

Box 5

ARE SUB-INDICES OF THE HICP MEASURES OF UNDERLYING INFLATION?

While the definition of price stability in the ECB's monetary policy strategy refers to annual headline HICP inflation, the Monthly Bulletin regularly also contains comments on sub-indices of the HICP, notably the HICP excluding energy, HICP excluding energy and food, and HICP excluding energy, food and changes in indirect tax rates. These components can sometimes help to explain the drivers of overall price developments. The question is whether the rates of change

in the sub-indices can be referred to as measures of underlying inflation. This box outlines the typical criteria for an underlying inflation measure and assesses the sub-indices of the HICP against those criteria.

The concept of underlying inflation

Underlying or core inflation is a concept with no widely accepted definition.¹ In practice, it has been put forward that a measure of underlying inflation should separate the transitory from the more persistent components of inflation, since the latter are less noisy indicators of current and future inflation developments. This general requirement has been translated into a number of criteria, which relate to the ability to track inflation trends or to forecast headline inflation.²

Different underlying inflation measures have been proposed, including some based on the permanent exclusion of certain items from the overall consumer price index. It has been observed that some measures often violate key underlying inflation criteria and that no single measure is the best according to all the criteria. Against this background, a popular practice has been to refer to different inflation measures to obtain a comprehensive picture of price developments.³

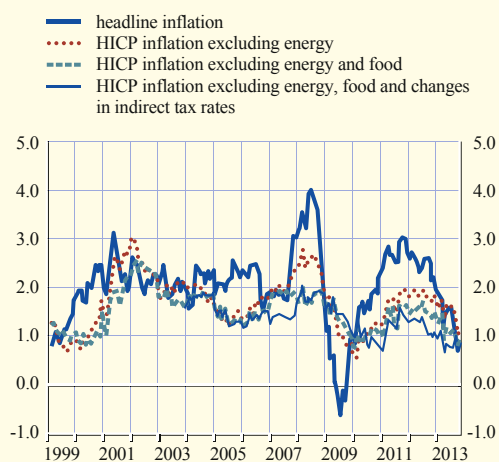
Assessing HICP sub-indices against criteria for underlying inflation

The ability to track the headline inflation trend is the key criterion for a measure of underlying inflation. In this respect, the unbiasedness, coincidence, volatility and overall precision of the sub-indices may be taken into consideration.

Unbiasedness can be assessed by comparing long-term averages (see Table A).⁴ Here the main finding is that, for the euro area, the

Headline HICP and sub-indices

(annual percentage changes, monthly data)



Sources: Eurostat and ECB calculations.
Note: The HICP excluding changes in indirect tax rates is based on the measure of HICP at constant tax rates.

- 1 For a discussion on the usefulness of an underlying inflation measure see, for example, Wynne, M.A., "Core Inflation: A Review of Some Conceptual Issues", *Federal Reserve Bank of St. Louis Review*, May/June 2008.
- 2 For a discussion of evaluation criteria see, for example, Armour, J., "An Evaluation of Core Inflation Measures", *Working Papers*, No 10, Bank of Canada, 2006; Clark, T.E., "Comparing Measures of Core Inflation", *Economic Review*, Federal Reserve Bank of Kansas City, second quarter 2001; and Rich, R. and Steindel, C., "A Comparison of Measures of Core Inflation", *Economic Policy Review*, Federal Reserve Bank of New York, December 2007.
- 3 See, for instance, the box entitled "Recent developments in selected measures of underlying inflation for the euro area", *Monthly Bulletin*, ECB, June 2009.
- 4 The evaluation is performed for quarterly data. However, the conclusions remain the same for data at monthly frequency. The comparisons for the mean and volatility are performed on annualised quarterly growth rates of seasonally adjusted data. The results are broadly similar to those obtained for annual growth rates, although the higher persistence in annual compared with quarterly growth rates alters some of the test results. The HICP inflation excluding energy, food and changes in indirect tax rates is compiled by the ECB based on HICP at constant tax rates for non-energy industrial goods and for services. These series are compiled under the assumption of an immediate and full pass-through of indirect tax rate changes and thus the estimated impact of these changes represents the upper bound of the actual impact. It should be noted that the exclusion of the impact of changes in indirect tax rates is conceptually different from the exclusion of energy and food items (for more information, see the box entitled "New statistical series measuring the impact of indirect taxes on HICP inflation", *Monthly Bulletin*, ECB, November 2009). For reasons of data availability, the properties for the HICP inflation excluding energy, food and changes in indirect tax rates are evaluated only over the period 2004-13.

