9) are cleary less than 1 and therefore regarded as acceptable. However, the statistics M10 and M11 exceed 1, indicating abnormal seasonality in the last years of our sample. However, the overall quality assessment statistic, Q, a weighted average of all the others, is less than 1.

To understand the implications of the enhanced seasonal pattern, we can examine the seasonally adjusted prices if the month-over-month increase in the unadjusted prices in the first months of 2024 equals the historical average of price increase in these months. In the

Table 2: Quality assessment statistics

	M1	M2	M3	M4	M5	M6
Published	0.080	0.024	0.000	0.504	0.000	0.587
Alternative	0.098	0.032	0.000	0.078	0.000	0.201

	M7	M8	M9	M10	M11	Q
Published	0.593	0.854	0.678	1.534	1.470	0.428
Alternative	0.322	0.498	0.312	0.396	0.345	0.184

For details, see Lothian and Morry (1978).

years 2003–2023, unadjusted house prices rose on average by 3.1 percent in January, and 1.2 and 0.8 percent, respectively, in February and March. During these 21 years, house prices rose by 219.8 percent, seasonally adjusted. Given a rise in house prices through the first quarter of 2024 equal to the historical average, seasonally adjusted prices should be expected to rise by 1.4 percent. However, such a rise in unadjusted prices in the first quarter of 2024 will result in unchanged seasonally adjusted house prices from December 2023 to March 2024. For the seasonally adjusted house price index to rise in these months, unadjusted house prices must therefore rise more than normal in the first quarter of 2024.

We have also repeated the seasonal adjustment where, as the only change, we have allowed the seasonal adjustment program to include various outliers based on the default critical t-value equal to 4. The program then identifies 3 outliers. One of these is a transitory outlier (with TC rate 0.7) in March 2020. This coincides with the beginning of the downturn with COVID-19, which contributed to a fall in house prices this month. It finds an additive outlier in December 2021. In addition, a new transitory outlier is detected in August 2022 when house prices rose sharply before they declined substantially for the rest of the year. With these new outliers included, we obtain seasonally adjusted figures which are about the same as those found without taking account of outliers.

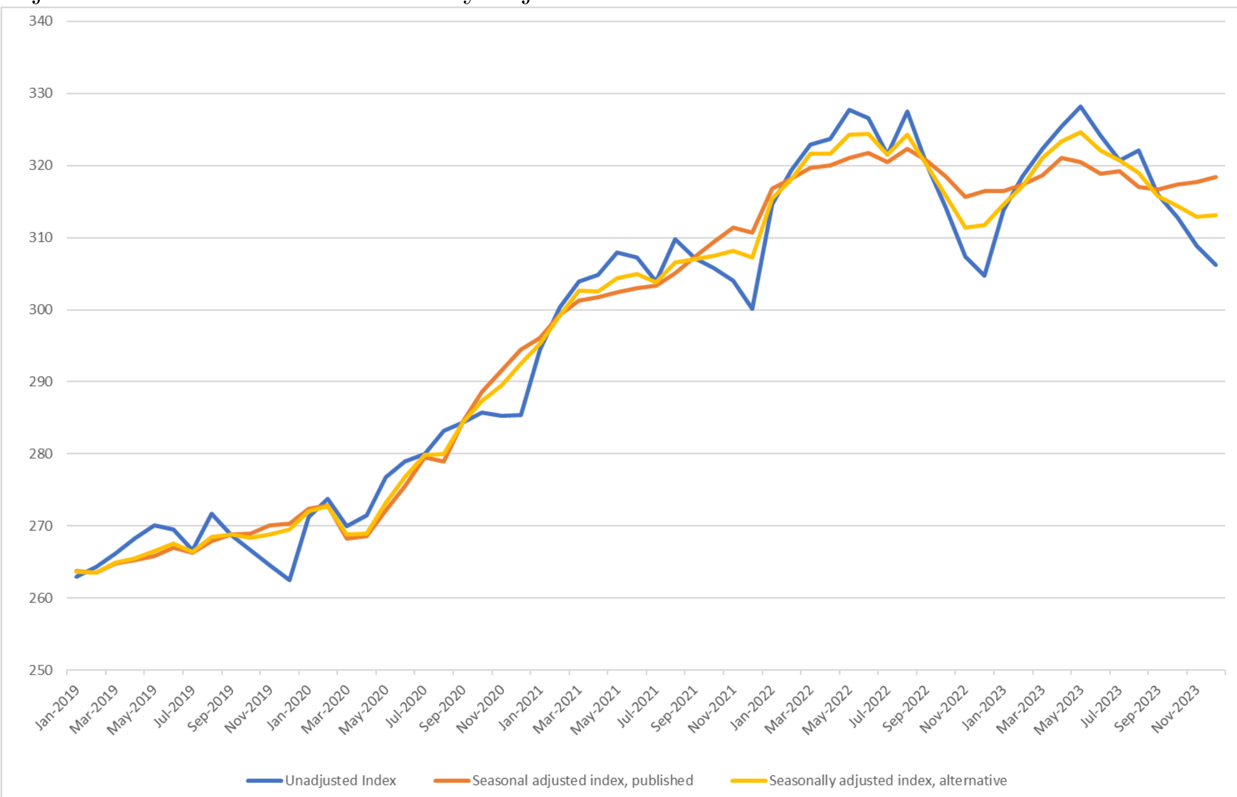
2.2 Seasonal adjustment excluding observations from 2022 and 2023

