# Calculation of average rates and an index for the SWESTR reference rate

SVERIGES RIKSBANK

# Table of contents

# Calculation of average rates and an index for the SWESTR reference rate

A consultation from Sveriges Riksbank, April 2021

---

During the third quarter of 2021, the Riksbank intends to start calculating and publishing backward-looking averages of and an index for the Riksbank's SWESTR reference rate. This document presents the Riksbank's proposal for calculation methods and aspects relating to publication of these.

The aim of this consultation is to gather opinions from financial institutions, other financial market participants and other stakeholders.

Any comments and answers to questions in this consultation shall be submitted to the Riksbank at remiss.referensranta@riksbank.se or sent to "Sveriges Riksbank, 103 37 Stockholm, no later than 7 May 2021. Please state the reference number 2021-00086.

A summary of the responses to the consultation will be compiled and published on www.riksbank.se.

Thank you for your participation!

---

# Summary of the proposals in the consultation

During the third quarter of 2021, the Riksbank intends to start calculating and publishing average rates based on SWESTR overnight (O/N). These rates will be calculated as averages over time periods back in time. The Riksbank proposes that the average rates are published for time periods of 1 week, 1 month, 2 months, 3 months and 6 months, to 5 decimal places.

The Riksbank also intends to publish an index for SWESTR at the same time so that users can calculate average rates over customised time periods in addition to the average rates published by the Riksbank. The Riksbank proposes that the index is given the starting value of 100 and published to 8 decimal places.

The Riksbank also intends to follow international practice by using formulae for calculation of average interest rates and an index corresponding to those already adopted by other central banks, including the European Central Bank (ECB). In these calculations, the Riksbank proposes that the day-count convention *actual number of days/360* (Act/360) is used. The Riksbank also proposes that weekends and public holidays are handled using the convention *modified previous business day* for all time periods, apart from the 1-week time period, for which (*standard*) *previous business day* is proposed.

It is proposed that the average rates and index are published on the Riksbank's website and via API every day on which SWESTR is published (each Swedish business day), at the same time as or just after the publication of SWESTR O/N (currently 11.00). The exact timing of this publication will be announced later in 2021.

When designing the calculation method for the average rates and the index, the Riksbank has considered international guidelines and international practice, as well as current conventions on the Swedish money market.

# 1 Introduction

In conjunction with its publication of the name of the new reference rate (SWESTR) on 20 January 2021, the Riksbank also announced the start of a project to develop average rates for SWESTR. The Riksbank also announced that it would gather opinions on this project from participants on Swedish financial markets during the spring of 2021. This consultation is one step in this process.

## 1.1 International reform efforts to strengthen confidence in reference rates

Reference rates fulfil an important function in the financial system, in both Sweden and other countries. They enable the pricing of financial products to be standardised and are used by a number of different financial market participants. Traditionally, so called Interbank Offered Rates (IBORs) have been used as reference rates for these purposes. These reference rates have usually been calculated based on bids from banks. In the absence of actual transactions to base these bids on, however, bids have instead been based on banks' judgements of what is a reasonable rate.[1]

During the global financial crisis that broke out in 2008, liquidity in the interbank loan market deteriorated significantly. This contributed to uncertainty over whether these interbank rates really reflected prevailing market conditions. When reference rates are calculated based on reported bids, there is also a risk of manipulation. During the LIBOR scandal in 2012, it was also revealed that several international banks had manipulated LIBOR (London Interbank Offered Rate) for their own benefit or for the benefit of individual employees. These events caused a loss of confidence in traditional reference rates.

International reform efforts were therefore initiated with the aim of strengthening confidence in and improving the reliability of reference rates. Some of these efforts were directed at strengthening the framework and methods for calculation of reference rates. The calculation method for several interbank rates has since been revised and it has also been made clear that LIBOR will cease altogether going forward.[2] Work is also ongoing in Sweden to review the method for the Swedish reference rate STIBOR (Stockholm Interbank Offered Rate).[3]

---

[1] For an in-depth description of the background, see the article "A new reference rate – the way forward" in the Riksbank's Financial Stability Report 2020:1.

[2] Press release: "Announcements on the end of Libor", Financial Conduct Authority, 5 March 2021. https://www.fca.org.uk/news/press-releases/announcements-end-libor

[3] On 1 March 2021, STIBOR's new administrator, the Swedish Financial Benchmark Facility (SFBF) sent out a consultation containing proposals for a new definition and method for STIBOR. SFBF has stated that it will apply for authorisation as STIBOR's administrator in 2021, a decision taken by the Swedish Financial Supervisory Authority.

