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THE EVOLUTION OF MEDICINE PRICES IN ROMANIA – AN ANALYSIS ON THE CONSUMER PRICE INDEX AS AGAINST DECEMBER USING JDEMETRA+ 2.2.4

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Abstract

The pricing of medicines has become a critical issue across the world, which has consequences on both healthcare accessibility and economic stability. In this regard, policymakers, healthcare providers, and the general public should understand the price change dynamics to ensure appropriate prices for the medicines and access to them by all. The focus in this paper is on the Consumer Price Index for medicines in Romania, for the January 2019 to December 2022 timeframe. In this research, JDemetra+ 2.2.4 has been used for seasonal adjustment in assessing the impacts of economic policy. Results show important seasonal variations which significantly influence the role that CPI plays as an indicator of inflation and its possible use for policy making. These findings highlight on the necessity of using seasonal adjustment methodologies for capturing correct price trends in the conditions of changing economic dynamics.

Keywords: Medicine pricing, Consumer Price Index (CPI), Seasonal Adjustment, Healthcare accessibility, JDemetra+

JEL Classification: E310

1. Introduction

The Constitution of the World Health Organization (WHO) defines health "a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity", while the "enjoyment of the highest attainable standard of health is one of the fundamental rights" (WHO, 2024a). However, there are often enormous differences in the degree this objective is achieved among people from different social and economic groups, that sustained efforts and long-term global partnerships among public and private entities are needed in order to achieve health equity (WHO, 2024b). A fundamental pillar towards health equity is access to medicines, which depends, first and foremost, on affordable pricing (WHO, 2024c). Thus, understanding medicine prices is a key issue for any decision maker in public health.

According to the WHO, Health Technology Assessment (HTA) is "a multidisciplinary process that aims to determine the value of a health technology and to inform guidance on how these technologies can be used in health systems around the world" (WHO, 2024d). The introduction of HTA has increased patient access to new and innovative medicines in Romania(Scintee and Ciutan, 2017).

The result of a study conducted by Vogler et al (2015) indicated massive medicine price variations across countries, including Europe. Paradoxically, the lowest medicine prices are found in wealthy European countries such as Germany rather than in poorer ones like Romania, resulting in reduced patient compliance in the latter (Zaprutko et al, 2017).At the 2019 World Health Assembly, it was agreed that

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countries would begin sharing the real prices they pay for medicines in an effort to increase transparency(WHO, 2024e)However, revealing prices may have the opposite effect in the case of low- and middle-income countries',undermining price strategies leading to more affordable medicines (Shaw and Mestre-Ferrandiz, 2020).

In many countries, medicine prices amplified the health disparities revealed by the COVID-19 pandemic. For example, in the USA, the price of insulin is so high that 25% of the American patients had to reduce the dose or stop taking it, and thus a special act was need in order for insulin-dependent publicly-insured patients may benefit from it free of charge during the pandemic (Peek, 2021). Kersten and Makaryus (2020) pointed out that, when developing treatments against COVID-19, affordability should be considered along with price limiting mechanisms, as cost is one of the greatest barriers in treatment compliance.

Even after the COVID-19 pandemic was declared over, many countries in the world, especially low-income ones, reported medicine prices often higher than one day's salary (Oldfield et al, 2025). This applies even to essential medicines, namely, those vital for preserving human life (Yenet et al., 2023).

Given the implications of medicine prices upon societies and individuals and the disrupting effects that the COVID-19 pandemic caused for these prices, the aim of this paper is to study the dynamic of medicines prices in Romania between 2019 and 2022. The Consumer Price Index was chosen as a study variable because it encompasses the evolution of final retail prices paid by patients for their treatment. For the statistical analysis, the seasonal adjustment method was used as it reveals seasonal patterns, trend, possible outliers and calendar effects.

2. Literature review

JDemetra+ is a statistical software officially recommended by Eurostat since 2015 for time series analysis, using a combination of Java routines, an ecosystem of R packages and a graphical user interface, providing algorithms for: graphical analysis, seasonal adjustment, trend estimation, benchmarking and temporal desegregation, nowcastingandrevision analysis (Smyk et al. 2024a). There are two families available for this software: 2.x (latest version 2.2.4) and 3.x (latest version 3.2.2). The 3.x family includes improvements on historical algorithms (for example, the possibility to work with very high frequency data), the Canova-Hansen test (allowing the possibility to detect multiple seasonal patterns) and modules for full production in R (Smyk et al. 2024b). The necessity of new algorithms for working with very high frequency data arises from the fact that such data may display multiple or non-integer periodicities (Smyk and Barthelemy, 2023). While the improvements in the 3.x family compared to the 2.x are substantial, Webel and Smyk (2023 p.3) argue that "more research is needed to achieve permanent acceptance of those modifications among practitioners". Also, Mirica and Petcu (2023) tested a highly problematic series, with several outliers using JDemetra+ 2.2.4 and JDemetra+ 3.0.0 and recommended caution when using the upgraded version for such series.

