Consultation Paper on Enhancements to EURIBOR's Hybrid Methodology

The European Money Markets Institute

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1. Introduction

With the start of the euro in January 1999, the EURIBOR index was created and replaced domestic reference rates across the Eurozone. EURIBOR is nowadays a major euro interest reference rate, administered by the European Money Markets Institute (EMMI). In light of its wide use in the global financial system as a reference rate for a large volume and broad range of financial products and contracts, EURIBOR was designated in 2016 as a critical benchmark in the Commission Implementing Regulation (EU) 2016/1368 of 11 August 2016 establishing a list of critical benchmarks used in financial markets pursuant to Regulation (EU) 2016/1011 of the European Parliament and of the Council (EU BMR). EMMI was authorized by the Belgian Financial Services and Markets Authority (FSMA) for the administration of EURIBOR on 2 July 2019 and was included in the European Services and Markets Authority's (ESMA) Register of benchmark administrators on 4 July 2019. On 1 January 2022, ESMA became EMMI's supervisory authority.

The EU BMR places a duty on benchmark administrators to have in place procedures for the potential need for the evolution of a benchmark. Article 11 (input data) and Article 28 (changes to and cessation of a benchmark) require benchmark administrators to maintain a procedure for actions to be taken in the event a material change to the benchmark occurs.

To guarantee EURIBOR's transparency toward users, facilitate the identification of material changes, and in line with international practice, the EURIBOR specification is the result of combining two aspects:

(i) EURIBOR's underlying interest, which defines the market or economic reality that EURIBOR seeks to measure; and
(ii) A statement of EURIBOR's determination methodology, which describes how the underlying interest is to be measured, stipulating the relevant data inputs and the method of calculation.

To this end, the *underlying interest* represents a fundamental element of the specification, as it defines the objective for establishing the benchmark. In turn, the determination methodology is a means to measure this objective. A benchmark administrator should choose a determination methodology that faithfully portrays the underlying interest, considering the structure and dynamics of the market for the underlying interest.

EURIBOR's underlying interest has been established as "the rate at which wholesale funds in euro could be obtained by credit institutions in current and former EU and EFTA countries in the unsecured money market" (c.f. paragraph 1 in Benchmark Determination Methodology for EURIBOR).

The EURIBOR methodology is the focus of this consultation paper. The current hybrid methodology was fully implemented in 2019, as an evolution of the previous quote-based methodology that did not fully satisfy some of the principles of the EU BMR. With the objective of further enhancing the hybrid methodology, at the end of 2021 EMMI started to explore the possibility of reformulating some of the methodology's levels in the waterfall approach and, as a by-product, discontinuing the recourse to Panel Banks' expert judgment from the EURIBOR calculation. The work toward this goal was performed with the support of a dedicated Task Force in which representatives of the current Panel Banks participated. Following a 'funnelling approach,' supported by extensive and in-depth analyses, in June 2023 EMMI selected a final candidate methodology.

This consultation paper sets out in more detail and seeks respondents' views on EMMI's proposed changes to the hybrid methodology of EURIBOR. By providing further insight on the methodology's

development work, EMMI expects to get a reliable indication of the market's opinion and view on the proposed methodology changes.

The questions on which EMMI would welcome feedback from market participants, interested parties and stakeholders are placed throughout the text in the relevant sections. Feedback may be submitted by e-mail to [hybrid2023@emmi-benchmarks.eu] specifying "EURIBOR Consultation 2023" as subject.

EMMI would be thankful if all responses reached the EMMI Secretariat by [Monday, 11 December 2023]. A summary of stakeholder feedback is intended to be published by end of February 2024.

2. EURIBOR's hybrid methodology

2.1. The current hybrid methodology

EURIBOR's underlying interest is "the rate at which wholesale funds in euro could be obtained by credit institutions in current and former EU and EFTA countries in the unsecured money market" (c.f. paragraph 1 in Benchmark Determination Methodology for EURIBOR®). The EURIBOR methodology is the tool that EMMI has designed to calculate this economic reality.

EURIBOR is published for five different maturities. Being a money market interest rate benchmark, EURIBOR's Defined Tenors are up to one year maturity, namely: 1 week, 1 month, 3 months, 6 months and 12 months.

The hybrid methodology seeks to ground the calculation of EURIBOR, to the extent possible, in euro money market transactions that reflect the Underlying Interest, following a hierarchical approach consisting of three levels:

Level 1	Submission based solely on transactions in the underlying interest at the Defined Tenor from the prior TARGET[1] day, using a formulaic approach provided by EMMI.		
Level 2	Submission based on transactions in the underlying interest across the money market maturity spectrum and from recent TARGET days, using a defined range of formulaic calculation techniques provided by EMMI.	**Level 2.1**	Adjusted linear interpolation from adjacent Defined Tenors.
		Level 2.2	Transactions at non-Defined Tenors.
		Level. 2.3	Eligible transactions from prior dates.
Level 3	Submission based on additional transactions in the underlying interest, excluded from Level 1 and Level 2 submissions, and/or other data from a range of markets closely related to the unsecured euro money market, using a combination of modelling techniques and/or the Panel Bank's judgment.		