In many countries, work also started on developing new reference rates based on actual transactions. The idea was that these reference rates would either replace already existing reference rates completely (as in the case of LIBOR) or exist as a complement so that users would have several rates to choose from. Several central banks around the world now publish new transaction-based reference rates, or are planning to do so shortly (see Table 1 below). In December 2019, the Riksbank also took a decision to provide a new transaction-based reference rate in Swedish kronor, SWESTR (Swedish Krona Short Term Rate).[4] Starting from 27 January 2021 and for a test period of about six months, the Riksbank publishes a preliminary listing for SWESTR.[5]

**Table 1. Transaction-based reference rates published by central banks**

The table contains a selection of rates published by central banks

| Jurisdiction | Traditional reference rate | Status | New reference rate | Launch |
|---|---|---|---|---|
| **EU** | EONIA | Will cease on 3 January 2022 | €STR (replaces EONIA) | 2 October 2019 |
| **EU** | EURIBOR | Adjusted method, no cessation date | €STR | 2 October 2019 |
| **EU** | LIBOR (EUR) | Will cease on 31 December 2021 | €STR | 2 October 2019 |
| **United States** | LIBOR (USD) | Will cease on: <br>- 31 Dec 2021 (1W & 2M maturities) <br>- 30 June 2023 (other maturities) | SOFR | 3 April 2018 |
| **United Kingdom** | LIBOR (GBP) | Will cease on 31 Dec 2021 | SONIA | Original version: March 1997 Updated version: 23 April 2018 |
| **Sweden** | STIBOR | Proposal for adjusted method, no cessation date | SWESTR | Q3 2021 (test period from 27 January 2021) |
| **Norway** | NIBOR | Adjusted method, no cessation date | NOWA | Original version: 2011 Updated version: 1 January 2020 |
| **Denmark** | CIBOR | Partially adjusted method, no cessation date | DESTR | Preliminary: launch in early 2022 |

Note. Note that LIBOR for the various currencies can be classified under several countries and that LIBOR is in practice used much more broadly than is specified in the table above. To provide a better overview of the various rates, however, we have classified them in this table so that LIBOR for each currency respectively appears under the country in which the currency originates.

Sources: Website of each administrator (for the traditional interbank rates) and central bank (for the new reference rates).

---

[4] Press release: New reference rate for financial markets, Sveriges Riksbank, 12 December 2019.

[5] SWESTR shall not be used in financial contracts during this test period. Once the test period is over, the Riksbank will start to publish an official version of SWESTR that can be used in financial contracts.

## 1.2 Requirement for fallback solution under the European Benchmarks Regulation

In addition to the international reform efforts, a new European regulatory framework for reference rates has emerged that Swedish market participants are obliged to follow, namely the European Benchmarks Regulation (BMR), which came into force in 2018. A requirement set by the Benchmarks Regulation is that there must be a plan in the event of a reference rate no longer being provided and thus ceasing to exist. If possible, this plan shall also specify one or more alternative reference rates that can be used to replace the reference rate that is no longer provided (known as a fallback rate).[6] As far as Sweden is concerned, this means that alternatives to the STIBOR reference rate are needed that can be used in financial contracts. Such a fallback solution can be based on the Riksbank's SWESTR reference rate.[7]

When designing the fallback solution, the existing maturities for the rate which the fallback is intended to replace need to be considered. The traditional interbank rates are provided at several different, forward-looking, maturities while the new reference rates are only provided for the very shortest maturity (overnight, O/N).[8] The reason for this is that the new reference rates are fully transaction-based and currently not enough transactions take place to be able to calculate them at longer maturities than the very shortest. This means that they cannot directly replace traditional reference rates at longer maturities than the very shortest, a problem that exists both internationally and in Sweden.

International discussions have mainly centred on two alternative ways of being able to use transaction-based reference rates in contracts with longer maturities. One alternative is to try to develop forward-looking rates based on traded derivative contracts (mainly overnight index swaps, OIS) with the new rates as a basis. This alternative presupposes that there is a sufficient volume of trade in such derivative contracts. The other alternative is to calculate backward-looking average rates based on the actual rate outcomes.

## 1.3 International standard for central banks to publish average rates

The benefit of using forward-looking rates in financial contracts is that the payment flows will be known in advance, which is more similar to how currently used interbank rates work. However, the derivative markets with the new reference rates as a basis are currently not large enough to form the foundation for reliable forward-looking

---

[6] Article 28.2 in Regulation (EU) 2016/1011 of the European Parliament and of the Council of 8 June 2016 on indices used as benchmarks in financial instruments and financial contracts or to measure the performance of investment funds and amending Directives 2008/48/EC and 2014/17/EU and Regulation (EU) No 596/2014, 8 June 2016.

[7] The actual fallback rate consists of an adjusted rate (average rate for a specific maturity) plus a so-called spread adjustment (an adjustment to take into account the difference between the new rate and the traditional interbank rate).

