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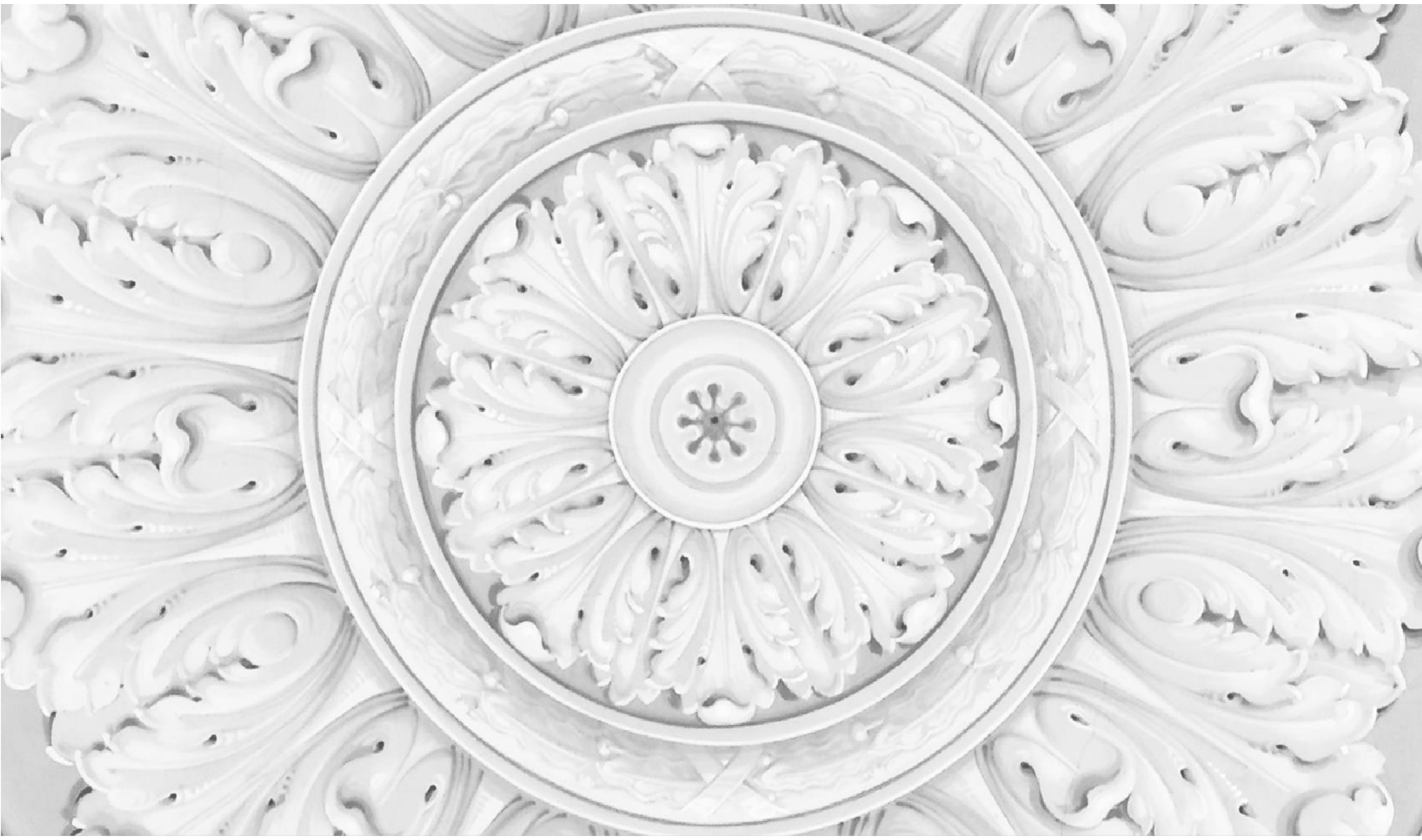

WORKING PAPER SERIES

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Review of Methodological Specifics of Consumer Price Index Seasonal Adjustment in the Bank of Russia

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Abstract

Under the inflation targeting regime, the main goal of the Bank of Russia is to maintain price stability. In order to analyse the options that the central bank can use to implement its monetary policy aimed at bringing inflation down to sustainable low levels it is necessary to understand, considering the available short-term statistical data, the dynamics of consumer prices and individual components of the seasonally adjusted consumer price index. At the same time, the seasonal adjustment of the consumer price index requires solving a number of methodological problems, one part of which is common for all economic time series with a seasonal component and the other part is determined by the specific nature of the consumer price index as an aggregate indicator. The paper suggests approaches to solving conceptual problems related to the seasonal adjustment of the consumer price index. It also describes basic principles and methods for their implementation that can lead to a significant increase in the quality of identification and interpretation of short-term meaningful variations in consumer prices that the Bank of Russia takes into account when making its monetary policy decisions.

Key words: consumer price index, inflation, seasonality, seasonal adjustment, aggregate index, consumer price dynamics
JEL classification: C18, C43, E31.

Contents

INTRODUCTION

Under the inflation targeting regime employed by the Bank of Russia, one of the key tasks is to monitor short-term tendencies and isolate the consumer inflation trend, which requires high-quality identification of the seasonal component of price dynamics and determines the importance of this process from the practical standpoint.

The identification and removal of the seasonal influence, or seasonal adjustment, is defined as cleaning the source time series of systematic (but not always regular) intra-year fluctuations related to calendar specifics, such as the regularity of production processes, weather conditions, mass holidays seasons, etc.

Obtaining reliable estimates of seasonally adjusted dynamics of consumer price growth based on short-term statistical data can be motivated by a wide range of tasks. In particular, they can be connected with both the necessity to build long retrospective time series for consumer price growth when conducting empirical research using model estimates and more practical and applied problems. The latter include the on-line monitoring of prices and tracking of various establishing or breaking trends in their dynamics based on short-term data.

From the standpoint of the state macroeconomic policy and, primarily, the monetary policy of the central bank, it is crucial to understand, considering the available short-term statistical data, the seasonally adjusted behaviour of consumer prices and individual components of the consumer price index (hereinafter, CPI). It is explained by the fact that the central bank must timely adjust its policy to potential medium-term inflationary risks if any prerequisites for their materialisation appear on the monetary policy horizon. The determination of trends and potential turning points in the short-term price dynamics is the primary task for the identification and analysis of the components of inflation processes affected by the monetary policy. Against this backdrop, it is expected that obtaining seasonally adjusted price growth estimates that are sustainable and meaningful is especially important.

