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Measuring the underlying component of inflation

Central banks use a range of underlying inflation indicators to measure inflationary pressures over the medium term. These indicators generally exclude the most volatile components of the Harmonised Index of Consumer Prices (HICP), such as food and energy. However, they do not necessarily exclude other transitory components that can give an incorrect signal of where inflation will stand in the medium term. Economists have therefore proposed alternative indicators that filter out these temporary movements, such as the "Persistent and Common Component of Inflation" (PCCI), and "Multivariate Core Trend" (MCT) inflation. This article provides a review of the indicators monitored and developed by the Banque de France, focusing in particular on developments in France and the euro area in the post-pandemic period.

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C32, E31, E52

Underlying inflation in France: April 2024 vs. June 2023

2.3% *vs* 4.4%
inflation excluding energy and food

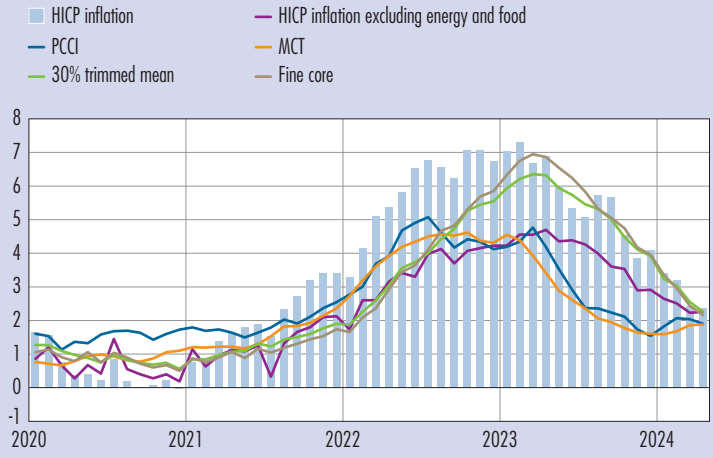
2.2-2.3% *vs* 5.7-6.2%
trimmed mean and fine core HICP*

1.9% *vs* 2.6-2.9%
Persistent and Common Component of Inflation (PCCI) and Multivariate Core Trend (MCT) inflation

* Harmonised Index of Consumer Prices

Headline inflation and measures of underlying inflation for France

(year-on-year % change)



Sources: Eurostat, authors' calculations.

BANQUE DE FRANCE
EUROSYSTÈME

The primary objective of the European Central Bank (ECB) is to maintain price stability throughout the euro area. In 2021, following its strategy review, the ECB reaffirmed its commitment to an inflation target, set at a 2% annual increase in the Harmonised Index of Consumer Prices (HICP) over the medium term. Inflation is volatile in the near term, exhibiting temporary fluctuations that do not necessarily indicate where the rate will be in the future. These fluctuations are often due to prices of specific goods, and reflect changes in relative prices rather than an increase in the general price level. Consequently, in implementing monetary policy, it is essential to identify the underlying inflationary trend, after filtering out these idiosyncratic and transitory movements.

One such approach, known as "exclusion-based" and used regularly by central banks, is to strip out sectors showing the biggest temporary price changes. The most prominent of these measures is **"core" inflation**, which excludes food and energy prices, the two most volatile components (see Gordon, 1975; Eckstein, 1981; and Clark, 2001, for a general introduction). As discussed by Lalliard and Robert (2022), other indicators have been developed, such as **trimmed mean HICP** and **fine core HICP**. These filter out the HICP components experiencing the biggest changes each month, with the analyst setting the exclusion threshold (e.g. 30% of items) on a discretionary basis. Trimmed mean inflation strips out items that are *temporarily* the most volatile (i.e. month to month). In contrast, the "permanent exclusion" index strips out items that are *historically* most volatile (i.e. over a reference period).

However, the exclusion-based approach is partial as it only eliminates the most volatile items, and does not directly eliminate the transitory component of inflation. Yet the latter component is vital to understanding the surge in inflation between 2021 and 2023, when many economic sectors, such as furniture and motor vehicles, were hit by a series of exceptionally strong temporary shocks. For a measure to capture trend inflation, it needs to be capable of stripping out these transitory effects. To address this issue, the Banque de France has expanded its range of underlying inflation indicators to include an approach based on statistical models, aimed at filtering out temporary inflation fluctuations and retaining only the persistent component.

