Box 3. Heat map of inflationary pressures in the economy

The practice of displaying economic indicators as heat map charts has been increasingly used by central banks, being intended to facilitate the interpretation of signals sent by a large number of economic variables. This multi-purpose toolkit is used to monitor economic activity[1], assess the financial system's soundness[2] and measure pressures on price developments[3].

Under the inflation targeting regime, such as that implemented by the NBR, the early identification of possible causes of inflation rate deviations from target is of the essence to ensure a prospective monetary policy, allowing their effective countering, *inter alia* by avoiding the de-anchoring of inflation expectations from the inflation target. In this context, the present analysis illustrates how a set of 24 monthly indicators relevant to the dynamics of prices in Romania are monitored by means of a heat map chart. These indicators may be categorised into four groups: core inflation measures, inflation expectations, domestic inflationary pressures and external inflationary pressures.

The first category includes three inflation measures built to reflect persistent inflationary pressures in the economy, given that the consumer price index (CPI) also incorporates the effects of some transitory factors[4]. These were selected either from among the set of measures in NBR *Occasional Paper* No. 19/2007, "Modalități de cuantificare a inflației de bază. Analiză comparativă: cazul României" ("Measuring core inflation. Comparative analysis: Romania's case") – (i.e. trimmed-mean CPI measure[5]) or from the extended set of measures developed following the publication of the mentioned *Occasional Paper* (i.e. supercore measure[6] and the persistent CPI measure[7]). Two surveys were used to show economic agents' inflation expectations, namely the NBR's *Survey among financial analysts* on the CPI inflation rate at the one- and two-year horizons and the European Commission's *Business Survey* (the balance of answers to the questions on the outlook for prices in industry, trade and services). The domestic inflationary pressures were captured by resorting to a series of indicators on the local dynamics of economic activity and labour market, as well as of producer prices of consumer goods. As regards the external environment, the focus was on the price of commodities relevant to the domestic consumer basket (agri-food commodities and oil). Useful information

1 See the case of Latvia (https://www.fdp.gov.lv/en/publications-and-reports/monitoring/siltuma-karte) or Turkey (*Inflation Report*, 2019-II – Box 4.3. "Heat Map for Economic Activity in Turkey"). The National Bank of Romania also uses this tool to monitor a series of indicators on the degree of economy overheating (see the box entitled "Corroborative evidence on the degree of economy overheating" in the November 2017 *Inflation Report*).

2 See U.S. Federal Reserve Note of 5 August 2015 – "Mapping Heat in the U.S. Financial System: A Summary".

3 For instance by the Federal Reserve of Saint Louis (https://fredblog.stlouisfed.org/2015/07/is-inflation-running-hot-or-cold/) or by Banco de España (*Economic Bulletin 4/2018* – "Composite indicators of inflationary pressures").

4 For instance, the impact of the agricultural output (as compared to a multi-annual average) on volatile food prices.

5 The trimmed-mean CPI measure excludes from the consumer basket those components reporting the smallest and the largest price changes in a certain period, the share of removed items amounting to 30 percent for the present analysis.

6 The supercore measure includes those CPI components that are highly sensitive to the business cycle (component selection criterion: counting the output gap among the determinants of the component's inflation rate enhances its predictive performance compared to a first-order autoregressive model).

