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CPI-FW: a frequency weighted indicator of underlying inflation

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* *The views expressed in this article are the views of the authors and do not necessarily reflect the views of Norges Bank*

CPI-FW: a frequency-weighted indicator of underlying price inflation

The monthly change in the CPI varies considerably, and the change from one month to the next often provides little indication about the future direction of inflation. In order to be able to form a picture of how much of these changes is due to special short-term factors and how much is due to real shifts in the rate of inflation, indicators of underlying inflation are used. Norges Bank has monitored various indicators of underlying inflation in recent years: CPI-ATE, CPIXE, a 20 per cent trimmed mean and a weighted median. In this commentary, we present a new indicator of underlying inflation, CPI-FW, which is based on the consumer price index but gives less weight to prices that change frequently than to those that change infrequently.

Some prices, such as the price of petrol, change frequently, while others, such as the price of a haircut, change infrequently. Prices that change frequently often contribute to short-term variations in the CPI. By giving greater weight to prices that change infrequently, the CPI-FW varies less than the CPI and can therefore be used as a measure of underlying inflation. The CPI-FW is calculated using a different principle to existing indicators of underlying inflation. The CPI-FW weights down prices that change frequently, whereas the CPI-ATE, CPIXE, trimmed mean and weighted median exclude prices that fluctuate widely relative to other prices. The CPI-FW can therefore provide information about developments in the CPI that do not emerge from other indicators of underlying inflation. Businesses that change their prices infrequently can also be expected to attach more importance to long-term trends in their own costs. In this case, the CPI-FW could provide information on businesses' expectations of future price and cost inflation.

We also show that the CPI-FW provides information on future inflation. This is important, because monetary policy operates with a time lag.[1] Woodford (2003) also argues that monetary policy should stabilise the rate of increase in prices that are changed infrequently.[2] The background to this conclusion is that prices that do not adjust to changes in economic conditions can distort the information in relative prices and so result in a welfare loss. This is a further reason to monitor developments in the CPI-FW.

1 See section 7 of Norges Bank (2004) for further information on how monetary policy impacts on inflation.

2 Norges Bank Watch 2007 emphasises equivalent arguments.

Calculation of the CPI-FW

The CPI-FW is based on Statistics Norway's price indices for 40 product groups defined on the basis of the COICOP system.[3] Weights are calculated for each of these sub-indices which take account of both share of consumption in Norway and the frequency of price changes for representative items in the sub-index.[4] The frequency of price changes is calculated as the number of changes relative to the number of observations for each representative item on the basis of selling prices in the period 1999–2004 (see Wulfsberg, 2009 for details). The frequency of price changes fw_i for each representative item i is aggregated to obtain a frequency of price changes fw_j for each product group j, taking into account that the items in each sub-index will differ in their importance for consumption. The weight for each product group in the CPI-FW is computed as

$$FW_j = \frac{\left(1/fw_j\right) \times w_{jt}}{\sum_{j=1}^{40}\left[\left(1/fw_j\right) \times w_{jt}\right]}$$

where w_{jt} is the CPI weight for the group in month t. FW_j is normalised so that the sum of the 40 weights is 1. An item that changes price relatively frequently will have a lower weight than that product group's share of consumption would in itself indicate. Finally, we calculate the CPI-FW as a weighted average of the consumer price sub-indices for these product groups using the formula

$$CPI\text{-}FW_t = \sum_{j=1}^{40}\left(FW_{jt} \times CPI_{jt}\right)$$

where CPI_{jt} is the sub-index for product group j in period t.

The weights calculated for August 2009 and the frequencies of price changes for the product groups in the CPI-FW are shown in Table 1. In Chart 1, we have aggregated the weights for the top level of the COICOP system so that the chart shows the average consumption and frequency weights for the 12 COICOP divisions.[5] Three of these divisions ("Food and non-alcoholic beverages", "Housing, water, electricity, gas and other fuels" and "Transport") are weighted lower in the CPI-FW than in

3 Classification of Individual Consumption According to Purpose, United Nations (2002). The COICOP system has various aggregation levels. The top level consists of 12 divisions, the second level of 47 groups, and the most disaggregated level of 170 classes (see, for example, Mai (2004) for a more detailed description of the classification in the COICOP system).

4 These representative items are around 650 set goods and services for which Statistics Norway collects monthly price data (see Statistics Norway (2009)).