[1] TARGET is the Trans-European Automated Real-time Gross settlement Express Transfer System. The Eurosystem maintains TARGET2, which is the second generation of TARGET and is a real-time gross settlement system. Throughout this document, references to "TARGET" should be read with respect to the Eurosystem's TARGET2 system.

Figure 1. Current Hybrid Methodology for EURIBOR

Under this methodology, each day, each individual Panel Bank's contribution, for each Defined Tenor, is determined based on one of these three levels and respective sub-levels. This approach is applied progressively. Thus, a Panel Bank's submission is determined using the Level 1 methodology when the conditions for such an approach are met. If such conditions are not met, it should be assessed whether the conditions for a Level 2 submission are satisfied, and, if so, the Panel Bank's submission will be based on Level 2. Finally, if neither a Level 1 nor a Level 2 submission can be made, the Panel Bank makes a Level 3 submission. In each case, the Panel Bank's submission shall consist of a submission rate and the corresponding submission Level.

Further details can be found in the Benchmark Determination Methodology for EURIBOR.

2.2. Proposed changes to the hybrid methodology

The waterfall approach described above has proven to be a robust and resilient calculation methodology for EURIBOR. Since its implementation in 2019, the hybrid methodology has withstood periods of market uncertainty, such as the one derived from the pandemic crisis in 2020, as well as the effects of sudden increasing inflation and of rapid tightening in the euro area's monetary policy by the European Central Bank. EURIBOR remained a representative measure of its underlying interest through these periods, which at times were marked by low market activity (pandemic period) or high volatility (changes in monetary policy).

Level 2.3 of the hybrid methodology relies on external input data for its calculation: for a given Defined Tenor, a Panel Bank's contribution rate is calculated as the sum of the contribution rate on the most recent day at that tenor when a Level 1 contribution was made and a so-called Market Adjustment Factor (MAF), which seeks to correct for the overall movement in interest rates between the day of the last Level 1 contribution and the current date. The MAF is currently calculated based on changes in the closing prices of the ICE EURIBOR futures contracts for the quarterly months. In the Summary of Stakeholder Feedback to the Second Consultation Paper on a hybrid methodology for EURIBOR (see here), EMMI indicated that "the choice of the EURIBOR futures curve as a MAF was made in the absence of benchmark rates for the overnight index swap (OIS) market that could be used as a means to observe movements in the swaps market." EMMI further agreed with the respondents "that OIS products could be preferable to futures in that the liquid maturities of these swaps align more closely to the EURIBOR tenors than those of the futures." EMMI further clarified that, "as part of the regular review of the methodology, ***should such benchmarks emerge in the future***, EMMI will re-visit the use of the OIS data to provide a set of MAFs." The recent start of the publication of EMMI-administered EFTERM® provided a change in paradigm to the reality described above, and an opportunity to **reformulate EURIBOR's Level 2.3 calculation** method as per EMMI's commitment above.

Re-visiting the use of OIS data to calculate Level 2.3 also gave EMMI the opportunity to **reassess the necessity of continuing EURIBOR's dependence on Level 3**. These contributions are determined individually by each Panel Bank and rely on input data and modelling techniques that reflect the specificities of their own funding model. While Panel Banks are not mandated to opt for a particular methodology for the determination of their contributions models, Section 13 of the Code of Obligations of Panel Banks (COPB) provides a series of guiding principles that should be respected. Level 3 contributions are closely monitored, and Panel Banks are required to put in place a strict control framework to protect their contributions' and, ultimately, EURIBOR's integrity.

From a **methodological perspective**, Panel Banks' models have proven to adequately proxy their cost of funding. However, from an operational and organisational perspective, by accepting their role as contributors toward EURIBOR, Panel Banks are exposed to considerable operational and

financial burden and risk, derived from strict three-level control models (c.f. Section 5 of the COPB), the obligation to implement an accountability framework and policies for independent review (c.f. Sections 9 and 14 of the COPB), or the development of specific IT control and contribution systems (c.f. Data Transmission and Validation under the Hybrid EURIBOR Methodology), among others.

In analysing the possibility of applying changes to Level 2.3, while discontinuing Level 3, EMMI had in mind the following two principles:

- Any changes should not put EURIBOR's representativeness at risk, nor its robustness and resilience or its reliability;
- Any changes should not affect EURIBOR's characteristics: a methodological change should simply provide an alternative way of measuring EURIBOR's Underlying Interest.

From a benchmark's **sustainability perspective**, the discontinuation of Level 3, hence eliminating the entry and periodic costs and burden derived from the considerations above, should provide an opportunity for the enlargement of the EURIBOR Panel.

The following figure reflects a high-level description of EMMI's proposed changes to the methodology: reformulation of Level 2.3 and elimination of Level 3.

