Decision annex

The Riksbank's new reference rate

Background

In light of the international reform work under way to develop transaction-based reference rates, and in common with a number of other central banks, the Executive Board of the Riksbank decided on 12 December 2019 that the Riksbank should take on the task of issuing a transaction-based reference rate for its own currency. 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 robustness requirements for the underlying transaction data.

On 7 October 2020, a proposal concerning the definition and calculation method of the Riksbank's new reference rate was sent for consultation, with a deadline of 21 October 2020. A total of 15 responses was received. The referral bodies all expressed support for the Riksbank's reference rate, but also suggested a number of changes to the Riksbank's proposal for the design of the reference rate.

It is important that the design of the Riksbank's new reference rate complies with international requirements and guidelines for transaction-based reference rates, that it does not deviate too far from international practice, and that it is well-suited to the Swedish market.[1] The adjustments to the proposal for consultation made following the views expressed by the referral bodies, and the reasons why the Riksbank in some respects has not considered it possible to accommodate the views of the referral bodies, are described in the following sections. Annex 1 contains a summary of the consultation responses.

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[1] International practice refers to how the international guidelines are put into practice in different jurisdictions, taking local conditions into account.

Starting points and properties

The Riksbank is of the view that the transaction-based reference rate should be based on actual transactions on a liquid and competitive market, where the transaction dataset is representative of the underlying market. This is in accordance with the EU Benchmarking Regulation and the 19 principles for reference values issued by IOSCO in 2013 ("the IOSCO principles") and which various central banks have decided to follow.

To meet these requirements, it is important that the reference rate takes into account local market conditions. Definitions and calculation methods need to be designed in accordance with these principles. This means that the definitions or calculation methods used for reference rates in other countries or currency areas are not necessarily appropriate in Sweden.

Consequently, the aim is to find a method that takes into account the specific properties of the Swedish overnight market, while attaining the overall purpose of supplying a credible transaction-based reference rate and meeting international guidelines and principles, such as the IOSCO principles.

One example of consideration to specific Swedish conditions is that transactions with the Swedish National Debt Office are included, although other central banks often exclude transactions with public authorities. Unlike many other countries, in Sweden it is the Swedish National Debt Office, which is an authority separate from the central bank, that is responsible for managing the sovereign debt and government payments. The Swedish National Debt Office is active on the Swedish market as part of the banking system, and is also a large participant on the Swedish overnight market. There is thus justification for including the Swedish National Debt Office when calculating the reference rate.

Another similar aspect that must be taken into consideration is the size and composition of the Swedish overnight market. Compared with, for instance, the markets in euros, dollars and pounds sterling, the Swedish market is small and concentrated on a small number of participants.[2] Most transactions are made with one of a few large participants on the market (see Annex 2). Different participant categories generally face different rates on the market, and their presence on the market varies from day to day, which affects how liquid and deep the market is. On a market with an average daily transaction volume of around SEK 35 billion and around 43 transactions (see Table 1 below), this means that even small changes in market composition can have major effects on rate setting. A concentrated market with limited volume and a limited number of transactions also means that it becomes relatively easy to manipulate a rate, especially for a large participant.

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[2] The average daily volume on the respective market during the period January 2020 – October 2020 has been: €STR 41 billion EUR, SONIA 52 billion GBP and SOFR 1000 billion USD. On average, €STR had 477 transactions per day during this period.

Table 1. Breakdown of transactions in SEK without collateral at O/N maturity between reporting agencies and different categories of counterparty, January 2020 – October 2020.

Average values during the period	Unsecured borrowing transactions at O/N maturity					
	Banks	Financial institutions	Non-financial corporations	NDO	Proposed sample[3]	All counterparties[4]
Difference between simple volume-weighted rate and the repo rate, bp	-14.2	-8.7	-1.6	-9.0	-9.1	-9.1
Total transaction volume per day, SEK bn	14.3	9.2	9.5	0.3	33.2	35.1
Number of transactions per day	30.8	6.0	5.4	0.1	42.3	43.5
Number of reporting agencies per day	5.5	3.2	2.6	1.1	5.9	5.9

All in all, it is therefore important that the Riksbank defines the new reference rate so that it is based on an underlying market with the largest possible breadth, volume and number of transactions.

Based on this, it is proposed that the Executive Board of the Riksbank decide on how the new transaction-based reference rate should be defined and calculated. The following sections describe the motives for the considerations made, partly as a result of the comments by the referral bodies.

In accordance with international practice, the EU Benchmarking Regulation and the IOSCO principles, the reference rate provided by the Riksbank will be subjected to regular evaluation, and may therefore be changed in the future. Such evaluations do not just cover assessments of the size or liquidity of the market on which the reference rate is based, but also whether the current calculation method satisfactorily reflects the interest rate on the underlying market. This also includes continual oversight and assessment of the robustness requirements and their capacity to safeguard both robustness and representation regarding the interest rate and to prevent the manipulation of the interest rate.

The proposed definition and calculation of the Riksbank's new reference rate will, after a decision has been taken, form the basis for the preliminary reference rate that the

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[3] This is a combination of the counterparty types Banks, Financial institutions, Non-financial corporations and the Swedish National Debt Office.
[4] 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.

Riksbank will publish over a six month trial period. The aim is for the trial period to begin in January 2021. During this trial period, the preliminary reference rate must not be used in pricing financial contracts. The reference rate and its framework and structure will be scrutinised and evaluated during the trial period.

Definition and calculation method

In addition to what has already been mentioned above regarding the importance of a transaction-based rate being based on a representative dataset from a liquid and competitive market, both the transaction dataset and the calculation method must also be robust enough form the basis for a reliable reference rate under different monetary policy and macrofinancial conditions.

The Riksbank, in common with many other central banks, considers that the new reference rate should reflect the banks' funding costs at the shortest maturity (overnight, O/N) in the national currency. It is therefore appropriate that the rate should be based on transactions without collateral with banks, financial institutions and non-financial corporations leading to deposits over night at the Riksbank's monetary policy counterparties.[5] The overnight market in SEK, which includes transactions with non-financial corporations, thus comprises the underlying market on which the Riksbank's new reference rate will be based. A description of this market can be found in Annex 2. A longer description of why the Riksbank proposes that the transaction dataset should consist of deposits without collateral is included in the consultation the Riksbank published in October 2020.

Transaction dataset

Comments from the referral bodies

The majority of the referral bodies agreed that the reference rate should be based on transactions with the Riksbank's monetary policy counterparties. A large majority also expressed support for the Riksbank's proposal to base the reference rate on transactions without collateral that lead to deposits overnight with the Riksbank's monetary policy counterparties. However, several referral bodies argues that non-financial corporations should not be included in the dataset. They motivated this by arguing that they did not think rate-setting for non-financial corporations was on market terms, and thereby did not reflect the banks' actual funding costs. This is because, according to the referral bodies, the banks often do not charge negative interest to non-financial corporations. These companies are instead covered by amount limits at the banks, or the banks deduct a charge that cannot be linked to individual transactions. The referral bodies therefore claim that including transactions with non-financial corporations gives a misleading picture of interest rates for the group, as it does not include all costs. In addition, the majority of the referral bodies considered that although including non-financial corporations increased the robustness of the transaction dataset, this did not outweigh the need to use an alternative calculation method.