[8] STIBOR exists at maturities Tomorrow-Next (T/N), 1 week, 1 month, 2 months, 3 months and 6 months.

reference rates. Only two countries have recently managed to generate enough trade in the new reference rates for private agents to be able to publish official and test versions of forward-looking term rates respectively.[9] As the use of SWESTR increases, it is thus possible that a derivative market with SWESTR as a basis will emerge, with which forward-looking transaction-based rates may also be calculated in Sweden.

As regards backward-looking average rates, the major benefit is that there is a reliable transaction-based reference rate as a basis for the average rates and that it is relatively easy to calculate these. The drawback of such average rates, however, is that someone borrowing money, for example, at a maturity of three months only finds out their financing costs afterwards, on the due date three months later.

An international standard has emerged, according to which central banks that provide transaction-based reference rates also calculate and publish *compounded average rates* and/or an index based on their respective reference rate.  For example, the central banks in the United States[10], and the United Kingdom[11] have already started to publish average rates and an index respectively. Several central banks have already announced that they intend to do the same shortly, for example the ECB.[12] One reason why this has become an international standard is that the fallback solution for derivative contracts in the ISDA protocol (International Swaps and Derivatives Association) is based on such average rates.[13]

## Reasons why central banks have started to publish average rates

There are several reasons why central banks around the world have started to publish average rates based on their respective reference rates. Reasons that are also applicable in a Swedish context.

Average rates are an important part of the fallback solution for traditional reference rates. However, there are slightly different ways of doing the calculation itself and results can vary depending on roundings or different ways of dealing with weekends and public holidays. This risks leading to ambiguity as to which interest rate level actually applies. This in turn can lead to an information advantage between a financial institution and the borrower, for example. The fact that the average rates are calculated and published by a public agent increases transparency, which in turn reduces the risk of ambiguity and differences with regard to the interest rate level used.

---

[9] In the United Kingdom, two official versions of forward-looking rates for the SONIA reference rate have been published since the beginning of 2021. Refinitiv Term SONIA and ICE Term SONIA Reference Rate were both published for the first time on 11 January 2021. In Japan, test rates have been published by the company Quick Corp since May 2020, the aim being to publish these officially, and thus be able to use them in actual contracts, in mid-2021.

[10] SOFR Averages and SOFR Index, Federal Reserve Bank of New York.

[11] SONIA Compounded Index, Bank of England.

[12] The ECB has announced that it will start publishing its averages (Compounded €STR average rates) and index on 15 April 2021.

[13] See ISDA 2020 IBOR Fallbacks Protocol, ISDA's name for the average rates is "Adjusted RFR".

In several jurisdictions, such as the United States, the EU and the United Kingdom, use of new transaction-based reference rates is also increasing as the main interest rate in new contracts. Financial markets are closely intertwined and it is therefore important that it is also possible in Sweden to use the type of reference rates, over the same time periods, as are used internationally.

By publishing average rates and an index, central banks are also promoting the use of the new transaction-based reference rates. This is in line with the international recommendations published by the Financial Stability Board (FSB). According to these recommendations, relevant authorities shall, as and when appropriate, encourage market participants to switch new contracts over to a suitable transaction-based reference rate.[14]

# 2 Calculation methods

## 2.1 Day-count convention

Similar to euro and dollar money markets, among others, the Swedish money market uses the convention that the year has 360 days in its interest rate calculations. STIBOR also currently uses this convention. The Riksbank sees no reason to deviate from this convention and therefore proposes that the convention *actual number of days/360* (Act/360) is used to calculate average rates and an index.

## 2.2 Formula for calculation of average rates

Two main methods can be used to calculate an average rate over a period of time. Either a *simple average*, that is the arithmetic mean, or a *compounded average* can be calculated. The benefit of the arithmetic mean is that it is easy to calculate and implement in different systems. However, it is uncommon to use it internationally when calculating average rates. Using a compounded average instead takes into account the compound interest effect (interest on interest), which can be considered to give a more accurate average as it better reflects the change in value over time.

The Riksbank intends to calculate compounded average rates according to the proposed formula below. This is the same formula that has already become standard as a result of ISDA's recommendations[15] and has been adopted by the ECB and several other central banks. The Riksbank sees no reason to deviate from international practice. See also the appendix for concrete calculation examples.

---

[14] See, for example, "Reforming major interest rate benchmarks", Financial Stability Board, 22 July 2014

[15] Note that ISDA's formula has an adjustment factor for cases when the day-count convention differs between the new and the old reference rate. This adjustment factor is not in the formulae published by each central bank as it is not needed due to the reasonable assumption that the same convention is used within a single jurisdiction.

**Formula 1 – compounded average rate**

$$Compounded\ average\ rate = \left[ \prod_{i=1}^{d_b} \left( 1 + \frac{r_i \times n_i}{N} \right) - 1 \right] \times \frac{N}{d_c}$$

where,

$i$ = an index representing each business day in the interest period.