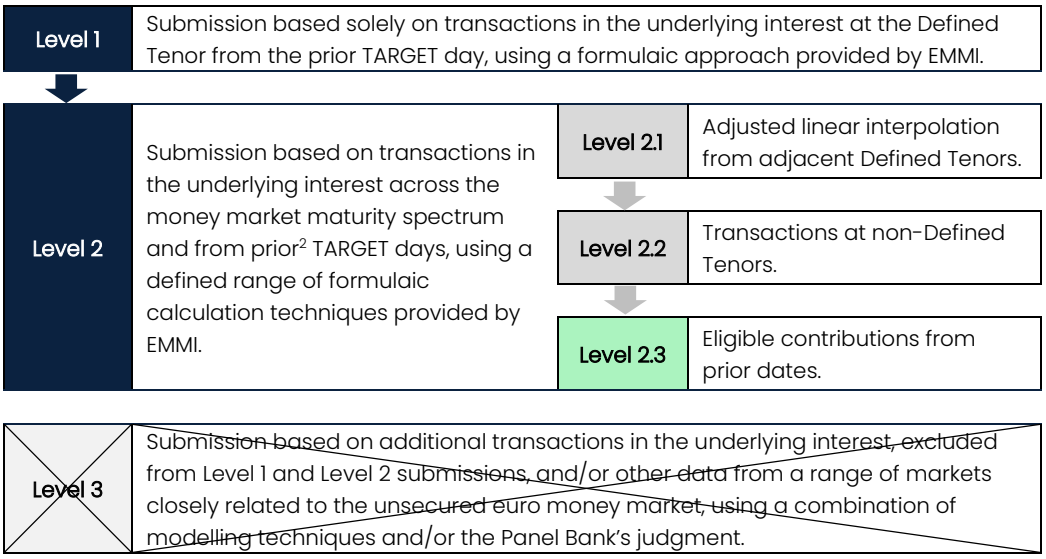

Figure 2. Proposed changes to the hybrid methodology for EURIBOR

It is worth noting that Level 1 and sub-levels 2.1 and 2.2 will not be subject to any modification. EMMI considers that these Levels fully capture Panel Banks' cost of funds: on the one hand (Level 1) due to its fully transaction-based nature, and on the other hand (sub-levels 2.1 and 2.2) due to their reliance on techniques that, in turn, rely on transaction-driven data.

In the following section, we further detail our proposal.

Question 1: Do you consider that EMMI's proposal to strengthen the Level 2.3 determination in a way that allows to discontinue Level 3 enhances the EURIBOR hybrid methodology?

[2] As further explained on page 10, under the paragraph "Look back methodology to guarantee a bank's contribution"; the wording for Level 2 is changed from "recent Target days" to 'prior Target days".

3. Reformulation of Level 2.3

As mentioned above, under the current hybrid methodology a Level 2.3 contribution is calculated as the sum of the most recent Level 1 contribution and a measure of the overall movement in interest rates between the day of the Level 1 contribution and the current date (the so-called MAF). This movement in interest rates is calculated based on changes in EURIBOR futures. In the following sections, whenever needed, T shall be understood as the date of *calculation and publication* of EURIBOR, representative of the market on day T-1.

The proposed calculation methodology for Level 2.3 contributions introduces two enhancements:

- On the one hand, **the starting point for the calculation of a Level 2.3 contribution is enlarged**, in the sense that not only prior Level 1 contributions can be considered as a basis of Level 2.3, but also any prior Level 2 contributions. EMMI considers that Level 2 contributions (coupled with the eligibility criterion explained below) are accurate representations of a Panel Bank's cost of funding, transparently derived from the Panel Bank's real transactions.

Question 2: Do you agree that not only Level 1 contributions but also Level 2.1 or Level 2.2 could serve as basis for Level 2.3 contributions?

- On the other hand, the MAF is redefined by considering not only a proxy of changes in interest rates, but also a component that intends to capture daily changes in the perceived (credit) risk in the economy. To reflect **changes in interest rates**, EMMI proposes to rely on the euro OIS market, thus better matching the different EURIBOR maturities. However, while OIS rates are mainly driven by the future path of overnight rate expectations,[3] and can be assumed as a proxy to the so-called "risk-free" rate curve, EURIBOR bears a notion of credit and liquidity risk[4] in its definition that cannot be captured solely by OIS rates. To correctly reflect EURIBOR's Underlying Interest, it is necessary to add, further to the "risk-free" rate, a component that captures **changes in the perceived credit risk in the economy**.

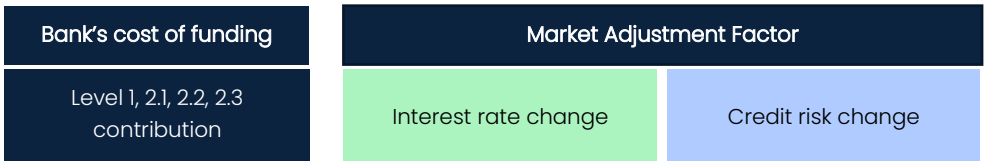

Figure 3. Enhanced Level 2.3 calculation method

The three components of the reformulated Level 2.3

The **Bank's cost of funding** component intends to measure the rate at which the bank acquires funds in the unsecured market. This component acts as the foundation of a Level 2.3 contribution.

[3] Thus linked to the market's expectations of the path of central bank key monetary policy rates.

[4] For the sake of simplicity, throughout the consultation, the term *credit risk* will be used to express this notion.

By relying on the most recent contribution (be it a Level 1, Level 2.1, Level 2.2, or Level 2.3) the Level 2.3 rate is anchored on a transaction-driven cost of funding specific to the Panel Bank.

Looking at the two components of the MAF, the **interest rate change** component captures daily changes in the euro area future "risk-free" rates trajectory. This component is calculated using the day-to-day EFTERM rate differential corresponding to the tenor for which the Level 2.3 contribution is being calculated, representing the adjustment of the Panel Bank's cost of funding to the changes in "risk-free" rates.

