The Riksbank's new reference rate

October 2020

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A consultation from Sveriges Riksbank

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This document presents the Riksbank's proposal for a new reference rate at the very shortest maturity in Swedish kronor.

The aim of the consultation is to gather the views and opinions of the Riksbank's monetary policy counterparties and other stakeholders about the proposed reference rate. Consultation responses should be sent to konsultation.referensranta@riksbank.se We would like to receive your responses by 21 October 2020 at the latest. The Riksbank will then compile the responses received. The Riksbank intends to present the compiled information in conjunction with the Executive Board's decision on the new reference rate about three weeks after the consultation response deadline. As it is important that the handling of this matter is not delayed due to late consultation responses, the Riksbank will be obliged to take a position on requests for deferment and whether to grant these or to decide the matter in its existing state without access to the requested responses.

Thank you for your participation!

Please state the name and contact details of the person in your organisation who is responsible for coordinating your response, including the coordinator's contact information.[1]

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[1] Read about how the Riksbank handles personal data in our integrity policy at https://www.riksbank.se/integrity-policy/

Introduction

In December 2019, the Riksbank announced that it would provide a new reference rate in Swedish kronor at the very shortest maturity overnight (O/N), i.e. loans that run from one day to the next. The Riksbank started to collect transaction-based data from the monetary policy counterparties in October 2019 with the aim of calculating and publishing a new transaction-based reference rate, among other objectives. In 2020, the Riksbank has been working on a suitable definition for the new reference rate for the very shortest maturity in Swedish kronor based on this transaction data. This definition includes transaction sample, calculation methods and identified robustness requirements for the underlying transaction data. In addition, an alternative method for calculating the reference rate has been created for cases in which the underlying transaction data does not comply with the robustness requirements or for situations when it is impossible to collect transactions for some reason. A fixing process that includes the routines and deadlines preceding the publication of the reference rate for each banking day has also been developed, as have the required system-technical solutions. The Riksbank would like to take this opportunity to thank all of the reporting agencies for the substantial work they have also undertaken to make the production of a new reference rate possible.

This consultation aims to gather opinions and obtain feedback on the Riksbank's proposal for a new reference rate, a rate that will affect many stakeholders once it starts to be used. Reference rates are used as a common benchmark, or a basic value, when pricing financial contracts such as interest derivatives, FX derivatives and debt securities, as well as when pricing variable-rate loans for households and companies. It is important therefore that all stakeholders are given the opportunity to express their views, which is why the Riksbank is publishing the consultation on its website. Stakeholders will be able to submit their views by sending an email to: konsultation.referensranta@riksbank.se .

More specifically, the Riksbank encourages stakeholders to provide their views on the proposed calculation method for the new reference rate, particularly regarding how appropriate it is considered for Swedish market conditions and how useful it will be for market participants.

The consultation is divided up into four sections. Section 1 "Definition and calculation method" contains more detailed descriptions of the proposed definition and calculation method for the new reference rate. Section 2 "The fixing process – From reporting to publication" describes the proposed process including all of the steps to be implemented on a daily basis, from the time the reporting agencies report transaction data to the Riksbank in the morning to the time the Riksbank publishes the day's reference rate. Section 3 "Comparison between the Riksbank's new reference rate and AGAR's recommendation" explains how the Riksbank's proposed reference rate differs from the recommendation presented by AGAR, the Working Group for Alternative Interest Rates, at the request of the Swedish Bankers' Association. To make it easier to submit comments on the Riksbank's proposal for a new reference rate, a set of questions can be found in Section 4 "Consultation questions about the new reference rate".

1. Definition and calculation method

This section presents the Riksbank's proposals concerning

- The sample of transactions on which the new reference rate should be based

- The normal calculation method for the new reference rate,

- A suitable trimming method for excluding extreme values from the transaction dataset on which the new reference rate is based

- Robustness requirements that the transaction data must fulfil in order to be able to use the normal calculation method

- An alternative method for calculating the reference rate when the transaction dataset does not fulfil the robustness requirements or when there is no transaction data.

The dataset on which the new reference rate is proposed to be based consists of transactions reported daily to the Riksbank by nine of its monetary policy counterparties[2] since October 2019[3]. Reporting agencies are monetary policy counterparties that report data on their transactions on the money market to the Riksbank every day. The current reporting agencies comprise nine out of the Riksbank's twenty-three monetary policy counterparties that are the largest and most active on the money market in Swedish kronor. The other fourteen monetary policy counterparties currently report their transactions on an annual basis to the Riksbank but can be included as reporting agencies in the future. The section below describes the Riksbank's proposal in each of the above-listed areas in a more general way and does not therefore contain any mathematical formulae. For those interested in more details about how the various calculations are specified, the mathematical definitions can be found in Appendix 1 "Mathematical Formulae". [4]

Transaction sample

The Riksbank's proposal: The reference rate should be based on the following transaction dataset:

- *Borrowing in Swedish kronor (SEK) without collateral to the reporting agencies*

- *Borrowing at the shortest maturity (overnight O/N).*

- *Borrowing for the reporting agencies from the following categories of participants on the overnight market: Banks, Financial institutions, Non-financial corporations and the Swedish National Debt Office (NDO).*

An important feature of the Riksbank's new reference rate is that it should reflect the funding costs for banks on the overnight market in Swedish kronor and that it should be based on transactions on a liquid market. The markets for transactions in Swedish kronor (SEK) are those for loans issued either against or without collateral.

The most liquid market in Sweden is the overnight market (O/N) for loans without collateral. In other words, this market has shown the highest transaction volumes and the most transactions per day (see Figure 1). Hence, this will be a more robust market on which to base a reference rate in contrast to the market for loans against collateral, where the volume is relatively low for the shortest maturity. To adequately capture banks' funding costs in SEK at the shortest maturity, it is also appropriate to base the reference rate on transactions that lead to borrowing for the reporting agencies. Figure 1 shows that transactions leading to borrowing for the reporting agencies are significantly more common than those that lead to their lending. Borrowing transactions thus provide more robust underlying data on which to base the reference rate than lending transactions would.

To obtain even larger underlying data, a combination of borrowing and lending rates might provide the basis for the calculation of the reference rate. However, there are certain problems associated with combining borrowing and lending rates as a basis for a reference rate as borrowing and lending

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[2] The nine monetary policy counterparties are currently: Handelsbanken, Swedbank, SEB, Danske Bank DnB, Skandiabanken, Länsförsäkringar Bank, SBAB and Nordea. See the Riksbank's website for the other 14 monetary policy counterparties: https://www.riksbank.se/en-gb/monetary-policy/monetary-policy-counterparties/ Over time, when new daily reporting agencies are included in the underlying dataset for the reference rate, the Riksbank will communicate this in good time.

[3] Transactions on 30 December 2019 are excluded in the analysis as these were carried out at extremely low interest rates. The reason for this phenomenon is that the resolution fee paid by credit institutions to the Swedish National Debt Office is determined at the turn of the year, which affects rate-setting.

[4] Please note that this appendix is only available in English.

rates differ quite considerably in level (see Table 1). The various rate levels in combination with the fact that volumes for borrowing and lending respectively change considerably from day to day mean that a reference rate based on both borrowing and lending rates will be more volatile and that, from one day to the next, it could reflect either a borrowing or a lending rate. In light of this, the Riksbank proposes that the reference rate should be based on the reporting agencies' unsecured borrowing in Swedish kronor at O/N maturity.