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[5] At present, these monetary policy counterparties consist of those who daily report information on their transactions on the money market to the Riksbank. Those submitting reports currently consist of nine of the Riksbank's twenty-three monetary policy counterparties, which are the largest and most active on the money market in Swedish krona.

The Riksbank's considerations

The consequences of excluding transactions with non-financial corporations from the transaction dataset for calculating the reference rate would be substantial. In particular, the dataset would be much less robust as the volume and number of transactions on which the reference rate is based would then decline from an average of around SEK 33 billion to around SEK 24 billion. Transactions with non-financial corporations as counterparties correspond to around 25 per cent of the overnight market, which is a significant share (see Table 1 above).

With regard to the effect of charges mentioned by the referral bodies, however, it is clear that the average rate to non-financial corporations has on average been negative since 2015 and only in exceptional cases been positive (see Figure A3.3 in Annex 3 and Figure 2 below). The non-financial corporations that are active on the Swedish overnight market often have separate financial divisions, trade in relatively large volumes and have long experience of operating on the financial markets. The Bank of England's reference rate SONIA, for instance, covers institutional investors, a definition that does not necessarily exclude non-financial corporations. The ECB also considered broadening €STR to include non-financial corporations that are professional participants on the market[6]. This is despite the markets in these two cases being much larger than the Swedish one, in terms of volume, number of transactions and number of participants. But in international terms, it is nonetheless unusual to include this type of transaction when the reference rate is based on unsecured transactions.

Figure 1. Volume-weighted mean rates for each sub-group respectively
Deviation from the repo rate in percentage points
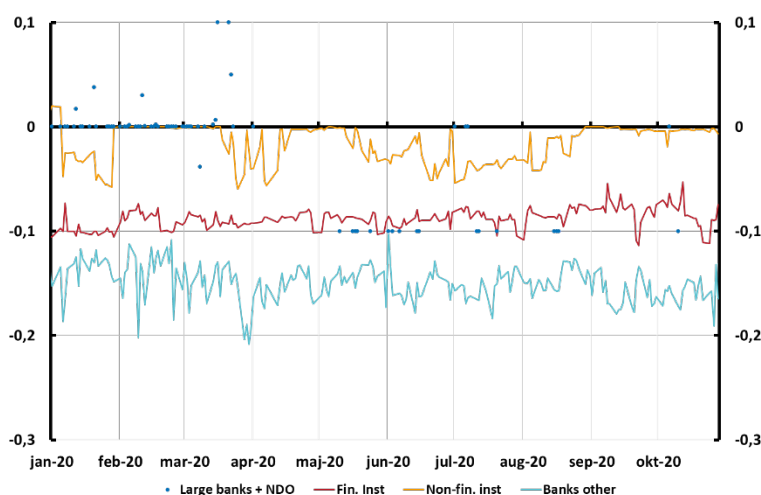
Based on both the transaction datasets on which the working group for alternative reference rates (AGAR) based its analysis, and the data collected by the Riksbank, it is clear that the share of the total volume on the overnight market stemming from non-financial corporations has grown in recent years. A comparison between these two datasets is contained in Annex 3. The growing share of transactions with non-financial

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[6] See the ECB website, where they describe these considerations
https://www.ecb.europa.eu/paym/intro/cons/html/euro_unsecured_overnight_interest_rate.en.html

corporations becomes particularly clear after March 2020, when this increase coincides with the transaction volumes in the sub-group Major banks (Sweden's five largest banks and the Swedish National Debt Office) declining (see Figure 2 below). This development indicates that transactions with non-financial corporations comprise a substitute to the banks' other financing sources. There are thus indications that these transactions not only contribute to increasing competition on the market, but that they also reflect the banks' funding costs. The increased share of transactions with non-financial corporations as counterparts also coincide with a period when the banking system's liquidity surplus towards the Riksbank has grown substantially. The probability that the liquidity surplus will prevail over a long period of time emphasises the need to include transactions with non-financial corporations to achieve a robust dataset.

Figure 2. Daily volume and volume shares for each sub-group respectively
In SEK million   Per cent
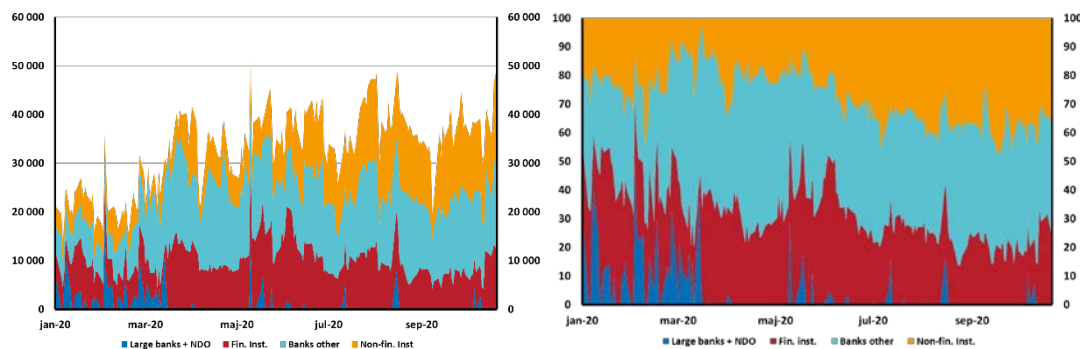
In addition, it can be noted that the transaction dataset and the resulting reference rate will become more volatile if transactions with non-financial corporations are excluded (see Figure 3 below). This is because the average rate in this sub-group of counterparts is similar to the average rate in the Major banks counterpart group (but deviates more in relation to the average rates in the other sub-groups, see Figure 2 above). As the activity in the sub-group Major banks is very varied and often there are no transactions at all with these counterparts, including transactions with non-financial corporations means not only that the dataset becomes more robust and representative of the underlying market, but also that the reference rate becomes somewhat more stable.

Figure 3. Volume-weighted mean rate per day, including and excluding transactions with non-financial corporations

Deviation from the repo rate in percentage points
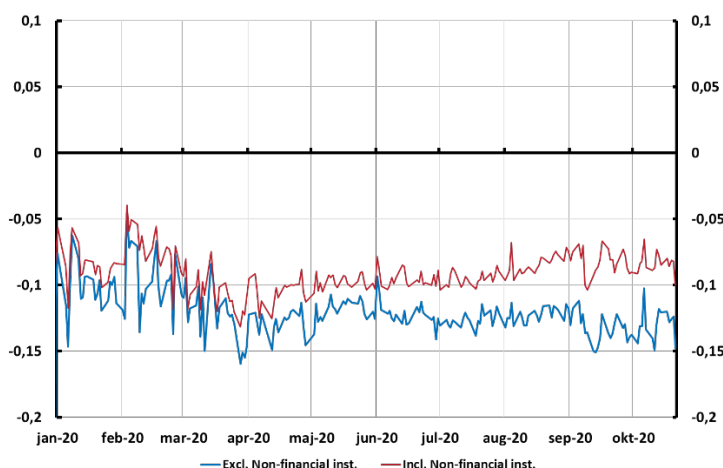
The referral bodies say that the rate in transactions with non-financial corporations is not in line with market terms, as it does not capture the effect of the additional charges. They therefore also consider that the rates on these transactions do not reflect the banks' funding costs. However, there is nothing to prevent a new charge structure being established, whereby the rate *de facto* reflects the cost and thereby also matches market terms. In addition, the current charge structure does not prevent the rates facing non-financial corporations from following movements in rates in other segments on the overnight market. The short time to maturity means the rates are flexible, while the charges are often much more sluggish. Finally, it is worth noting that rate-setting for the other sub-groups Major banks, Other banks and Financial institutions varies as a result of factors similar to charges, such as regulations relating to macrofinancial stability and money laundering. These factors affect the level of the average rates in these sub-groups in a way that can affect how well they reflect market terms.