Finally, the **credit risk change** component captures daily changes in the perceived credit risk in the economy. This component is calculated using the EURIBOR – EFTERM spread term rate differential. This last component acts as a proxy for the ability of credit institutions (or lack thereof) to return funds to the counterparties from which they borrowed, e.g., when the gap between both rates widens, one can derive there are tensions in the financial sector.

Question 3: Do you agree with the proposed redefinition of Level 2.3's Market Adjustment Factor in terms of the changes in the euro "risk-free" rate curve and changes in the perceived credit risk? Do you agree with the proposed proxies of the respective components?

A Qualifying Criterion for the Panel Bank's cost of funding component

The increase in the number of eligible Levels that may act as anchor for the determination of a Level 2.3 contribution must be accompanied by some controls that guarantee the representativeness of this 'Bank's cost of funding' component in previous contributions that are not done at Level 2.3. By introducing these controls, EMMI will prevent the perpetuation of one-off anecdotic market-driven outlier rate behaviour.

On a given day, the previous day's Level 1, Level 2.1 or Level 2.2 can be used as basis for the determination of a Level 2.3 contribution if any (or both) of the following two tests are passed:

- **Dynamic rate threshold test.** When compared against a measure of the dispersion of prior days' contribution rates, the candidate rate to act as the 'Bank's cost of funding' is in line with the usual Panel Bank's contribution pattern.
- **Volume threshold test.** The notional volume associated with the candidate rate is above a predefined notional volume.

Look-back methodology to guarantee a Bank's contribution

In case the previous day's Panel Bank's contribution under Level 1, Level 2.1 or Level 2.2 does not successfully pass one of the two tests, and to guarantee that representative Level 2.3 contributions can always be derived, the enhanced Level 2.3 methodology looks back to ***older*** Level 1 and Level 2 contributions reversed-chronologically, until it encounters a contribution that was either:

- Performed at Level 2.3; or
- Performed at Level 1, Level 2.1, or Level 2.2 and successfully passes one of the two tests in the Qualifying Criterion described above.

Using this qualifying contribution as the 'Bank's cost of funding' component, the corresponding MAF will be calculated to reflect moves from the date of this qualifying rate (say *T-n*) and *T-1*: the interest rate change component will be obtained as the sum of day-to-day interest rate changes between *T-1* and *T-n*. The credit rate change component will be calculated similarly.

This approach guarantees:

- **Operational robustness**, as it allows for the calculation of Panel Banks' Level 2.3 contributions in all circumstances; and

- **Contributions representativeness**, as it adjusts Banks' cost of funding based on the evolution of market conditions, catering for changes in the "risk-free" rate curve and changes in the perceived credit spread.

The following sections provide further insight on the proposed reformulation for Level 2.3.

3.1. The components of the reformulated Level 2.3

As mentioned above, EMMI proposes an enhancement of Level 2.3 calculation methodology to be composed of three components: a Panel Bank's **cost of funding** component, an **interest rate change** component, and a **credit risk change** component.

3.1.1. The Bank's cost of funding component

The **Bank's cost of funding component** represents the rate at which the Panel Bank borrowed funds in the unsecured market and anchors the Level 2.3 contribution rate. EMMI proposes to rely on the Panel Bank's contribution rate on the previous day as a proxy for this component—regardless of the methodological Level obtained to calculate it. However, due to its importance in determining the future path of the Panel Bank's contributions, **whenever the contribution rate of the previous day is determined at either Level 1, Level 2.1 or Level 2.2**, EMMI intends to implement a **Qualifying Criterion** to eliminate potential biases on future contribution rates emanating from one-off anecdotic market driven outlier contributions. Note that if a previous day's contribution was performed at Level 2.3, it will be directly eligible.

The Qualifying Criterion is composed of two different tests: the **dynamic rate threshold test** and the **volume threshold test**. If *any* (or both) of these two tests is successfully passed, the previous day's candidate rate to act as the 'Bank's cost of funding' will be deemed eligible.

In case the candidate rate fails to pass both tests, then older contributions will be examined until one that meets the Qualifying Criterion is encountered. Using this qualifying contribution as the 'Bank's cost of funding component,' the corresponding MAF will be calculated to reflect moves from the date of this qualifying rate and *T-1* as per the methodology described in Section 3.2.

The following diagram describes the logic for the proposed enhancement of Level 2.3.