Table 1. Unsecured transactions in Swedish kronor at O/N maturity between reporting agencies and all counterparties in the dataset, October 2019 – September 2020

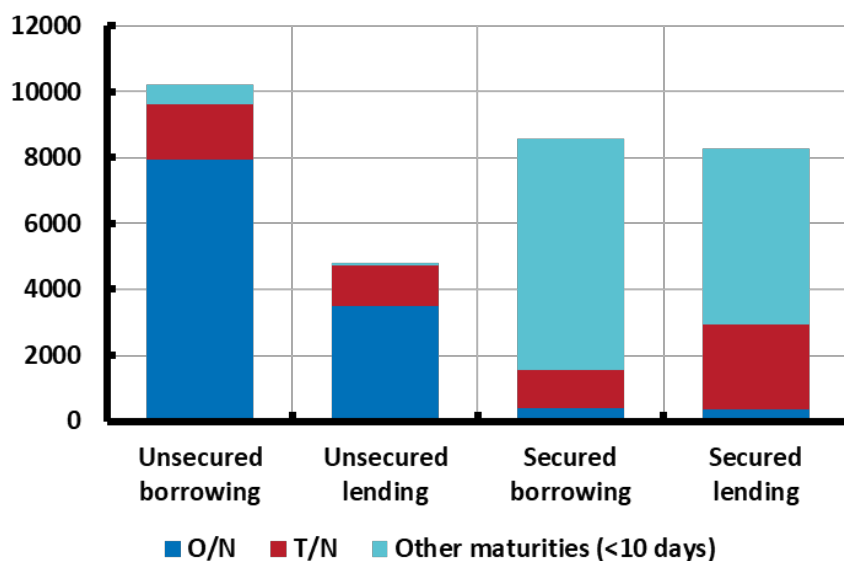| Average values during the period of	Unsecured transactions at O/N maturity	
	Borrowing	Lending
Difference between volume-weighted rate[5] and the repo rate, basis points	-8.5	5.1
Total transaction volume per day, SEK bn	31.77	13.91
Number of transactions per day	41.8	15.5
Number of reporting agencies per day	5.9	5.1

With the aim of establishing a reference rate that is representative of the underlying market and represents the funding costs of the reporting agencies in a reliable way, it is important to consider the types of counterparties with which the reporting agencies transact. A rough breakdown of the counterparty categories in the transaction dataset is: *Banks, Central banks, Other financial institutions, Non-financial corporations and Authorities*. Transactions with authorities and central banks are often excluded in reference rate calculations as such transactions largely do not take place on market terms. In Sweden, however, the Swedish National Debt Office (NDO) is a major player on the overnight market and its transactions with reporting agencies are comparable to those carried out between the major banks. On the overnight market in Sweden, non-financial corporations constitute an important funding source for banks and several large non-financial corporations are active on this market (see Table 2).

To reflect banks' overnight funding costs on the overnight market in a reliable way and obtain a robust and representative transaction dataset for the reference rate, the Riksbank therefore proposes that the reference rate shall be based on the transactions carried out by the reporting agencies with banks, financial institutions, non-financial corporations and the NDO as counterparties. Furthermore, the Riksbank's proposed transaction data for calculating the reference rate is in line with both international practice and international recommendations for new transaction-based reference rates developed in recent years.[6]

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[5] A volume-weighted average rate is a mean rate where the individual rates have been weighted with the size of the transaction.

[6] See Principles for Financial Benchmarks Final Report, July 2013 (https://www.iosco.org/library/pubdocs/pdf/IOSCOPD415.pdf). See also conclusions in BIS Quarterly Review, March 2019, Beyond LIBOR: a primer on the new reference rates, Andreas Schrimpf, and Darrel Duffies article in Risk.Net, 4/8-2020, Stanford's Duffies shakes up SOFR credit race with AXI Index

Figure 1. Breakdown of total volume for different maturities for secured and unsecured transactions respectively during the period October 2019 – September 2020
SEK billions

Table 2. Breakdown of transactions in SEK without collateral at O/N maturity between reporting agencies and different categories of counterparties, October 2019 – September 2020.

Average values during the period of	Unsecured borrowing transactions at O/N maturity					
	Banks	Financial institutions	Non-financial corporations	NDO	Proposed sample	All counterparties[7]
Difference between volume-weighted mean rate and the repo rate, basis points	-12.9	-9	0.5	-8.1	-8.5	-8.5
Total transaction volume per day, SEK bn	13.74	8.41	7.64	0.26	30.05	31.77
Number of transactions per day	29.2	5.9	5.4	0.09	40.6	41.8
Number of reporting agencies per day	5.4	3.3	2.6	1.1	5.9	5.9

Normal calculation method for the reference rate

The Riksbank's proposal: A volume-weighted mean rate is calculated for each of the four counterparty sub-groups: Major banks and the NDO[8], Other banks, Other financial institutions and Non-financial corporations. These rates are then compounded with weights calculated as a moving

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[7] Note that this is a summation of all types of counterparties in the reported dataset, including types (e.g. authorities) not listed in this table.
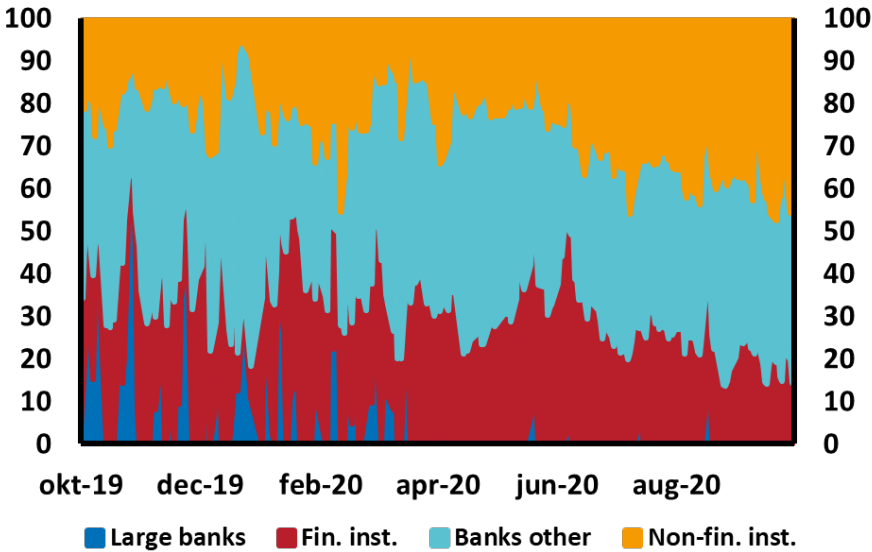
[8] The Major banks group consists of Nordea, Swedbank, Handelsbanken, SEB and Danske Bank, in addition to the Swedish National Debt Office.

average of the volume share for each sub-group respectively over the last 40 trading days (the equivalent of approximately two months)

According to the IOSCO principles, the calculation method for the reference rate should consider national conditions on the money market and the structure of the financial sector[9]. Furthermore, the Riksbank is of the view that the method should not deviate too much from international practice. In line with this view, the Riksbank has elected to use an internationally established method for calculating the reference rate and then adapted it to reflect the functionality of the Swedish money market, which, according to international guidelines such as the principles presented by IOSCO, is an important aspect for a representative reference rate. There are two common methods used to calculate international reference rates; the volume-weighted median rate and the volume-weighted mean rate. The Riksbank has chosen to use the latter.

As we have seen in Table 2 above, however, the transaction data is rather heterogeneous and the standard way of calculating a volume-weighted mean rate thus causes a number of problems. Based on specific characteristics, the transaction data can be divided into four sub-samples based on four different types of reporting agency counterparty: *Major banks and the NDO, Other banks, Other financial institutions and Non-financial corporations.* These counterparty sub-groups exhibit different characteristics in terms of their respective average rates, and volume shares per day, see Figure 2 and Figure 3. It is also the case that the average rates in each sub-group are relatively stable over time, see Figure 3. This has implications for the determination of the most suitable calculation method to use when compounding the various rates in the underlying sample of transactions into a reference rate.