Regarding the seasonal adjustment of the Consumer Price Index (CPI), Dagum and Morry (1984) argue that CPI, as a general proxy indicator of inflation, provides a summary of the most up-to-date price trend; seasonally adjusted CPI is used by the government as basis of comparison to the target rates, therefore the quality of the seasonal adjustment process, being of utmost importance. When eliminating the seasonal component from the CPI, the analyst must account for intra-annual variations with plausible economic explanations while ensuring the robustness and objectivity of the seasonal adjustment process (Bank of Russia, 2020).

In the context of seasonal adjustment, there are two types of calendar effects that may influence the seasonal adjustment process: the trading day effect – impacts the time series affected by variation by day of the week – and the holiday effect – for series affected by holiday related activity (U.S Department of Transportation, 2024). In particular, for the Harmonized Consumer Price Index for the EU, the introduction of the Easter effect in the seasonal adjustment pre-processing phase reduced the standard deviation of month-on-month growth rates by 0.05 pp (European Central Bank, 2016).

The seasonally adjusted CPI may be published for all items as well as by category. For example, the Philippine Statistics Authority publishes seasonally adjusted CPI for all items and by category as follows:

food and non-alcoholic beverages; clothing and footwear; housing, water, electricity, gas and other fuels; furnishings, household equipment and routine household maintenance; health; transport; education services; restaurants and accommodation services; personal care services (Philippine Statistics Authority, 2024).

Revision policy is a key element for ensuring transparency of the seasonal adjustment process and revisions must be provided with a high accuracy at the end of the time series (Mirica et al. 2016). Besides the good quality and low revision rates, the seasonal adjustment process of indices must account for the country particularities such as the Julian Easter (see for example Toma et al, 2018; Andrei et al 2023). In the context of the COVID-19 pandemic, revisions were often necessary for the CPI series (U.S. Bureau OfLabor Statistics, 2021).

The seasonal adjustment process design significantly impacts the revision of the seasonally adjusted data (Eurostat, 2015). In this respect, there are three approaches: concurrent adjustment (every time a new data point becomes available, the model, filters, outliers, regression parameters are re-estimated); current adjustment (at predefined intervals, the model, filters, outliers, regression parameters are re-estimated); a mixed approach of current and concurrent adjustment (Eurostat, 2015). While current adjustment with full review every year is considered an acceptable practice by Eurostat (Eurostat, 2015), concurrent adjustment might be an option for the CPI especially is the case when level shift outliers are present (Chow et al 2005). The concurrent adjustment means that each time an observation is added, the entire series is revised, implying that it may take up to 5 years for a final adjustment to be available (Tiller et al. 2022). A partially concurrent revision may be employed as follows: once a year, the intervention variables are revised; during the year, when a new observation becomes available, the ARIMA model and outliers regressors are revised (INE Spain, 2019).

3. Methodology

For the purpose of this paper, data on the Consumer Price Index as against December for medicines in Romania was retrieved form the Tempo Online database of the National Institute of Statistics Romania on May 12th 2024. In order to perform the seasonal adjustment process, JDemetra+ 2.2.4 was used.

The chosen time span is January 2019 – December 2022, in order for the analysis to cover the COVID-19 pandemic time frame. The calendar was defined using the Romanian legal holidays and several fixed days to cover the emergency state declared in the context of the pandemic – from March 16th 2020 to May 14th 2020 (Decree no 195/2020 issued by the Romanian President; Decree 240/2020 issued by the Romanian President). Incorporating these fixed days within the calendar was necessary due to the fact that the emergency state impacted the pharmaceutical industry directly. The state of emergency permitted the emergency "provision of protective materials and equipment, of disinfectants, medicines, sanitary materials, devices medical or other products necessary in the context of managing the COVID-19 pandemic" (Romanian Presidency, 2020 p.9). The Emergency Act 11/2020 issued by the Romanian Government explains in detail how the emergency acquisitions were made.

The series was tested for the presence of seasonality with the seasonality test tools and the periodogram. The periodogram identifies the periodic components of unknown frequency in the time series and may be used after the seasonal adjustment on the seasonally adjusted series as well as before, on the raw series (National Bank of Belgium and Eurostat, 2024a, https://jdemetradocumentation.github.io/JDemetra-documentation/pages/theory/spectral_periodogram.html accessed May 16th 2024). For comparison purposes, the series from January 2019 until February 2024 (latest data available at the moment of the retrieve of data) was also represented.

The outlier detection tool in JDemetra+ was used in order to check for the presence on level shift, transitory change, additive or seasonal outliers; the default specification TRfull was selected (National Bank of Belgium and Eurostat, 2024b, https://jdemetradocumentation.github.io/JDemetra-documentation/pages/case-studies/modelling-basic.html accessed May 16th 2024). For comparison purposes, the series from January 2019 until February 2024 (latest data available at the moment of the retrieve of data) was also checked.

Next, two specifications were defined: RSAfull (from the Tramo-Seats package) and RSA5c (from the X-13 package) with the calendar as designed above and trading days. With these specifications, the seasonal adjustment process was conducted for both concurrent and current adjustment.

4. Results

4.1. *Exploratory analysis*

Table 1 shows the results of the seasonality tests. The autocorrelation on seasonal lags and the test on regression with fixed dummies show that seasonality is present, while the Friedman and the Kruskal-Wallis test show that seasonality is not present. Given these contradictory results, the combined test in seasonal adjustment phase must be checked in order to make sure that seasonality is present.