Table A Volatility of HICP sub-index inflation rates and their ability to track the headline inflation trend

	Trend tracking		Volatility			
	Average inflation rate	RMSE for trend in headline inflation	Standard deviation	Coefficient of variation	Mean absolute change	Volatility around own trend
1999 to Q3 2013						
Headline HICP	2.1	1.2	1.2	0.6	1.1	1.2
HICP excluding energy	1.7*	0.7	0.7***	0.4	0.4	0.5
HICP excluding energy and food	1.5***	0.7	0.5***	0.3	0.4	0.4
2004 to Q3 2013						
Headline HICP	2.1	1.3	1.3	0.6	1.1	1.4
HICP excluding energy	1.7	0.7	0.6***	0.3	0.4	0.5
HICP excluding energy and food	1.5**	0.7	0.4***	0.3	0.4	0.3
HICP excluding energy, food and changes in indirect tax rates	1.3***	0.8	0.5***	0.4	0.5	0.4

Sources: Eurostat and ECB calculations.

Notes: All statistics are computed for annualised quarterly growth rates of consumer prices (seasonally adjusted). Stars denote a significant difference in the average and the variance compared with the corresponding figures for headline inflation, with 3, 2 and 1 star(s) denoting the 1%, 5% and 10% levels respectively. The trends are estimated as three-year centred moving averages (similar results are obtained when the Baxter and King filter is used). The root mean square error (RMSE) is the square root of the average squared difference between the trend in the headline rate and either the headline rate itself or a sub-index measure. The coefficient of variation is the standard deviation growth rate divided by the mean. "Volatility around own trend" refers to the standard deviation of the difference between the annualised quarterly growth rate and the centred moving average. The mean absolute change is the average of the absolute value of the first difference of inflation.

average headline inflation rate is significantly higher than the average inflation rates from the sub-indices (i.e. the latter have a downward bias). The primary reason for this is that the period from 1999 to the third quarter of 2013 has featured a number of large commodity price shocks that had a greater impact on developments in headline inflation than on the rates of change in the sub-indices (see the chart). For example, the average oil price in 2012 was more than 500% higher than the average oil price in 1999, which led to a disproportionately large contribution of the energy component to overall inflation. The bias is further increased when other components such as food and the impact of changes in indirect tax rates are excluded.

Coincidence is analysed by means of correlations at various leads and lags. The highest correlation for the rates of change in sub-indices (shown in bold in Table B) is found to occur with lagged headline inflation. This implies that headline inflation tends to lead inflation as measured by the sub-indices, rather than vice versa, which is likely to be related to differences in the speed of transmission of commodity price shocks to various components of the HICP. For

Table B Correlation between the headline inflation rate at leads and lags and sub-index inflation from 1999 to the third quarter of 2013

	-4Q	-3Q	-2Q	-1Q	0	1Q	2Q	3Q	4Q
Headline HICP	-0.1	0.2	0.5	0.8	1.0	0.8	0.5	0.1	-0.3
HICP excluding energy	-0.2	-0.1	0.2	0.4	0.6	0.7	0.7	0.5	0.3
HICP excluding energy and food	-0.1	0.0	0.1	0.2	0.4	0.5	0.5	0.5	0.4
HICP excluding energy, food and changes in indirect tax rates	-0.5	-0.4	-0.2	0.0	0.3	0.4	0.4	0.4	0.3

Sources: Eurostat and ECB calculations.

Notes: Correlations are computed for annual growth rates of consumer prices. Q stands for quarter, with -1Q (1Q) meaning that the correlation is calculated under the assumption that headline inflation is lagging (leading) the sub-index measures by one quarter. The highest values in each row are shown in bold. For the HICP excluding energy, food and changes in indirect tax rates, correlations are computed over the period from 2004 to the third quarter of 2013. The last row is therefore not comparable with the first three.

example, oil price shocks first hit energy prices, but over time they also affect input prices for industrial goods or wages and thereby also services prices. The measure of inflation excluding the food component and that also excluding the impact of changes in indirect tax rates tend to lag the headline rate more than the measure excluding only the energy component.

Looking at volatility, Table A shows that standard deviations are significantly lower for the rates of change in the sub-indices than for the headline HICP inflation. A similar picture is given by the coefficient of variation that scales the standard deviation by the mean of the series. Two further metrics, the mean absolute change and the volatility around trend, indicate even larger differences in terms of lower volatility for the rates of change in the sub-indices. HICP inflation excluding energy and food has the lowest volatility. Excluding in addition the impact of changes in indirect tax rates tends to increase the volatility of the series, which is most likely an artefact of the assumption made in the HICP compilations that such changes see an immediate and full pass-through.