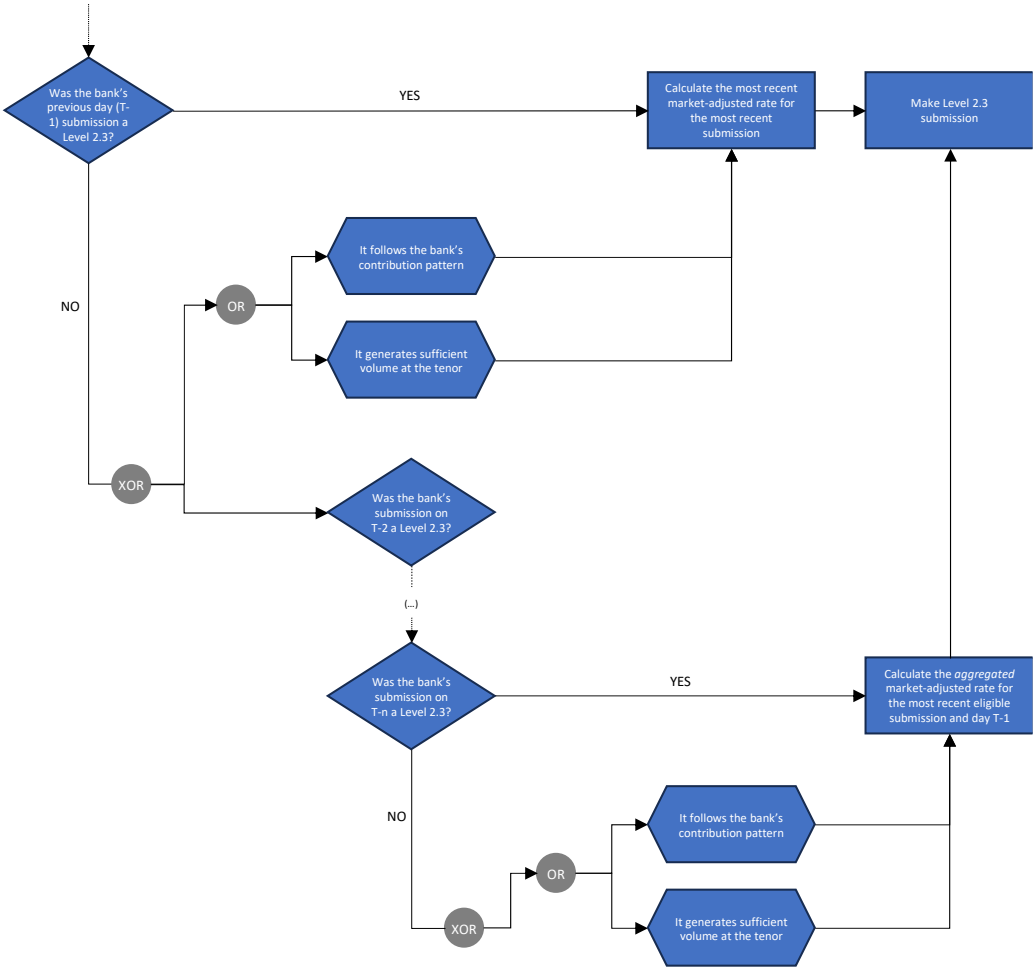

Figure 4. Proposed Level 2.3 calculation logic

3.1.1.1. Dynamic rate threshold test

The first of the eligibility tests of the Qualifying Criterion relates to the behaviour of an individual Panel Bank's contribution rates from previous days. At times, transaction-driven contributions may present a volatility higher than expected; this test limits the perpetuation of one-off anecdotic market-driven outlier rate behaviour.

Under the assumption that day-on-day changes in term spreads of individual Panel Banks' contribution rates versus EFTERM have a distribution that is approximately bell-shaped,[5] EMMI proposes to identify outlier rates as per the Empirical Rule in statistics,[6] and discard rates that are more than two standard deviations away from the average.

[5] In other words, we assume that the probability distribution of term spreads is normal.

[6] The Empirical (or 68-95-99.7) Rule states that for data sets having a distribution that is approximately bell-shaped, the following properties apply:

- About 68% of all values fall within 1 standard deviation of the average.
- About 95% of all values fall within 2 standard deviations of the average.
- About 99.7% of all values fall within 3 standard deviations of the average.

Let us assume that, for a given Panel Bank, on a given day and for a given tenor, it is necessary to decide whether a given candidate rate (a previous day's contribution under Level 1, Level 2.1 or Level 2.2) shall be used as the Level 2.3's Bank's cost of funding component. First, EMMI will calculate Panel Bank specific contribution spreads (vis-à-vis EFTERM for the corresponding tenor) over a pre-defined lookback period as well as a set of day-on-day changes in term spreads over this same period. After the determination of the average and the standard deviation of this set of day-on-day changes in term spreads, the spread of the candidate rate vis-à-vis EFTERM will be calculated,[7] as well as the corresponding change since the previous day. If the absolute difference between the day-on-day change of the candidate rate with respect to the previous day and the average day-on-day change falls within two standard deviations from the average spread, the candidate rate will have passed the dynamic rate threshold test, and thus be considered eligible. Otherwise, the candidate rate will have failed the test, being then considered an outlier not qualifying as the 'Bank's cost of funding' component.

To capture trends in individual Panel Banks' contribution patterns and based on analyses conducted with contributions spanning three and a half (3.5) years between January 2020 and May 2023, EMMI proposes a **21-days long lookback period**. Out of the different lookback periods studied, the proposed 21 days strike the right balance to guarantee the representativeness of the candidate rate.

Question 4: Do you agree with the application of the Empirical Rule (under the assumption of normality referred to in the text) for the identification of outlier candidate rates for Level 2.3's Bank's cost of funding component?