This article presents two recently developed, additional measures of underlying inflation for France and the euro area, namely the **Persistent and Common Component of Inflation (PCCI)** (Bańbura and Bobeica, 2020), and **Multivariate Core Trend (MCT) inflation** (Stock and Watson, 2016, 2020, and Almuzara and Sbordone, 2022). In the second section, we analyse the statistical properties of the different underlying inflation indicators. We focus in particular on metrics that are relevant for central banks, notably the indicators' volatility, their lead or lag versus observed inflation, and their ability to predict medium-term inflation. We show that "statistical model-based" measures generally perform best on the chosen evaluation criteria.

1 PCCI and MCT: new measures of underlying inflation

The Persistent and Common Component of Inflation (PCCI)

The PCCI (Bańbura and Bobeica, 2020; also, Cristadoro et al., 2005) seeks to eliminate high-frequency fluctuations in inflation and retain only medium and long-run variations. The aim is to break down changes in inflation into a persistent component and a transitory component (where the latter represents fluctuations caused by one-off factors). The PCCI is constructed by estimating a dynamic factor model on the HICP price indices. For the euro area, it is estimated using the indices for nearly all HICP items and for the main euro area countries (around 1,000 series), whereas for the French PCCI, only French price indices are used (around 90 series). The euro area PCCI is then constructed by aggregating the estimated persistent components for all the indices, based on euro area HICP item/country weightings.

Expressed formally, in a given country, for each item $i = 1, \ldots, n$, inflation $\pi_{i,t}$, observed monthly, is described as the sum of two orthogonal unobserved components, respectively a common and an idiosyncratic component:

$$\pi_{i,t} = \chi_{i,t} + \xi_{i,t},$$

where the common component $\chi_{i,t}$ is related to q common factors $f_t = (f_{1,t}, \ldots, f_{q,t})'$. These factors are estimated over the entire dataset using the generalised factor model approach (Forni et al., 2020):

$$\chi_{i,t} = \lambda_{i,1}(L) f_{1,t} + \ldots + \lambda_{i,q}(L) f_{q,t},$$

where $\lambda_{i,p}(L)$ is a lag polynomial of factor loadings, which measures the statistical relationship between the p^{th} common factor and the inflation rate of item i. The method then makes it possible to extract the persistent component of $\chi_{i,t}$ ($\widetilde{\chi}_{i,t}$), in other words the component that reflects the medium and long-run movements in the common component.[1] The PCCI at date t is then obtained as follows:

$$PCCI_t = \sum_i \omega_{i,t} \widetilde{\chi}_{i,t},$$

where $\omega_{i,t}$ is the weight of each item $\pi_{i,t}$ in the HICP calculated by Eurostat based on household final consumption.

In calculating the PCCI for the euro area, the n price indices of each country $j = 1, \ldots, m$ are pooled together, such that:

$$\pi_{ij,t} = \chi_{ij,t} + \xi_{ij,t},$$

where $\chi_{ij,t}$ is the common component for all items and countries in the euro area. The euro area PCCI at date t is therefore calculated as the double-weighted sum of this common component:

$$PCCI_t^{ZE} = \sum_{j,i} w_{j,t}\, \omega_{ij,t}\, \widetilde{\chi}_{ij,t},$$

where $w_{j,t}$ is the weight of each country in the euro area HICP and $\omega_{ij,t}$ is the weight of each item $\pi_{ij,t}$ in the euro area HICP.

Multivariate Core Trend (MCT) inflation

Like the PCCI, the MCT is a "statistical model-based" approach that aims to eliminate temporary fluctuations in inflation and retain only its persistent component. It differs from the PCCI, however, in that it uses a less opaque statistical model where the internal mechanisms are easier to understand and interpret. The main drawback of the MCT model is that it uses a limited dataset: it relies on an aggregation of the HICP items in 13 indices, reflecting the main categories of consumption, whereas the PCCI looks at all indices individually.[2]

The MCT model breaks down inflation for each consumption item into its common trend, a specific trend, a common transitory shock and a specific transitory shock.[3] Using estimates from this model, we then construct the trend in HICP inflation as the sum of all common and specific trends weighted by each item's weight in the overall HICP. Although the model is estimated using all consumption items, the trend in inflation is constructed excluding energy and food. This trend is known as Multivariate Core Trend (MCT) inflation.