$r_i$ = the SWESTR rate published on business day *i* (based on eligible trades executed on the previous business day, *i-1*).

$n_i$ = number of calendar days for which rate $r_i$ applies (generally 1 day, except for Mondays where it will be 3 days to account for the accrual over the weekend or where adjustment is needed due to other holidays) = number of calendar days for which $r_i$ is compounded.

$N$ = Number of days in the year, i.e. 360.

$d_c$ = Number of calendar days in the interest period.

$d_b$ = Number of business days in the interest period.

---

**Question 1:** Does the above-specified formula to calculate compounded average rates for SWESTR fulfil the needs of the market? If not, please explain why.

---

## 2.3 Formulae for index calculation

The Riksbank also intends to calculate and publish an index for SWESTR. The index enables the user to calculate compounded average rates themselves between two optional dates and thus create a customised time period. This is a complement to the average rates that will be published by the Riksbank.

The index reflects the value of a capital investment which accrues interest at the current SWESTR rate on each business day. The index is thus a measure of the compounded return since the start date. By comparing the value of the index on two dates and adjusting for the number of days between the dates, the average SWESTR rate between these dates can be calculated.

The Riksbank intends to use the formula (formula 2) below to calculate an index. Formula 3 then shows how the user can calculate an average rate based on this index. These formulae are also the same as those adopted by the ECB and several other central banks. The Riksbank sees no reason to deviate from international practice.

When calculating an index value for a single day, all the SWESTR listings published since the start of the index are included.[16] See also the appendix for concrete calculation examples. The exact start date for the index will be announced later in 2021.

**Formula 2 – index calculation**

$$SWESTR \; cumulative \; index \; on \; date \; i = \begin{cases} 100, & if \; i = 0 \\ 100 \times \prod_{t=1}^{i} \left(1 + \frac{r_t \times n_t}{N}\right), & if \; i > 0 \end{cases}$$

**Formula 3 – calculation of average SWESTR rate based on the index**

$$SWESTR \; cumulative \; average \; x, y = \left(\frac{SWESTR \; index_y}{SWESTR \; index_x} - 1\right) \times \frac{N}{d_c}$$

where,

$r_t =$ is the SWESTR rate published on business day $t$ (based on eligible trades executed on the previous business day, *t-1*).

$n_t =$ Number of calendar days for which rate $r_t$ applies (generally 1 day, except for Mondays where it will be 3 days to account for the accrual over the weekend or where adjustment is needed due to other public holidays) = number of calendar days for which $r_t$ is compounded.

$N =$ Number of days in the year, i.e. 360.

$d_c =$ Number of calendar days in the interest period.

$t = 0$ refers to the first SWESTR reference date, this date will be announced in conjunction with the publication of the index.

$x, y =$ SWESTR compounded average from date **x** to date **y**

---

**Question 2:** Does the above-specified formulae to calculate an index and average rates based on this index fulfil the needs of the market? If not, please explain why.

---

[16] The calculation of the index for a single day is therefore not just based on the published index value for the previous business day. This distinction is important to make as such a stepwise rounding in the calculation over time can lead to major deviations.

# 3 Proposed time periods and forms of publication

## 3.1 Proposed time periods

As it should also be possible to use SWESTR as a fallback for STIBOR, the Riksbank finds it appropriate to publish averages of SWESTR for all time periods that STIBOR exists at, the exception being the shortest maturity Tomorrow/Next (T/N) in line with international practice. The Riksbank therefore proposes that averages for SWESTR are published over the time periods 1 week, 1 month, 2 months, 3 months and 6 months.[17]

The Riksbank proposes that the time periods are calculated based on fixed dates, see e.g. Table 2 below.[18] This is the method adopted or proposed by the majority of other central banks, including the ECB. Using a fixed date also follows the currently applicable convention for STIBOR, which can, for example, facilitate its use in fallback solutions. The time periods are calculated from and including the rate for SWESTR on the start date, up to (excluding) the rate for SWESTR on the end date, in accordance with the convention when rate calculation periods are to be determined.[19] See also Figure 1 further down for an illustration of the input values used in the calculation of the 1-month time period.

If the start date were to be a non-existent calendar date (e.g. 31 April), the start date is moved to the last business day of the month (30 April). The Riksbank's proposal for how to handle weekends and public holidays can be found in Section 4.

**Table 2. Examples of start dates for each time period**
On the end date (also publication date) 1 April 2021

| Time period | Start date | End date |
|-------------|------------|----------|
| **1 week** | 25 March 2021 | 1 April 2021 |
| **1 month** | 1 March 2021 | 1 April 2021 |
| **2 months** | 1 February 2021 | 1 April 2021 |
| **3 months** | 1 January 2021 | 1 April 2021 |
| **6 months** | 1 October 2020 | 1 April 2021 |

Source: The Riksbank

---

[17] The term "time period" in this context refers to the length of the period over which the average is calculated (e.g. one month). It is thus not a question of maturities in the traditional sense as the term "maturity" is mainly used for forward-looking rates.