As an alternative, we have included (level-shift) outliers for every month of 2022 and 2023. Therefore, observations in these two years have not been used to estimate seasonal components.

In Table 1, the column labelled "Alternative" reports results for this model. Instead of an ARIMA(2,1,0) process for the non-seasonal part, we now have only one AR lag but also one MA lag. The process for the seasonal part is unchanged. The final seasonal filter is 3×5 and implies that the seasonal components are constructed as a weighted average of 7 observations of the deviation between Z_t and the estimated trend. A wider seasonal filter implies more stable seasonal factors.

Figure 2 shows our alternative seasonally adjusted index with both the unadjusted and published seasonally adjusted indices for 2019–2023. The two seasonally adjusted series follow each other closely in 2019 and 2020, but diverge somewhat in 2021. In 2022 and 2023, the alternative seasonally adjusted index shadows the fluctuations in the unadjusted index

Figure 2: House prices in Norway 2019-2023, seasonally unadjusted, published seasonally adjusted and alternative seasonally adjusted indices



to a greater extent. The alternative seasonally adjusted index shows a continuous fall from May to November 2023 of 3.6 percent. The published seasonally adjusted index shows a fall of just 0.9 percent in the same period.

We have not applied automatic outlier detection for this alternative model for generating seasonally adjusted house prices in Norway. If we had — using the standard criteria — we would have identified an additional outlier in March 2020 — coinciding with the start of the COVID-19 pandemic. However, the resulting seasonally adjusted time series will be hardly changed by allowing for this outlier.

2.3 Seasonal adjustment with an alternative program

In January 2024, Eiendom Norge revised its unadjusted house price series. They also changed the seasonal adjustment program from X11-ARIMA to TRAMO-SEATS; see e.g. Gómez and Maravall (1996), Dagum and Bianconcini (2016, ch. 5) or Maravall (2018). The change in the seasonal adjustment program (applied to the non-revised unadjusted series) implied that the corresponding seasonally adjusted figures show a decline in house prices in 6 out of the 7 last months in 2023 — the same as we found in conjunction with our alternative seasonal adjustment in Section 2.2. The decline in seasonally adjusted house prices from May till December 2023 was 1.8 per cent. When (level-shift) outliers were included throughout 2022 and 2023, the corresponding seasonal figures show a fall in house prices in all of the 7 last months of 2023, and the total fall throughout this period was 2.6 percent. This implies that the house price fluctuation through 2022 and 2023 changed the seasonal factors generated by TRAMO-SEATS to a much lesser extent than was the case for X11-ARIMA.