Table no. 1: Seasonality test results Consumer Price Index as against December – Medicines;

Seasonality test	Value
Auto-correlation on seasonal lags	14.66*
Friedman test	12.19
Kruskal-Wallis test	12.88
Test on regression with fixed seasonal dummies	10.49*

*Significant 5%

Source: designed by the authors using JDemetra+ 2.2.4

Figure 1 shows the periodogram of the series from January 2019 to December 2022. The grey lines mark the seasonal frequencies while the red line marks the trading day frequency (Perrucci and Pijpers, 2017). The analyzed series has peaks overlapping the seasonal frequencies, indicating that there is seasonality present. However, when inspecting the periodogram for the series from January 2019 to February 2024, there are only 3 obvious peaks over the grey lines. This means that seasonal effects are somewhat less obvious or the outliers in the series makes them difficult to detect.

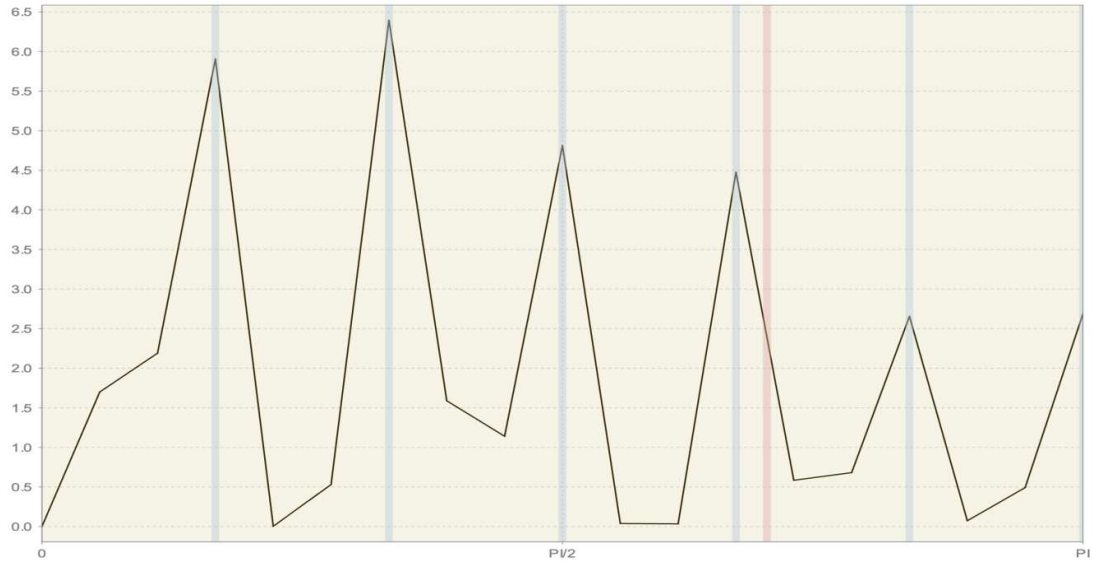

Figure no. 1: Periodogram Consumer Price Index as against December – Medicines (January 2019 until December 2022)

Source: designed by the authors using JDemetra+ 2.2.4

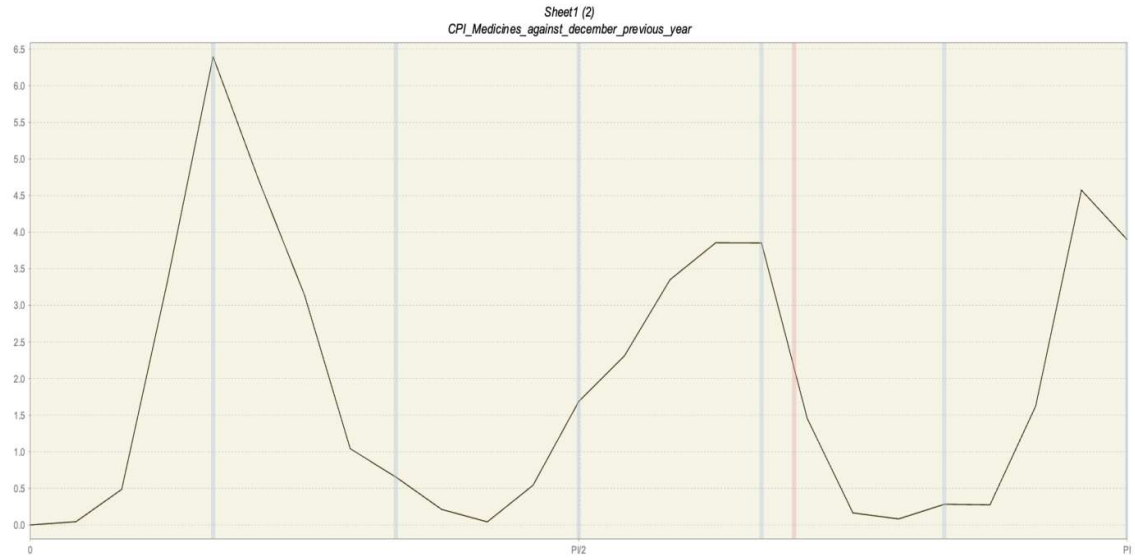

Figure no. 2: Periodogram Consumer Price Index as against December – Medicines (January 2019 until February 2024)

Source: designed by the authors using JDemetra+ 2.2.4

There are two level shift outliers present in the series from January 2019 until December 2022 – the series that will be further analyzed (figure 3): January 2020 and June 2022. Meanwhile, there are seven level shift outliers and one additive outlier in the series from January 2019 until February 2024 (figure 4).