Conclusion and proposed form

All in all, this means that for a small market like the Swedish one, there is a substantial risk that daily volumes and number of transactions will not be sufficiently large to comprise a robust dataset if transactions with non-financial corporations are excluded. Despite the fact that it is unusual in an international comparison to include transactions with non-financial corporations in the dataset for reference rates, the Riksbank deems it necessary to include them in the current situation. Transactions with non-financial corporations comprise a large share of an active, liquid and competitive market. To supply a credible transaction-based reference rate, and to meet international guidelines and principles such as IOSCO, the transaction dataset for the reference rate needs to be robust and representative of the underlying market. This is also emphasised in the Benchmarking Regulation.

For Sweden, this means that transactions with non-financial corporations need to be included. There is nothing in either the Benchmarking Regulation or the IOSCO principles to prevent transactions with non-financial corporations being included in the transaction dataset. On the contrary, they both emphasise that the transaction dataset should take

into account national conditions and different countries have decided on different definitions for their transaction-based reference rates. In addition, these transactions contribute to making the transaction dataset less sensitive for the times when there are no transactions between the major banks. Thus, the transaction dataset included in the calculation for the Riksbank's new reference rate is designed in accordance with the proposal sent for consultation.

This means that the Riksbank's new reference rate ought to be based on transactions without collateral with banks, financial institutions and non-financial corporations leading to deposits overnight (O/N) at the Riksbank's monetary policy counterparties.

If the market develops in such a way that later analysis shows it is inappropriate or unnecessary to include this type of transaction, a new assessment can be made.

Normal calculation method

Comments from the referral bodies

Several referral bodies argued that the Riksbank's proposed method deviates unnecessarily from international practice of using a normal volume-weighted mean value. They also argued that the proposed method entailed a departure from the purpose that the rate shall reflect the market and that a transaction-based rate should primarily capture what the rate is on the day in question. In addition, the referral bodies admitted that the proposed method entailed that the new reference rate would be more stable, but claimed that stability did not have a value in itself. Further, they observed that transaction-based rates will be more volatile than the current IBOR, which was considered unacceptable. Finally, it was thought that although the inclusion of non-financial corporations would increase robustness in the transaction dataset, this would not be sufficient to justify a modified calculation method with sub-groups and sluggish weights. No referral body had any comments on the Riksbank's proposed trimming method.

The Riksbank's considerations

Many of the new transaction-based reference rates administered by central banks are calculated as a volume-weighted mean rate. This has also been the Riksbank's point of departure. As a result of the varying volume distribution between the counterparts, which entails a large variation in a volume-weighted mean rate, the Riksbank nevertheless proposed in the consultation document that a modified volume-weighted mean rate should be used to calculate the reference rate. This type of calculation makes the volume share for the respective sub-groups a little more sluggish to dampen the effect of changes in volume distribution in the actual rate. Without this modification, the Riksbank's transaction-based reference rate would be more volatile than similar rates, such as €STR and SONIA (see Figure 4).

The argument on not deviating from international practice where possible, and the fact that the market appears prepared to accepted a certain degree of volatility in the transaction-based rate, are important aspects to consider. Moreover, transactions with non-financial corporations and the trimming method proposed by the Riksbank to make the reference rate more stable (see Figures 5 and 6) help reduce the need to use the modified calculation method. The modified method could help stabilise the rate

somewhat, but not to the extent that it would match the low volatility that characterises €STR and SONIA.

Figure 4. The Riksbank's reference rate calculated as a volume-weighted mean rate according to the proposed method, plus the reference rates €STR (euro) and SONIA (pounds sterling)

Percentages, deviations from the policy rate (the ECB's deposit rate for ESTR, BoE's bank rate for SONIA and the Riksbank's repo rate for the Riksbank's reference rate)
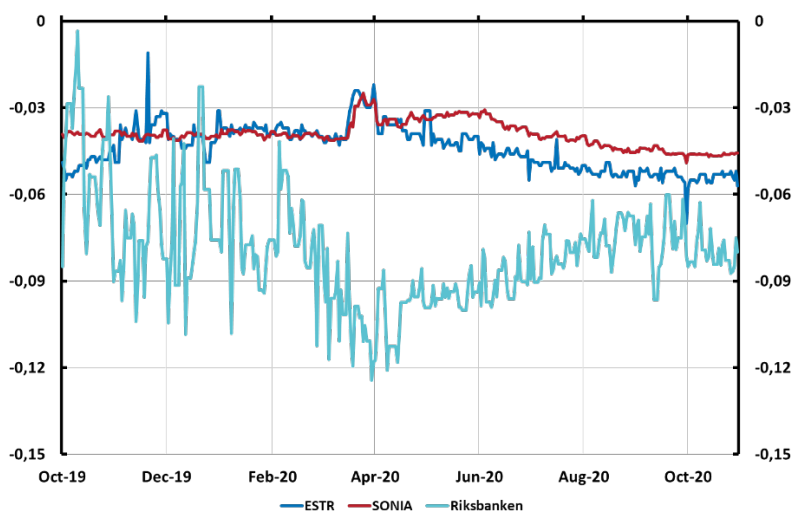