1 The persistent component is extracted using an approach that avoids distortions at the sample edges.

2 The MCT model relies on a multivariate parameter model that uses a Kalman filter to infer the unobservable components (common and specific to the items). The multivariate dimension implies that the inflation series in the model interact with unobservable components. Therefore, the larger the number of series, the larger the number of parameters that need to be estimated, and the harder the estimation. Consequently, we follow Stock and Watson (2020) and only disaggregate inflation into 13 components.

3 The model also contains a common seasonal component and a seasonal component specific to each item. To avoid overcomplicating the model description, these components have been omitted.

The MCT was initially proposed in a New York Federal Reserve blog post, using US data (Almuzara and Sbordone, 2022). It relies on the multivariate unobserved-components model with stochastic volatility of Stock and Watson (2016, 2020). More specifically, for each item $i = 1, \ldots, n$, inflation $\pi_{i,t}$ observed monthly, is broken down as follows:

$$\pi_{i,t} = \alpha_{i,\tau}\,\tau_{c,t} + \alpha_{i,\varepsilon}\,\varepsilon_{c,t} + \tau_{i,t} + \varepsilon_{i,t},$$

where $\tau_{c,t}$, $\varepsilon_{c,t}$ are common to all items, $\tau_{i,t}$, $\varepsilon_{i,t}$ are specific to item i, and $\alpha_{i,\tau}$, $\alpha_{i,\varepsilon}$ are time-fixed factors. Components τ and ε follow processes representing the trend and irregular (or transitory) components, respectively. In particular, if we assume that $\eta_{\tau,t}$ and $\eta_{\varepsilon,t}$ follow stochastic (Gaussian) processes,[4] the trend component, which primarily exhibits low-frequency movements, follows a random walk:

$$\tau_t = \tau_{t-1} + \eta_{\tau,t},$$

The irregular component is a white noise process:

$$\varepsilon_t = \eta_{\varepsilon,t}.$$

The MCT at time t is then obtained by:

$$MCT_t = \sum_{i=1}^{n-2} \omega_{i,t}\,(\tau_{c,t}\,\alpha_{i,\tau} + \tau_{i,t})$$

where $\omega_{i,t}$ is the weight of item i in the overall HICP index at date t. This is equivalent to keeping only the common or specific trend components. It is important to note that only items up to $i = n - 2$ are summed, as the MCT is constructed excluding energy and food to make it more comparable with a measure excluding volatile items and for which prices depend on non-exogenous factors.[5] The model is estimated using Bayesian methods which rely on an extension of the methods developed by Stock and Watson (2016).

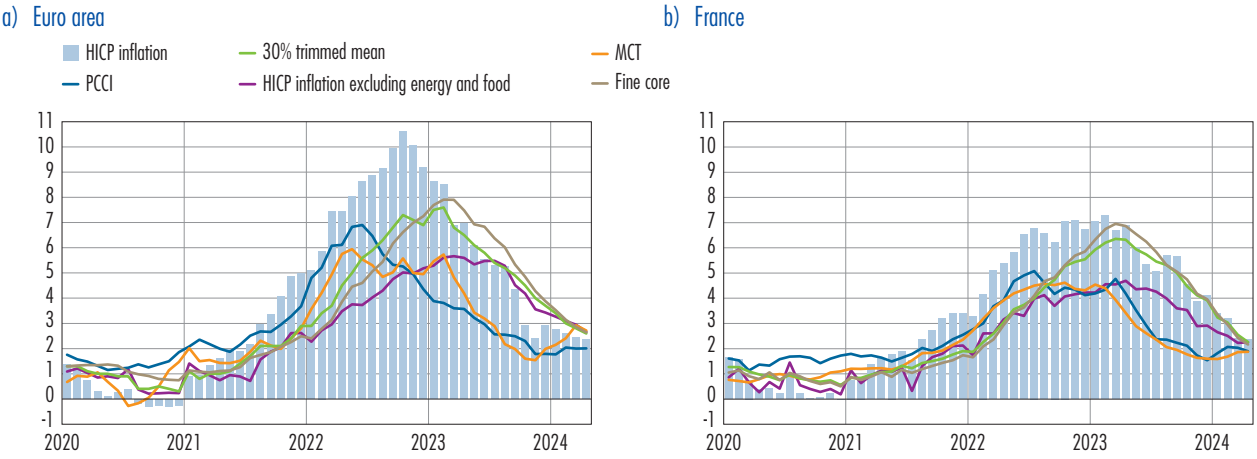
2 Recent developments in underlying inflation in the euro area and France