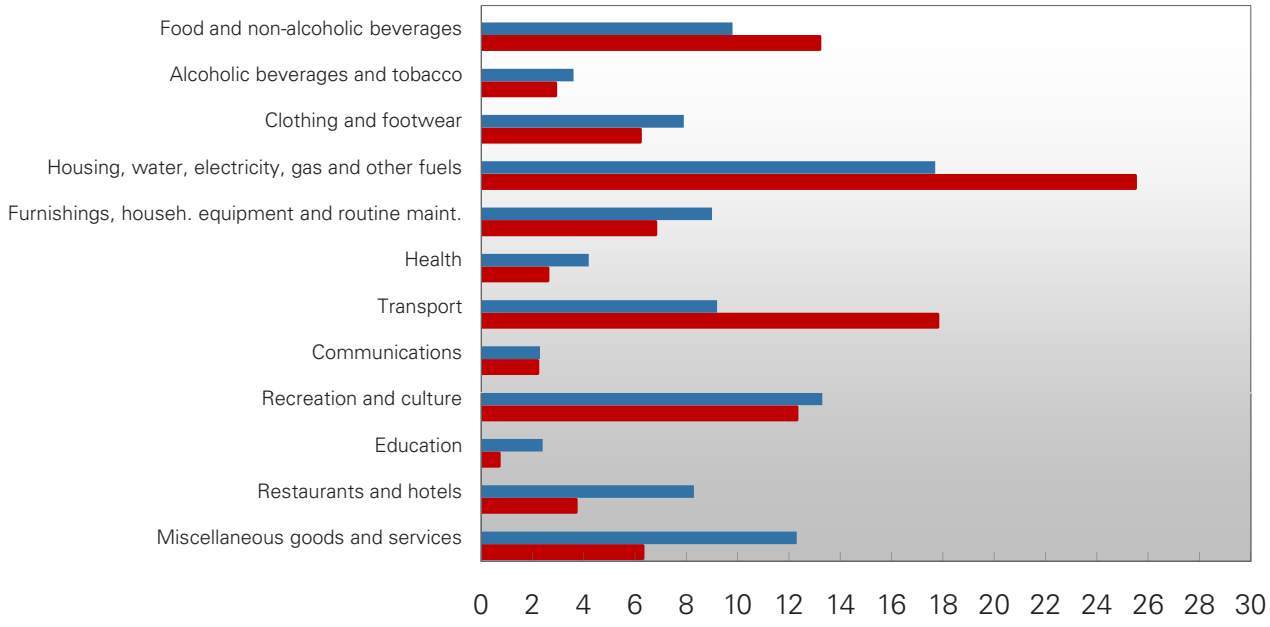
5 Chart 1 uses average share of consumption during the period 1992-2008 to calculate both CPI-FW and CPI weights.

Table 1. Frequency of price changes and percentage wieghts for 40 COICOP groupsr

COICOP-group		August 2009		Frequency
		w_{jt}	FW_j	fw_j
1.1	Food	10.4	6.7	23.5
1.2	Non-alcoholic beverages	1.1	1.2	14.0
2.1	Alcoholic beverages	1.7	1.9	13.6
2.2	Tobacco	0.9	1.0	13.1
3.1	Clothing	4.8	5.3	13.7
3.2	Footwear	0.9	1.4	9.3
4.1	Actual rentals for housing	2.5	5.2	7.4
4.2	Imputed rentals for housing	15.8	13.0	–
4.3	Maintenance and repair of the dwelling	6.3	4.7	20.4
4.5	Electricity, gas and other fuels	4.5	1.9	35.8
5.1	Furniture and furnishings, carpets and other floor coverings	2.4	2.7	13.7
5.2	Household textiles	0.5	0.7	11.6
5.3	Household appliances	1.0	0.8	18.5
5.4	Glassware, tableware and household utensils	0.5	0.8	9.0
5.5	Tools and equipment for house and garden	0.7	1.1	9.1
5.6	Goods and services for routine household maintenance	1.2	2.4	7.3
6.1	Medical products, appliances and equipment	1.2	1.6	12.2
6.2	Outpatient services	1.4	2.3	9.1
7.1	Purchase of vehicles	9.0	7.5	18.3
7.2	Operation of personal transport equipment	5.8	1.6	54.6
7.3	Transport services	2.4	2.7	13.6
8.1	Postal services	0.1	0.2	6.6
8.2	Telephone and telefax equipment	0.3	0.2	28.5
8.3	Telephone and telefax services	1.9	2.0	14.8
9.1	Audiovisual photographic and information processing equipment	2.4	1.7	21.4
9.2	Other major durables for recreation and culture	1.4	2.0	10.8
9.3	Other recreational items and equipment, gardens and pets	2.2	2.9	11.7
9.4	Recreational and cultural services	2.7	4.0	10.2
9.5	Newspapers, books and stationery	1.4	1.1	19.7
9.6	Package holidays	2.0	2.1	14.3
10.1	Pre-primary and primary education	0.1	0.2	5.2
10.2	Secondary education	0.1	0.3	4.5
10.4	Tertiary education	0.1	0.3	4.4
11.1	Catering services	3.2	7.1	6.8
11.2	Accommodation services	0.4	0.5	11.6
12.1	Personal care	2.0	2.9	10.4
12.3	Personal effects n.e.c.	0.6	1.4	6.8
12.4	Social protection	1.1	1.6	10.4
12.5	Insurance	1.9	1.7	16.7
12.6	Financial services n.e.c.	0.1	0.3	4.8