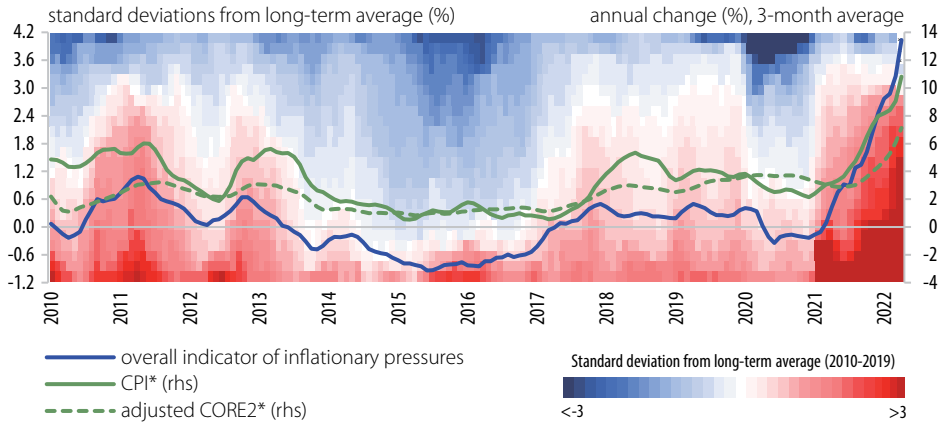
7 The persistent CPI measure is calculated based on an algorithm for the weighting of CPI components that depends on the persistence over time of the inflation rate for each component.

was also provided by the HICP inflation rate excluding energy in the euro area and the EUR/RON exchange rate; these variables are important from the perspective of import price dynamics. Table A shows the entire set of monitored indicators.

Table A
Indicators monitored in order to identify (dis)inflationary pressures across the economy

Indicator group	Indicator	Number of indicators	Source
Measures of core inflation	Supercore; Trimmed-mean CPI; Persistent CPI	3	NIS, NBR calculations
Inflation expectations	Inflation expectations on annual CPI inflation rate at the one- and two-year horizons; Outlook for prices in industry (consumer goods; food industry*), trade (retail trade, except for trade in motor vehicles and motorcycles; trade in food items*), services	7	NBR (monthly *Survey among Financial Analysts*), EC (monthly *Business Survey*)
Domestic inflationary pressures	Industrial output; Retail sales (food and non-food items, excluding fuels); Turnover volume of market services to households; ILO unemployment rate; Net real wage in the private sector; Domestic producer prices (energy industry, food and non-food industry)	9	NIS, Eurostat, NBR calculations
External inflationary pressures	Commodity prices (agri-food items, oil); HICP excluding energy in the euro area; EUR/RON nominal exchange rate	5	ECB, Eurostat, NBR

*) the food component was separately considered in data capture given its relevance for the consumer basket (32 percent share)



*) excluding the first-round effects of VAT rate changes

Note: The variables under analysis are shown in the ascending order of the signals sent based on a colour-code system. Thus, for each period, inflationary pressures are highlighted in red (the indicator is above the long-term average, running below it in the case of the ILO unemployment rate), while disinflationary pressures are marked in blue colour (the indicator is below the long-term average, running above it for the ILO unemployment rate). The intensity of the signals sent by each variable on inflationary/disinflationary pressures in the economy is correlated with the colour intensity (the most intense colours indicate the largest deviations in absolute terms).

Chart A
Heat map of inflationary pressures in the economy

Source: ECB, Eurostat, NIS, NBR calculations

The variables were reported based on the standard approach, according to the literature; more exactly, the variables were expressed as standard deviations of the annual dynamics[8] – expressed as a three-month average to avoid false positive or negative signals on a possible turning point in inflation – from the long-term average. The latter, calculated for a period of 10 years, was determined for the

[8] Except for the indicators used to reflect economic agents' inflation expectations and the ILO unemployment rate, which were included in the analysis as data at level.

2010-2019 period in order to avoid distortions caused by the pandemic shock. To facilitate the interpretation of signals from the set of analysed variables, an overall indicator was also determined as the arithmetic mean of the variables used for the analysis (and processed according to the methodology described previously)[9]. Chart A shows the inflationary pressures in Romania's economy, as captured by the variables under analysis, for the period that followed the global financial crisis, i.e. from January 2010 to April 2022.