Overall precision can be assessed by means of the root mean squared error (RMSE) for the trend in headline inflation (see Table A). The RMSE is lower for the rates of change in the sub-indices than for the headline rate, suggesting that the inflation rates given by the sub-indices are more precise real-time indicators of the trend in headline inflation than the headline rate itself. The fact that the rates of change in the sub-indices “miss” the average of the headline inflation rate and lag somewhat is more than offset by their lower volatility around the inflation trend. By contrast, despite obviously having the same long-term average, the headline inflation rate is a poor indicator of its trend because it is so volatile. Consequently, the sub-indices seem to contain some real-time information on the current trend in headline inflation.

Finally, the criterion of good forecasting performance can be assessed on the basis of what deviations between headline and sub-index measures of inflation imply for future inflation developments, in particular, whether sub-index inflation rates are likely to “converge” towards the headline rate (no predictive power) or vice versa (predictive power). The results in Table C suggest that the rates of change in the sub-indices have predictive power for developments in headline inflation, especially for longer horizons. They are based on the following regressions:

$$\pi_{t+h} - \pi_t = \alpha + \beta(\pi_t^s - \pi_t) + \varepsilon_{t+h} \quad (1)$$

Table C Predictive regressions for headline and sub-index inflation, between 1999 and the third quarter of 2013

	Deviation predicts headline inflation						Deviation predicts sub-index inflation					
	R ²	1 year		2 years			R ²	1 year		2 years		
		Intercept	Slope	R ²	Intercept	Slope	R ²	Intercept	Slope	R ²	Intercept	Slope
HICP excluding energy	0.2	0.3	0.8**	0.2	0.3	0.9**	0.1	-0.1	0.4*	0.1	0.0	0.4
HICP excluding energy and food	0.4	0.5***	1.0***	0.4	0.5**	1.0***	0.2	-0.1*	0.3**	0.0	-0.1	0.2
HICP excluding energy, food and changes in indirect tax rates	0.4	0.7**	1.1***	0.6	0.8***	1.3***	0.1	-0.2**	0.1**	0.0	-0.1	0.0

Sources: Eurostat and ECB calculations.

Notes: “Intercept” and “slope” refer to, respectively, α and β from regressions (1) and (2) above. Stars denote significant difference from 0, with 3, 2 and 1 star(s) denoting the 1%, 5% and 10% levels respectively. “1 year” and “2 years” refer to the forecast horizons denoted by “h” in regressions (1) and (2). The left-hand panel shows the results for regression (1) and the right-hand panel the results for regression (2). “Deviation” refers to the difference between headline inflation and the sub-index inflation. For the HICP excluding energy, food and changes in indirect tax rates, the statistics are computed over the period from 2004 to the third quarter of 2013. The last row is therefore not comparable with the first two.

and

$$\pi_{t+h}^s - \pi_t^s = \alpha^s + \beta^s(\pi_t - \pi_t^s) + \varepsilon_{t+h}^s \quad (2)$$

where π_t refers to annual headline inflation while π_t^s is the annual rate of change in a sub-index. In the case that $\alpha=0$ and $\beta=1$ in the first equation, a deviation of headline from sub-index inflation implies a correction in the future headline rate of the same magnitude. Considering forecast horizons of one and two years, the coefficients and in-sample fit are larger in the first regression than in the second, indicating that headline inflation moves towards the sub-index inflation rather than otherwise. Exclusion of the energy and food components appears to result in a stronger predictive power than with the exclusion of energy only. This runs to some extent counter to the results on correlation. It can, however, be rationalised by the fact that this framework focuses more on relationships at longer horizons, abstracting from the effects that might arise as a result of different speeds in the transmission of commodity price shocks.

Conclusion

None of the sub-indices of the HICP satisfies the criteria for an unbiased underlying inflation measure. Over the period 1999-2013 these measures are downward biased (significantly lower on average) and lag headline inflation developments. Bias and lag mostly reflect the strong increase in real commodity prices from 1999 and their delayed pass-through to the non-energy and non-food components of the HICP. At the same time, the sub-index inflation rates are less volatile and do seem to contain information on the current trend in headline inflation and on its future developments. The sub-indices should thus be seen as providing additional information on the driving forces and underlying dynamics of headline inflation developments. However, they are not official ECB measures of underlying or core inflation, as they do not provide an adequate description of the medium-term price developments relevant for monetary policy.