Considering the practical aspect of the problems reviewed in this paper, it is important to note that seasonally adjusted estimates based on short-term economic indicators, currently used and regularly published by analytical departments of various public and private institutions, including as part of the ongoing research, often rely on different approaches and, consequently, can differ substantially.

The process of the CPI seasonal adjustment requires solving a number of methodological problems and can be, for our purpose, broken down in two levels. The first level includes common issues for all time series that are subject to seasonal volatility. They include, *firstly*, the necessity to develop such seasonal adjustment methods that would be able to catch seasonal effects of different amplitude (by amplitude we mean the range of seasonal volatility). While the range of seasonal fluctuations in the structure of certain time series can be very pronounced, they can be absent or hardly identifiable in others. *Secondly*, seasonal waves can evolve in time, which can be related to changes in their amplitude, strength and intensity (frequency). It is also necessary to determine how well the chosen method adapts to the evolving seasonality and how robust are the estimates of the mutual dependency of changes in the seasonal component of the time series and other components (trend cyclical, calendar or irregular) [3, p. 571].

The second level includes issues related to CPI seasonal adjustment due to its specific nature. As CPI is an aggregate indicator, its seasonal pattern (nature of seasonal fluctuations, stable seasonal waveform) is comprised of the seasonal waves of subcomponents that are included in the calculation. The reasons behind seasonal fluctuations of CPI subcomponents (subindices) can be completely different, but it is necessary to identify them in order to improve the quality of seasonal adjustment, which greatly increases the labour intensity of the process. Another problem is related to the fact that, due to the specifics of certain CPI subcomponents, it is not possible to use standard seasonal adjustment methods.

This paper suggests the solution to the above issues, lays out the approaches to solving the conceptual problems related to CPI seasonal adjustment, and describes basic principles and methods for their implementation. The presented methodology can significantly improve the quality of identification of current short-term meaningful trends in consumer prices that the Bank of Russia takes into account when making its monetary policy decisions.

1. INTERNATIONAL EXPERIENCE IN SEASONAL ADJUSTMENT OF INFLATION

Seasonal adjustment of inflation is widely used in many countries. Despite significant differences in the CPI calculation methodologies used, seasonality remains an important factor of the economic analysis. It should be noted that the use of seasonally smoothed data when analysing current economic situation and the publication of series of seasonally smoothed indicators are both highly popular. This practice creates prerequisites for developing methodological tools for the analysis of seasonal adjustment making it more transparent.

The most popular methods of seasonal smoothing include TRAMO/SEATS and the X-11 family. Their popularity is based, among other things, on the organisations responsible for their development and support. TRAMO/SEATS was developed and is currently supported by the Bank of Spain, which explains its wide adoption in the EU countries [10]. The X-11 family methods, developed by the U.S. Census Bureau, are primarily used in the USA. Moreover, the X-11 methods are used for seasonal adjustment of inflation in Australia [8], New Zealand [4], Singapore [9], and many other countries largely owing to the fact that they appeared earlier than TRAMO/SEATS.

Each country develops its own approach to seasonal adjustment determined by the primary analysis values and the economic nature of drivers behind seasonal price fluctuations. In particular, according to Statistics New Zealand, the primary criterion of quality is the absence of any residual seasonality and the smoothness of seasonally adjusted data. In this case, it is logical to apply a direct approach to seasonal adjustment, which implies a seasonal correction of already aggregated indicators. At the same time, many countries (the USA, Australia, certain EU members, e.g. Malta [11]) prefer to focus on studying the economic nature of the seasonality of individual inflation components, and for that purpose the indirect approach is more useful because it is based on the seasonal smoothing of individual indicators with their further aggregation (for details see Section 3 ‘Specifics of seasonal adjustment of aggregated indicators’). The EU, being an association of individual countries, uses an even more complex kind of indirect approach when, at the first stage, seasonally smoothed indicators of price growth for individual inflation subindices are aggregated at the country level, and then, at the second stage, price growth levels by country are aggregated into the total EU inflation.

The next important methodological characteristic is the approach to reviewing seasonal smoothing parameters. For example, in Australia and New Zealand these parameters are reviewed every time when the information is updated. It can be explained by the small number of inflation subindices. At the same time, the number of subindices that are taken into account for calculation in the USA and EU is much greater, which makes their less frequent revision reasonable. For instance, in the USA, seasonal factors are updated annually. It is done simultaneously with updating the data for the past five years and fixing the seasonal factors for the next 12 months. The list of inflation subindices that are called ‘seasonal’ is also reviewed annually. This helps increase the robustness of estimates of the seasonally smoothed inflation.

Apart from the above differences in the seasonal smoothing methods, certain countries can incorporate additional procedures into the deseasonalising process. In the USA, for example, the analysis of contribution of different shocks to inflation is applied in addition to standard seasonal smoothing procedures. The importance of such an analysis is increased when an external shock affects inflation during the same period of consecutive years. In this case, an automatic algorithm can attribute the influence of the external shock to seasonality though its nature could be other than seasonal. The analysis of contribution of different shocks comes down to subtracting this contribution from inflation dynamics with further seasonality analysis. This algorithm allows cleaning inflation dynamics from the influence of individual shocks and provides an opportunity to obtain more correct seasonality estimates.

2. EVOLUTION OF SEASONAL ADJUSTMENT

Seasonal adjustment is performed using specialised algorithms that have been developed since the early decades of the 20th century. The evolution of algorithms and the competition between them led to the fact that the overwhelming majority of experts all over the world currently employ seasonal adjustment algorithms of one of the following two families: non-parametric (and later, semi-parametric) methods of the X-11 family and the parametric TRAMO/SEATS method [2, p. 24].

The X-11 algorithm was first developed in 1950-s by the U.S. Census Bureau [12]. The main idea behind this method was to separate the trend and the seasonal components in a number of stages using a specific set of filters. The main drawback of the method consisted in the boundary points problem due to the application of asymmetrical filters at the series boundaries.

The next method, X-11-ARIMA, was developed by Statistics Canada in 1980. Instead of applying asymmetrical filters at the series boundaries, it was suggested to complete the available series with the ARIMA model estimated on the available data.