Figure 5. **Volume-weighted mean rate per day, including non-financial corporations, trimmed at different levels and using different methods**
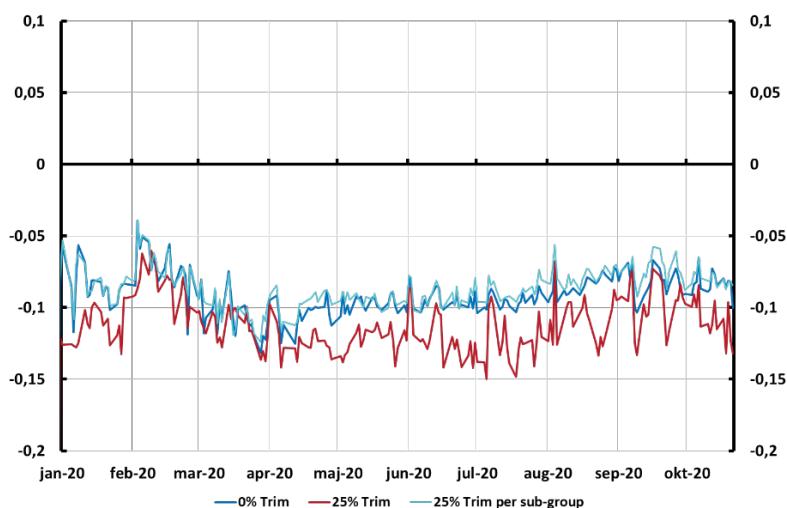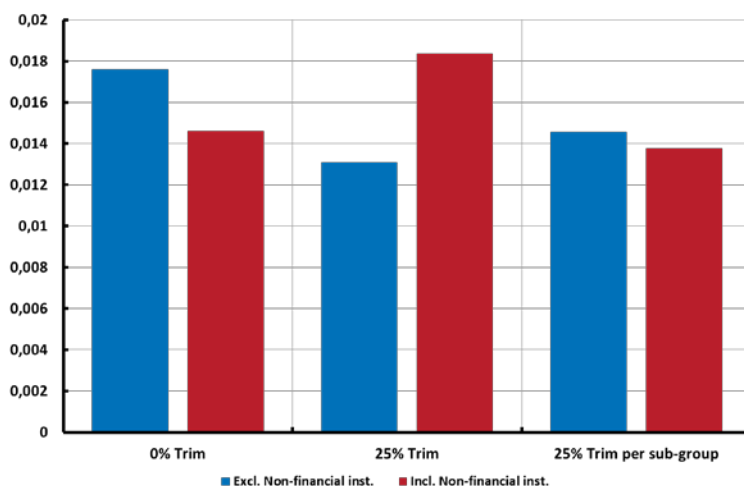Deviation from the repo rate in percentage points

Figure 6. Standard deviation in mean rate calculated as a volume-weighted mean rate, including non-financial corporations
Percentage points

Conclusions and proposed form

Given the comments of the referral bodies and the considerations described above, there is justification for simplifying the normal calculation method and using a common volume-weighted mean rate. As a result of this change in relation to the consultation document, it is also important to take into account the method for trimming the transaction dataset.

The arguments for trimming the dataset at sub-group level remain.[7] In accordance with the IOSCO principles and the EU Benchmarking Regulation, which emphasise that the calculation method should ensure the representativity of the reference rate, the trimming method in the consultation document will be retained. In addition, the trimming method contributes to reducing volatility in the reference rate, which nevertheless becomes somewhat more volatile than other reference rates.

Explicit formulae for calculation are included in Annex 4.

Robustness requirement

Comments from the referral bodies

Most referral bodies expressed support for the Riksbank's view of the need for a robustness requirement, but at the same time pointed out that it is very important, from the point of view of credibility, that the alternative calculation method does not need to be used too often. Several referral bodies considered that the proposed robustness requirements, which according to the dataset had activated the alternative calculation method 7-8 times a year, were too strict.

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[7] Trimming the respective sub-group prior to the transactions being weighted together into a volume-weighted mean rate means that extreme values in the respective sub-groups are captured in a more adequate manner. This also means that the allocation in the transaction dataset is retained to a greater degree, which means that the trimmed dataset is still representative of the underlying market.

The Riksbank's considerations

The Riksbank considers it to be of great importance that the transaction-based reference rate is regarded as reliable and credible by market participants and other stakeholders. Basing the reference rate on a weak dataset too often could reduce its credibility, but so can an overly frequent use of an alternative calculation method. Compared with, for instance, €STR the proposed robustness requirements would also lead to an alternative calculation method being used more often in Sweden. Consequently, the Riksbank proposes that the criteria be adjusted in relation to the proposal in the consultation document to attain a better balance between ensuring robustness, that is, that the transaction dataset has sufficient volume, number of transactions and number of participants, and preventing an overly frequent use of the alternative method.

One way making the robustness requirements more flexible is to apply them to the transaction dataset before it is trimmed, instead of afterwards, as proposed in the consultation document. The purpose of the robustness requirements and trimming thus coincides in part, as they both aim to secure robustness and representativity as well as reducing the risk of manipulation. As trimming takes place at sub-group level, this ensures that the trimmed transaction dataset is representative of the whole market in that the allocation of the different sub-groups' participation in the market is preserved. It is therefore sufficient to apply the robustness requirements for lowest volume, least number of report submitters and highest share of volume for a report submitter to the untrimmed dataset.

Conclusions and proposed form

Given this, it is reasonable to make the robustness requirements somewhat more flexible. This can be done first and foremost by applying them to the transaction dataset before trimming, but also by adjusting the calibration of the requirements somewhat. The volume requirement should be lowered from SEK 8 billion to SEK 5 billion and the highest share of transaction volume a participant may account for should be raised from 60 to 75 per cent. The lowest number of report submitters remains at three, as specified in the consultation document. The Riksbank's assessment is that the requirements will mean that the alternative method needs to be used a maximum of twice a year.

Alternative calculation method
Comments from the referral bodies

When the robustness requirements are not met, or in the event of technical problems preventing the normal calculation method being used, the Riksbank will activate an alternative calculation method. One way of doing this is to use historical transaction data to calculate the reference rate. The consultation responses included a request for a method that uses historical data to a lesser degree than is proposed in the consultation document. The majority of the referral bodies also considered that the alternative calculation method should reflect, and be adapted to, the robustness requirement, or requirements, that are not met.

The Riksbank's considerations

The referral bodies' views on limiting the retrospective dimension in the alternative calculation method make the reference rate more unpredictable, which reduces the incentives for manipulation. It also means that the reference rate will to a greater degree depend on how rate-setting in the near term has been.

The alternative calculation method in the consultation document is simple and transparent with an approach that also has the advantage that it can be used more than one day in a row. In the case of technical problems, when the previous day's transactions are not available, the method only needs to be modified slightly in that only historical transaction data can then be used in the calculation.

With regard to giving consideration to which of the robustness requirements is not met, the starting point should be that the transaction dataset as a whole is either regarded as robust, and the normal calculation method is used, or the transaction dataset is regarded as not being robust, which requires use of the alternative calculation method. This is consistent and transparent with regard to both approach and method.
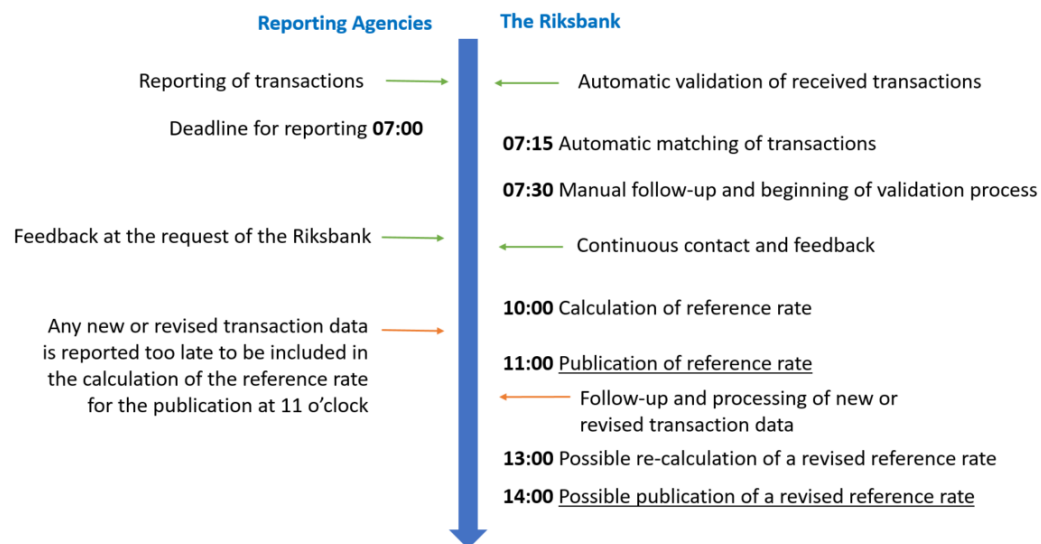
Conclusions and proposed form

Given the above comments and considerations, the retrospective dimension in the alternative calculation method should be reduced (from 5 to 3 trading days), but otherwise the method should be retained in line with the proposal in the consultation. This means that the same method should be used regardless of which of the robustness requirements caused the need for using an alternative method.