The visual analysis of the heat map enables to identify the correspondence between the signals from the indicators and the evolution of the CPI inflation rate, excluding the first-round effects of VAT rate changes. Thus, the first part of the period under review featured two important episodes of higher inflation, namely March 2010 – May 2011, and May 2012 – January 2013, highlighted by the prevalence of inflation signals (marked in red in the chart). These are mainly associated with the increase in international commodity prices, reflected also in the hikes in domestic producer prices of consumer goods, as well as in economic agents' inflation expectations, *inter alia* in the context of rises in some administered prices at that time (electricity and natural gas prices). These two episodes were followed by a longer period with low inflation rates, in spite of a relatively robust economic activity domestically, yet against the background of the global disinflationary environment (highlighted in blue in the chart) and the increase in the relative importance of external factors in explaining the domestic price dynamics[10]. From 2017 until the onset of the pandemic crisis, a new inflationary bout was manifest, being associated with the step-up in domestic inflationary pressures, reflected *inter alia* in specific labour market indicators (historical lows of the ILO unemployment rate, robust dynamics of private sector wage earnings). Mobility restrictions imposed after the outbreak of the health crisis led to a plunge in economic activity worldwide, as well as to a steep fall in energy prices, including oil price, the evolution of which was also mirrored by the domestic fuel prices. In this context, the annual CPI inflation rate entered a downward path, despite the adjusted CORE2 inflation rate remaining relatively elevated (in the latter case, at the beginning of the pandemic, the pronounced disinflationary pressures following the significant adjustment in domestic demand, were offset by the inflationary pressures associated with disruptions in global production and distribution chains of food items and durables, but also by the marked increase in the demand for non-durables). The (partial) lifting of mobility restrictions as of the second half of 2020 led to a reversal of the downward trend in headline inflation. The acceleration in headline inflation in the second half of 2021 and the first part of 2022, which was the most pronounced episode of higher prices for the inflation targeting monetary policy regime (implemented in August 2005), was ascribable to the fast growth of energy commodity prices, overlapping with additional

[9] Given the major impact (also singular for the period under review) of the pandemic shock on the dynamics of a subset of monitored indicators, i.e. the industrial output, the turnover volume of market services to households and the Brent oil price, in the context of the mobility restrictions imposed amid the first pandemic wave (March-April 2020), but also of the subsequent total/partial lifting of these restrictions (particularly in May-August 2020), for the calculation of the overall indicator of inflationary pressures in the economy, the annual growth rate of the mentioned variables was excluded in March 2020 – July 2021, being treated as an outlier.

[10] For details, see Box 1 entitled "The relevance of external factors to domestic inflation dynamics" in the August 2016 *Inflation Report* and Box 2 "The relationship between economic activity and inflation" in the May 2017 *Inflation Report*.

supply-side shocks, visible at a global level (substantial rises in agri-food prices, bottlenecks in global production and supply chains). These unfavourable developments were compounded by the conflict in Ukraine.

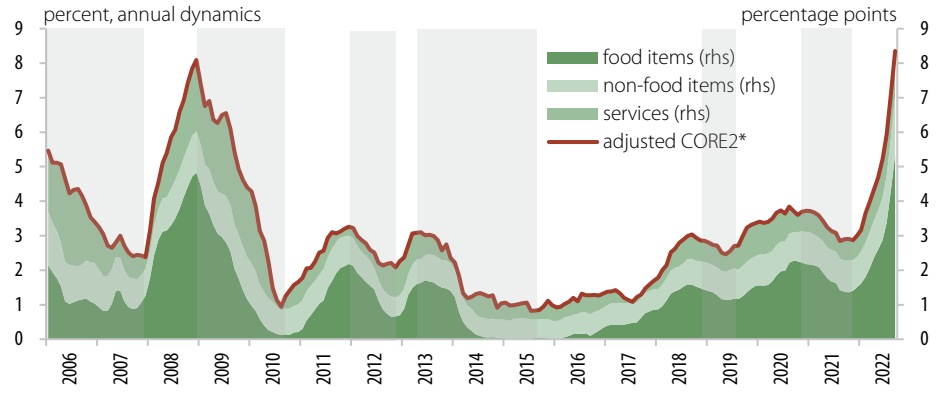


Chart B
Adjusted CORE2 inflation rate* – breakdown by sub-component

*) excluding the first-round effects of VAT rate changes

Note: The bands in grey colour mark disinflationary cycles.