BOX 1: Methodological note: outliers in the dynamic threshold test

The EU BMR, Article 11, 1(a) establishes the obligation for benchmark administrators to rely on transaction data for the determination of a benchmark. In the Benchmark Determination Methodology for EURIBOR (BDM), EMMI establishes eligibility criteria for individual transactions both in terms of their notional volume (among other conditions) and the minimum number of eligible transactions (c.f. Section 3 in the BDM) to guarantee that input data to EURIBOR is an accurate representation of its Underlying Interest. Under the proposed dynamic threshold test, transactions or contributions that were considered as representative of a Panel Bank's cost of funds on a given day may be regarded as ineligible as anchor for future Level 2.3 contributions. The rationale behind this apparent discrepancy lies in the fact that transaction-based or transaction-derived contributions may present increased volatility due to the fact, for example, that Panel Banks may borrow funds, in legitimate transactions, from a diverse set of counterparties, with slight variations in their pricing. If the day-on-day variation is too high, the dynamic threshold test guarantees that this "uncommon behaviour" is not transmitted to future contributions under Level 2.3, hence avoiding introducing a bias that would not be representative of the Panel Bank's cost of funding.

3.1.1.2. Volume threshold test

The second eligibility test imposes a condition on the notional volume associated to a Panel Bank contribution under Level 1, Level 2.1 and Level 2.2 for it to be used as a Level 2.3 'Bank's cost of funding component.' As mentioned above, this kind of control is already embedded in the hybrid methodology: in the case of Level 1, "only transactions with notional volume of EUR 10 million or more are eligible" (BDM, paragraph 24), and in the case of Level 2.2, "a Panel Bank's contribution

[7] This calculation is the well-known process of standardisation or calculation of z-values for normal distributions.

should be calculated using this technique when (…) the transaction volume (…) is at least EUR 10 million" (BDM, paragraph 33). The main objective behind the implementation of these minimum size thresholds is to minimise the potential of single *small* transactions to influence or drive the benchmark to levels not reflective of the market. In the case of the proposed test for the enhanced calculation of Level 2.3, this same logic applies. In addition, it also aims at guaranteeing that transactions with a significant volume are considered. These transactions are regarded to reflect genuine changes in an individual Panel Bank's appetite for funds.

Let us assume that, for a given Panel Bank, on a given day and for a given tenor, it is necessary to decide whether a given candidate rate (a previous day's contribution under Level 1, Level 2.1 or Level 2.2) shall be used as the Level 2.3's 'Bank's cost of funding component.' The volume threshold test looks at the notional volume associated to the candidate contribution rate. The formulation of the volume threshold test changes: depending on the Level at which the candidate rate was submitted:

- If the candidate rate corresponds to a Level 1 contribution, EMMI will assess whether the sum of the volume(s) underlying the transaction(s) composing the contribution is larger than or equal to EUR 20 million.
- If the candidate rate corresponds to a Level 2.1 contribution, EMMI will assess whether the weighted average of the sum of the volumes of the transaction underlying the Level 1 contribution in the adjacent tenors is larger than or equal to EUR 20 million. The weights will be based on the respective number of days over the spot settlement date applying to each tenor (following the logic used to determine contributions under Level 2.1).
- If the candidate rate corresponds to a Level 2.2 contribution, EMMI will assess whether the sum of the volume(s) underlying the split transaction(s) composing the contribution is larger than or equal to EUR 20 million.

If the candidate rate satisfies the volume threshold condition, the candidate rate will have passed the volume threshold test. Otherwise, the candidate rate will have failed the test, not qualifying as the 'Bank's cost of funding' component.

The threshold of EUR 20 million has been selected based on back testing between January 2020 and May 2023. It provides an optimal trade-off prioritising as much as possible eligible transactions against discarding transactions rates that are not in line with the specific Panel Bank contribution pattern. This threshold is higher than the EUR 10 million threshold used in Level 1. Such a prudent approach ensures that the anchoring of Level 2.3 is based on larger and therefore more significant amounts.

Question 5: Do you consider that EMMI's proposal to introduce the two eligibility tests described above ensures the representativeness of the 'Bank's cost of funding' component and prevents the perpetuation of one-off anecdotic market-driven outlier rate behaviour?

3.1.2. The Market Adjustment Factor

The Market Adjustment Factor (MAF) of Level 2.3 seeks to correct eligible contributions from prior dates for the overall movement in market rates. While the MAF is currently calculated based on

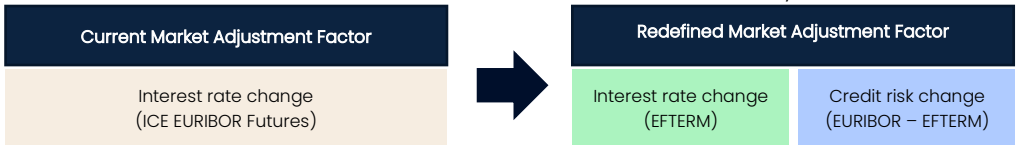

Figure 5. Suggested changes in the calculation of the MAF

changes in the closing prices of the ICE EURIBOR futures contracts for the quarterly months, the recent start of the publication of EMMI-administered EFTERM® provides an opportunity to **reformulate the calculation** method for the MAF. In addition, EMMI's proposal considers now not only a proxy of changes in interest rates, but also a component that intends to capture daily changes in the perceived (credit) risk in the economy.