Explicit formulae for calculation are included in Annex 4.

The fixing process

There were no comments from the referral bodies regarding the fixing process proposed in the consultation document (see Figure 8 below). The Riksbank will work with the report submitters to produce a more detailed fixing process that ensures the quality of the transaction dataset on a daily basis, and that has continuity routines in place to manage various types of incident. All of these parts will be subject to testing and streamlining during the test period when a preliminary reference rate is published.

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

Reporting Agencies		The Riksbank
Reporting of transactions →		← Automatic validation of received transactions
Deadline for reporting **07:00**		**07:15** Automatic matching of transactions
		07:30 Manual follow-up and beginning of validation process
Feedback at the request of the Riksbank →		← Continuous contact and feedback
		10:00 Calculation of reference rate
Any new or revised transaction data is reported too late to be included in the calculation of the reference rate for the publication at 11 o'clock →		**11:00** Publication of reference rate
		← Follow-up and processing of new or revised transaction data
		13:00 Possible re-calculation of a revised reference rate
		14:00 Possible publication of a revised reference rate

Annex 1 Summary of consultation responses to the Riksbank's proposed definition of a new reference rate

A total of 15 consultation responses were received. Most referral bodies were positive to the Riksbank's new reference rate being based on the reporters' deposits in SEK, at the shortest maturity O/N. The views of the referral bodies primarily concerned the transaction datasets on which the reference rate will be based, the robustness requirements the dataset should meet, and parts of the method.

The referral bodies' most important comments

Below we present the most important comments from the referral bodies. They have been arranged in order according to the content of the comments.

Properties of the reference rate

Some comments concerned the bases the Riksbank had used when designing the properties of the reference rate. In particular, the referral bodies commented on the existence of volatility not being the most important aspect for a reference rate and that measures to reduce volatility should not lead to compromises on other important aspects. The principal starting point should instead be that the reference rate reflects the banks' funding costs on the overnight market in SEK, and that it is based on transactions on a liquid market.

Another comment, which concerned the overall analysis, was that it is difficult to analyse the effect on the reference rate of a potential decline in liquidity on the market in the future.

Underlying market and transaction dataset

A large number of the comments from the referral bodies concerned the underlying market and which transactions should for the basis for calculating the reference rate. Some of these comments contained criticism that the Riksbank's proposal lacked a well-defined underlying market that could be used as a starting point for calculating and defining the reference rate.

One referral body mentioned the limit of deposits at the maturity overnight (O/N), and proposed that the maturity Tomorrow-Next (T/N) also be included to better reflect the funding costs. An alternative transaction dataset could consist of Riksbank Certificates, deposits in RIX, lending in RIX and transactions between clearing banks. Another referral body stated that repos (repurchase agreements) were not mentioned in the consultation, but that they could affect rate-setting in the O/N market.

Several referral bodies had views on the inclusion of transactions with non-financial corporations in the dataset. For instance, they said that these companies face a misleadingly high or different interest rate and instead face charges, which means that the rate does not reflect the funding costs. One referral body also pointed out that the

inclusion of non-financial corporations deviates from the models applied internationally, which was considered undesirable.

In the event that non-financial corporations were excluded from the transaction dataset, one referral body pointed out that the calculation method would need to be corrected.

Calculation method

Several referral bodies argued that the Riksbank's proposed method deviates unnecessarily from international practice of using a normal volume-weighted mean value. The comments primarily concerned the moving averages for the weighting of the sub-groups in the transaction dataset. According to the referral bodies, this should not be motivated on the basis of reduced volatility, as this should not be a base for calculating the reference rate, in line with the above. In addition, one assumed that the transactions with non-financial corporations contributed to increased volatility, which thus justified the modified calculation method. It was therefore considered, in line with the above, that these should not be included in the transaction dataset. It also introduces a delay into the rate calculation that leads to less relevant estimates of the current rate.

Robustness requirements and alternative method

Several referral bodies stated that the robustness requirements in the consultation were too strict and would entail an overly frequent use of the alternative method.

Other referral bodies were more specific, for instance, by pointing out that the third robustness requirement of the transaction dataset (highest share after trimming) were set too high, especially considering the requirement would apply after trimming. Another proposal from a referral body was to reduce the requirement regarding transaction volumes from eight billion to, for instance, five billion, to minimise use of the alternative calculation method.

If the transaction dataset does not meet the robustness requirement, an alternative method is activated. Several referral bodies considered this to be too predictable and retrospective, and that it did not take into account which of the robustness requirements was not met.

One referral body also pointed out that the publication of a revised reference rate would require more work, especially for agents with manual processes, in that one would need a special internal process for entering a revised reference rate into all of the internal systems.

Compilation of referral bodies responding to the questions asked by the Riksbank in the consultation

The consultation included a form with questions regarding the definition for the reference rate. Nine of the 15 respondents chose to answer these questions. Each question was followed by a number of statements that either gave support to the Riksbank's definition, or did not. For the statements, see the consultation. The respondents' replies have been summarised as net figures, in the same way as the responses in the Riksbank's Business Survey (1 = supports the Riksbank's proposal, 0 =

no opinion, -1 = does not support the Riksbank's proposal). The net result per question is shown below.