In 1990, the U.S. Census Bureau developed the X-12-ARIMA seasonal adjustment algorithm [13], whose key feature was the application of the regARIMA model. This allowed using a single structure to consider calendar effects, estimate the ARIMA model parameters, fill in the gaps in data, and take outliers[1] into account. It was not only possible to select the ARIMA model from the

[1]By outliers we mean sharp deviations from the trend (an excessive share of the irregular component in the relevant period neighbourhood) observed over a single period or a group of isolated periods. Outliers can be either informative (connected to economic events, shocks, etc.) or non-informative (errors in the data).

list of specifications but also conduct the evaluation in the automatic mode starting from the simplest specification and gradually adding lags and differences. X-12-ARIMA is one of the most popular seasonal adjustment methods.

In 1996, the Bank of Spain proposed a new seasonal adjustment algorithm that was conceptually different from the earlier methods and was called TRAMO/SEATS [5, p. 321]. It is essentially a combination of two programs (TRAMO and SEATS) solving different problems. This method conceptually differs from any X-11 family methods because time series models that it is based upon are build separately for each time series. The properties of the model upon which the decomposition is based largely depend on the properties of the processed time series.

The first part, TRAMO (Time Series Regression with ARIMA Noise, Missing Observations and Outliers), is an alternative to regARIMA that allows taking into account calendar effects, correcting different types of outliers, and restoring missing observations. This is all implemented as part of a regression model. The second part, SEATS (Signal Extraction in ARIMA Times Series), is responsible directly for the seasonal adjustment of the residuals obtained with TRAMO.

The main assumptions of the method are:

1) residuals obtained with TRAMO are described by an additive model
2) all these components are orthogonal
3) all these components are described by ARIMA models
4) the random component is the ‘white noise’.

If we know the residuals estimated with TRAMO, we can explicitly obtain models for the trend and the seasonality. As there can be more than one solution, the best one can be chosen based on a certain criterion (e.g., noise minimisation).

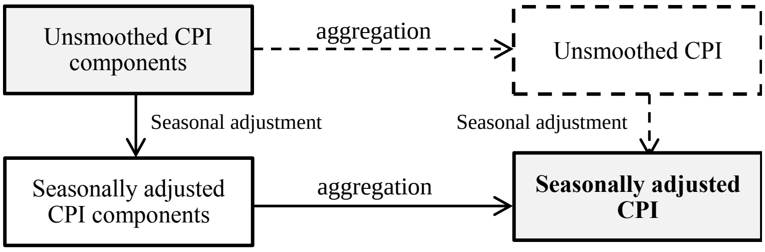
The result obtained with TRAMO/SEATS has smaller variance than that of X-12-ARIMA because its structure presumes that the series’ stochastic component partially falls under the seasonality estimation while in X-12-ARIMA all the stochastic component is irregular. Moreover, the TRAMO/SEATS method is considered more resilient to adding new points. The seasonality estimate obtained with SEATS is considered more precise than that obtained with X-12-ARIMA, because the seasonality form depends on the data and is optimal (e.g., by the noise minimisation criterion).

As each of these methods has its pros and cons, the most reasonable approach would be to use the latest method, X-13-ARIMA-SEATS, which enables using both parametric and non-parametric methods. It was developed by the U.S. Census Bureau together with the Bank of Spain [14]. It encompasses the expanded versions of X-12-ARIMA and SEATS and allows using their combinations, simultaneously featuring all the advantages of regARIMA with regard to the preliminary processing of the time series and SEATS with regard to seasonal adjustment.

3. SPECIFICS OF SEASONAL ADJUSTMENT OF AGGREGATED INDICATORS

Most macroeconomic indicators are aggregated (or composite), i.e., they consolidate many individual indicators by adding them (e.g., GDP) or by using a system of weights (e.g., CPI). The seasonal adjustment of aggregated indicators can be performed using a direct or indirect approach (Figure 1).

Figure 1. Direct (dotted line) and indirect (solid line) approaches to seasonal adjustment

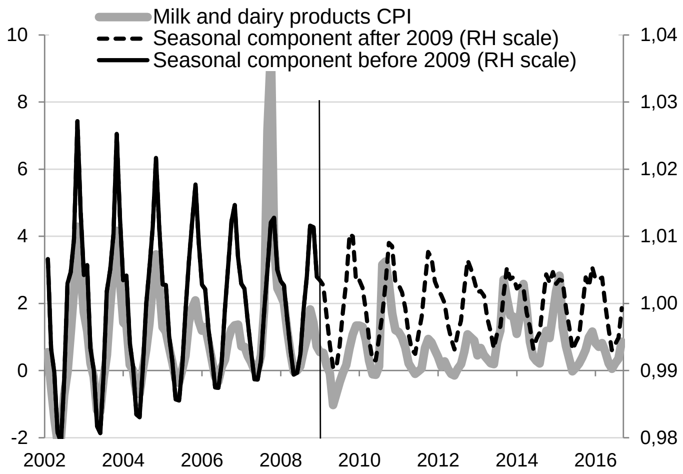


The direct approach involves aggregating at the first step with further elimination of the seasonal component from the obtained indicator. The indirect approach functions the other way round: at first, each individual indicator is seasonally adjusted, and then the aggregated indicator is calculated.

The direct approach is less precise than the indirect one. The seasonal pattern of the aggregated indicator is generated as a result of averaging the seasonal fluctuations of time series of individual indicators [2, p. 39]. The weights of subcomponents comprising the aggregated indicator change annually. Besides, the set of representative goods also regularly varies. Abrupt and potentially large fluctuations of seasonal waves can occur at concatenation boundaries of the time series resulting from the use of different weights and components.

See for example the dynamics of consumer prices for milk and dairy products, whose components are represented in Fig. 2.

Figure 2. Milk and dairy products CPI (% MoM) and the seasonal component of the time series (RH scale)



Sources: Rosstat, authors' calculations.

In 2009, both the amplitude of seasonal fluctuations and the periods with the maximum influence of the seasonal factor changed sharply (Figure 2). This was caused by the fact that in 2009 the component 'Whole milk for pouring' was excluded from the calculation of milk and dairy products CPI.

The jumps of seasonal waves at concatenation boundaries cannot be completely removed at the stage when the seasonal adjustment of the time series of the aggregated indicator is performed. The reason for this is that abrupt changes can occur not only in the amplitude of seasonal fluctuations but also in their strength and length.