[18] This is different from e.g. New York Fed in the United States that calculates its time periods based on a fixed number of days. One month is thus always exactly 30 days, three months 90 days, and so on.

[19] Note that this refers to the value day of SWESTR. SWESTR is published one business day later.

13

**Value day and publication day respectively**

There is a difference between the value day and the publication day of the SWESTR rates. The value day is the day on which the underlying transactions were made, publication of the SWESTR rate then takes place on the following business day. Regarding average rates and an index for SWESTR, the Riksbank intends to use all available information each business day for calculation and publication. The data used for calculation will therefore be the SWESTR rates published up to and including the relevant business day. See the illustration in Figure 1 below.

In contrast to the SWESTR rates, average rates and index values will be designated after their publication date, i.e. their value day is the publication day.[20] This proposal reflects international practice and is in line with how, for example, New York FED and the ECB publish their average rates for SOFR and €STR respectively.

**Figure 1. Illustration**
Average rate at 1M for the period 24 February – 24 March



Source: The Riksbank

---

**Question 3:** Do the proposed time periods fulfil the needs of the market? If not, please explain why and specify which time periods are needed and are missing.

**Question 4:** Calculation of the time periods is proposed to be based on a fixed date (and not on a fixed number of days). Does this method fulfil the needs of the market? If not, please explain why.

## 3.2  Forms of publication

**Information to be published**

Each publication day, the Riksbank intends to publish an index value and a value for the average rates for each time period. For the average rates, the start date for the applicable listing is also published for the sake of clarity.

---

[20] This means that the value day for average rates is the same as the end date for the period for which the average rates apply.

The Riksbank also proposes that the average rates are published to 5 decimal places and that the index is given the starting value 100 and published to 8 decimal places. This proposal is in line with what the majority of other central banks, including the ECB, have decided to publish.

**Table 3. Examples of published information**
Publication date 1 April

| Time period/Index | Value | Start date |
|---|---|---|
| **Index** | 100.00000000 | N/A |
| **1W** | -0.10243 % | 25 March 2021 |
| **1M** | -0.09893 % | 1 March 2021 |
| **2M** | -0.09381 % | 1 February 2021 |
| **3M** | N/A | 1 January 2021 |
| **6M** | N/A | 1 October 2020 |

Note. Note that the table and its content are just an example. The exact information to be published will be determined during the spring.

Source: The Riksbank

**Question 5:** Does the proposed publication information fulfil the needs of the market? If not, please explain why.

**Question 6:** Does publication of average rates to 5 decimal places and an index with a starting value of 100 and to 8 decimal places fulfil the needs of the market? If not, please explain why.

## 3.3   Time of publication and corrections

The Riksbank proposes that average rates and an index for SWESTR is published on the Riksbank's website and via API at the same time or shortly after the publication of SWESTR O/N on each business day (currently 11.00).

New, corrected publication of the average rates and the index is proposed to only take place if SWESTR needs to be republished due to a correction, or an error in the calculation has been identified. In that case, this occurs on the same day and at the same time as SWESTR is republished (currently 14.00).

**Question 7:** Does the proposed approach to publication of average rates and an index fulfil the needs of the market? If not, please explain why.

# 4 Handling of weekends and public holidays (non-business days)

When calculating average rates, weekends and public holidays (non-business days) need also to be taken into account. This applies to both regular weekends (Saturdays and Sundays) and other public holidays. The latter can be both individual public holidays (such as Sweden's National Day), and longer periods of holiday (such as over Christmas/New Year or Easter). In practice, this means that there must be a method for determining the start date of the period since the end date is already fixed.[21]

There are mainly two ways of dealing with non-business days; the date can be either brought forward or put back. Practice on the Swedish fixed-income market is to use the conventions *(standard) previous business day* (aka *preceding business day*)[22] and *(standard) following business day*[23] to describe these two methods. However, there are many reasons, including for accounting purposes, why it is important for users of reference rates that interest flows are calculated for a date that falls within the "correct" month. Therefore, the conventions *modified previous business day* and *modified following business day* are common (we refer hereinafter to these only as *modified previous* and *modified following*). The conventions mean that the date is brought forward or put back as long as this does not lead to the date rolling over into another month. If this is the case, an adjustment is made in the opposite direction.