Figure 2. Daily volume shares for each sub-group respectively.
Percent

Legend: Large banks, Fin. inst., Banks other, Non-fin. inst.

[9]Principles for Financial Benchmarks Final Report, July 2013 (https://www.iosco.org/library/pubdocs/pdf/IOSCOPD415.pdf).

Figure 3. Volume-weighted mean rates for each sub-group respectively.
Deviation from the repo rate, percentage points

Legend: Large banks — Fin. inst. — Banks other — Non-fin. inst.
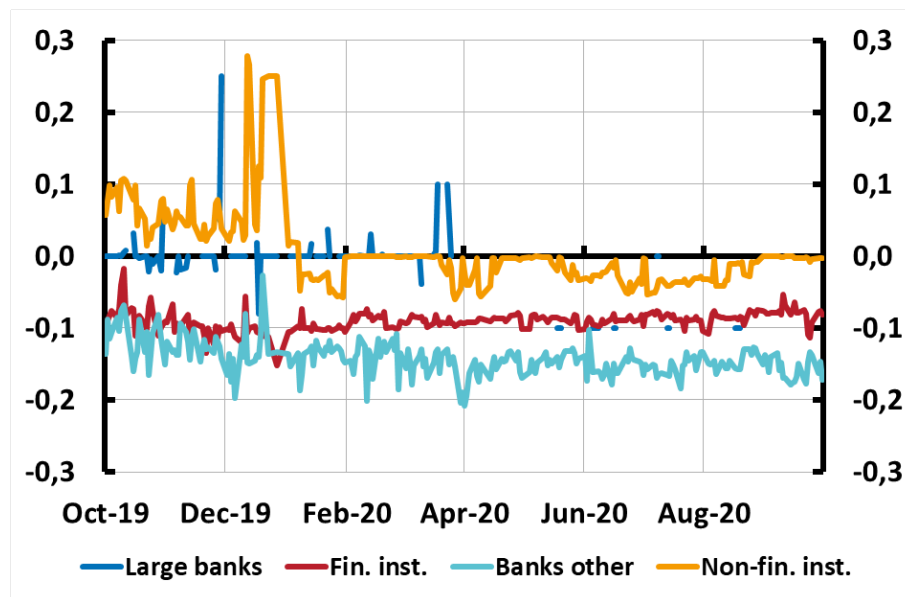
It can be shown that around 65 per cent of the volatility in a volume-weighted mean rate, calculated using the entire transaction sample without having first divided it into sub-groups, is explained by the volatility in the volume shares for the sub-groups[10]. Much of the volatility is the result of transactions to the Major banks and NDO sub-group taking place rather infrequently. When they do occur, however, transactions are typically of large volumes and at an interest rate that is very close to the repo rate, see Figure 2 and Figure 3. This means that a reference rate based on a standard method for a volume-weighted mean rate would not reflect daily changes in market rates as much as it would reflect daily changes in the volumes between these sub-groups.

Figure 4. Reference rate calculated as a volume-weighted mean rate and as a volume-weighted median rate according to standard methods.
Deviation from the repo rate, percentage points

Legend: Volume weighted mean rate — Volume weighted median rate

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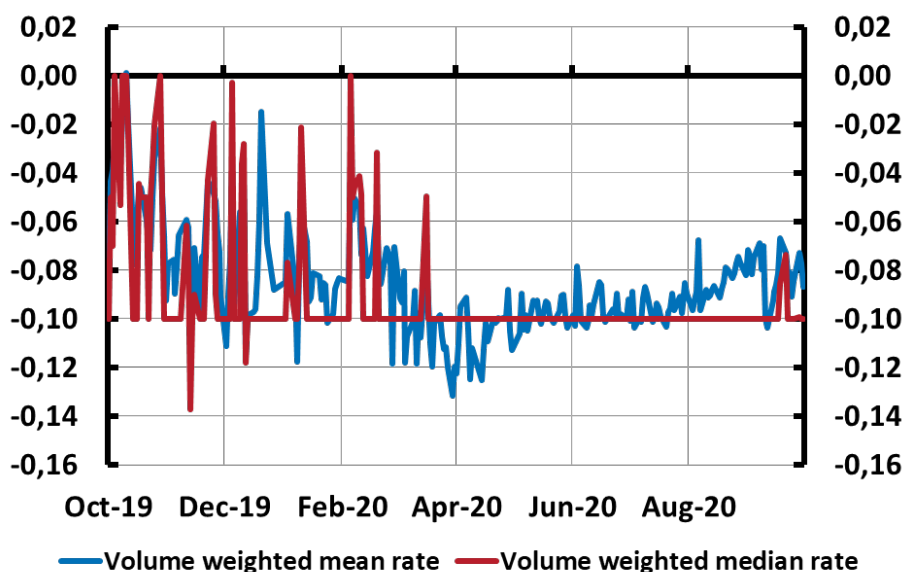
[10] Appendix 1. Mathematical formulae describe the statistical test performed to arrive at this conclusion.

The same applies to a volume-weighted median rate based on the whole transaction sample, which exhibits even more volatility than the standard volume-weighted mean rate, see Figure 4. The fact that both the volume-weighted mean rate and the volume-weighted median rate are stable after April 2020 is due to no transactions being carried out to the Major banks and NDO sub-group during this period. As a result, there is less variation in the volume shares between the sub-groups during this period, see Figure 2.

Letting the weights for the sub-groups be sluggish better captures the variation in rates, which is what the reference rate is intended to measure. At the same time, and by not making the weights fixed over time, sluggish weights will still capture the structural changes on the market, albeit in a slower manner. The weights are based on a moving average over the last 40 trading days, the equivalent of approximately two calendar months.

Figure 5. Effect of the length of the calculation window on standard deviation and deviation from the volume-weighted mean rate.
Basis points
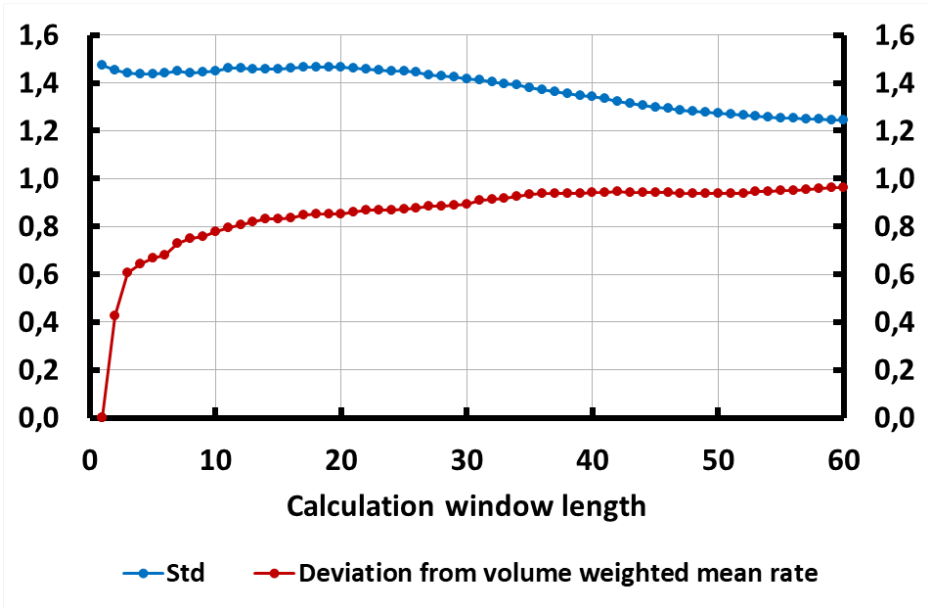
The sluggishness in these weights is a trade-off between, on the one hand, reducing the volatility in the reference rate caused by short-term fluctuations in the volume distribution between the sub-groups and, on the other, capturing new trends in the volume distribution on the overnight market and not deviating too much from a standard method. The relationship between the volatility in the reference rate (measured in terms of standard deviation) and number of days during which the weights are calculated (see Figure 5) indicates that, after about 40 trading days, the reduction in volatility in the reference rate from an additional number of days for the calculation of the weights starts to diminish.