In order to avoid the limitations of the direct approach, the indirect approach is used globally, its main drawback being that it is relatively labour intensive. Thus, in the direct approach, the seasonal adjustment is performed through a decomposition of the single time series while the indirect approach involves, firstly, a decomposition of a large number (tens or hundreds) of time series and, secondly, their aggregation into a composite index.

The indirect approach to seasonal adjustment has a number of benefits vs. the direct approach [2, p. 42], with the most important of them being that it provides more information because it requires analysing each subcomponent. Besides, in the direct approach, source data time series still contain unidentified errors that can be found using the indirect approach.

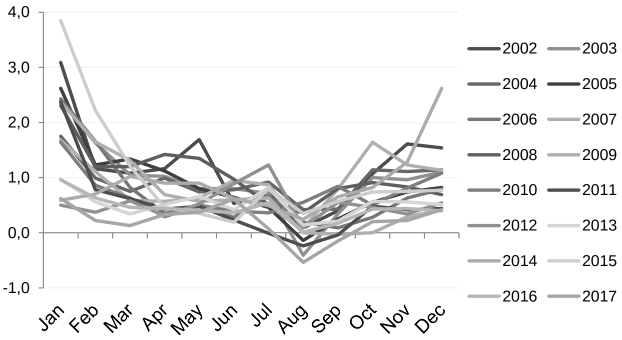
It should be noted that, in order to ensure the comparability of the time series levels for the purpose of calendar and seasonal adjustment, the standard economic dynamics analysis technique assumes the use of basis time series (normalised to a certain base).

4. SEASONAL ADJUSTMENT OF CPI

The Bank of Russia conducts its monetary policy under the inflation targeting regime, which determines high practical significance of interpreting short-term trends in consumer price dynamics. High quality interpretation of short-term CPI variations is impossible without its seasonal adjustment because the range of seasonal fluctuations often substantially exceeds the total contribution of all other meaningful factors in the indicator's dynamics. This paper offers a theoretical solution of problems related to the seasonal adjustment of CPI based on Rosstat CPI data for 2002–2017.

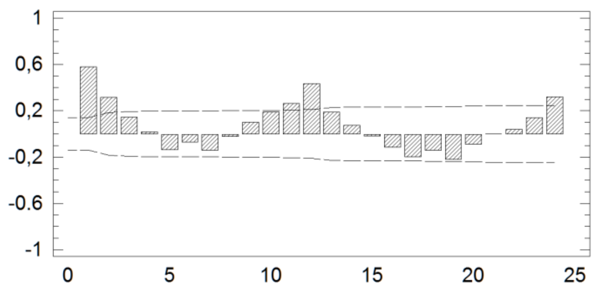
Based on the dynamics presented on the chart, we assumed the presence of seasonality because the price growth in the beginning of each year is higher than the price growth in late summer and early autumn (Figure 3). The presence of seasonality is confirmed by the autocorrelation function chart (Figure 4).

Figure 3. CPI in 2002–2017 (% MoM)



Sources: Rosstat, authors' calculations.

Figure 4. CPI autocorrelation function chart



Source: authors' calculations.

The main *purpose of the seasonal adjustment* is to clean the source time series of systematic (but not always regular) intra-year fluctuations related to the regularity of production processes, weather conditions, mass holiday seasons and other calendar-specific events.

The seasonality is removed from times series where there are systematic intra-year fluctuations with the following characteristics:

- *economic justification* (the seasonality in the economic time series dynamics can be explained in various ways: the regularity of weather conditions, production and educational processes, mass sale seasons, religious holidays, traditions, customs, etc.);
- *robustness* (the seasonality estimate is robust enough to be predicted with reasonable confidence);
- *objectivity* (formal tests confirm the seasonality assumption).

Formal tests that can be used to confirm or reject the presence of seasonality include:

- *Kruskall-Wallis test* is a non-parametric test for stable seasonality that is used for comparing two or more samples in order to verify whether they originate from the same distribution. The null hypothesis stipulates that all months or quarters have the same expected value.

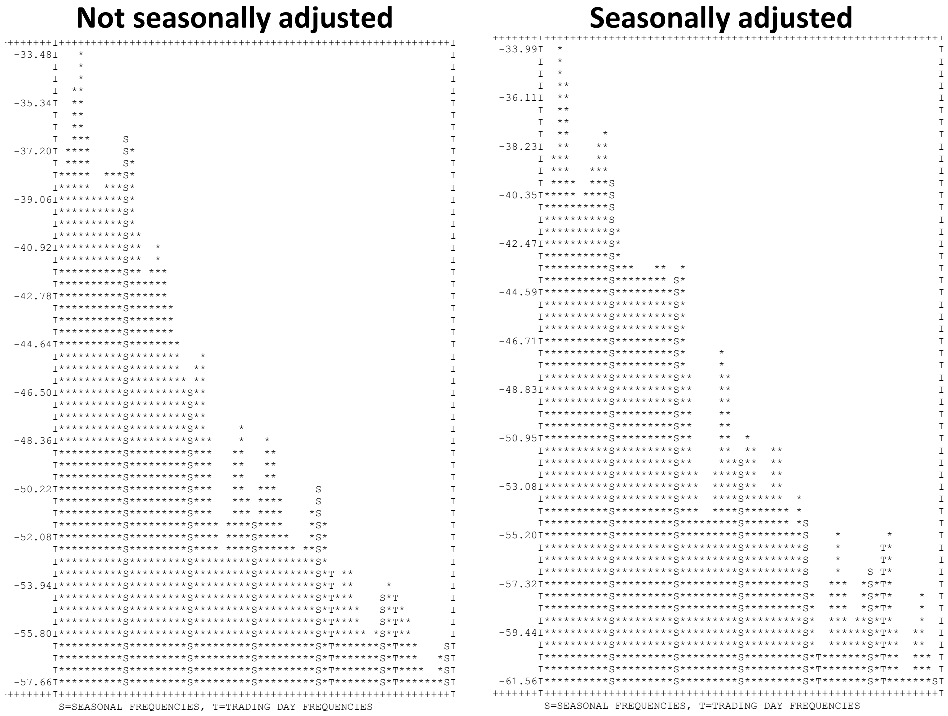
- *Friedman test* is a non-parametric test for stable seasonality in a time series. If the p-value is below 0.1%, the null hypothesis of unstable seasonality is rejected; otherwise, it is considered that the time series contains no seasonal fluctuations.