Figure A1.1: "What do you think of the method the Riksbank is proposing for normal calculation of the new reference rate?"
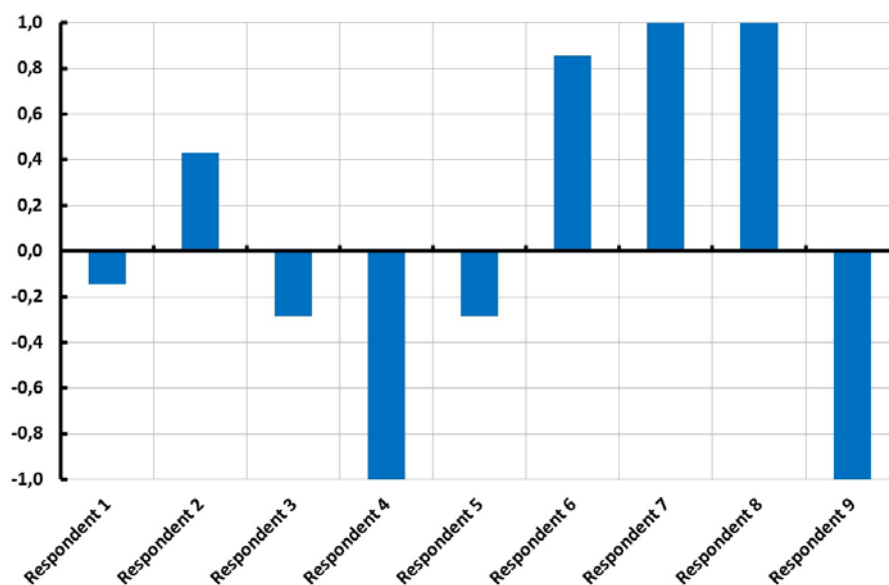Net result per question per referral body

Figure A1. "What do you think of the sample of transactions the Riksbank proposes the new reference rate should be based on?"
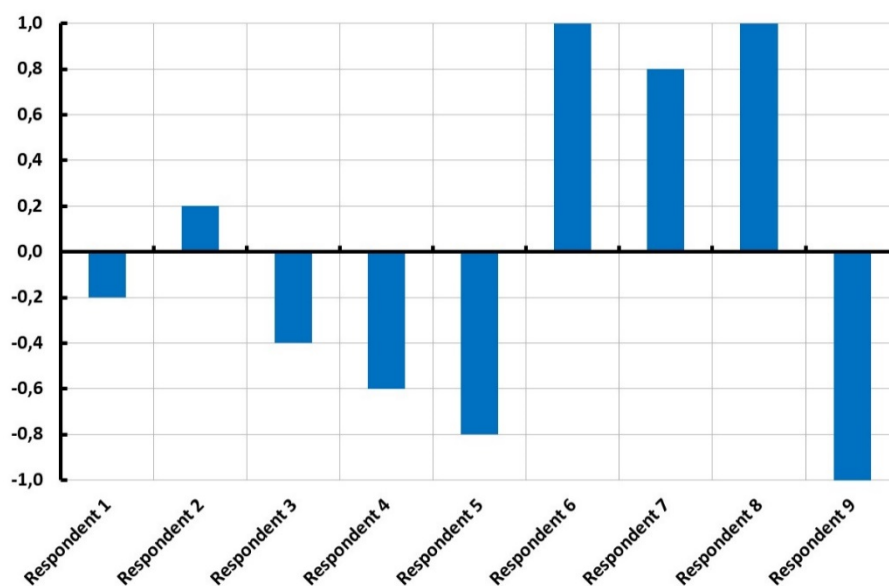Net result per question per referral body

Figure A1.3: What do you think of the alternative calculation method applied when the transaction dataset does not meet demands, or when transactions from yesterday cannot be compiled for some reason?
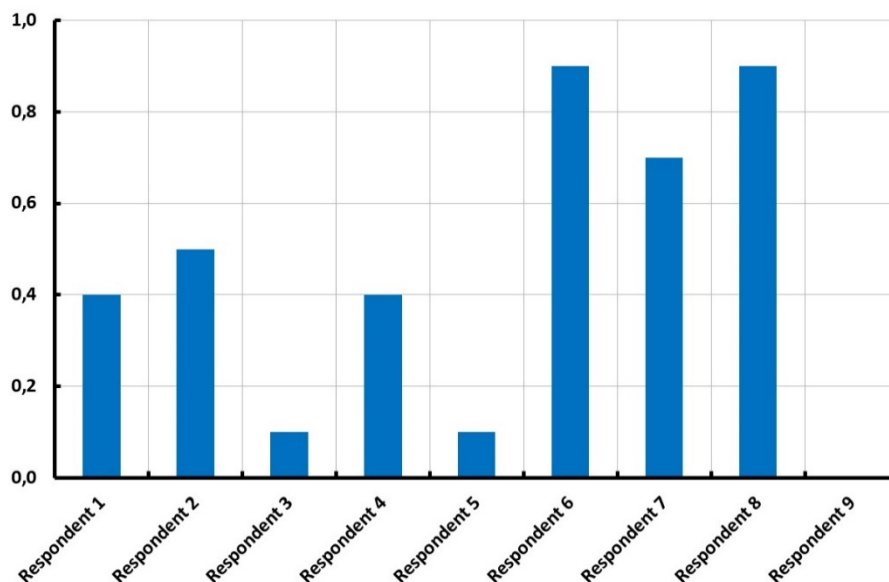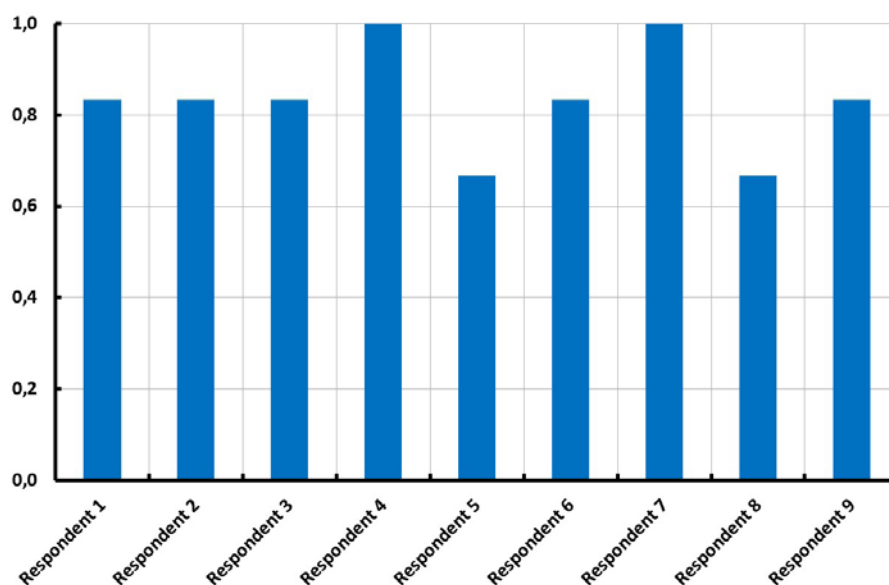
Net result per question per referral body

Figure A1.4: "What do you think of the routines for validation of transaction datasets in the fixing process aimed at ensuring the quality of the dataset the reference will be based on every day?"

Net result per question per referral body

Annex 2 - The underlying market for the Riksbank's reference rate

The consultation on the Riksbank's new reference rate and this annex state that the sample of transactions the Riksbank proposes should form the base for the reference rate comprise unsecured transactions that lead to deposits at the maturity O/N in Swedish krona. To ensure that this transaction sample is representative of the underlying market (the Swedish market for overnight loans in SEK), we need to identify how this market is composed. We can do this with the aid of statistics from Swedish Monetary and Financial Institutions (MFIs), which are more comprehensive than the statistics the Riksbank receives through the reporting requirement from its monetary policy counterparties.

The size of the Swedish market for overnight loans can be estimated as the volume for all overnight loan transactions reported in by Swedish monetary financial institutions. This means that all transactions received in the form of deposits from large, medium-sized and also smaller banks, mortgage institutions and financial companies are included. Counterparties in these transactions are both Swedish and foreign MFIs and non-MFIs. At the end of 2019, 163 MFIs reported their volumes. This statistic can be used to evaluate how representative the transaction dataset is that the Riksbank proposes using as a base for the reference rate.