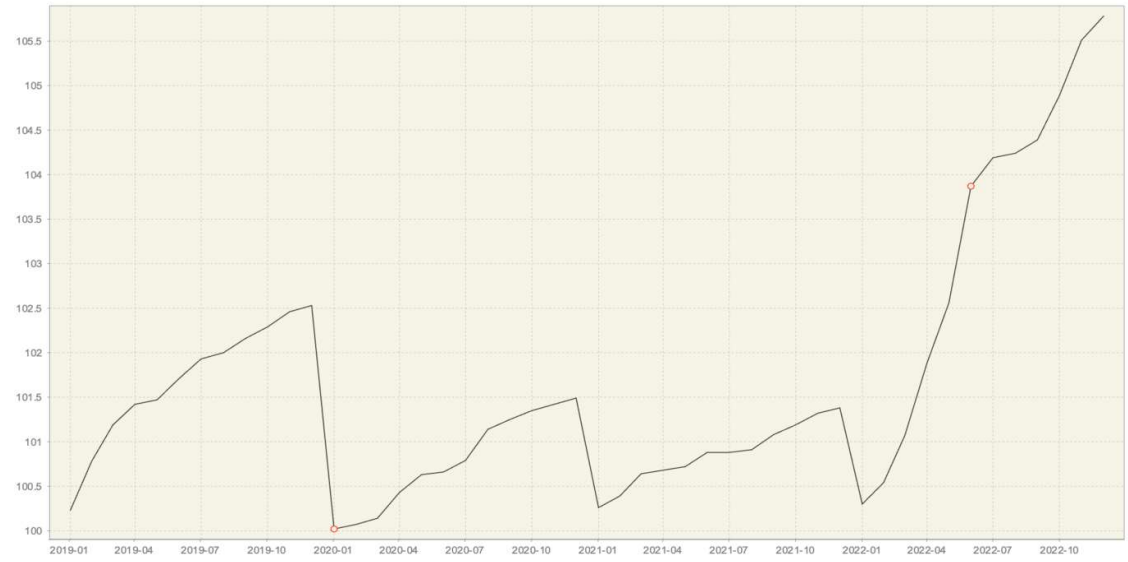

Figure no. 3: Identification of outliers on Consumer Price Index as against December – Medicines (January 2019 until December 2022)

Source: designed by the authors using JDemetra+ 2.2.4

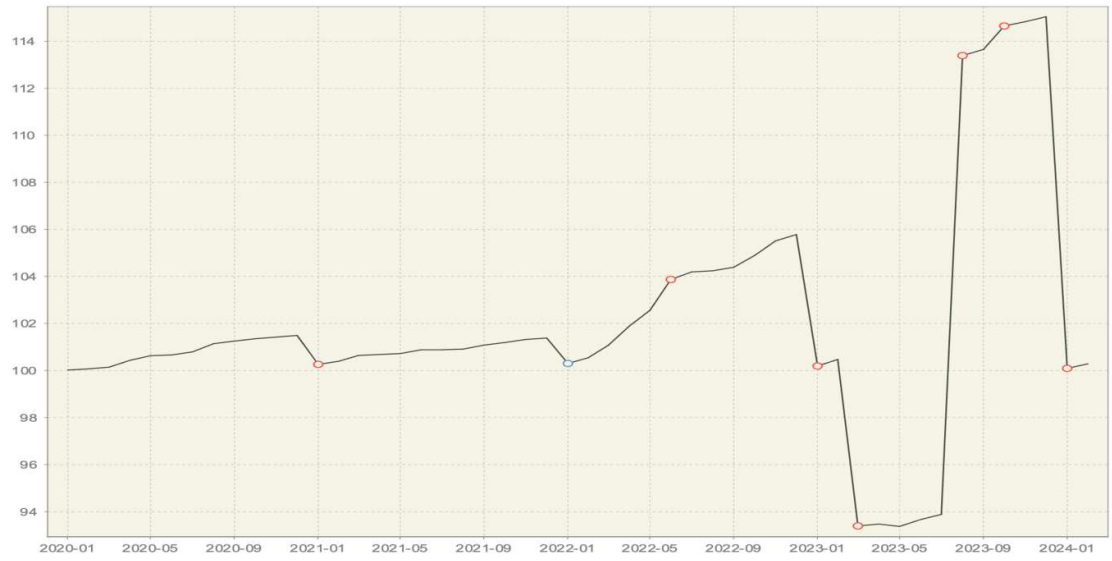

Figure no. 4: Identification of outliers on Consumer Price Index as against December – Medicines (January 2019 until February 2024);

Source: designed by the authors using JDemetra+ 2.2.4

4.2. *Concurrent Adjustment*

In this subsection, the results of the concurrent adjustment are reported. The Consumer Price Index for Medicines as against December is seasonally adjusted using the automatic procedure available in JDemetra+ for X13 and Tramo-Seats.