The post-Covid period, which saw the biggest inflationary shocks since the creation of the euro area, is an ideal time window for assessing the performance of underlying inflation measures. Chart 1 compares measures for the euro area and France between January 2020 and April 2024. First, we find that the PCCI and MCT indicators followed a very specific path: a slow upward phase in 2020 followed by an acceleration over 2021, followed by a peak in the spring of 2022 (of around 6-7% for the euro area and 4-5% for France), then a persistence well above 2% up to the spring of 2023 (around a plateau for the euro area MCT and for the two measures for France, with an early turning point for the euro area PCCI, as discussed in the following paragraph), and then a downward trajectory to around 2% at the end of 2023 and start of 2024. Moreover, the PCCI and MCT indicators began to fall well before the other indicators (excluding energy and food, but also trimmed mean and fine core), which all peaked at the start of 2023, after or at the same time as the peak in headline inflation. Moreover, the gap between the PCCI/MCT and the other exclusion-based measures widened markedly as of 2022, and only narrowed again partially in the euro area at the start of 2024. As a real-time assessment tool, the measures also provide contrasting signals on the dynamics of inflation: at the turn of 2023, the exclusion-based measures were still signalling an upward phase in inflation, whereas the PCCI and MCT indicators were already forecasting (correctly) a stabilisation, and even a turning point. That said, all of the indicators pointed to inflation remaining persistently above 2% for the majority of 2023, which justified the ECB's decision to raise policy rates up to September of that year.

4 For the purposes of clarity, we have eliminated the index associated with the common or specific parameters.
5 Including energy and food gives an indicator know as Multivariate Trend (MT) inflation

C1 Measures of underlying inflation for the euro area and France

(year-on-year % change)



Sources: Eurostat, European Central Bank, Banque de France; authors' calculations.
Notes: Most recent observation April 2024.
The PCCI (Persistent and Common Component of Inflation) and MCT (Multivariate Core Trend) inflation exclude transient components of headline inflation. The MCT excludes energy and food. The measures TM30% (30% trimmed mean) and fine core are constructed by excluding certain items: the 15% least and most volatile in the overall HICP.

Decomposing the PCCI to understand its recent trajectory

Chart 1 shows that the PCCI and MCT both signalled a change in the path of underlying inflation – and even a clear turning point in the case of the euro area PCCI – well before the other indicators. It is therefore important to understand the factors determining this trajectory. Focusing on the PCCI, we break the indicator down into its five main aggregates (processed and unprocessed food, energy, non-energy industrial goods and services) and calculate their respective contributions to the indicator's trajectory. The results, illustrated in Chart 2, show that the change in the PCCI as of the summer of 2022 was mainly determined by the "direct" contribution of the energy component, which fell in France and especially in the euro area. As of spring 2023, the PCCI fell markedly, an outcome that can be attributed to all non-energy components. However, the services component remained persistent and helped to maintain the PCCI above its pre-2020 level, both in France and the euro area.

Chart 2 also shows the trajectory of the PCCI after stripping out the direct contributions of energy and food ("core" PCCI). Unlike the "total" PCCI, the core indicator did not signal a turning point in the summer of 2022, but rather a stabilisation, and even a slight rise up to the start of 2023. As illustrated in Chart 3, these dynamics are attributable to a historically high contribution from industrial goods relative to services between the end of 2021 and start of 2023. It is important to note, however, that core PCCI excludes energy and food, but does not strip out their indirect contribution as it is constructed using all the items of the HICP. For example, energy prices were transmitted indirectly to industrial goods via input prices. In contrast, the MCT excludes the energy and food components by construction. Its trajectory between 2021 and 2023 was primarily determined by the contribution of transport services and housing (results not shown here) and was similar to that of the PCCI, albeit much more persistent. However, at the start of 2024, we note a divergence between the indicators for the euro area, with the MCT