There is currently no uniform practice among the central banks that publish, or have announced that they will publish, average rates for how to deal with non-business days.[24] STIBOR currently uses *modified following*. However, like existing interbank rates, STIBOR is a forward-looking rate where the period is determined by the start date and the end date is adjusted. This is in contrast to the proposed average rates that are backward-looking, and where the calculation is based on the period's end date and the period's start date is adjusted. The *modified following* method implies in practice that the periods that STIBOR relates to are as a rule extended when adjusting for weekends and public holidays. Applying the same reasoning here, i.e. a main rule of extending the period for interest calculation, would subsequently lead to the use of *modified previous* for the average rates, as in these cases it is the start date that is adjusted.

---

[21] The Riksbank considers that both start and end dates for average rates should be business days. This is in line with emerging European practice. However, the US central bank, New York FED, allows the start date for its SOFR averages to be on a non-business day.

[22] If the applicable date is a weekend or public holiday, the value is instead taken from the closest previous business day.

[23] If the applicable date is a weekend or public holiday, the value is instead taken from the closest following business day.

[24] For example, the ECB uses modified previous. Norway has instead chosen modified following.

The Riksbank has analysed how well the periods for the average rates tally with the corresponding periods for STIBOR depending on the method used to adjust the start date, see Table 4 below.[25] Due to its current special position among STIBOR's various maturities, the 3-month maturity has been analysed. This analysis shows that a better match is achieved between STIBOR's maturities and the maturities for the average rates if the convention *modified previous* is used. In this case, the dates tally in 90 per cent of cases, while *modified following* only gives 80 per cent. The pattern that *modified previous* provides better concordance is also clear if a mismatch of +/- one day is allowed, as this convention gives 97 per cent concordance.

The analysis also shows that the average length of a backward-looking three-month period with start date adjustments according to *modified previous* is 91.56 days, while it is 91.21 days with adjustments according to *modified following*.[26] Also with this measure, *modified previous* subsequently provides better concordance with existing three-month periods for STIBOR (91.63 days).

The Riksbank considers it appropriate to prioritise concordance between the conventions for average rates for SWESTR and the conventions applied by the ECB for the €STR reference rate. The ECB chooses to apply the *modified previous* method with the exception of the 1-week time period, for which it will apply *standard previous* instead. The Riksbank subsequently proposes that *modified previous* is used to deal with non-business days as regards the start date for the time periods 1 month, 2 months, 3 months and 6 months. For the 1-week time period, the Riksbank proposes that *standard previous* is used.

---

**Question 8:** Do the proposed conventions *modified previous business day* and *standard previous business day* fulfil the needs of the market? If not, please explain why.

---

[25] In this analysis, the Riksbank has largely been inspired by the analysis performed by the ECB in conjunction with its consultation containing proposals for calculation methods for average rates for €STR (published in July 2020). The ECB did its analysis for the 1-month time period, but arrived at the same conclusions as the Riksbank, namely that *modified previous* provides the best match with existing periods for IBOR.

[26] The analysis refers to the average length of all periods that start from 1 July 2017 to 1 July 2027 inclusive, irrespective of the period's end date.

**Table 4. Concordance with STIBOR's periods depending on adjustment method**

Deviation from periods whose date is determined forward-looking

| Deviation (number of days) | Modified previous | | Modified following | |
|---|---|---|---|---|
| | Number of dates | % | Number of dates | % |
| -5 | 0 | 0 | 0 | 0 |
| -4 | 4 | 0 | 2 | 0 |
| -3 | 6 | 0 | 0 | 0 |
| -2 | 5 | 0 | 3 | 0 |
| -1 | 39 | 2 | 41 | 2 |
| 0 | 2267 | 90 | 2011 | 80 |
| 1 | 135 | 5 | 121 | 5 |
| 2 | 41 | 2 | 42 | 2 |
| 3 | 10 | 0 | 271 | 11 |
| 4 | 4 | 0 | 19 | 1 |
| 5 | 1 | 0 | 2 | 0 |
| 6 | 0 | 0 | 0 | 0 |
| **Total** | **2512** | **100** | **2512** | **100** |

Note: The table shows a comparison between the start dates for periods whose dates are determined forward-looking (STIBOR) and periods whose dates are determined backward-looking (average rates). The concordance is presented for each adjustment method. The comparison refers to three-month periods and is based on periods for STIBOR 3m starting between 1 July 2017 and 1 July 2027. Based on the end dates for the STIBOR periods, the start dates are determined for the average rate periods with the same end dates as the STIBOR periods. A positive (negative) deviation means that the STIBOR period is longer (shorter) than the period for average rates. The percentages have been rounded off.

Source: The Riksbank

# APPENDIX – Calculation examples

Below follows a number of calculation examples to illustrate the formulae presented in the consultation. In these calculation examples, the proposed conventions *actual number of days/360* and *modified previous business day* are used (and *previous business day* for the 1-week time period).

## A1. Calculation example average rate (formula 1)

Below follows an example of average rate calculation for 1 week for the period 1 February – 8 February 2021. See the input values in Table 5 below.