- *periodogram and autoregressive spectrum* are tools used for the spectral analysis to detect seasonal and calendar effects in the time series dynamics. If the series contains a seasonal component, the vertices on the spectrum chart will correspond to seasonal frequencies.

In the Bank of Russia's practice, the seasonality is removed using the indirect approach that involves the adjustment of subcomponents comprising the indicator. According to the recommendations of the European Central Bank (ECB), to determine the optimal disaggregation it is necessary to analyse seasonal patterns of subcomponents: if the components comprising the indicator contain different seasonal patterns, it would be more correct to consider them separately [6]. At the same time, if the seasonal patterns of the subcomponents are similar[2], further disaggregation is not required. The issue of selecting the correct disaggregation depth arises if the share of subcomponents with seasonality is relatively low. During the above mentioned period, this case was observed with respect to fish products: the seasonality was discovered only in the dynamics of prices for live and cooled fish, which comprises about 9.5% of fish products. In this case, it is necessary to focus on the spectral seasonal vertices chart: if after separating the seasonal wave the aggregated indicator chart is better[3] than the source time series chart, the seasonality should be removed despite the low weight of the component that contains it [7, p. 38]. In case of the CPI for fish products, the spectral chart obtained after eliminating the seasonality in the 'Live and cooled fish' subcomponent does not contain peaks falling on seasonal frequencies, in contrast to the chart based on the source data (Figure **5**).

[2] In this case, similarity rate is determined by the same or similar amplitude and intensity of seasonal fluctuations, with the seasonal peaks of such time series falling on the same periods.
[3] I.e., spectral peaks do not fall on seasonal frequencies.

Figure 5. Spectral chart corresponding to the 'Fish products' component in the aggregated CPI not seasonally adjusted (left) and seasonally adjusted (right)



Source: authors' calculations.

Below we describe a few large CPI components that were reviewed for the presence of seasonality and the necessity of further disaggregation before smoothing (Table 1).

Table 1. Seasonality in large CPI components

Category	Weight (2016)	Seasonality	Seasonality in subcomponents	Disaggregation	Notes
Meat products	9.6	-	+ (poultry, weight – 1.5%)	-	The seasonality in the dynamics of poultry prices is very unstable and cannot be predicted well. It does not pass most of the tests.
Fish products	2.1	+	+ (live and cooled fish, weight – 0.2%)	+	Isolating the seasonality in the dynamics of prices of live and cooled fish improved the result (the spectral chart improved: spectral peaks do not fall on seasonal frequencies)
Oils and fats	1.1	+	+ (butter, weight – 0.6%)	+	Isolating the seasonality in the dynamics of prices of butter improved the result (the spectral chart improved: spectral peaks do not fall on seasonal frequencies)
Milk and dairy products	2.9	+	+	-	Most subcomponents have the same seasonal pattern as the main component, therefore there is no need in disaggregation.
Fruit and vegetables	4.2	+	+	-	Disaggregation decreases the coherence of the first and second seasonality estimates[4]. Many subcomponents have 'roaming' seasonality[5]. Disaggregation should not be applied.
Electrical products and household appliances	1.6	-	-	-	Subcomponents do not demonstrate any clear seasonality
Oil products	3.4	-	-	-	Subcomponents do not demonstrate any clear seasonality
Utility services	8.8	+	+	+	Utility services demonstrate a deterministic seasonality while hotel and other housing services demonstrate a stochastic seasonality. Disaggregation is required.
Passenger transport services	2.6	+	+	+	Railway transport services generally demonstrate a deterministic seasonality while other transport services demonstrate a stochastic seasonality. Disaggregation is required.
Education services	2.2	+	+	+	Pre-school education and other education services have different seasonal patterns. Disaggregation is required.

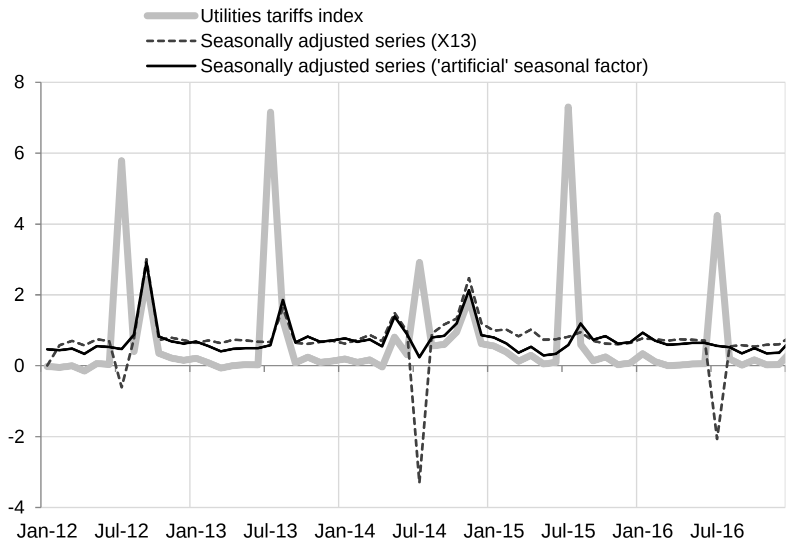
[4] Usually, Rosstat publishes two monthly CPI estimates: the first estimate is published for the shortened data list and has one decimal digit, while the other is published a few days later (3 to 4 days on average) for the full list and has two decimal digits. The CPI seasonal adjustment algorithm is developed to provide a preliminary seasonality estimate on the date of the first CPI publication which will be improved on the date when the data for the complete list of goods and services comes out. The preliminary and the final seasonality estimates should not contradict. As the first Rosstat publication does not contain the information on price dynamics of the subcomponents of the fruit and vegetables component, the direct approach to its smoothing helps greatly improve the correspondence between the first and the second estimates of the seasonally adjusted inflation.

[5] This kind of seasonality is determined by the fact that the seasonal peak does not fall on the same period but can fluctuate within 2 to 3 months. It is hard to predict when exactly the seasonal peak will be in the future. As most components with this kind of price dynamics refer to fruit and vegetables, it was decided not to disaggregate this component.

4.1. Seasonal adjustment of regulated tariffs

The seasonal adjustment of tariffs for utility and railway passenger transport services can be seen as a special case of seasonality. These time series are not stochastic because they are regulated by the state. We cannot apply standard seasonal adjustment methods because the seasonality here is predominantly deterministic and each applied method adds distortions that are not justified due to their technical nature (Figure 6).