Note: CPI weights and price indices are not published for the groups that make up the "Education" division. To produce weights for groups 10.1, 10.2 and 10.4, therefore, a third of the CPI weight for the overall "Education" division has been used. We do not have data to calculate the frequency of price changes in the groups "Imputed rentals for housing", "Water supply and miscellaneous services relating to the dwelling" and "Other services n.e.c.". To calculate the CPI-FW weight for the group "Imputed rentals for housing", price frequencies for the group "Actual rentals for housing" have been used. The groups "Water supply and miscellaneous services relating to the dwelling" and "Other services n.e.c." have been excluded from the indicator.
Sources: Statistics Norway and Norges Bank.

Chart 1. Percentage weights for the 12 divisions



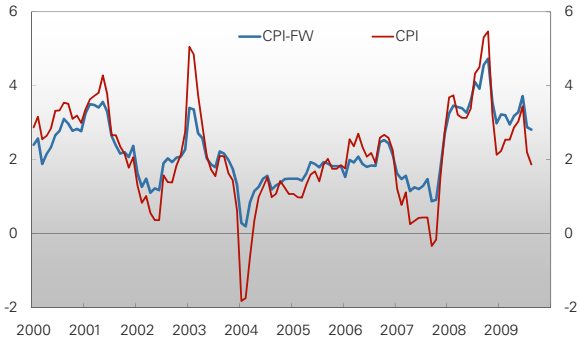
Sources: Statistics Norway and Norges Bank

the CPI. "Housing, water, electricity, gas and other fuels" has been downweighted from 25.5 per cent in the CPI to 17.7 per cent in the CPI-FW, "Transport" from 17.8 per cent in the CPI to 9.2 per cent in the CPI-FW, and "Food and non-alcoholic beverages" from 13.2 per cent in the CPI to 9.8 per cent in the CPI-FW.

Prices in the "Education", "Restaurants and hotels" and "Miscellaneous goods and services" divisions change very infrequently and are weighted much higher in the CPI-FW than in the CPI. "Education" has been upweighted from 0.7 per cent to 2.4 per cent, "Hotels and restaurants" from 3.7 per cent in the CPI to 8.3 per cent in the CPI-FW, and "Miscellaneous goods and services" from 6.3 per cent in the CPI to 12.3 per cent in the CPI-FW.

The "Housing, water, electricity, gas and other fuels" division is a special case, as it includes both items that change price very infrequently (rentals for housing) and items that change price frequently (electricity). The CPI-FW is calculated on the basis of more disaggregated product groups. Within "Housing, water, electricity, gas and other fuels", for example, the group "Actual rentals for housing" has been upweighted from 2.5 per cent of the CPI to 5.2 per cent of the CPI-FW, whereas the group "Electricity, gas and other fuels" has been downweighted from 4.5 per cent in the CPI to 1.9 per cent in the CPI-FW.

Chart 2. 12-month rise in the CPI and CPI-FW. Per cent. January 2000 to August 2009



Sources: Statistics Norway and Norges Bank

Table 2. Descriptive Statistics. CPI-FW and other indicators of underlying inflation. January 2000 — August 2009

	Snitt	St.dev	Max	Min
CPI-FW	2.2	0.88	4.7	0.2
Weighted median	2.5	0.81	4.1	1.1
Trimmed mean	2.2	0.87	4.0	0.3
CPIXE*	1.9	0.86	3.7	0.3
KPI-ATE*	1.7	0.88	3.3	0.0
CPI	2.1	1.32	5.5	-1.8
CPI*	1.9	1.34	5.5	-1.8