**Table 5. Input values when calculating the compounded average rate**
Compounded average rate for SWESTR for one week, 8 February 2021

| SWESTR | | | | Average rate |
|---|---|---|---|---|
| Value day | Publication date | SWESTR (%) | Number of days for which the SWESTR rate is applicable | Publication day = value day (%) |
| 1 Feb (Mon) | 2 Feb (Tues) | -0.081 | 1 | - |
| 2 Feb (Tues) | 3 Feb (Wed) | -0.084 | 1 | - |
| 3 Feb (Wed) | 4 Feb (Thurs) | -0.086 | 1 | - |
| 4 Feb (Thurs) | 5 Feb (Fri) | -0.080 | 1 | - |
| - | (Sat) | N/A | N/A | - |
| - | (Sun) | N/A | N/A | - |
| 5 Feb (Fri) | 8 Feb (Mon) | -0.081 | 3 | -0.08200 |

Note. For the example, the test rates for SWESTR O/N published by the Riksbank are used. Note that these are not to be used in financial contracts.

Source: The Riksbank

$$Compounded\ average\ rate\ (length\ 1W)_{1\,feb-8\,feb} =$$

$$= \left[ \left( \left(1 + \frac{-0{,}00081 \times 1}{360}\right) x \left(1 + \frac{-0{,}00084 \times 1}{360}\right) x \left(1 + \frac{-0{,}00086 \times 1}{360}\right) x \left(1 + \frac{-0{,}00080 \times 1}{360}\right) x \left(1 + \frac{-0{,}00081 \times 3}{360}\right) \right) - 1 \right] \times \frac{360}{7}$$

$$= -0{,}0008200 \ = \ -0{,}08200 \ \%$$

## A2. Index calculation example (formula 2 and 3)

Note that the Riksbank will communicate the exact start date for the index at a later date. In the example below, the start date 1 February is used for the index as an illustration of how the index is calculated and used.

**Table 6. Example for calculation of index**

| | SWESTR | | | Index | |
|---|---|---|---|---|---|
| Value day | Publication date | SWESTR (%) | Number of days for which the SWESTR rate is applicable | Publication date = value day | Index value (%) |
| 29 Jan (Fri) | 01 Feb (Mon) | -0.094 | 3 | 01 Feb (Mon) | 100.00000000 |
| 01 Feb (Mon) | 02 Feb (Tues) | -0.081 | 1 | 02 Feb (Tues) | 99.99977500 |
| 02 Feb (Tues) | 03 Feb (Wed) | -0.084 | 1 | 03 Feb (Wed) | 99.99954167 |
| 03 Feb (Wed) | 04 Feb (Thurs) | -0.086 | 1 | 04 Feb (Thurs) | 99.99930278 |
| 04 Feb (Thurs) | 05 Feb (Fri) | -0.080 | 1 | 05 Feb (Fri) | 99.99908056 |
| 05 Feb (Fri) | 08 Feb (Mon) | -0.081 | 3 | 08 Feb (Mon) | 99.99840556 |

Note. For the example, the test rates for SWESTR O/N published by the Riksbank are used. Note that these cannot be used in any financial contracts and that the index values are therefore not representative.

Source: The Riksbank

The illustrative index value for 8 February 2021 is given by (formula 2):

$$= 100\left(1+\frac{-0{,}00081\times1}{360}\right)\left(1+\frac{-0{,}00084\times1}{360}\right)\left(1+\frac{-0{,}00086\times1}{360}\right)\left(1+\frac{-0{,}00080\times1}{360}\right)$$
$$\times\left(1+\frac{-0{,}00081\times3}{360}\right)$$

$$= 99{,}99840556$$

Using formula 3, the average rate for the period 1 February to 8 February inclusive, i.e. the average rate for one week on 8 February 2021, can be calculated:

$$= \left(\frac{99{,}99840556}{100{,}00000000}-1\right)x\frac{360}{7} = -0{,}0008200 = -0{,}08200\ \%$$

## A3. Examples with more complex dates (handling of weekends and public holidays)

As all days are not business days, situations that at first glance may appear to be problematic regarding the period for which the average rates are to be determined are inevitable.

The examples below illustrate some of the situations that can arise. In order to facilitate the interpretation of the average rates and the period to which each rate refers, the Riksbank intends to publish the start date to which the relevant rate refers for each rate. As the example below shows, situations may also occur in which a user needs an average rate over a time period that the Riksbank does not publish. In these cases, the index can be used to calculate the sought-after average rate.[27]

### Example at the end of the month and repetition of the start date

The example below, for an average rate for the 1-month time period published around the turn of the month March-April 2021 illustrates the use of the adjustment principle *modified previous* and the effect on the start date at the end of a month. The example also shows that there are cases in which the same start date can be repeated for several end dates.