The general results of the seasonal adjustment process are displayed in table 2, while the combined seasonality test results are shown in table 3. After applying the combined seasonality test, it could be concluded that there is identifiable seasonality within the series. The seasonal adjustment process led to good overall results for both X-13 and Tramo-Seats. Moreover, both methods returned uncertain results for outlier correction.

A particularly interesting result is that no Easter effect and no trading day effect were observed for either Tramo-Seats, nor X-13. This means there are no variations by day of the week and the Julian Easter does not affect the series.

Table no. 2: Seasonal adjustment process of the Consumer Price Index as against December – Medicines general results

	X-13	**Tramo-Seats**
Series Transformation	None	Log-transformed
Trading day effect	None	None
Easter effect	None	None
Outliers	2 outliers – Uncertain (0.042)	2 outliers – Uncertain (0.042)
Summary	Good	Good
Basic checks	Definition – Good (0.00) Annual totals – Good (0.00)	Definition – Good (0.00) Annual totals – Good (0.00)
Regarima Residuals	Normality – Good (0.959) Independence – Good (0.826) Spectral td peaks – Good (0.459)	Normality – Good (0.979) Independence – Good (0.849) Spectral td peaks – Good (0.448)

	X-13	Tramo-Seats
	Spectral seas peaks – Good (0.456)	Spectral seas peaks – Good (0.460)
Residual seasonality tests	F-Test on SA (seasonal dummies) – Good (0.984)	F-Test on SA (seasonal dummies) – Good (1.00)
Residual trading days tests	F-Test on SA (td) – Good (0.431)	F-Test on SA (td) – Good (0.608)
Specific tests	m-Statistics q: Good (0.184) q2: Good (0.217)	Seats Seas Variance – Good (0.683) Irregular Variance – Good (0.377) Seas/Irr cross correlation – Good (0.412)
ARIMA Model	SARIMA [(0,1,1)(0,1,1)]	SARIMA [(0,1,1)(0,1,1)]

*p-values in brackets

Source: designed by the authors using JDemetra+ 2.2.4

Table no. 3: Seasonal adjustment process of the Consumer Price Index as against December – Medicines combined seasonality test results

	X-13	Tramo-Seats
Friedman test	Test statistics = 42.73 P-value = 0.00 Stable seasonality present at 1% level.	Test statistics = 44.00 P-value = 0.00 Stable seasonality present at 1% level.
Kruskal-Wallis test	Test statistics = 45.10 P-value = 0.00 Stable seasonality present at 1% level.	Test statistics = 46.69 P-value = 0.00 Stable seasonality present at 1% level.
Test for the presence of seasonality assuming stability	Test statistics = 91.2 P-value = 0.00 Stable seasonality present at 1% level.	Test statistics = 49973.1 P-value = 0.00 Stable seasonality present at 1% level.
Evolutive seasonality test	Test statistics = 0.09 P-value = 0.96 No evidence of moving seasonality.	Test statistics = 0.04 P-value = 0.98 No evidence of moving seasonality.
Combined seasonality test	Identifiable seasonality present	Identifiable seasonality present

Source: designed by the authors using JDemetra+ 2.2.4

Figures 5 and 6 display the components and the SI ratio respectively for the Consumer Price Index as against December for Medicines obtained using X13. The detrended line in the S-I ratio chart for each month (blue line) is smooth, therefore there is no moving seasonality and no abnormal patterns are identified across months, suggesting there are no seasonal breaks (UNECE, 2020). Similar results are obtained using Tramo-Seats (figures 7 and 8). However, in this case, the dots in the S-I ration chart are closer to the detrended line, suggesting that the irregular component is better captured.

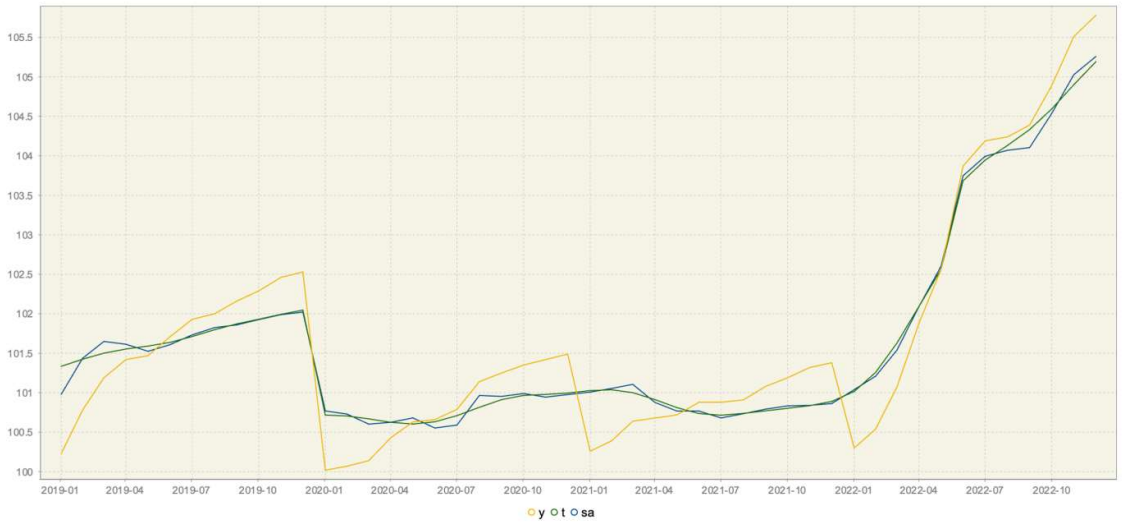

Figure no.5:Consumer Price Index as against December – Medicines series decomposition using X13 automatic procedure