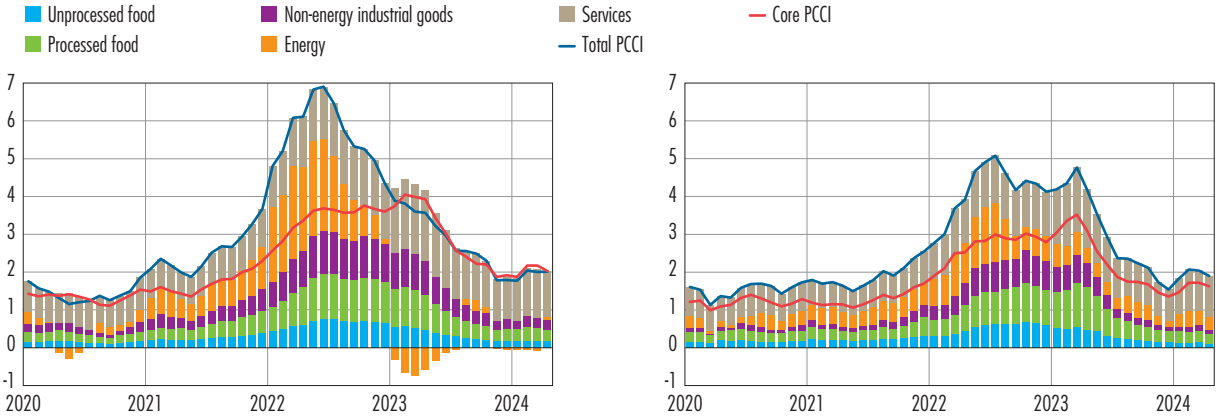
rising markedly up until March (+1 percentage point compared with December 2023). This result can be attributed to a rise in the contribution of certain services items, as in core PCCI, which also slightly exceeds the PCCI. The divergence can also be observed at the start of 2023, when the persistence of the services component began to be the main driver of underlying inflation, and the divergence of the MCT from the PCCI appears to coincide with a divergence of the same sign between core PCCI and total PCCI.

C2 Breakdown of the PCCI for the euro area and in France

(year-on-year % change; percentage point contributions)

a) Euro area

b) France



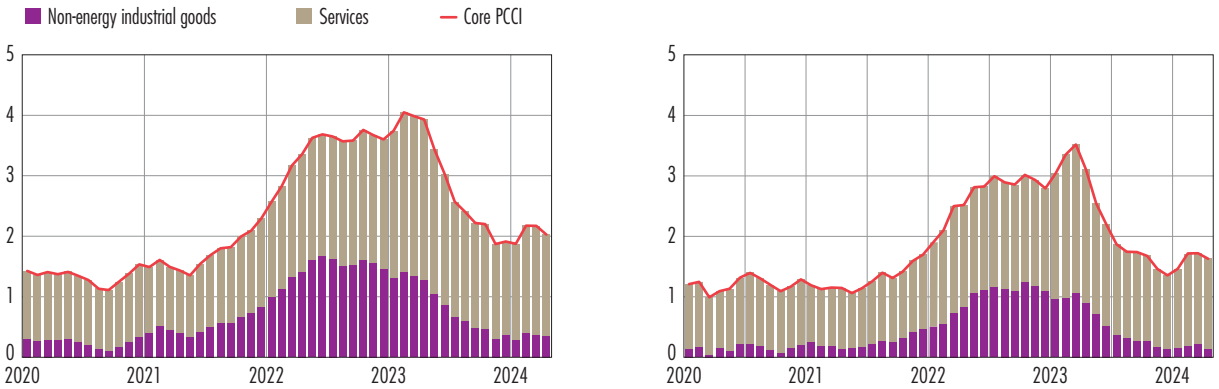
Sources: Eurostat, Banque de France; authors' calculations.
Notes: See Chart 1.
Core PCCI is the PCCI (Persistent and Common Component of Inflation) excluding the direct contribution of energy and food.

C3 Breakdown of core PCCI for the euro area and France

(year-on-year % change; percentage point contributions)

a) Euro area

b) France



Sources: Eurostat, Banque de France; author's calculations.
Notes: See Chart 2.

3 Evaluating and ranking the measures of underlying inflation

It is difficult to formally assess the relevance of underlying inflation measures, as there is no model that would enable us to rate their performance against a theoretical underlying inflation target, which is itself unmeasurable. We can only rank them by assessing their performance empirically, based on statistical and economic criteria selected according to the objective we want the measures to achieve. For a central bank, three criteria appear most relevant: low volatility, the leading or lagging property with respect to observed inflation, and the indicators' ability to predict medium-term inflation.