* Indicates the sub-sample 2002m1 – 2009m8

Source: Norges Bank

Comparison of the CPI and CPI-FW

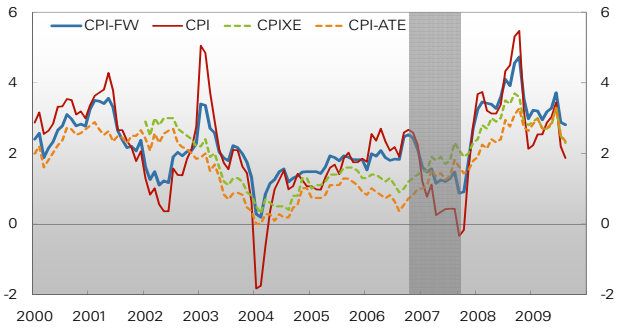
Chart 2 shows movements in the CPI-FW and CPI. During the period from January 2000 to August 2009, the CPI-FW closely mirrors movements in the CPI but "shaves off" inflation peaks and troughs. The highest 12-month rise in the CPI is 5.5 per cent, whereas the highest rise in the CPI-FW is 4.7 per cent. The lowest 12-month rise in the CPI is –1.8 per cent, whereas the lowest rise in the CPI-FW is 0.2 per cent. The correlation coefficient for the two indicators is 0.93. The CPI and CPI-FW increase at approximately the same average rate during the period: the average annual rise from January 2000 to August 2009 is 2.1 per cent for the CPI and 2.2 per cent for the CPI-FW (see Table 2). Table 2 also shows that the CPI-FW is more stable than the CPI with a standard deviation of 0.88, compared with 1.32 for the CPI. Smaller variations but approximately the same increase over time indicate that the CPI-FW removes temporary noise from the CPI without changing the underlying rate of increase.

Comparison with other indicators of underlying inflation

While the CPI-FW downweights prices that change frequently, the other four indicators (CPI-ATE, CPIXE, trimmed mean and weighted median) completely disregard prices that rise much further or less far than other prices.[6] The CPI-ATE is defined as the CPI adjusted for taxes and excluding energy products. The CPIXE is based on the CPI-ATE but takes account of an estimated trend increase in prices for energy products (see Nordbø (2008a and 2008b) and Hov (2009)). The trimmed mean ranks the product groups by their 12-month percentage change and excludes the groups that have risen the most/least. With a 20 per cent trimmed mean, the 10 per cent of product groups that have risen the most (or fallen the least) and the 10 per cent that have risen the least (or fallen the most) are excluded, thus removing a total of 20 per cent of the groups (see Jonassen and Nordbø (2006)). With a weighted median, the groups are ranked in the same way, but all groups are trimmed with the exception of the one in the very middle of the ranking (see page 44 of Norges Bank (2006)).

Whether the CPI-FW provides a better picture of underlying inflation depends on why rises in some prices deviate from price increases in general. Prices may change in large increments or decrements because they are affected by special factors that do not impact on other prices – for example, power prices could fall sharply after a wet summer without this having any impact on price levels in general (see Nordbø (2008b)). Bryan and Cecchetti (1994) argue that these prices should be removed from an indicator of underlying inflation. In practice, these prices can be difficult to identify. By excluding from an indicator those prices that move very differently to prices in general, information about underlying price inflation may be lost. The CPI-FW differs from the other four indicators in that no prices are removed completely from the indicator. Prices that change very frequently are given a low weight in the CPI-FW but are not removed. Large changes in prices that change frequently will therefore have some influence on the rate of CPI-FW inflation. This may be important, as large changes in flexible prices can feed through to stickier prices.

Chart 3. 12-month rise in the CPI, CPIXE, CPI-ATE and CPI-FW.
Per cent. January 2000 to August 2009