 Overall, 40 trading days is considered to be a well-balanced calculation window for the sluggish weights as it reduces the volatility in the reference rate while still capturing trend shifts in the short fixed-income market. If a sub-group has not carried out any transactions, the weights are recalculated for the remaining groups so that these still total 1.

Trimming of data

The Riksbank's proposal: Before a volume-weighted mean rate can be calculated for each of the four sub-groups, the transaction dataset is trimmed in each sub-group. In total, 25% of the

transaction volume is removed by subtracting 12.5% of the transaction volume for the transactions with the highest and the lowest rates.

To ensure that a volume-weighted mean rate accurately reflects the rates in a transaction dataset, it is common to reduce the effect of rates that stand out in the sample by excluding transactions with the lowest and the highest rates before calculating the volume-weighted mean rate based on the remaining transactions. This process is known as "trimming" the data. The Riksbank has chosen to trim 25% of the transaction volume for each sub-group by removing 12.5% of the transaction volume for the transactions with the highest and lowest rates respectively. This level of trimming is internationally common and in our case increases the stability of the Swedish reference rate while the remaining dataset is still representative of the original transaction data, see Figure 6.

Figure 6. Reference rate calculated using different levels of trimming.
Deviation from the repo rate, percentage points
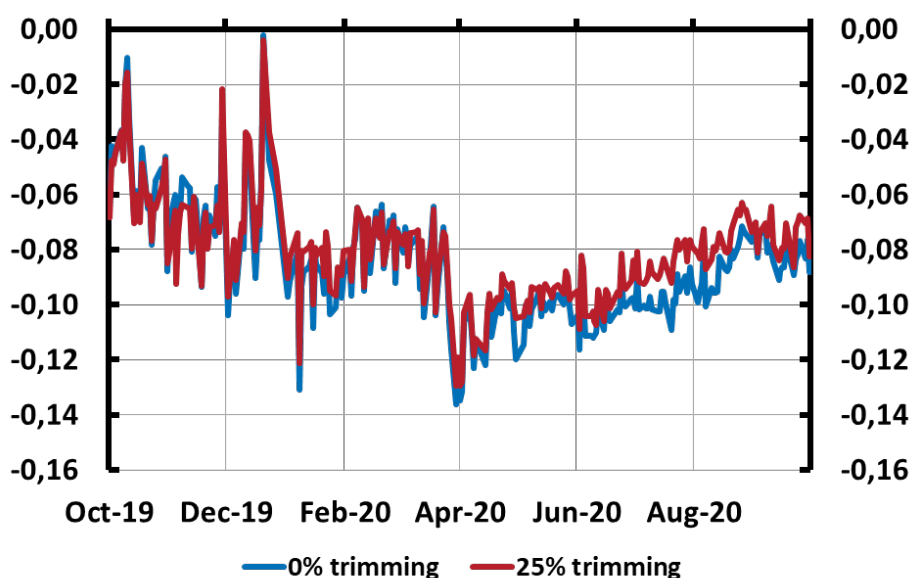
Robustness requirements imposed on the transaction dataset

The Riksbank's proposal: All the following three robustness requirements on the whole transaction dataset must be fulfilled <u>after</u> trimming in order to calculate the reference rate using a normal calculation method: (1) the minimum total transaction volume shall be SEK 8 billion, (2) at least 3 reporting agencies (out of 9 in total) shall be represented, and (3) a single reporting agency may make up a maximum of 60% of the total transaction volume.

To ensure that the transaction dataset is representative of the underlying market on an everyday basis and to reduce the risk of any manipulation of the reference rate, some "minimum requirements" are often imposed on the underlying transaction data. These requirements help to create confidence in the reference rate. It is important, however, that the requirements are not set too high as this would lead to an alternative calculation method having to be used too often. This risks the robustness requirements having the opposite effect and undermining confidence in the reference rate. For the Swedish market, three robustness requirements have been identified as relevant for the calculation of the reference rate using a normal method.

The first two requirements, i.e. a minimum limit for the total transaction volume and a minimum number of reporting agencies, are common abroad, while the third requirement is less frequently

used, a variant is, however, used by the ECB[11]. The third requirement is, however, important for the Swedish market as the underlying market has a small number of very large participants. When the market is characterised by a few large players, there is a risk of manipulation of the reference rate if this type of restriction is not put in place. However, using the calculation method with sluggish weights proposed by the Riksbank reduces the risk of manipulation. The transaction sample does not fulfil the robustness requirements on about 8 trading days per year and it is primarily the third requirement that is not fulfilled on these days, see Figure 7.

Figure 7. Number of reporting agencies, highest volume share for a reporting agency and total volume, per day.
Volume share in per cent and total volume in SEK billions on the left axis and number of reporting agencies on the right axis
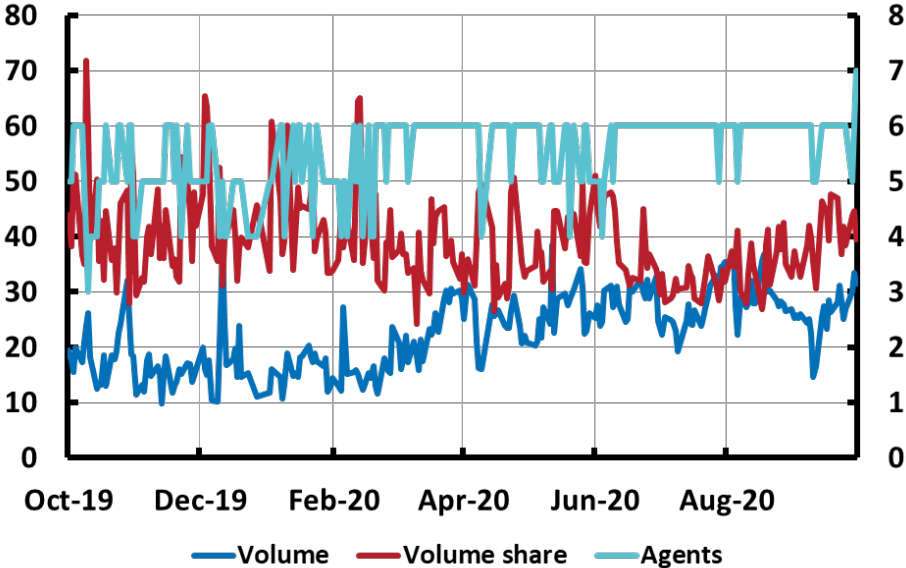
Alternative calculation method for the reference rate

The Riksbank's proposal: In the alternative calculation method, the reference rate is calculated by taking the policy rate for the current day and adding an unweighted average difference between the reference rate and the policy rate starting on the day for which the reference rate is to be calculated and then for the previous four banking days (the equivalent of one trading week).

For occasions when the transaction dataset does not fulfil the three requirements presented above or in the event of technical problems that prevent the Riksbank from calculating the reference rate using a normal calculation method, an alternative calculation method is required. Here, too, the Riksbank's uses an internationally established method, and calculates an average difference between the reference rate and the policy rate over the past trading week (5 banking days) that is added to the policy rate for the current day. To avoid the outcome of the alternative calculation method being known in advance and thus create an incentive for manipulation of the reference rate, the Riksbank has chosen to include the transactions for the current day.[12] Hence, in addition to the previous day's transactions, the transactions for the last four banking days are used when calculating the reference rate according to the alternative method. In the event of technical problems that prevent the Riksbank from accessing the previous day's transactions, the alternative calculation method will only use historical data, that is, the difference between the reference rate and the policy rate for the four most recently published days and not include the transaction dataset for a given day. This is

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[11] When the number of reporting banks is less than 20; or five banks account for 75% or more of total transaction volumes, an alternative method for calculation is used.
[12] In other words, the previous day's transactions on which the current day's reference rate is normally based.

consistent with how the Riksbank deals with sub-groups that have no transactions for a day. By giving each day the same weight in the calculation, the calculation will be less sensitive to extreme values. The method also smooths out substantial rate variations that can be expected to be associated with occasions when the transaction dataset does not fulfil the three stipulated robustness requirements.