Source: designed by the authors using JDemetra+ 2.2.4

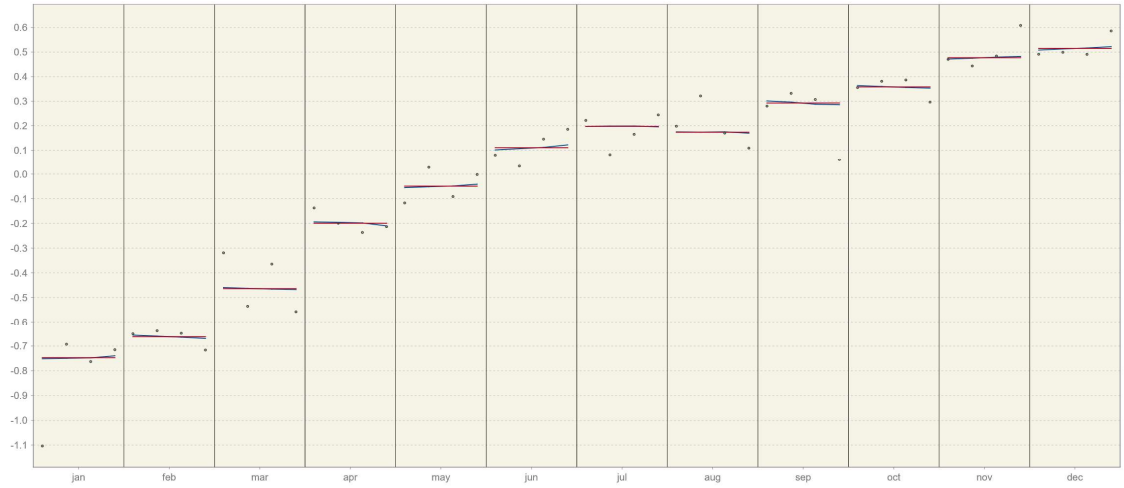

Figure no. 6: Consumer Price Index as against December – Medicines SI ratio using X13 automatic procedure

Source: designed by the authors using JDemetra+ 2.2.4

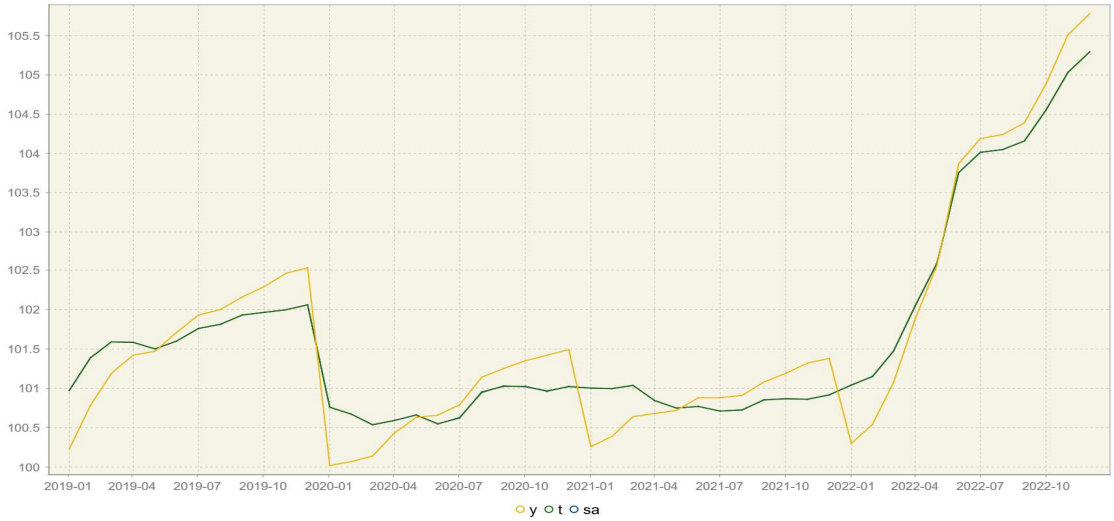

Figure no. 7: Consumer Price Index as against December – Medicines series decomposition using Tramo-Seats automatic procedure