**Figure A2.1. Entire overnight market based on statistics from MFIs**

SEK billion per day, deposits
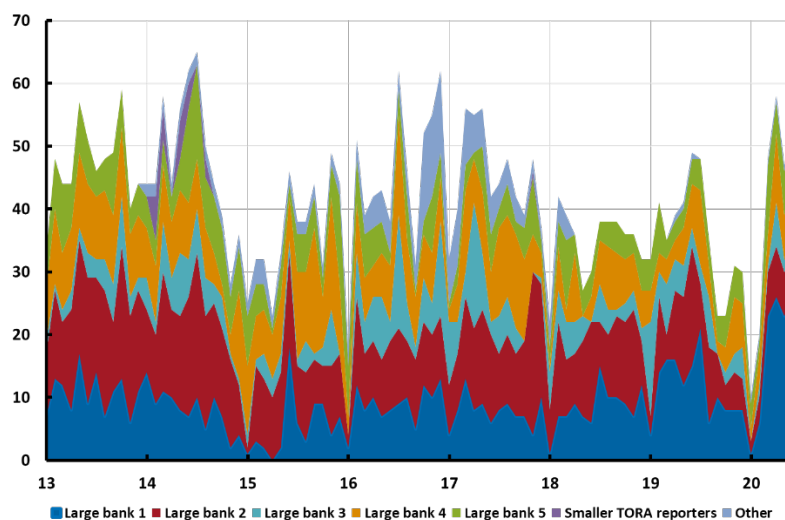
Note: Data at month-end. Data include MFIs' overnight loans in SEK in the form of deposits from foreign and Swedish non-MFI and MFI clients. Data exclude intragroup flows by excluding hypotek and various financial companies that belong to a bank already included in the statistics.

Figure A2.2. Entire overnight market based on statistics from MFIs

Per cent, deposits
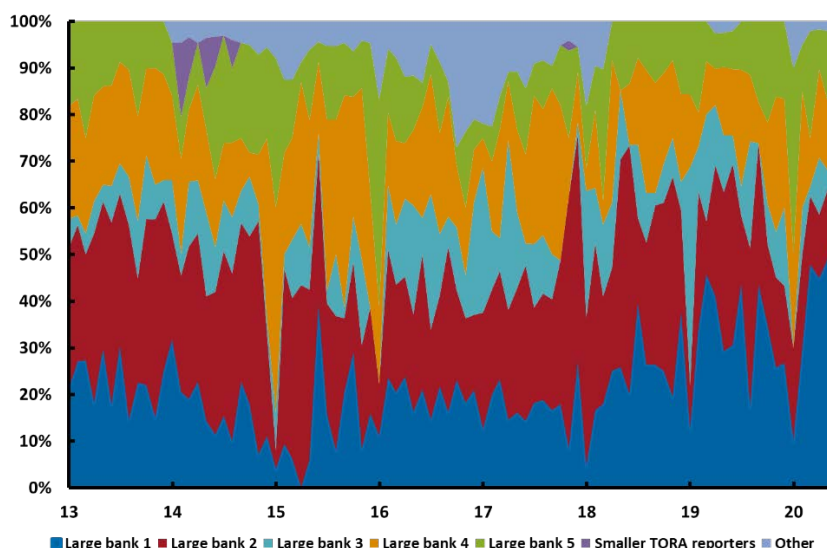
The Riksbank's proposed transaction dataset comprises a large share of the entire overnight market (see Figures A1 and A2). The average volume on the overnight market 2013-2020 was around 41 billion. Of this, around 39 billion was managed by the nine of the Riksbank's monetary policy counterparties reporting their transactions on deposits in SEK with the maturity O/N. Over the past two years, these nine report submitters have represented more than 90 per cent of the entire market. Five major banks (Svenska Handelsbanken, Skandinaviska Enskilda Banken, Danske Bank, Nordea and Swedbank) account for almost the entire volume on the overnight market. This means that the transaction dataset that we propose to base the reference rate on would in principle capture the entire underlying market.

Given this, we can draw the conclusion that the Riksbank's nine largest monetary policy counterparties (out of a total of 23) cover in their reporting almost all active financial agents in the Swedish overnight market. These nine counterparties daily report transactions on the underlying market as identified above. However, the other monetary policy counterparties annually report their transactions on the underlying market. This means that at the time of the first annual report submission, the Riksbank will have the opportunity to ensure to a greater extent that the transaction dataset based on the current 9 report submitters is really representative. Moreover, there is an opportunity to increase the number of report submitters over time. When the counterparts who do not report daily now become more active on the market, they will also have to report on a daily basis. This will ensure that the transaction dataset for the reference rate continues to be representative of the underlying market. The reporting requirement is regulated through the Terms and Conditions for RIX and Monetary Policy Instruments.

Annex 3. Length of time series for transaction data – consequences for the analysis

The referral bodies expressed some doubts about the quality of the Riksbank's dataset and called for longer time series to ensure that the analysis and conclusions presented by the Riksbank are reliable.

The transaction dataset that forms the base for the Riksbank's new reference rate comprises the transactions reported daily to the Riksbank by the nine largest and most active of the Riksbank's monetary policy counterparties since October 2019. It is also the base that has been a foundation for the analysis made by the Riksbank prior to the publication of a transaction-based reference rate. Consequently the dataset comprises relatively short time series, but it reflects the underlying market for the reference rate. Moreover, the dataset the Riksbank has used has a granularity that enables a more detailed analysis than the dataset used by the working group for alternative reference rates ("AGAR", commissioned by the Swedish Bankers' Association). For instance, the Riksbank's transaction dataset contains more information on counterparties in the report submitters' transactions.

Further, it is the transaction dataset that the Riksbank has used in its analysis gathered during a period with a large liquidity surplus, which is something that will most probably, given the measures the Riksbank has taken during the coronavirus crisis, remain for a long time to come.

In a comparison with the dataset used by AGAR, we can observe that it shows the same characteristics as the Riksbank's dataset, despite AGAR's data referring to a different and moreover longer period of time (2015-2018). For a comparison of data, see Table A3.1 and Figures A3.1-3 below. Mean rates in the respective sub-groups and volume shares behave in a similar manner and the results of the analysis the Riksbank has carried out point to very similar results regardless of the dataset on which they are based. The datasets can therefore be regarded more as a complement to one another, in that they cover different time periods. All in all, this means that the Riksbank's transaction dataset can be used to draw well-founded conclusions.