Figure 6. Utilities tariffs index (% MoM)



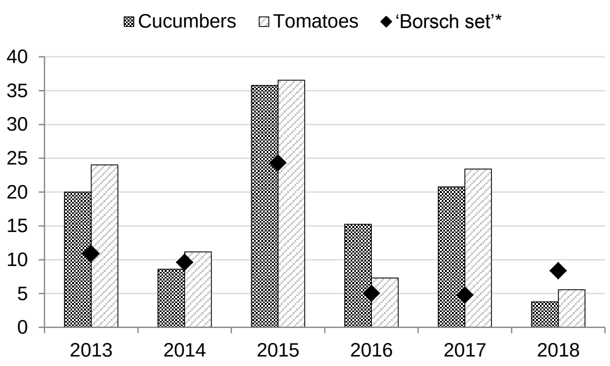
Sources: Rosstat, authors' calculations.

Based on the fact that the information on the future size and period of indexation of regulated tariffs is known up to 2019 (4% each July) according to the forecast of the Ministry of Economic Development, the authors decided to consider this increase as a seasonal factor. All indexations that do not fall under the above increase are considered random and, therefore, make it to the seasonally adjusted time series providing the opportunity for interpretation of unexpected short-term inflation fluctuations. The correspondence between the annual growth rate of the source and seasonally adjusted data is ensured by making monthly adjustments for the amount equal to the average monthly growth rate calculated based on the assumed indexation size (for 2016–2019, the adjustment is 0.33).

4.2. Structural shift in fruit and vegetable prices dynamics

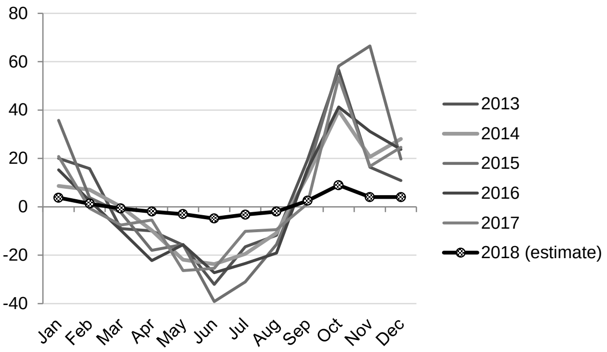
When analysing consumer prices using this seasonal adjustment method, we found that, in January 2018, the growth rate of prices for cucumbers and tomatoes was much higher than in the previous years (Figure 7). The principal reason for this was the continuing development of greenhouse facilities[6] with cucumbers and tomatoes being their main products[7].

Figure 7. Price growth in January across several food products (% MoM)



Sources: Rosstat, authors' calculations.
* potatoes, cabbages, onions, beetroots and carrots.

Figure 8. CPI for cucumbers in 2013–2018 (% MoM)



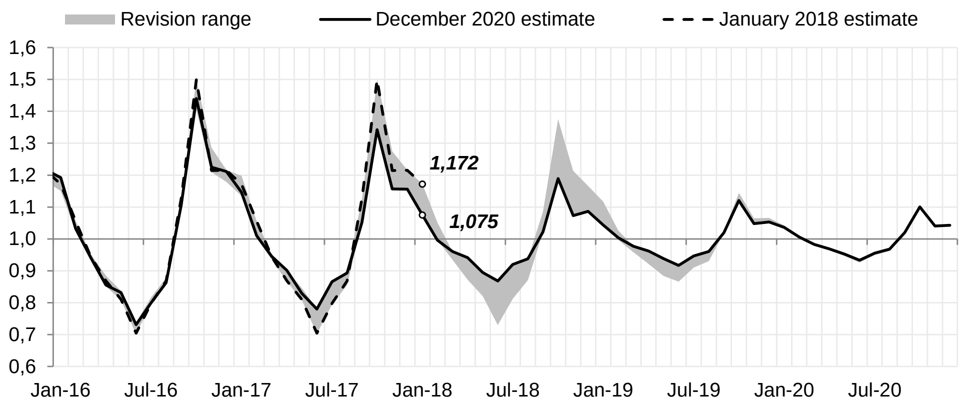
Sources: Rosstat, authors' calculations.

Fig. 8 shows the time series generated by combining the actual Rosstat data on CPI for cucumbers for the period from January 2013 to January 2018 and the time series of the generated data with the lower amplitude of seasonal fluctuations from February 2018 to December 2020. This time series was seasonally adjusted by adding points consecutively. The seasonality estimate improved with every new point. At first (for the period from January 2013 to January 2018) the seasonality estimate in January 2018 was 1.172, but after adding the observations for the next three years (for the period from January 2013 to December 2020) the seasonality estimate in January 2018 was 1.075. The seasonally smoothed rates of growth also changed from -11.4% MoM to -3.4% MoM (Figure **9**).

[6] According to the Ministry of Agriculture, gross output of greenhouse vegetables was up 17% against 2016 and 34.2% against 2015. Greenhouse development is a key priority in agricultural policy. Imports of vegetables show a considerable contraction: they dropped from 2,4 million tonnes in 2014 to 1.1 million tonnes in 2016.

[7] According to the 2016 data, cucumbers account for 62% of greenhouse vegetables, tomatoes account for 35%, and other vegetables account for 3%.

Figure 9. Seasonal component of CPI for cucumbers and its revision range



Source: authors' calculations.

Therefore, a booming growth of greenhouses, as long as it continues, is expected, on the one hand, to distort seasonally adjusted monthly price growth rates, inasmuch as statistical methods fail to promptly capture the drastic changes in seasonality that may be ongoing. On the other hand, it is certain to push intra-year seasonal price volatility downwards. The implication is, it is crucial to come up with an accurate estimate for the disinflationary effect from fruit and vegetable prices given the structural shift to the 'new normalcy' in the agricultural sector's prices. Once complete, the currently dynamic greenhouse construction is supposed to ramp up and align the performance of greenhouse fruit and vegetables with that of other food categories, other things being equal.