The results for the euro area and France respectively are shown in the following tables. Regarding volatility, measured as the standard deviation, all the indicators examined are less volatile than headline inflation, but the PCCI and MCT are less volatile than trimmed mean and fine core, and exhibit similar volatility to HICP excluding energy and food. To verify the indicators' leading properties, we calculate the maximum correlation with headline inflation. The results show that the PCCI and MCT are leading indicators (with a lead of around 2 months), whereas the other indicators exhibit a lag of around 2 to 4 months. For all leading horizons tested (3, 6, 9 and 12 months), the PCCI and MCT display the strongest correlations. Finally, we also analyse the indicators' ability to forecast a centred 25-month moving average inflation rate with a 12-month lead. Using this target measure of inflation, the PCCI and MCT are found to have better forecasting performances (average quadratic error relative to the error using headline HICP

Predictive performance of indicators of underlying inflation in the euro area and France

a) Euro area

Indicator	Volatility	Max lead/lag		Relative RMSE in predicting smoothed HICP at *t+12*	
	Standard deviation	Pre-Covid	Full sample	Pre-Covid	Full sample
HICP	1.99	0	0	1	1
HICP excluding energy and food	1.06	2 (0.67)	3 (0.92)	0.81	1.02
30% trimmed mean	1.39	3 (0.88)	3 (0.96)	0.87	0.96
Fine core	1.43	4 (0.78)	4 (0.94)	0.87	0.99
PCCI	0.99	-2 (0.82)	-2 (0.94)	0.68	0.81
MCT	1.04	-1 (0.75)	-2 (0.92)	0.77	0.95

b) France

Indicator	Volatility	Max lead/lag		Relative RMSE in predicting smoothed HICP at *t+12*	
	Standard deviation	Pre-Covid	Full sample	Pre-Covid	Full sample
HICP	1.60	0	0	1	1
HICP excluding energy and food	0.92	2 (0.57)	2 (0.82)	0.77	0.99
30% trimmed mean	1.19	2 (0.79)	2 (0.91)	0.87	0.99
Fine core	1.28	2 (0.70)	4 (0.87)	0.84	1.01
PCCI	0.73	-3 (0.75)	-2 (0.86)	0.76	0.84
MCT	0.83	0 (0.59)	-1 (0.88)	0.72	0.96

Source: Authors' calculations.
Note: Tests conducted on the period from March 2003 to December 2023, and from March 2003 to December 2019 for the pre-Covid period. The value highlighted in dark green indicates the best performance for a given metric, while light green indicates the second-best performance. The value in brackets is the absolute value of the correlation at the chosen horizon (e.g.: for the pre-Covid PCCI, the PCCI at *t-2* shows the strongest absolute correlation (0.82) with the HICP). The value in the last column (relative RMSE) is the ratio between the square root of the average quadratic error of the forecast obtained using the given indicator as a predictor at *t* of the 25-month centred moving average headline inflation rate observed at *t+12* (for the indicators in the first column) and the error obtained using headline inflation itself as a predictor at *t*: a value of less than 1 denotes a better predictive performance for the underlying inflation indicator.

inflation) than all the other indicators. When predicting future values of HICP inflation rather than the moving average (results not shown here), all indicators perform poorly at 3 months, but their predictive ability increases markedly at longer horizons (between 6 and 24 months). Again, the PCCI and MCT score highest, with the PCCI systematically outperforming the MCT.

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In this article, we show that, over the recent period characterised by a major inflationary shock, statistical model-based indicators (PCCI and MCT) provided an earlier signal of the dynamics of underlying inflation than those based on other approaches. They appear to have better statistical properties (volatility, lead and predictive ability) than exclusion-based indicators. However, it is important to stress that changes in statistical model-based indicators can be difficult to interpret, especially as they are slightly more volatile. Conversely, due to their conceptual simplicity, exclusion-based indicators are more transparent and easier to understand. It is important, therefore, to look at the full set of indicators in order to follow underlying inflationary trends. Similarly, indicators that aim to provide information on underlying inflationary dynamics should be used as a complement to – and not a substitute for – inflation forecasts macroeconomic models.

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