2. Fixing process – From reporting to publication

This section describes the fixing process which includes all of the steps that will be implemented on a daily basis, from the time at which the reporting agencies report the transaction data to the Riksbank in the morning to the time the Riksbank publishes the reference rate. Figure 8 illustrates what happens during the fixing process. A more detailed account can be found in Table 3. ***The times stated in this section are those that will apply during the test period when a preliminary reference rate is published.*** After the test period, when the Riksbank starts publishing the reference rate, the aim is to publish the reference rate earlier in the day. Figure 8 and Table 3 show in detail the most important check-points for the Riksbank and the reporting agencies respectively during the transaction day (T) and publication day (P).

Figure 8. Diagram of the fixing process on the publication date
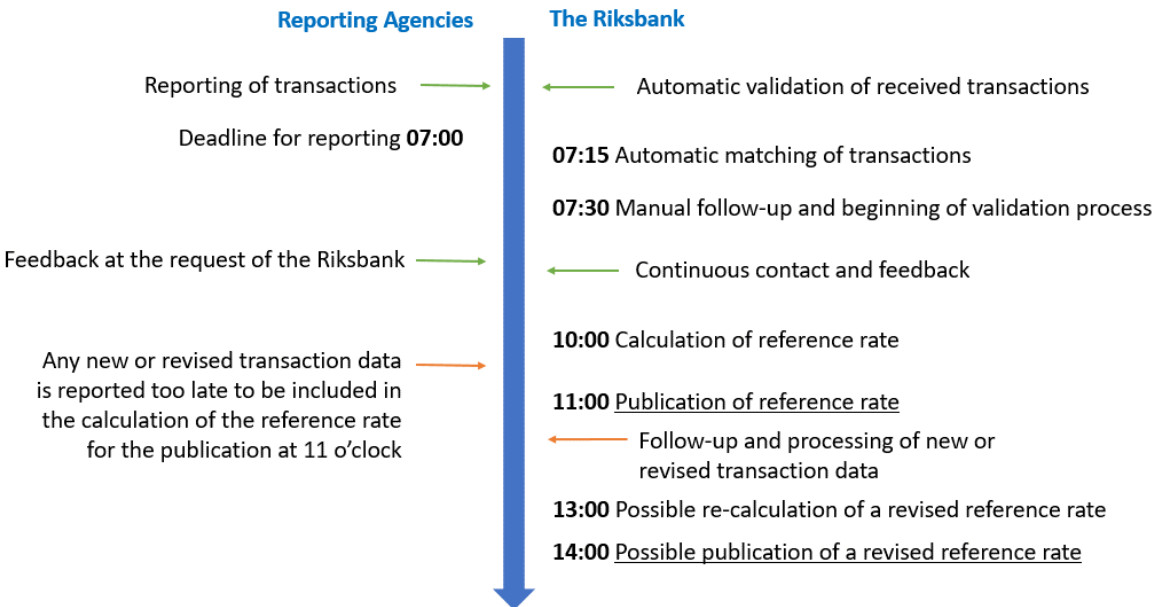
Details of the fixing process

The different steps in the fixing process are described in Table 3. More detailed information is given below on the steps in the fixing process for:

- Times for publication of the reference rate and associated information,
- Transaction sample and calculation method, and
- Publication of a revised reference rate.

Time for publication of the reference rate and associated information

During the test period, the reference rate will be published at 11.00 in the morning on the day after the transactions used as a basis for the rate have been executed. Together with the publication of the reference rate, expressed with three decimals, the following information will be published daily:

- Number of transactions on which the calculation is based

- Total transaction volume
- Number of reporting agencies that have contributed at least one transaction
- Calculation method used, normal or alternative
- If appropriate; the reason why the alternative calculation method has been used

A revised reference rate may be published at 14.00 if new or amended transaction data is received after the first calculation.

Transaction sample and calculation method

The sample of transactions on which the reference rate is based and the methods used to calculate the reference rate are described in detail in Section 1 "Definition and calculation method". The normal calculation method for the reference rate will involve several steps. Below is a summary of the different steps in this calculation

- The transactions reported undergo both automatic and manual qualitative controls carried out by the Riksbank.
- The transactions are run through a filter which sorts out the relevant transactions to be used in the calculation of the reference rate. This data consists of unsecured transactions in Swedish kronor with a maturity of O/N made between a reporting agency and one of the following counterparts: Banks, the Swedish National Debt Office, Financial institutions and Non-financial corporations.
- The transaction sample is divided into four sub-groups based on four different categories of reporting agency counterparty (Major banks and the NDO, Other banks, Financial institutions and Non-financial corporations). These four samples of transactions (one for each sub-group) are then trimmed by 25 per cent.
- A volume-weighted mean rate is calculated for each of the four sub-groups.
- The four volume-weighted mean rates are compounded with weights calculated by first computing a moving average of volume share for each sub-group respectively over the last 40 trading days (the equivalent of approximately two months).

An alternative calculation method is used if any of the following robustness requirements are not met after the four sub-groups have been trimmed by 25 per cent each:

- Total transaction volume at least SEK 8 billion
- At least 3 reporting agencies that have contributed at least one transaction
- A maximum of 60 per cent of the total transaction volume may be reported from one reporting agency

The transaction sample for the alternative calculation is partly the transactions from the transaction day that do not meet all of the robustness requirements, and partly all of the transactions from the most recent four working days. An average historical difference is calculated between the reference rate and the policy rate for these five days (a trading week), and then added to the current policy rate.

In the event of technical problems, only historical data will be used in the alternative calculation method, i.e. the reference rate and the policy rate for the four most recently published days. It will thus not include the transactions from the current transaction day, as these will not be accessible in the event of system failure.

Publication of a revised reference rate

If new or amended transaction data is received by the Riksbank after the first calculation of the reference rate in the morning, a new revised reference rate will be calculated. If the difference between the recalculated reference rate and the earlier published reference rate is 2 or more basis

points[13], a revised reference rate will be published later in the day. This revised reference rate will then replace the earlier publication as the official reference rate. In addition, a revised rate series will be published regularly with a time lag. This rate series are not the official rate, but revised rates that incorporate all potential revisions received afterwards.

Table 3. The fixing process in chronological order during the testing period
Note. T = Transaction day, P = Publication day

Date	Time	Reporting agencies	The Riksbank
T	07.00 – 18.00	The reporting agencies conduct their business operations, which result in transactions on the overnight market in the form of borrowing and/or lending with their counterparties.	The RIX payment system, in which the reporting agencies settle all of their transactions in Swedish kronor, is open.
T+P	19.00 – 07.00[14]	Transactions are reported within the given time interval.	- Receipt of transactions reported. - Automatic sending of confirmation of receipt. - Validation of the transactions against the rules set. - In the event of an error, an automatic message will be sent to the counterparty for correction or verification.
P	07:01	Receipt of reminder via e-mail.	Automatic reminder to those reporting agencies that have not reported their transactions or reported that they have no transactions to report.
P	07:15		- Automatic pairing of transactions made between two reporting agencies. - In the event of an error, an automatic message will be sent to the counterparty for correction or verification.
P	07:30		Manual follow-up and validation.
P	10:00	Deadline for reporting agencies to send back corrections or verifications to the Riksbank. New or amended transaction data received after this time	Calculation of the reference rate.