Source: NIS, NBR calculations

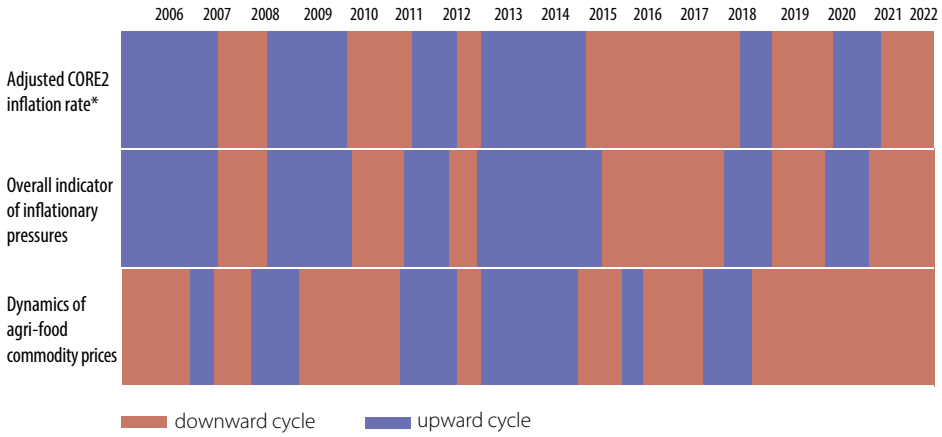


Chart C
Succession of inflationary/ disinflationary cycles for selected indicators

*) excluding the first-round effects of VAT rate changes

Source: NIS, ECB, NBR calculations

The overall indicator of inflationary pressures shows a high degree of correlation with both headline inflation and adjusted CORE2 inflation (around 80 percent). In the latter case, the degree of correlation increases for lags in the overall indicator of inflationary pressures (the maximum level is reached for lag 3). This suggests that the indicator may provide forward-looking information on the adjusted CORE2 inflation. In this context, Chart C shows, for the period following the implementation of the inflation targeting regime, upward and downward cycles of the adjusted CORE2 inflation rate, excluding the first-round effects of VAT rate changes, the overall indicator of inflationary pressures and the dynamics of agri-food commodity prices. The latter were selected given their relevance to the food component of the consumer basket[11], which often prompts the evolution of the adjusted CORE2 inflation rate (Chart B). (Dis)inflationary cycles are defined as a minimum

[11] Food items account for 32 percent of CPI and 41 percent of the adjusted CORE2 index.

six-month period of consecutive (decreases) increases in the indicators under analysis, preceded and followed by a minimum six-month period of consecutive (increases) decreases thereof[12]. The overall indicator provided early signals on the turning points in the evolution of adjusted CORE2 inflation, more accurately for disinflationary cycles (on average, by three months), while for inflationary cycles, the dynamics of agri-food commodity prices offered more forward-looking information.

In conclusion, the recent evolution of monitored indicators points to an unprecedented step-up in upward pressures on prices for the inflation targeting period, in the context of a global environment dominated by multiple and synchronised supply-side inflationary shocks. These developments reflect in the record highs of the annual CPI dynamics for the mentioned period seen over the last months. The overall indicator of inflationary pressures (that provides information on the start of periods with lower inflation rates), also running at record highs and following an upward path, indicates further unfavourable developments in the forthcoming periods as well.

[12] While there is no consensus in the literature on the duration of a (dis)inflationary cycle, the six-month period is among the most frequent criteria and, in addition, it seems to capture with sufficient accuracy the cyclical evolution of the adjusted CORE2 inflation rate, with identified cycles having a magnitude of at least 0.5 percentage points.