Table A3.1. Average of volume-weighted mean rates over the respective period for AGAR's and the Riksbank's data
Deviation from the repo rate, percentage points

	Banks	Financial institutions	Major banks/Stibor banks + SNDO	Non-financial corporations
Riksbank data (2020)	-0.15	-0.09	-0.02	-0.02
AGAR data (2015-2018)	-0.18	-0.11	-0.02	-0.06

Figure A3.1. Daily volume share for respective sub-group in AGAR's and the Riksbank's data[8]
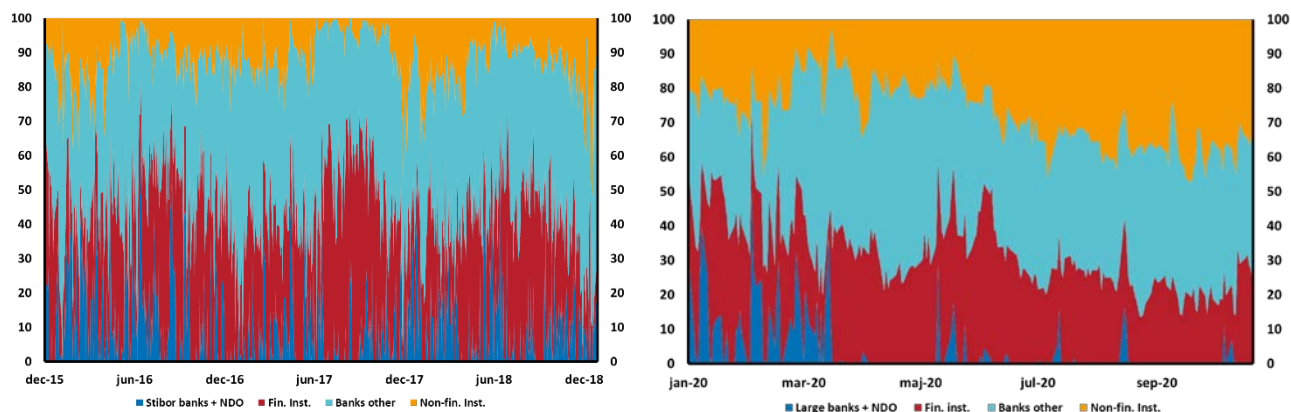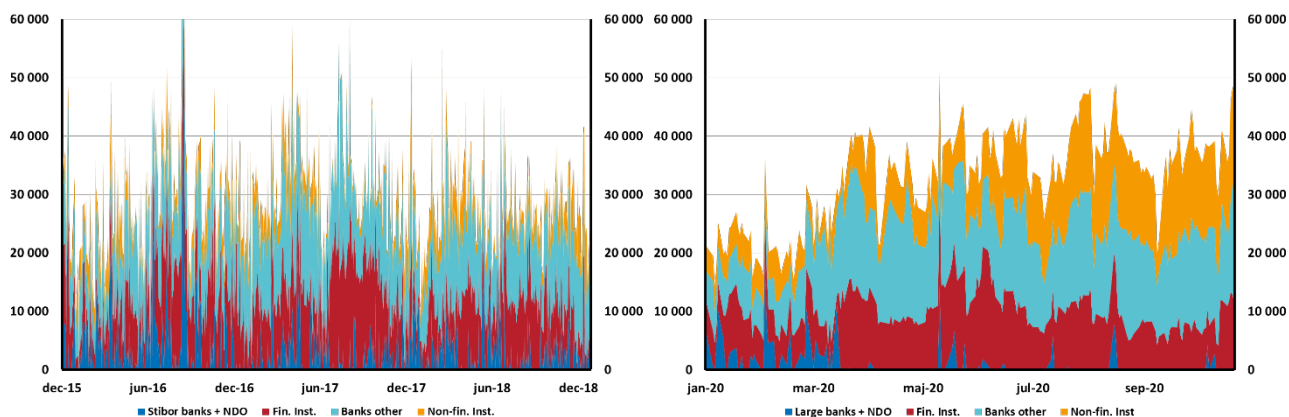
Per cent

Figure A3.2. Daily volume share for respective sub-group in AGAR's and the Riksbank's data

In SEK millions

[8] As the data on which AGAR has based its analysis is not as granular as the Riksbank's data, the sub-groups are not identical. The counterparty group Major banks in the Riksbank's data contains the 5 largest banks and the SNDO, while the STIBOR banks in AGAR's data also include Länsförsäkringar Bank and SBAB. Nor is it possible to ensure that the STIBOR banks are correctly categorised in the AGAR data.

Figure A3.3. Volume-weighted mean rates for respective sub-group in AGAR's (left) and the Riksbank's (right) data

Deviation from the repo rate in percentage points
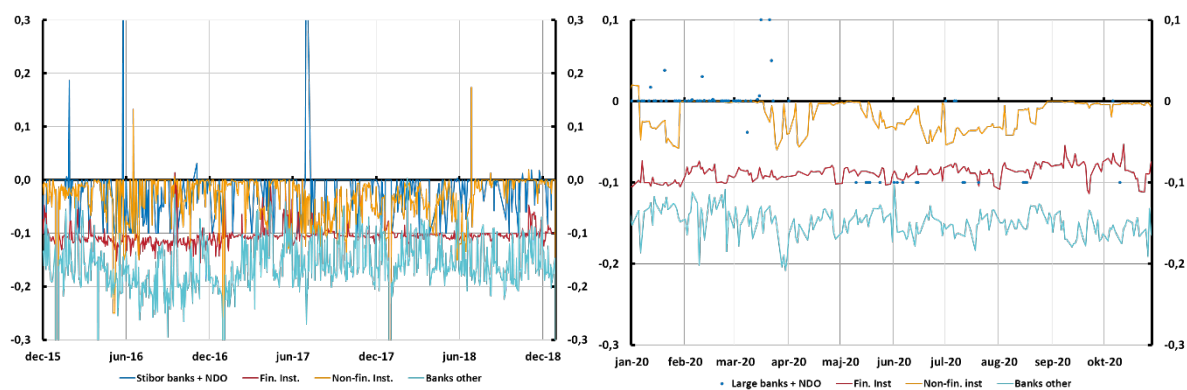
Annex 4. Mathematical Formulae

Normal calculation routine for reference rate

The below formulation of the normal calculation routine is somewhat more complicated than might seem necessary in order to create a natural flow of calculations since trimming is made on each subgroup of counterparties. The reference rate is computed as a volume weighted average of four individually computed volume weighted average rates after trimming. This corresponds to a simple volume weighted average.

Let I be the set containing the following subgroups of counterparties; Large banks and the Swedish national debt office (Riksgälden(RGK/SNDO)), Other banks, Other financial institutions and Non-financial firms.

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 after trimming on each subgroup,

$V_i^\tau = \sum_{j \in J_i^\tau} V_j^\tau$ 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,

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

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

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

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:

$$R_{alt.}^\tau = Repo^\tau + \frac{1}{3} \sum_{j=0}^{2} (R^{\tau-j} - Repo^{\tau-j})$$

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:

$$R_{alt.}^{\tau} = Repo^{\tau} + \frac{1}{2}\sum_{j=1}^{2}(R^{\tau-j} - Repo^{\tau-j})$$

Trimming

Let:

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

$$r_k \le r_{k+1} \; \forall k = 1, \dots, N$$

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:

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

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

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

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

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 the cumulative volume of the first k rate buckets:

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

and define i_α as:

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

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

$$\bar{V}_{k,j} = 0, \forall k \le i_\alpha, \forall j = 1, \dots m_k$$

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

$$\bar{V}_{k,j} = V_{k,j}, \forall k > i_\alpha + 1, \forall j = 1, \dots m_k$$