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[13] A basis point is one hundredth of a percentage point. Basis points are often used in connection with descriptions of small changes in interest rates or similar financial products. An interest rate that has risen/fallen by 2 basis points has risen/fallen by 0.02 percentage points.
[14] The time window for reporting during the testing period may be changed after publication of this consultation.

		cannot be included in the calculation for the regular publication. These transactions will instead be included in the calculation of the revised reference rate.	
P	10:30		- Publication of the reference rate in the system. If the requirement criteria are not met, the rate will be published on the basis of the normal calculation method, otherwise the rate calculated using the alternative method will be published. - If the alternative calculation method is used, the reason needs to be stated.
P	10:45		- Preparation for external publication, which is on: The Riksbank's website and TORA API.
P	11:00	Everyone will have access to the reference rate via API. www.riksbank.se comprises an external user of this API.	Publication of the reference rate which includes: - The reference rate with 3 decimals. - Other data: Transaction volume, number of transactions, number of reporting agencies, calculation method (normal or alternative) and reason for using an alternative calculation method.
P	13:00		Calculation of a revised reference rate if new or amended transaction data has been received after the first calculation. If the revised reference rate differs by more than 2 basis points from the published rate at 11.00, it will be published again. This new published rate will then be the official rate for the day.
P	14:00	Everyone will have access to the reference rate via API. www.riksbank.se comprises an external user of this API.	Publication of the revised reference rate.

3. Comparison between the Riksbank's new reference rate and AGAR's recommendation

This section explains how the Riksbank's proposed reference rate differs from the recommendation presented by AGAR, the Working Group for Alternative Interest Rates, at the request of the Swedish Bankers' Association. The aim of both the Riksbank and AGAR is a robust and representative rate that reflects banks' funding costs in Swedish kronor at the shortest maturity. To achieve this, the Riksbank's proposal for a new reference rate includes a few modifications compared with AGAR's proposal. The two rates are thereby very similar but have a few important differences.

Support for AGAR's proposal has been secured via consultation among Swedish market participants and it is important to utilise the conclusions of their work. As the Riksbank has taken on the responsibility for providing a reference rate in Swedish kronor (SEK), it is important that the Riksbank analyses this task thoroughly. Section 1, "Definition and calculation method", presents the Riksbank's proposal for a definition of the reference rate for the shortest maturity on the market in Swedish kronor. In addition, the Riksbank has drafted proposals for an alternative calculation method and fixing process for such a reference rate, which are presented in Section 2. "Fixing process – From reporting to publication".

Transaction dataset

This section describes the extent to which, and the grounds on which, the Riksbank's transaction dataset for the new reference rate deviates from AGAR's recommendation[15].

Type of transactions

Both the Riksbank and AGAR have concluded that rates for unsecured borrowing on the overnight market (O/N) provide the most appropriate basis for a new reference rate in Swedish kronor. The main reason for this is that a reference rate based on this type of transaction will capture banks' short-term funding costs in Swedish kronor. In addition, the overnight market for unsecured loans is the most liquid market in Swedish kronor for short maturities measured in volume and number of transactions. Furthermore, a reference rate based on this type of transaction follows international practice and is similar to many of the new transaction-based reference rates developed by central banks in other currency areas.

Suitable counterparties to the reporting agencies

In order for the reference rate to be representative and robust, AGAR recommends that a new reference rate should be based on transactions between the reporting agencies and their counterparties that consist of Banks, Other financial institutions and the NDO. The Riksbank's assessment is that the rate should be made even more representative of the Swedish overnight market. The transaction dataset for the new reference rate should therefore be expanded to include transactions with counterparties in the form of non-financial corporations in order to better reflect banks funding costs at the very shortest maturity in Swedish kronor. In the transaction dataset on which the new reference rate will be based, non-financial corporations constitute about 15 per cent of the average daily volume on the market in Swedish kronor, O/N. Accordingly, they affect banks' funding costs. By including transactions with non-financial corporations in the dataset that forms the basis of the calculation of the reference rate, almost the entire underlying overnight market for unsecured loans in Swedish kronor is included. This makes the reference rate representative of the underlying overnight market in Swedish kronor, which is both desirable and an important criterion according to international guidelines such as those identified by the International Organisation of Securities Commissions (IOSCO). In addition, the transaction data for the new reference rate will be

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[15] Working Group for Alternative Interest Rates (2019c), "Definition of interest rates: Decision", Swedish Bankers' Association, 11 June 2019

more robust in terms of number of transactions and volumes. Regardless of whether transactions with non-financial corporations are included or not in the transaction dataset, it is still relatively heterogeneous. This heterogeneity has a bearing on the method applied to calculate the reference rate.

Calculation methods

This section explains differences between AGAR's and the Riksbank's proposals for the calculation methods and requirements to be fulfilled by the transaction dataset.

Normal calculation method

In accordance with international practice, AGAR recommends that the reference rate be calculated as a volume-weighted mean interest rate based on a trimmed transaction dataset. The Riksbank also proposes that the reference rate be calculated as a volume-weighted mean. But to make the rate even more representative of the underlying overnight market, the Riksbank proposes a slightly modified calculation method in order to take into account the heterogeneity that characterises the underlying overnight market in Swedish kronor. The Riksbank thereby proposes that four volume-weighted mean rates are calculated for four specific sub-groups (Major banks and the NDO, Other banks, Financial institutions and Non-financial corporations) that exhibit differing characteristics in terms of interest rate levels and volumes. The volume-weighted mean rates for each sub-group are trimmed before being compounded into a volume-weighted mean rate. The volume weights for each sub-group are sluggish in that they are calculated as 40-day moving averages for each category's volume share of the overnight market over time.

As the data can be categorised into four distinct sub-groups of reporting agency counterparties, each with stable average rates but varying volume shares over time, a reference rate calculated using a standard method will be too volatile. Interest rate outcomes are driven too much by changes in volume shares, rather than changes in rate levels when using a standard method. A reference rate that does not reflect the development of rates in the underlying transactions will not be representative of the underlying market and hence less useful and more difficult to interpret. The Riksbank therefore proposes an element of stabilisation via the use of sluggish weights (but which are still based on volume shares) of the sub-groups in the calculation of the reference rate.

Both AGAR's and the Riksbank's proposal involve the transaction dataset being trimmed at the 25-percent level. This means that 12.5 per cent of the highest and lowest interest rates are discarded from the transaction dataset. Only the remaining 75 per cent of the transaction dataset is thus used in the calculation of the reference rate. AGAR's proposal involves the full transaction dataset being trimmed jointly while the Riksbank's proposal involves the data in each sub-group being trimmed separately before being compounded into a reference rate. If the whole dataset is trimmed jointly, there is a risk of some of the sub-groups almost completely disappearing from the calculation of the reference rate as the various sub-groups differ in their characteristics in terms of interest rates. Trimming is a method used to purge extreme values from the calculation data. For a heterogeneous transaction dataset, an extreme value in one sub-group need not be extreme in another sub-group. Trimming the data for each sub-group, as proposed by the Riksbank, is therefore justified.

Robustness requirements imposed on the transaction data

Both the Riksbank and AGAR consider that a certain minimum volume and minimum number of reporting agencies are required for the dataset to be considered robust and representative of the underlying market and thereby could constitute a basis for the calculation of the reference rate using a normal calculation method[16]. AGAR recommends that the transaction dataset should have a

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[16] Working Group for Alternative Reference Rates (2020), "AGAR's conclusions from consultation 4", Swedish Bankers' Association, 15 January 2020.

minimum volume <u>before</u> trimming of SEK 2 billion. The Riksbank proposes that the transaction dataset should have a minimum volume <u>after</u> trimming of SEK 8 billion for it to be considered representatives and sufficiently robust. Despite the fact that the dataset used by the Riksbank is larger than the one used by AGAR, due to the Riksbank including transactions between reporting agencies and non-financial corporations, the Riksbank's requirement on the transaction dataset is stricter. Similar to AGAR, the Riksbank considers it important that an alternative calculation method should not need to be used too often. However, it is also important to ensure that the transaction dataset is representative and sufficiently robust for a normal calculation method to be used.