**Table 7. Illustrative example 1**
Start date and setting for average rate 1 month

| Date (day of the week) | Type of holiday | Business day | Start date, (day of the week) | End date (day of the week) | Number of calendar days ($d_c$) |
|---|---|---|---|---|---|
| **29 Mar (Mon)** | | Yes | 26 Feb (Fri) | 29 Mar (Mon) | 31 |
| **30 March (Tues)** | | Yes | 26 Feb (Fri) | 30 March (Tues) | 32 |
| **31 March (Wed)** | | Yes | 26 Feb (Fri) | 31 March (Wed) | 33 |
| **1 Apr (Thurs)** | *Holy Thursday* | Yes | 1 Mar (Mon) | 1 Apr (Thurs) | 31 |
| **2 Apr (Fri)** | *Good Friday* | No | N/A | N/A | N/A |
| **3 Apr (Sat)** | *Easter Saturday* | No | N/A | N/A | N/A |
| **4 Apr (Sun)** | *Easter Day* | No | N/A | N/A | N/A |

Source: The Riksbank

### Example for a 1-week time period over Easter

Table 7 below shows the start and end date for 1-week average rates around Easter 2021. The example illustrates two complex situations regarding the periods' start and end dates that can arise, that is repetition of the start date (1 April) and two start dates (26 March and 29 March) are not calculated.

---

[27]However, this applies only if both the start and end dates are suitable business days.

In this example, Holy Thursday, which is a business day, becomes the start date for the average rate for three different publication days. Due to the weekends and public holidays, the period covered by the 1-week average rate is up to 11 days long. For anyone searching for an average rate with start day on Holy Thursday, it will be important to know which end date is suitable for the period.

The missing average rates for the 1-week period for the start dates 26 March and 29 March, both of which are business days, is also due to the Easter holidays. These rates are not calculated on the grounds that there is no holiday-free end date that gives these start dates. Using the index values, however, the user can calculate an average rate for a period between one of these two days and any end date that is a suitable business day.

**Table 8. Illustrative example 2**
Start date and number of calendar days for average rate, one week

| Date (day of the week) | Type of holiday | Business day | Start date (day of the week) | End date (day of the week) | Number of calendar days ($d_c$) |
|---|---|---|---|---|---|
| **29 Mar (Mon)** | | Yes | 22 Mar (Mon) | 29 Mar (Mon) | 7 |
| **30 March (Tues)** | | Yes | 23 March (Tues) | 30 March (Tues) | 7 |
| **31 March (Wed)** | | Yes | 24 March (Wed) | 31 March (Wed) | 7 |
| **1 Apr (Thurs)** | *Holy Thursday* | Yes | 25 March (Thurs) | 1 Apr (Thurs) | 7 |
| **2 Apr (Fri)** | *Good Friday* | No | N/A | N/A | N/A |
| **3 Apr (Sat)** | *Easter Saturday* | No | N/A | N/A | N/A |
| **4 Apr (Sun)** | *Easter Day* | No | N/A | N/A | N/A |
| **5 Apr (Mon)** | *Easter Monday* | No | N/A | N/A | N/A |
| **6 Apr (Tues)** | | Yes | 30 March (Tues) | 6 Apr (Tues) | 7 |
| **7 Apr (Wed)** | | Yes | 31 March (Wed) | 7 Apr (Wed) | 7 |
| **8 Apr (Thurs)** | | Yes | 1 Apr (Thurs) | 8 Apr (Thurs) | 7 |
| **9 Apr (Fri)** | | Yes | 1 Apr (Thurs) | 9 Apr (Fri) | 8 |
| **10 Apr (Sat)** | *Saturday* | No | N/A | N/A | N/A |
| **11 Apr (Sun)** | *Sunday* | No | N/A | N/A | N/A |
| **12 Apr (Mon)** | | Yes | 1 Apr (Thurs) | 12 Apr (Mon) | 11 |
| **13 Apr (Tues)** | | Yes | 6 Apr (Tues) | 13 Apr (Tues) | 7 |
| **14 Apr (Wed)** | | Yes | 7 Apr (Wed) | 14 Apr (Wed) | 7 |
| **15 Apr (Thurs)** | | Yes | 8 Apr (Thurs) | 15 Apr (Thurs) | 7 |
| **16 Apr (Fri)** | | Yes | 9 Apr (Fri) | 16 Apr (Fri) | 7 |
| **17 Apr (Sat)** | *Saturday* | No | N/A | N/A | N/A |
| **18 Apr (Sun)** | *Sunday* | No | N/A | N/A | N/A |

Note. For the 1-week time period, it is proposed that the adjustment principle standard previous shall apply. The way the weekends and public holidays occurred in 2021, however, using the *modified previous* adjustment method would not have had any effect for the 1-week time period.

Source: The Riksbank