3.1.2.1. Interest rate change

The role of the **interest rate change component** in the MAF is to ensure that a contribution rate calculated at Level 2.3 correctly reflects changes in the interest "risk-free" rate curve. For example, assuming a change in the ECB key policy rates, in the absence of transactions to determine a Level 1, Level 2.1 or Level 2.2 contribution on a given day, the Level 2.3's Bank's cost of funding component (which is ultimately an eligible contribution from prior days) should be adapted to reflect this change in funding conditions.

EMMI proposes to **rely on the EFTERM term rate** to assess these changes in the interest "risk-free" rate curve and calculate this component.

Use of EFTERM as input data for the interest change component

Given the critical role of EURIBOR for the well-functioning of financial markets, the choice for the reference rate underlying the calculation of the MAF's interest rate change component was carefully analysed, and the following criteria were regarded as crucial:

- The reference rate should be forward-looking, and able to capture interest rate changes and changes in the expected monetary policy path;
- The reference rate should align closely with the EURIBOR tenors;
- The reference rate should be published daily with a guarantee of future and continuous publication;
- The reference rate should be equipped with a robust governance framework; preferably as a benchmark as defined by EU BMR;
- The reference rate should be readily available.

EMMI examined three possibilities, illustrated in the table below: the European Central Bank's €STR, the Compounded €STR, and EFTERM which is the only available for use forward-looking €STR-based term benchmark.

Rate	Reflects monetary policy expectations	Forward looking	Available daily	Available for all EURIBOR tenors	Continuity	Governance
€STR	✓	✗	✓	✗	✓	✓
Compounded €STR	✓	✗	✓	✓	✓	✓
EFTERM	✓	✓	✓	✓	✓	✓

Table 1. Summary of attributes of selected reference rates

The **euro short-term rate (€STR)** is a rate which reflects the wholesale euro unsecured overnight borrowing costs of euro area banks. The European Central Bank (ECB) is the administrator of €STR, thus benefitting from a solid governance framework. The calculation methodology is transparent and published on the ECB's website. From an economic perspective, changes in the overnight rate cannot be applied uniformly to maturities ranging from 1 week to 12 months.

The **compounded €STR average rates** are backward-looking rates, calculated with the classical compound interest formula. From a conceptual perspective, it would be economically incorrect to assess changes in the market affecting a forward-looking rate as EURIBOR via changes in backward-looking compounded rates.

The EFTERM measures the expected (i.e., forward-looking) average evolution of wholesale euro unsecured overnight borrowing costs of euro area banks over defined tenor periods. It is a benchmark published daily for maturities that agree with the EURIBOR tenors. The determination methodology is transparent and available on the administrator's website. It benefits from the controls, the oversight and experience of an administrator authorised under EU BMR (https://www.emmi-benchmarks.eu/benchmarks/efterm/governance/).

Based on this analysis, EMMI considers that EFTERM is the only suitable benchmark to be used in Level 2.3's interest rate change component is EFTERM.

BOX 2: EFTERM®

EFTERM measures "the expected (i.e., forward-looking) average evolution of wholesale euro unsecured overnight borrowing costs of euro area banks over defined tenor periods."

The EU BMR requires supervised entities that use a benchmark to have robust written plans in place for the event that a benchmark materially changes or ceases to exist. Where feasible and appropriate, these plans should nominate one or more fallback rates.

To facilitate the establishment of such written plans for EURIBOR® licensees, the European Money Markets Institute has developed a forward-looking fallback rate based on available market data on overnight index swaps and futures that reference the European Central Bank's Euro Short Term Rate (€STR).

The current EFTERM® methodology follows a hierarchical approach consisting of three levels, which should be employed progressively and in the following order:

i. Level 1 consists of €STR-based OIS tradeable bid and offer prices and volumes collected for the defined tenors and available on the Central Limit Order Book of the selected Trading Venues over a predefined window preceding the EFTERM® calculation.
ii. Level 2 consists of €STR-based OIS dealer-to-client bid and offer prices and volumes displayed for the defined tenors by the selected Trading Venues over a predefined window preceding the EFTERM® calculation.
iii. Level 3 consists of a step function model using €STR-linked futures' settlement prices, €STR rates, ECB reserve maintenance periods calendar and the ECB interest rates ahead of each maintenance period.

This approach ensures, as with the EURIBOR, that there is a daily fixing of interest rates.

EFTERM has proven to be representative of the underlying market it seeks to measure. EMMI performs an annual assessment of the methodology which seeks to improve or revise any elements which need to be changed.

Question 6: Do you agree that EFTERM is an adequate rate for the interest rate change component for the reviewed MAF in Level 2.3?

3.1.2.2. Credit risk change

The role of the **credit risk change component** in the MAF is to capture changes in the perceived risk in the economy. EURIBOR is a benchmark that represents how much credit institutions pay to

obtain funds in the **unsecured segment** of the euro money market[8] from **wholesale counterparties**. Due to the absence of collateral to guarantee the position of the lender, and the extended maturity of the transactions (when compared to "risk-free" one-day trades), among other considerations, unsecured rates tend to include a margin that protects the lender against situations in which the borrower is unable to pay back the borrowed funds. Thus EURIBOR contains a component that is sensitive to the perceived (credit, liquidity, etc.) risk in the economy. It is therefore necessary to take this into account for the determination of Level 2.3 contributions in addition to the changes in the risk-free component.

