Technical documentation for the Nowa compounded index Nowai (Nowa index) and compounded Nowa averages

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Version 2 is updated with a clarification regarding which formula Norges Bank uses to calculate the compounded index. Table 1 is updated to reflect this.

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1. Definitions

The Nowai (Nowa index) represents the geometric return on an investment earning daily compound interest at the Nowa (Norwegian Overnight Weighted Average) rate for a specific period.

The Nowa1m (Nowa average 1m), Nowa3m (Nowa average 3m) and Nowa6m (Nowa average 6m) are annualised compounded averages for reference periods of 1, 3 and 6 months respectively. The Nowa1m, Nowa3m and Nowa6m are calculated using a two-day observation shift. The averages are calculated based on the Nowa rate in an observation period shifted two banking days back relative to the interest rate period to which the averages apply.

Banking days are days when NBO is open[1].

2. Publication

The Nowai is published every banking day at 9 am, at the same time as publication of the Nowa rate for the previous banking day. If Nowa is republished, the index will also be recalculated and republished. Once the republication deadline for Nowa has passed, no amendments will be made to the Nowai.

The Nowai is published to eight decimal places.

[1] NBO is an abbreviation for Norges Bank's settlement system. NBO settlement days are listed here: https://www.norges-bank.no/en/topics/Norges-Banks-settlement-system/Settlement-days/

The Nowa1m, Nowa3m and Nowa6m averages are published every banking day at 9 am. If the Nowa rate used in the averages is republished, the averages will also be recalculated and republished. The averages are published at the same time as the Nowa rate on the last observation date and two banking days before the last day of the period to which the averages apply.

The Nowa1m, Nowa3m and Nowa6m averages are published to five decimal places.

3. Calculation of the Nowai (Nowa index)

The starting value of the Nowai was set at 100.00000000 on 2 January 2020[2]. The daily index values reflect compounded Nowa over the period of banking days starting on 2 January 2020.

The following formula is used to calculate the value of the Nowai on a given date i. As shown in the calculation, the Nowa rate is based on a day-count convention of 365 days in a year:

$$Nowai_i = \begin{cases} 100, & i = 02.01.2020 \\ 100 \times \prod_{j=03.01.2020}^{i} \left(1 + \frac{Nowa_{j-1} \times n_{j-1}}{365}\right), & i \geq 03.01.2020 \end{cases} \quad (1)$$

where j applies over the period from 3 January 2020 to date i and

$$\begin{aligned} Nowa_j &= Nowa\ for\ banking\ day\ j. \\ n_j &= Number\ of\ calendar\ days\ Nowa_j\ applies. \end{aligned}$$

Formula (1) can also be expressed in recursive form:

$$Nowai_i = Nowai_{i-1} \times \left(1 + \frac{Nowa_{i-1} \times n_{i-1}}{365}\right) \quad (2)$$

Norges Bank uses the recursive form to calculate the index values. The calculation only includes published Nowa values.

An example calculation of the Nowai on selected dates is shown in Table 1. The Nowa values in the example are fictive.

Table 1. Example calculation of the Nowai

Date i	**Banking day**	**Nowa for date i[3]**	**Calculation**	$\boldsymbol{Nowai_i}$	**Publication date for $\boldsymbol{Nowai_i}$**
02.01.2020	Thursday	1.48%	100	100.00000000	02.01.2020
03.01.2020	Friday	1.49%	$= 100 \times \left(1 + \frac{0.0148 \times 1}{365}\right)$	100.00405479	03.01.2020
06.01.2020	Monday	1.47%	$= 100.00405479 \times \left(1 + \frac{0.0149 \times 3}{365}\right)$	100.01630187	06.01.2020
07.01.2020	Tuesday	1.46%	$= 100.01630187 \times \left(1 + \frac{0.0147 \times 1}{365}\right)$	100.02032992	07.01.2020
08.01.2020	Wednesday	1.49%	$= 100.02032992 \times \left(1 + \frac{0.0146 \times 1}{365}\right)$	100.02433073	08.01.2020

[2] 2 January 2020 is the first date on which Nowa was published using the current calculation principles.
[3] Published on date i+1.

4. Calculation of the Nowai on weekends and public holidays

If the previous calendar day falls on a public holiday or a weekend, the Nowa rate for the preceding banking day is used. Table 2 shows how the index would have been calculated at Easter 2020. The Nowa rates and index values in the example are actual values.