Both the Riksbank and AGAR consider that at least three reporting agencies should be represented in the transaction dataset for a normal calculation method to be appropriate. However, AGAR considers that it is sufficient for three reporting agencies to be represented in the transaction dataset prior to it being trimmed. In the Riksbank's view, the requirement for a minimum of three reporting agencies to be represented in the transaction dataset should also be fulfilled after trimming.

In addition to these two requirements, the Riksbank proposes an additional requirement to ensure that the transaction dataset is considered to be representative and not manipulated. According to this requirement, a single reporting agency may make up a maximum of 60 per cent of the transaction volume in the transaction dataset after trimming. On a concentrated market with a few individually large participants, there is a risk of an individual participant being able to carry out large-volume transactions in order to influence the reference rate for its own benefit if there was no maximum limit on an individual reporting agency's share of the total transaction volume.

Alternative calculation method

AGAR's recommendation differs quite considerably form the Riksbank's proposal regarding the alternative calculation method to be used when the transaction dataset does not fulfil the above-described robustness requirements. AGAR recommends what it calls the ECB model. This method involves yesterday's transactions and those from the day before being compounded to be able to provide a reference rate on those days when the transaction dataset does not fulfil the robustness requirements, but that this is done in different ways depending on which of the requirements the transaction dataset does not fulfil. One of the main reasons why AGAR recommends this model is that, in AGAR's view, it is better at managing transaction dataset in connection with the turn of the year, when interest rates tend to deviate from what is normal for the rest of the year. The Riksbank instead proposes that a model for an alternative calculation be used in which the reference rate is calculated as an average based on the transaction dataset of the last five days, including the transaction dataset for the publication date that did not fulfil the robustness requirements. This model is similar to the model for an alternative calculation method used by the Bank of England. The Riksbank has aimed for a method that is easy to understand, consistent and robust for different types of shortcomings and/or errors and that reduces the risk of manipulation by using transactions from the current day.

4. Questionnaire for consultation on the new reference rate

To help you provide opinions on the Riksbank's proposals for the new reference rate, we have compiled a number of simple questions below. The questions are both multiple-choice with different response options and open questions where you have scope to give more detailed answers. Respondents can also add an attachment to the completed questionnaire with further comments, additional quantitative data and/or further analysis in the form of tables, figures, etc.

Before you answer the questions below, please indicate which of the following categories of interested party you are representing in your answers:

☐ Company   ☐ Household   ☐ Bank   ☐ Financial institution

☐ Interest group   ☐ Government agency   ☐ Academia   ☐ Other public sector

☐ Other:

1. Do you understand how the Riksbank's new reference rate will be calculated in normal cases (according to normal calculation methods)? *Choose an alternative*
   a. ☐ Completely
   b. ☐ Sufficiently
   c. ☐ Not at all

2. If you answered b or c to question 1 above, please explain why.

3. What do you think of the method proposed for normal calculation? *Please give the response you feel is most appropriate for each assertion*

Assertion	Agree	Disagree	No opinion
The method succeeds well in capturing the banks' overnight funding costs in SEK			
The method is unnecessarily complicated			
The method results in a usable reference rate			
The method is well adapted to the structure of the overnight market in SEK for the maturity O/N			
The method results in a reference rate that reflects actual interest rate adjustments on the market.			
The method results in a reference rate that is representative of the underlying market.			
The method means that the reference rate differs too much from international reference rates.			

4. The Riksbank proposes basing the reference rate on a broad dataset of transactions of a certain type. What is your opinion of the sample of transactions proposed by the Riksbank? *Please give the response you feel is most appropriate for each assertion*

Assertion	Agree	Disagree	No opinion
The Riksbank's proposed transaction dataset results in a representative and robust reference rate.			
The Riksbank's proposed transaction dataset makes the reference rate <u>less</u> usable on the market.			
The Riksbank's proposed transaction dataset makes the reference rate <u>more</u> usable on the market.			
The Riksbank's proposed transaction dataset makes the reference rate reflect the banks' actual funding costs.			
The Riksbank's proposed transaction dataset is too heterogeneous, making it uncertain what the rate reflects			

5. For a normal calculation method to be used to calculate the reference rate, the transaction dataset must meet certain demands. These demands are aimed at safeguarding representation and reducing possibilities for manipulation. What is your opinion of the demands proposed by the Riksbank for this purpose? *Choose an alternative*
- a. ☐ The demands meet their aims well
- b. ☐ All demands are necessary but are set too low to meet their aims
- c. ☐ All demands are necessary but are set too high to meet their aims
- d. ☐ Not all demands are necessary to meet the aims. Indicate all that are <u>not</u> necessary.
  - i. ☐ Minimum 8 SEK billion
  - ii. ☐ Minimum 3 reporting banks
  - iii. ☐ Maximum volume share for a reporting bank of 60%

6. What is your opinion of the alternative calculation method applied to the calculation of the reference rate when the transaction dataset does not meet demands, or when transactions from yesterday cannot be compiled for some reason? *Please give the response you feel is most appropriate for each assertion*

Assertion	Agree	Disagree	No opinion
The method is simple and easy to understand			
The method is inconsistent			
The method is simultaneously responsive and stable			
The method does <u>not</u> encourage manipulation			
The method is robust and seems to be usable in all conceivable situations			
The method results in a reference rate that is usable on the market			
The method is too focused on the past and does not take sufficient account of the near-term situation (does not place enough emphasis on yesterday's transactions)			

Assertion	Agree	Disagree	No opinion
The method places too much emphasis on yesterday's transactions			
The method is well in line with international practice and thereby preferable to other methods			
The method is too complicated			

7. What is your opinion of the routines for the validation of transaction datasets in the fixing process aimed at ensuring the quality of the dataset every day? ***Please give the response you feel is most appropriate for each assertion***

Assertion	Agree	Disagree	No opinion
The reporting banks will face difficulties in meeting these			
They seem robust and help ensure the quality of the dataset			
They are unnecessary and contribute to delays in the publication of the reference rate			
They correspond well with what other central banks are doing			
They are necessary but also insufficient to ensure the quality of the dataset			
There are better ways of safeguarding quality (describe your suggestion below)			

Suggestion:

8. If you want to provide more detailed opinions on the Riksbank's proposed transaction dataset, calculation methods or requirements imposed on the transaction dataset, please do so here. For further comments, please provide an Attachment as described below.

9. If you want to provide more detailed opinions on the fixing process that the Riksbank proposes, please do so here. For further comments, please provide an Attachment as described below.

10. If you want to provide supplementary Attachments including mathematical formulae, tables and diagrams to support or illustrate your arguments, further comments related to item number 8 or 9, state the name of your attachment here and enclose it in PDF format when you return this questionnaire to konsultation.referensranta@riksbank.se.

Name of Attachment:

Thank you for your input!