3 Conclusions

House prices have fluctuated more than previously in 2022 and 2023, possibly due to two legislative changes. These fluctuations led to significant changes in the seasonal adjustment factors from the years before. An alternative seasonally adjusted price index created by treating the observations in 2022 and 2023 as outliers shows a clear fall in house prices in the latter part of 2023. Consequently, Norges Bank's (Norges Bank, 2023) description of house price developments in the months before they raised the key policy rate could be wrong.

References

Dagum E, Morry M (1985). "Seasonal Adjustment of Labour Force Series During Recessions and Non-Recession Periods." *Survey Methodology*, **XI**(2), 133–144. `https://www150.statcan.gc.ca/n1/en/catalogue/12-001-X198500214375` (accessed June 2024).

Dagum EB, Bianconcini S (2016). *Seasonal adjustment methods and real time trend-cycle estimation*. Springer. `https://doi.org/10.1007/978-3-319-31822-6`.

Eurostat (2015). "ESS guidelines on seasonal adjustment." *Eurostat, Manuals and guidelines 2015 edition*. `https://doi.org/10.2785/317290`.

Eurostat (2024). "ESS guidelines on seasonal adjustment." *Eurostat, Manuals and guidelines 2024 edition*. `https://doi.org/10.2785/705102`.

Evans TD, Tiller RT (2013). "Seasonal adjustment of CPS Labor Force Series during the Latest Recession." Unpublished manuscript, `https://www.bls.gov/osmr/research-papers/2013/pdf/st130200.pdf` (accessed June 2024).

Findley DF, Monsell BC, Bell WR, Otto MC, Chen BC (1998). "New capabilities and methods of the X-12-ARIMA seasonal-adjustment program." *Journal of Business & Economic Statistics*, **16**(2), 127–152. `https://doi.org/10.1080/07350015.1998.10524743`.

Foley P (2021). "Seasonal adjustment of Irish official statistics during the COVID-19 crisis." *Statistical Journal of the IAOS*, **37**(1), 57–66. `https://doi.org/10.3233/SJI-200778`.

Gómez V, Maravall A (1996). "Programs TRAMO and SEATS : instructions for the user." *Documentos de Trabajo / Banco de España, 9628*. `https://repositorio.bde.es/handle/123456789/6579` (accessed June 2024).

Harvey AC (1989). *Forecasting, Structural Time Series Models and the Kalman Filter*. Cambridge University Press. `https://doi.org/10.1017/CBO9781107049994`.

JDemetra (2023). "JDemetra+ v3." `https://github.com/jdemetra` (accessed June 2024).

Lothian J, Morry M (1978). "A set of quality control statistics for the X-11-ARIMA seasonal adjustment method." *Research Paper 78-10-005, Seasonal Adjustment and Time Series Analysis Staff, Statistics Canada*. https://www.census.gov/library/working-papers/1978/adrm/lothian-01.html (accessed June 2024).

Maravall A (2018). "Quality of Seasonal Adjustment in the Model-Based Approach of TRAMO-SEATS." In Eurostat (ed.), "Handbook on Seasonal Adjustment 2018 edition," chapter 13. Eurostat. https://doi.org/10.2785/279605 (accessed June 2024).

Mehrhoff J (2010). "Ajuste estacional en tiempos de cambios económicos fuertes." *Ensayos Enonómicos*, **July–September, 59**, 7–23. https://www.bcra.gob.ar/pdfs/investigaciones/59_Mehrhoff.pdf (accessed June 2024).

Norges Bank (2023). "Monetary Policy Report 4/2023." https://www.norges-bank.no/en/news-events/news-publications/Reports/Monetary-Policy-Report-with-financial-stability-assessment/2023/mpr-42023/ (accessed June 2024).

Statistics Norway (2020). "Seasonal adjustment during the Corona crisis." https://github.com/statisticsnorway/SeasonalAdjustmentCorona (accessed June 2024).

US Census Bureau (2023). "X-13ARIMA-SEATS Reference Manual Accessible HTML Output Version." https://www.census.gov/data/software/x13as.About_X-13.html (accessed June 2024).

Wright JH (2013). "Unseasonal seasonals?" *Brookings Papers on Economic Activity*, **Fall 2013**, 65–110. https://doi.org/10.1353/eca.2013.0017.