4.3. Seasonality estimates revision issue

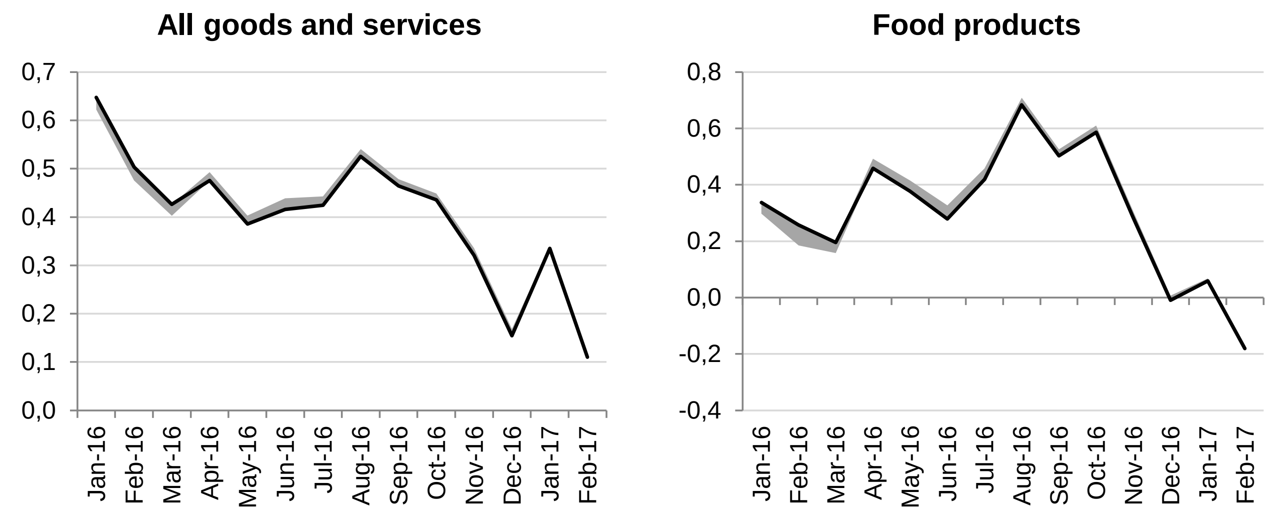
The revision of estimates of a seasonally adjusted time series is an important drawback of the seasonal smoothing procedure. The situation when adding a new point leads to the re-calculation of values of all old points, which can cause inconvenience for users of the statistical data, is called *'tail wagging'*. To mitigate this issue, the authors suggest an approach that involves fixing the principal seasonal smoothing parameters, such as the specific nature and the length of the series, the specification of ARIMA models and the list of outliers. In this case, in order to ensure the comparability of the series levels, the price index series was characterised by the usage of the index normalised to the common base (i.e., base index) for analysis purposes.

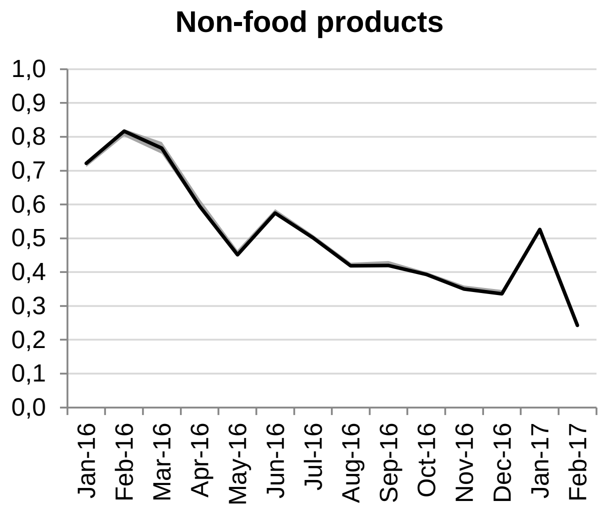
For the purpose of correct determination of the series length, the following criteria were used: *firstly*, the use of the single methodology over the whole time horizon; *secondly*, the stability of the seasonal factor over the selected period (only slight and gradual change is allowed, i.e. seasonal waves of the adjoining years must be virtually identical). It should be noted that time series used must not be too short: e.g., when using the X-13-ARIMA-SEATS method, the series length should be at least three years for monthly observations. Therefore, when selecting the time horizon, one should try and maximise the sample period in line with the above criteria.

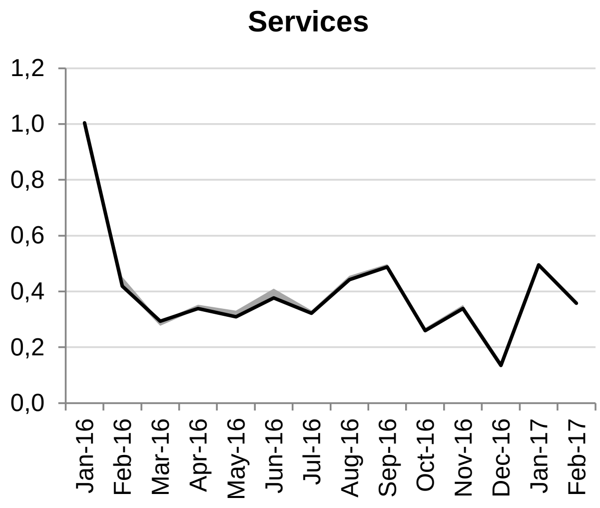
The search for outliers can be broken down in two stages: the automatic search and the expert manual calibration. After the automatic search has been completed, the expert method is used to isolate the outliers that cause an economic and visually noticeable influence on the trend and seasonality. A particular attention is paid to the analysis of reasons of one-time shocks and shifts. As a result, the list of outliers is corrected and checked again using the appropriate software (such as JDemetra+ or EViews). This procedure is repeated until the results that are satisfactory from the point of view of both the statistical criteria (significance of outliers tested using the t-statistic) and the economic justification (comparability to actual events).

When using this approach, the revision of seasonal adjustment estimates does not exceed 0.1 p.p., which is acceptable (Figure 10). Largest revisions of data are observed in the estimates of inflation of food products, which is expected due to the unstable seasonality of many of their components.

Figure 10. Range of revision of seasonally adjusted inflation estimates (% MoM)





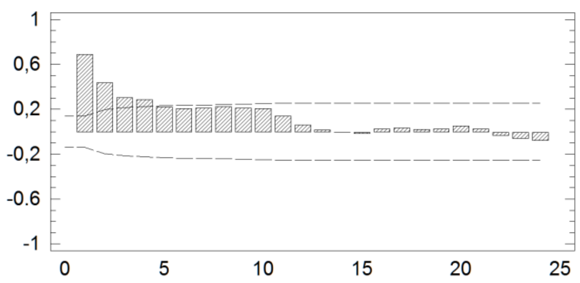


Sources: Rosstat, authors' calculations.