The Riksbank

Appendix 1. Mathematical Formulae

Normal calculation routine for reference rate

Let I be the set containing the four subgroups, i.e. categories of counterparties, defined in the normal calculation routine for the reference rate; Large banks and the Swedish National Debt Office (Riksgälden (RGK)), Other banks, Other financial institutions and Non-financial corporations

For $i \in I$ and day $t = \tau$ let;

N_i^τ be the total number of transactions for subgroup i at day τ,

$N^\tau = \sum_{i \in I} N_i^\tau$ be the total number of transactions at day τ,

$J_i^\tau = \{j_k\}_{k=1}^{N_i^\tau}$ be the index set for transactions in subgroup i at day τ,

V_j^τ be the volume for transaction $j \in \{1, 2, 3, \dots, N^\tau\}$ at day τ,

$V_i^\tau = \sum_{j \in J_i^\tau} V_j^\tau$ be the total transaction volume for subgroup i at day τ,

$V^\tau = \sum_{i \in I} V_i^\tau$ be the total transaction volume at day τ,

r_j^τ is the interest rate for transaction $j \in \{1, 2, 3, \dots, N^\tau\}$ at day τ,

$\varphi_i^\tau = \frac{V_i^\tau}{V^\tau}$ be the volume share for subgroup i at day τ,

$w_i^\tau = \frac{1}{40} \sum_{j=0}^{39} \varphi_i^{\tau-j}$ be the 40 bank day moving average for the volume share for each subgroup i at day τ,

$W_i^\tau = \frac{w_i^\tau}{\sum_{j \in I} w_j^\tau}$ be the adjusted 40 bank day moving average for volume share for each subgroup i at day τ,

$R_i^\tau = \frac{1}{V_i^\tau} \sum_{j \in J_i^\tau} V_j^\tau * r_j^\tau$ be the volume weighted rate for subgroup i at day τ.

Finally, we are ready to define the reference rate at day τ as:

$$R^\tau = \sum_{i \in I} W_i^\tau * R_i^\tau$$

A special case is when $V_{\bar{I}}^\tau = 0$ for $\bar{I} \subset I$, i.e. when one (or more) subgroup(s) has no transactions for the specific day, then the formula for the adjusted 40 bank days moving average for the volume share for subgroup $i \in I/\bar{I}$ changes to:

$$W_i^\tau = \frac{w_i^\tau}{\sum_{j \in I/\bar{I}} w_j^\tau}$$

In the same manner, the formula for the reference rate changes to:

$$R^\tau = \sum_{i \in I/\bar{I}} W_i^\tau * R_i^\tau$$

Alternative calculation routine for reference rate

Let all notations be defined as in the previous section and let $Repo^t$ be the repo rate at day t. The alternative computation method for the reference rate at day τ is then calculated as:

$$R_{alt.}^{\tau} = Repo^{\tau} + \frac{1}{5}\sum_{j=0}^{4}(R^{\tau-j} - Repo^{\tau-j})$$

In the special case when there is a technical issue which makes it impossible to retrieve transactions from the previous day ($j=0$), the Riksbank is unable to compute the reference rate according to above procedure, and thus, $R_{alt.}^{\tau}$ will be computed as:

$$R_{alt.}^{\tau} = Repo^{\tau} + \frac{1}{4}\sum_{j=1}^{4}(R^{\tau-j} - Repo^{\tau-j})$$

Trimming

Let:

$$T = \{(r_1, V_1), (r_2, V_2), (r_3, V_3), \ldots, (r_N, V_N)\},$$

$$r_k \leq r_{k+1} \, \forall k = 1, \ldots, N$$

be a set of transactions represented as an ordered, ascending by interest rate, list of pairs with interest rate and volume. This set can be partitioned into "rate buckets", i.e. set of subsets of T where all transaction in a rate bucket has the same interest rate and rates are different between buckets, which can be represented in the same way as T:

$$T = \{RB_1, RB_2, RB_3, \ldots, RB_M\} = \{(r_1^b, V_1^b), (r_2^b, V_2^b), (r_3^b, V_3^b), \ldots, (r_M^b, V_M^b)\}$$

$$r_k^b < r_{k+1}^b \, \forall k = 1, \ldots, M$$

Each rate bucket consist of a set of transactions with the same interest rate:

$$RB_k = \{(r_k^b, V_{k,1}), (r_k^b, V_{k,2}), (r_k^b, V_{k,3}), \ldots, (r_k^b, V_{k,m_k})\}$$

where:

$$\sum_{i=1}^{m_k} V_{k,i} = V_k^b$$

Furthermore, let $0 < \beta < 1$ be the trim level, a.e. 25 percent in the case of the reference rate. The Riksbank uses the following method to trim off the bottom:

$$\alpha = \frac{\beta}{2}$$

percent of the sample volume. To trim off the top α percent of the sample volume each rate is multiplied by -1 and then the same algorithm is run again.

Define S_k to be de cumulative volume of the first k rate buckets:

$$S_k = \sum_{j=1}^{k} V_j^b, \, k \leq M$$

and define i_α as:

$$i_\alpha = \max_k S_k \leq S_M * \alpha$$

Once this index is computed the volume for each transaction should be adjusted according to:

$$\bar{V}_k = 0 \, \forall k \leq i_\alpha$$

$$\bar{V}_{i_\alpha+1} = \left(1 - \frac{S_M * \alpha - S_{i_\alpha}}{V_{i_\alpha+1}^b}\right) * V_{i_\alpha+1}$$

$$\bar{V}_k = V_k \, \forall k > i_\alpha + 1$$

Thus, the new set of transactions is given by:

$$T = \{(r_1, \overline{V}_1), (r_2, \overline{V}_2), (r_3, \overline{V}_3), \ldots, (r_N, \overline{V}_N)\}$$

Explanation of variation in simple volume weighted rate

Let Y be simple volume weighted rate computed on the whole sample after trimming 25 percent of the transaction volume with the method described above, but without regard for subgroups.

An ANOVA test, with H_0 defined as that the variance in Y is explained by the variance in interest rates for the different subgroups, shows that H_0 can be rejected on the 1 percent confidence level. This is consistent with the high variance in the simple volume weighted rate compared to the more stable volume weighted rates in each subgroup.

Applying a test inspired by Oaxa-Blinder decomposition shows how much of the variation in Y that is explained by the variation in volume shares for each subgroup. This test is completed by defining a linear regression model for the simple volume weighted rate with volume shares for three of the four subgroups as explanatory variables, the volume share for the fourth subgroup is just a linear combination of the other three since they all sum to 1:

$$Y = \beta_0 + \beta_1 * w_{large\ banks} + \beta_2 * w_{banks\ other} + \beta_3 * w_{fin.inst.} + error\ term$$

The result shows that the variation in Y is explained by almost 65 percent by the variation in volume shares for the different subgroups. Even a simple regression model with $\beta_2 = \beta_3 = 0$ explains a large share of the variation in Y. If the same test is applied to a subsample of transactions, covering the period October 2019 to April 2020, during which the activity between large banks was much higher, the variance in Y is explained by the variation in volume share by the subgroups to a much higher degree.

To verify the robustness of the result given above another linear regression model is applied, this time with the volume weighted rates for all four subgroups as explanatory variables:

$$Y = \gamma_0 + \gamma_1 * R_{large\ banks} + \gamma_2 * R_{banks\ other} + \gamma_3 * R_{fin.inst.} + error\ term$$

This model shows that about 40 percent of the variation in Y is explained by the variation in interest rates for the four subgroups, which confirms the results of the test above.

Another way to verify the robustness of the results is to apply another somewhat simpler test for explaining the variance in Y. First compute a trimmed (25%) volume weighted rate as per the description above but with static weights for the subgroups defined as mean volume share for each respective subgroup. Hereafter this rate is called $\tilde{Y}$. This rate is then compared to Y, the trimmed (25%) volume weighted using weights for each subgroup that are updated daily and given by the volume share for the each subgroup. The share of variation in Y emerging from the variation in volume shares for the different subgroups is then given by:

$$A = 1 - \frac{Var(\tilde{Y})}{Var(Y)}$$

The result shows that A is almost 60 percent which is consistent with the result obtained using the linear regression model above. The conclusion is therefore that the variation in volume shares for the different subgroups explains a large portion of the variation in a standard trimmed volume weighted rate.