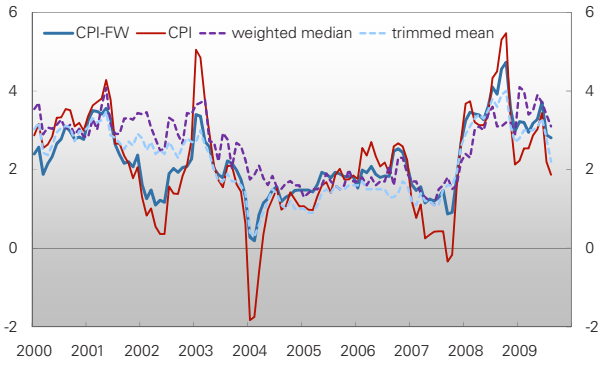


Sources: Statistics Norway and Norges Bank

Chart 3 compares movements in the CPI-FW with the CPI-ATE and CPIXE, while Table 2 provides an overview of empirical statistics for these indicators. Like the CPI-FW, the average rise in the CPIXE is close to the average rise in the CPI. During the period from January 2002 to August 2009, the CPIXE rose by 1.9 per cent, which is the same as the CPI during that period. The long-term rise in the CPI-ATE is less similar to the rise in the CPI. The CPI-ATE rose by 1.7 per cent from January 2000 to August 2009, which is 0.4 percentage point less than the CPI during that period. Chart 3 shows that the CPI-FW mirrors variations in the CPI more closely than the other two core indicators. In particular, it is worth noting the period from the second half of 2006 through to the end of 2007 (the shaded area in the chart). During this period, the CPIXE and CPI-ATE rose, while the CPI-FW and CPI fell. The CPI-FW does not vary more than the CPI-ATE and CPIXE. The CPI-ATE and CPIXE have standard deviations of 0.88 and 0.86 respectively (see Table 1). By way of comparison, the CPI-FW has a standard deviation of 0.88. Chart 4 shows the CPI-FW together with a 20 per cent trimmed mean and a weighted median for the CPI. The trimmed mean shows approximately the same long-term rise as the CPI of 2.2 per cent during the period from January 2000 to August 2009.

6 Energy prices are excluded from the CPI-ATE because historically they have varied widely (see Lilleås (2001)).

Chart 4. 12-month rise in the CPI, trimmed mean, weighted median and CPI-FW. Per cent. January 2000 to August 2009



Sources: Statistics Norway and Norges Bank

Chart 4 shows that, in many cases, the CPI-FW provides much of the same information as the trimmed mean, which excludes the product groups that rise the most/least each month. The similarity in the movements of the CPI-FW and trimmed mean suggests that the prices excluded in the trimmed mean are often the same prices that are downweighted in the CPI-FW, and therefore that many of the prices that vary widely also change frequently. The rise in the CPI-FW differs considerably from the rise in the weighted median. The rise in the weighted median over the period was 2.5 per cent, which is 0.4 percentage point higher than the rise in the CPI.

Does the CPI-FW predict future CPI inflation?

To the extent that different measures of underlying inflation capture the long-term trend in prices, these indicators can be used to provide forecasts of future inflation. The forecasting power of the CPI-FW has been tested on the basis of the following relationship

$$\pi_{t+k} - \pi_t = \alpha + \beta\left(\pi_t - \pi_t^{fw}\right) + \varepsilon_{t+k}$$

π_{t+k} is the 12-month rise in the CPI k months ahead, while π_t^{fw} is the 12-month rise in the CPI-FW. α and β are unknown parameters estimated using the ordinary least squares (OLS) method. We have estimated the equation for 12, 18 and 24 months ahead.[7]

If the CPI-FW does not contain temporary variations in the CPI but represents the underlying rate of increase, we would expect any deviation between the CPI and CPI-FW to disappear over a moderate period of time. A β of less than zero means that, if the rise in the CPI is higher than the rise in the CPI-FW, CPI inflation will fall over the next k months.

7 In this test, we looked only at the indicator's ability to predict future changes in the rate of inflation, regardless of whether there is a systematic increase in the rate of inflation. We have therefore included a constant term in line with, for example, Jonassen and Nordbø (2006).

Table 3. Predictive power of the CPI-FW on monthly changes in the rate of inflation.Monthly obsrvations. January 2000[1] — August 2009. Standard deviation in paranthesis.

	$k = 12$	$k = 18$	$k = 24$
CPI-FW	-2.87*	-2.21*	-1.83*
	(0.58)	(0.29)	(0.30)
Weighted median	-1.46*	-0.94*	-0.48
	(0.27)	(0.23)	(0.38)
Trimmed mean	-2.02*	-1.12*	-0.57
	(0.32)	(0.33)	(0.46)
CPIXE	-1.61*	-0.83*	-0.39
	(0.26)	(0.28)	(0.37)
CPI-ATE	-1.60*	-0.91*	-0.46
	(0.25)	(0.27)	(0.34)

* Signifies static significance at the 5 percent level..
1 Indikerer perioden 2002m1 — 2009m8. CPIXE is not calculated previously of January 2002.
Source: Norges Bank.

Table 3 shows the results of this test The CPI-FW has significant explanatory power for the rise in the CPI 12, 18 and 24 months ahead (5 per cent significance level).[8] Corresponding tests for the other core indicators show that only the CPI-FW has significant explanatory power over a horizon of 24 months ahead. None of the other indicators are significant over this horizon, even if we accept a 10 per cent significance level.

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