Source: designed by the authors using JDemetra+ 2.2.4

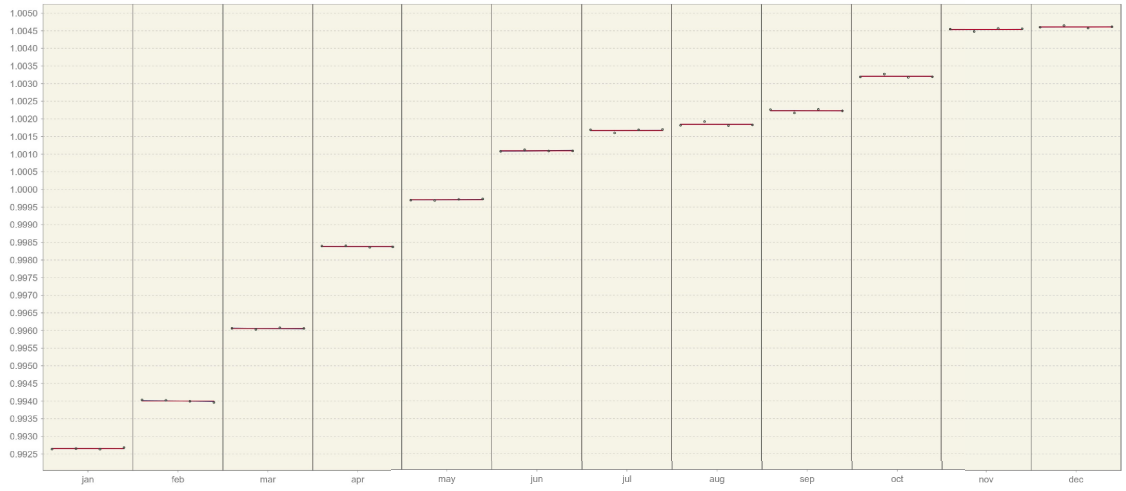

Figure no. 8: Consumer Price Index as against December – Medicines SI ratio using Tramo-Seats automatic procedure

Source: designed by the authors using JDemetra+ 2.2.4

4.3. *Current adjustment*

This subsection is dedicated to the results of the current adjustment of the Consumer Price Index for Medicines. Table 4 presents the general results of the seasonal adjustment process while table 5 presents the results of the combined test. According to the combined test, there is identifiable seasonality present. Based on the outlier test, it is possible to conclude that this method better corrects for outliers compared to the concurrent adjustment.

Table no. 4: Seasonal adjustment process of the Consumer Price Index as against December – Medicines general results

	X-13	Tramo-Seats
Series Transformation	None	Log-transformed
Trading day effect	None	None
Easter effect	None	None
Outliers	2 outliers – Good (0.00)	2 outliers – Good (0.00)
Summary	Good	Good
Basic checks	Definition – Good (0.00) Annual totals – Good (0.00)	Definition – Good (0.00) Annual totals – Good (0.00)
Regarima Residuals	Normality – Good (0.959) Independence – Good (0.896) Spectral td peaks – Good (0.459) Spectral seas peaks – Good (0.456)	Normality – Good (0.979) Independence – Good (0.912) Spectral td peaks – Good (0.448) Spectral seas peaks – Good (0.460)
Residual seasonality tests	F-Test on SA (seasonal dummies) – Good (0.984)	F-Test on SA (seasonal dummies) – Good (1.00)
Residual trading days tests	F-Test on SA (td) – Good (0.431)	F-Test on SA (td) – Good (0.608)
Specific tests	m-Statistics q: Good (0.184) q2: Good (0.217)	Seats Seas Variance – Good (0.685) Irregular Variance – Good (0.462) Seas/Irr cross correlation – Good (0.412)
ARIMA Model	SARIMA [(0,1,1)(0,1,1)]	SARIMA [(0,1,1)(0,1,1)]

*p-values in brackets

Source: designed by the authors using JDemetra+ 2.2.4

Table no. 5: Seasonal adjustment process of the Consumer Price Index as against December – Medicines combined seasonality test results

	X-13	Tramo-Seats
Friedman test	Test statistics = 42.73 P-value = 0.00 Stable seasonality present at 1% level.	Test statistics = 44.00 P-value = 0.00 Stable seasonality present at 1% level.
Kruskal-Wallis test	Test statistics = 45.10 P-value = 0.00 Stable seasonality present at 1% level.	Test statistics = 46.69 P-value = 0.00 Stable seasonality present at 1% level.
Test for the presence of seasonality assuming stability	Test statistics = 91.2 P-value = 0.00 Stable seasonality present at 1% level.	Test statistics = 49973.1 P-value = 0.00 Stable seasonality present at 1% level.
Evolutive seasonality test	Test statistics = 0.09 P-value = 0.96 No evidence of moving seasonality.	Test statistics = 0.04 P-value = 0.96 No evidence of moving seasonality.
Combined seasonality test	Identifiable seasonality present	Identifiable seasonality present

Source: designed by the authors using JDemetra+ 2.2

Figures 9 and 10 display the components and the SI ratio respectively for the Consumer Price Index as against December for Medicines obtained using X13, while figures 11 and 12 show the results for the Tramo-Seats method. Similarly to the case of concurrent adjustment, Tramo-Seats better captures the irregular component.