Table 2. Example of calculation of the Nowai over Easter 2020.

Date	Banking day	Nowa	Calculation	Nowai
07.04.2020	Tuesday	0.25%		100.33176980
08.04.2020	Wednesday	0.25%	$= 100.33176980 \times \left(1 + \frac{0.0025 \times 1}{365}\right)$	100.33245700
09.04.2020	Thursday (public holiday)	N/A	N/A	N/A
10.04.2020	Friday (public holiday)	N/A	N/A	N/A
11.04.2020	Saturday (weekend)	N/A	N/A	N/A
12.04.2020	Sunday (weekend and public holiday)	N/A	N/A	N/A
13.04.2020	Monday (public holiday)	N/A	N/A	N/A
14.04.2020	Tuesday	0.24%	$= 100.33245700 \times \left(1 + \frac{0.0025 \times 6}{365}\right)$	100.33658025

5. Using the Nowai to calculate compounded Nowa averages

The compounded Nowa average between date x and date y is expressed by the following formula:

$$Compounded\ Nowa\ average\ between\ x\ and\ y = \left(\frac{Nowai_y}{Nowai_x} - 1\right) \times \left(\frac{365}{d_c}\right), \quad (3)$$

where

$$\begin{aligned} x &= start\ date\ of\ the\ reference\ period \\ y &= end\ date\ of\ the\ reference\ period \\ d_c &= number\ of\ calendar\ days\ in\ the\ reference\ period^4 \end{aligned}$$

Example 1. Calculation of compounded Nowa average between two dates.

This example shows the calculation of a compounded Nowa average for the historical period from 31 March 2020 to 30 June 2020. There are 91 calendar days in the period, and index values for the start and end of the reference period are 100.32701449 and 100.35238784 respectively. The compounded Nowa average between the start and end dates will then be expressed as follows:

$$Compounded\ Nowa\ average = \left(\frac{100.35238784}{100.32701449} - 1\right) \times \left(\frac{365}{91}\right) = 0.0010144 \approx 0.10144\%.$$

6. Calculation of compounded Nowa average for tenors of 1, 3 and 6 months

Calculation of the Nowa1m, Nowa3m and Nowa6m for a period from date x to date y using a two-day observation shift is shown below. A day-count convention of 365 days in a year is applied, as in the calculation of the underlying Nowa rate.

$$Nowa\ average_{x,y} = [\prod_{j=x}^{y} \left(1 + \frac{Nowa_{j-2} \times n_{j-2}}{365}\right) - 1] \times \frac{365}{d_c}, \quad (4)$$

where

[4] Including the start date (x) and the calendar day preceding the end date (y-1).

$$
\begin{aligned}
Nowa_j &= Nowa\ for\ date\ j, as\ published\ on\ date\ j+1 \\
n_j &= Number\ of\ calendar\ days\ Nowa_j\ applies \\
d_c &= Number\ of\ calendar\ days\ in\ observation\ period \\
j &= A\ series\ of\ dates\ representing\ banking\ days\ in\ the\ period
\end{aligned}
$$

In the calculation, the start and end dates for the interest rate periods have been adjusted so that they always fall on a banking day.[5] This means that end dates that fall on a weekend or public holiday are moved forward to the next banking day. If the next banking day falls in the next calendar month, the end date is rolled back to the preceding banking day.

Table 3 shows an example of interest rate periods and associated observation periods.

Table 3. Interest rate periods and observation periods for Nowa1m on selected dates.

Tenor	Interest rate period start	Interest rate period end	Observation period start	Observation period end	Rate	Publish date
Nowa1m	29.04.2020	29.05.2020	27.04.2020	27.05.2020	0.08800%	27.05.2020
Nowa1m	30.04.2020	29.05.2020	28.04.2020	27.05.2020	0.08276%	27.05.2020

7. Example calculation of the periodic interest rate between two dates using the compounded index and averages

An investor invests NOK 1 million with a counterparty at the daily compounded Nowa rate from 17 March 2020 to 17 April 2020. The parties have agreed to use a two-day observation shift and a modified following banking day. The observation period for the calculation is thus 13 March 2020 to 15 April 2020. The interest rate for the period is finalised on 15 April 2020. The parties then have two days to settle payment.

The standardised periodic interest rate can be found by using the Nowai in formula (3) or using the Nowa1m as published on Norges Bank's website. The two methods will result in the same interest rate to five decimal places, but minor differences can arise if the result is rounded to more than five decimal places.