4.4. Result of seasonal adjustment

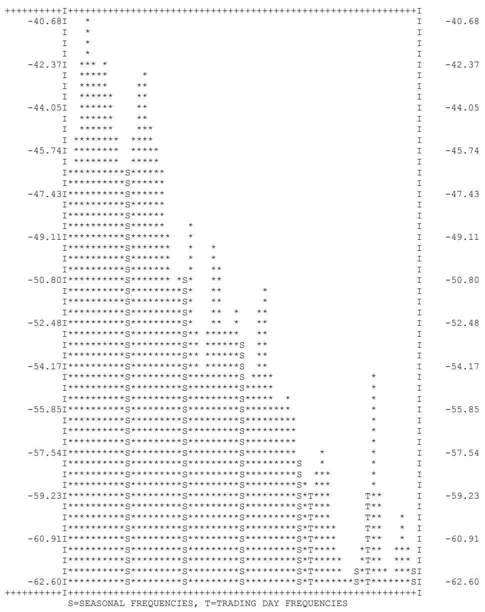
The above algorithm was used to analyse for seasonality 57 CPI subcomponents, out of which 27 were found to be seasonal (their weight in the CPI basket exceeds 51%). The seasonally adjusted CPI series obtained with the above method does not contain any residual seasonality, which is evidenced by the autocorrelation function chart (Figure 11) and the spectral chart (Figure 12).

Figure 11. Seasonally adjusted CPI autocorrelation function chart



Source: authors' calculations.

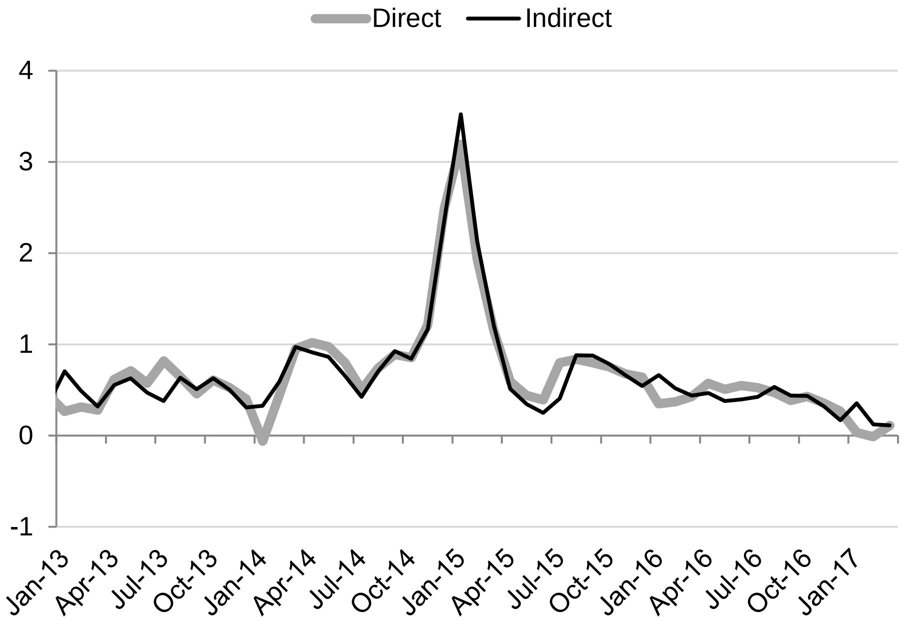
Figure 12. Seasonally adjusted CPI spectral chart



Source: authors' calculations.

Having compared the indirect approach, which involves the adjustment of CPI subcomponents with their further aggregation, and the direct approach, where the aggregate CPI is adjusted, we have obtained the results that differ, for the most part, in the beginning of the year (Figure 13). This is explained by the fact that the algorithm applied for the direct approach has ‘learned’ on the previous data when the growth rate for January was much higher. As a result, during the recent years, when the growth rate in January was not as high as before, the calculated values were understated: the monthly growth rate in early 2017 was nearly zero. At the same time, the algorithm based on the indirect approach provides less volatile estimates; no understated values have been identified. The absence of understated values was achieved because many components that saw a sharp variation in the amplitude of seasonal fluctuations (mostly in 2012) were divided in two parts that were smoothed separately.

Figure 13. Range of revision of seasonally adjusted inflation estimates (% MoM)



Sources: Rosstat, authors’ calculations.

CONCLUSION

Among the wide range of challenges that the Bank of Russia is facing, maintaining price stability is one of the most important and fundamental.

The analysis of options for the central bank to implement its monetary policy aimed at reducing inflation to consistently low levels is linked to, among other things, monitoring short-term statistics on the dynamics of the consumer price index and its individual components. In order to conduct a conceptual analysis of this data and, in particular, to perform a model-based economic research, it is important to select an appropriate approach to the seasonal adjustment of the statistical data on price dynamics.

The developed methodology of the CPI seasonal adjustment helps boost the quality of the analysis of short-term meaningful variations that the Bank of Russia takes into account when making its monetary policy decisions.

When justifying the methodological solutions proposed by the authors, it was established that the dynamics of many CPI subcomponents demonstrate an evolution of seasonal waves [1, p. 114] that may be caused by various reasons: from changes in the structure of representative goods included in the calculation to the specifics of the manufacturing process or consumer demand fluctuations. Solving this problem requires finding the cause of the instability with further breaking the time series into several parts and their individual adjustment.

Moreover, the authors proposed a solution to the problem of the revision of seasonally adjusted estimates near the right-hand end of the time series upon adding new points that involves fixing the principal seasonal smoothing parameters. Regulated tariffs should be considered a special case for seasonal adjustment purposes because, if they are adjusted using standard methods, the result can contain unjustified distortions.

An indirect approach to CPI seasonal adjustment helped boost the quality of interpretation of short-term variations in consumer prices dynamics. From the conceptual point of view, this is explained, primarily, by the fact that the indirect approach is much more explicitly aimed at accounting for evident differences in the seasonality of CPI subcomponents when smoothing the time series. In particular, it was established that the direct approach generates understated inflation values in the beginning of the year due to technical reasons and without any economic justification. Despite relatively high costs, the indirect approach has a number of significant benefits vs. the indirect one.

The seasonally adjusted CPI obtained using the developed methodology does not contain any residual seasonality and the revision of seasonal adjustment estimates does not exceed the level acceptable for practical macroeconomic analysis and forecast purposes.

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