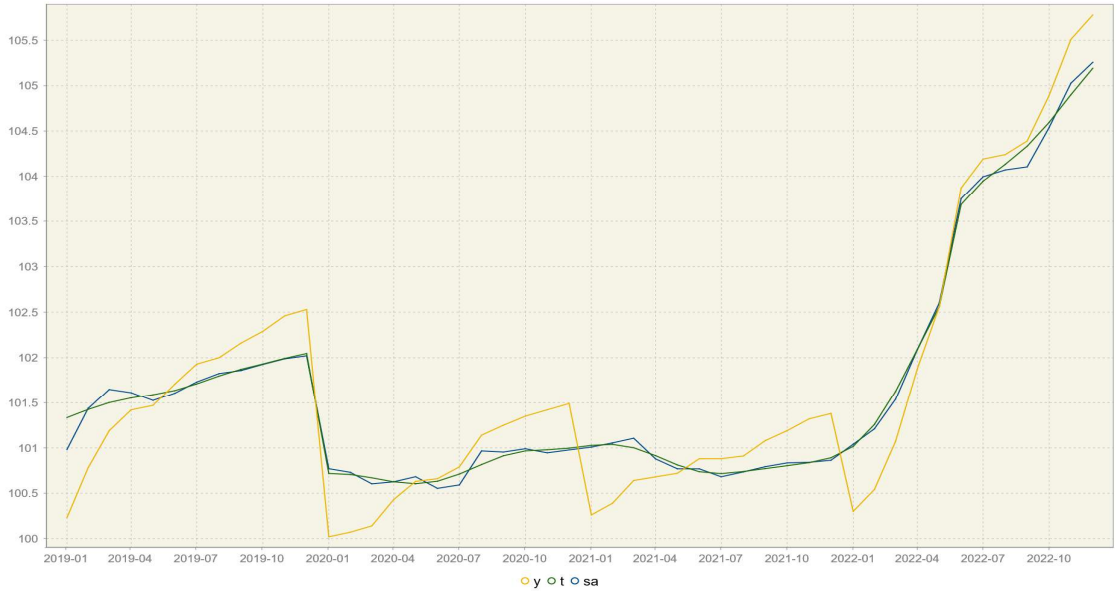

Figure no. 9: Consumer Price Index as against December – Medicines series decomposition using X13 automatic procedure

Source: designed by the authors using JDemetra+ 2.2.4

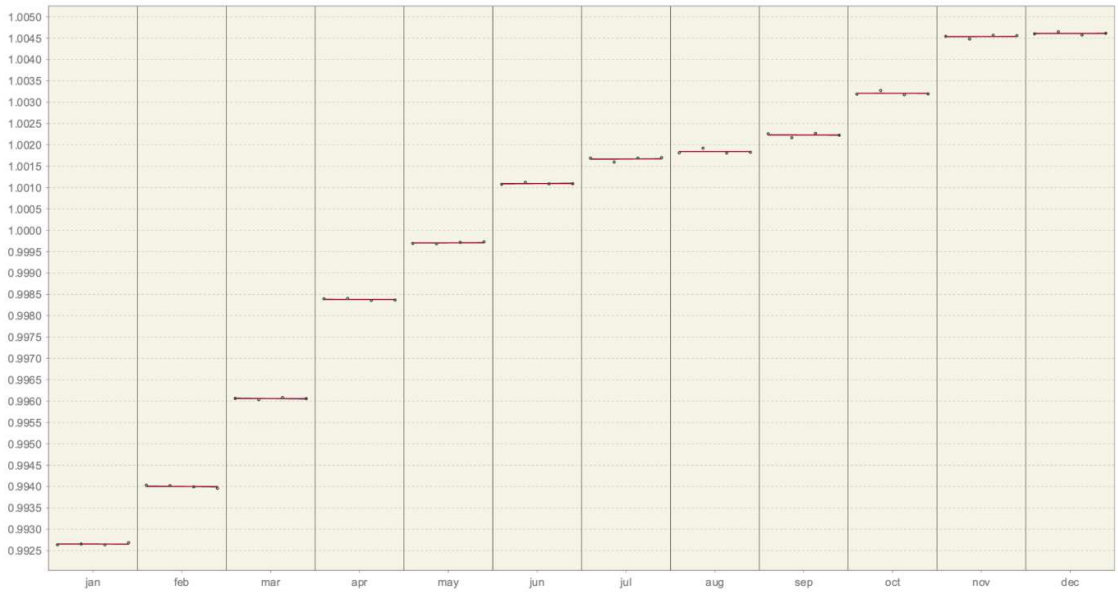

Figure no. 10: Consumer Price Index as against December – Medicines SI ratio using Tramo-Seats automatic procedure

Source: designed by the authors using JDemetra+ 2.2.4

5. Conclusions

This paper conducted a comparative analysis on the Consumer Price Index for Medicines in Romania from January 2019 until December 2022 using various methods for seasonal adjustment with the purpose

to identify the most suitable one. Four combinations of statistical packages and revision methods were tested: Tramo-Seats with current adjustment; X-13 with current adjustment; Tramo-Seats with concurrent adjustment and X-13 with concurrent adjustment. For both concurrent and current adjustment, Tramo-Seats captured the seasonal component better. Also, the current adjustment policy is preferred in order to obtain a good correction for the outliers.

The paper is not without limitations. Firstly, it captures the effects of the pandemic until the end of 2022. However, the series until the last available data is too severely affected by outliers. Secondly, there are other types of revision policy that are not incorporated within this paper such as partial concurrent adjustment. Both these issues are subject for further research.

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