To calculate the periodic interest rate using the Nowai and formula (3), the index values for 13 March 2020 and 15 April 2020 are used. The Nowai on these dates was 100.29040994 and 100.33724000 respectively. The observation period is 33 calendar days. The periodic interest rate can then be calculated as follows:

$$
Perioderente = \left(\frac{100.33724000}{100.29040994} - 1\right) * \frac{365}{33} = 0.51647\%
$$

Alternatively, the Nowa1m for the interest rate period 17 March 2020 to 17 April 2020 can be used. Since the Nowa1m is calculated using a two-day observation shift, this rate is published on 15 April 2020. Table 4 below shows how Norges Bank calculates the Nowa1m for this period using (4). Whichever method is used, the investor will on 17 April 2020 receive repayment of the principal of NOK 1 million and an interest payment of $1{,}000{,}000 * 0.0051647 * 31/365 = 438.65 NOK$.

[5] The so-called modified following banking day.

Table 4. Calculation of the Nowa1m with a two-day observation shift.

Interest rate period start	17.03.2020
Interest rate period end	17.04.2020
Calendar days in interest rate period	31
Calendar days in observation period	33
Shift days	2

Interest rate period	**Observation period**	**Nowa on the observation date**	**Calculation of factor**	**Factor**
Tuesday 17.03.2020	Friday 13.03.2020	1.49%	1	1
Wednesday 18.03.2020	Monday 16.03.2020	0.99%	$1+\frac{0.0149*3}{365}$	1.0001224658
Thursday 19.03.2020	Tuesday 17.03.2020	0.99%	$1+\frac{0.0099*1}{365}$	1.0000271233
Friday 20.03.2020	Wednesday 18.03.2020	0.99%	$1+\frac{0.0099*1}{365}$	1.0000271233
Monday 23.03.2020	Thursday 19.03.2020	0.99%	$1+\frac{0.0099*1}{365}$	1.0000271233
Tuesday 24.03.2020	Friday 20.03.2020	0.99%	$1+\frac{0.0099*1}{365}$	1.0000271233
Wednesday 25.03.2020	Monday 23.03.2020	0.24%	$1+\frac{0.0099*3}{365}$	1.0000813699
Thursday 26.03.2020	Tuesday 24.03.2020	0.24%	$1+\frac{0.0024*1}{365}$	1.0000065753
Friday 27.03.2020	Wednesday 25.03.2020	0.24%	$1+\frac{0.0024*1}{365}$	1.0000065753
Monday 30.03.2020	Thursday 26.03.2020	0.24%	$1+\frac{0.0024*1}{365}$	1.0000065753
Tuesday 31.03.2020	Friday 27.03.2020	0.24%	$1+\frac{0.0024*1}{365}$	1.0000065753
Wednesday 01.04.2020	Monday 30.03.2020	0.24%	$1+\frac{0.0024*3}{365}$	1.0000197260
Thursday 02.04.2020	Tuesday 31.03.2020	0.24%	$1+\frac{0.0024*1}{365}$	1.0000065753
Friday 03.04.2020	Wednesday 01.04.2020	0.25%	$1+\frac{0.0024*1}{365}$	1.0000065753
Monday 06.04.2020	Thursday 02.04.2020	0.25%	$1+\frac{0.0025*1}{365}$	1.0000068493
Tuesday 07.04.2020	Friday 03.04.2020	0.25%	$1+\frac{0.0025*1}{365}$	1.0000068493
Wednesday 08.04.2020	Monday 06.04.2020	0.24%	$1+\frac{0.0025*3}{365}$	1.0000205479
Tuesday 14.04.2020	Tuesday 07.04.2020	0.25%	$1+\frac{0.0024*1}{365}$	1.0000065753
Wednesday 15.04.2020	Wednesday 08.04.2020	0.25%	$1+\frac{0.0025*1}{365}$	1.0000068493
Thursday 16.04.2020	Tuesday 14.04.2020	0.24%	$1+\frac{0.0025*6}{365}$	1.0000410959
Friday 17.04.2020	Wednesday 15.04.2020	0.24%	$1+\frac{0.0024*1}{365}$	1.0000065753
		Nowa1m:	$[\prod_{13.03.2020}^{15.04.2020}(factors)-1]*\frac{365}{33}=$	**0.51647%**