EMMI suggests to adopt the **spread between EURIBOR and EFTERM as the best available measure for this component**. This measure presents several positive features:

- It can be easily calculated on a daily basis for each of the EURIBOR tenors;
- It is based on the latest updated market information;
- It is already used by market practitioners to estimate the perception of risk in shorter maturities.

As the MAF intends to reflect *changes* in the market since the date of Level 2.3's 'Bank's cost of funding' component, we are interested in **day-on-day differences** between successive EURIBOR-EFTERM spreads, and not the spreads themselves.

In practice, in the absence of transactions to determine a Level 1, Level 2.1 or Level 2.2 contribution on a given day, the Level 2.3's 'Bank's cost of funding component' will be adapted to reflect changes in funding conditions, resulting, for example, from the difficulty of credit institutions to borrow liquidity.

Question 7: Do you consider that EMMI's proposal to base the change in the credit risk component on the EURIBOR versus EFTERM spread is adequate?

Question 8: Do you agree that the enhancements introduced in the MAF are adequate to capture both interest rate and perceived risk developments in the underlying market?

3.2. Level 2.3 calculation

Due to the constraints in the ECB's Money Market Statistical Reporting (MMSR) data availability, among other limitations, which is the basis of Level 1's Panel Banks' submissions, **EURIBOR is calculated and published in the morning of day *T* with contributions reflecting the market throughout day *T-1***. As mentioned in paragraph 67 of the EURIBOR Code of Obligations of Panel Banks, "a Level 3 contribution should reflect the average rate of borrowing by the Panel Bank over the TARGET day preceding the day of publication." In turn, **EFTERM is calculated and published in the morning of day *T* with input data reflecting the market on day *T***. The apparent one-day lag in the sub-indices of the terms in the formulas below simply reflect these characteristics, so as to guarantee the correct calculation of the components of the MAF.

[8] The euro money market is usually divided into five segments, characterised mainly by the features of the financial instruments used therein: (i) secured – repos and reverse repos, (ii) unsecured, (iii) the issuance of short-term securities (STS), (iv) foreign exchange (FX) swaps, and (v) overnight index swaps (OIS). For a full description of these segments, we refer the reader to the ECB's euro money market studies.

For a given tenor and a given Panel Bank, let *T* denote a given TARGET day of calculation and publication of EURIBOR representative of the market on TARGET day *T-1*. In particular, contributions under either of the levels of the hybrid methodology should abide to this logic.

Let $Cont_t^L$ denote a Panel Bank contribution under Level *L* performed on day t. Note that the variable *L* may take the values 1, 2.1, 2.2, or 2.3, and *t* may take any TARGET day value; we will use the notation $Cont_{t=T}^L$ to refer to contributions of a Panel Bank on day $t = T$, or by abuse of notation simply use $Cont_T^L$. Other variables will have similar super- and sub-indices, and the same abuse of notation may occur.

Let $EUR_{t=T}$denote the EURIBOR rate (for the given tenor) published on day *T* (thus reflective of the market on *T-1*) and $EFT_{t=T}$ denote the EFTERM rate (for the corresponding given tenor) published on *T* (thus reflective of the market on *T*).

Under the proposed reformulation of Level 2.3, on day *T* the calculation of the contribution will be performed as per one of these three formulas:

a) If the contribution on day *T-1* was performed under Level 2.3, then

$$Cont_T^{2.3} = Cont_{T-1}^{2.3} + \left(EFT_{T-1} - EFT_{T-2}\right) + \left[\left(EUR_{T-1} - EFT_{T-2}\right) - \left(EUR_{T-2} - EFT_{T-3}\right)\right]$$

b) If the contribution on day *T-1* was performed under Level 1, Level 2.1, or Level 2.2., and this contribution passed any (or both) of the tests of the Qualifying Criterion, then

$$Cont_T^{2.3} = Cont_{T-1}^{X} + \left(EFT_{T-1} - EFT_{T-2}\right) + \left[\left(EUR_{T-1} - EFT_{T-2}\right) - \left(EUR_{T-2} - EFT_{T-3}\right)\right]$$

where *X* = 1, 2.1, or 2.2, as appropriate.

c) If the contribution on day *T-1* was performed under Level 1, Level 2.1, or Level 2.2., and it did not pass any of the tests of the Qualifying Criterion, then

$$Cont_T^{2.3} = Cont_{T-n}^{X} + \sum_{i=1}^{n}\left(EFT_{T-i} - EFT_{T-(i+1)}\right) + \sum_{i=1}^{n}\left[\left(EUR_{T-i} - EFT_{T-(i+1)}\right) - \left(EUR_{T-(i+1)} - EFT_{T-(i+2)}\right)\right]$$

where *n* the minimum value for which either *X* = 2.3 or *X* = 1, 2.1, or 2.2 and $Cont_{T-n}^{X}$ passes any (or both) of the tests of the Qualifying Criterion.[9]

4. Impact assessment

To obtain an indicative quantification of the impacts on rate level and volatility arising from the proposed changes in Level 2.3, EMMI performed a comparison of EURIBOR calculated under the current hybrid methodology and a simulation, over the same period, of EURIBOR with the enhanced Level 2.3. The analysis spans over a year of daily contributions and has a starting point on the first day of publication of the Beta EFTERM rates on 13 June 2022. A range of further detailed analyses were undertaken to assess the contributions of individual factors to the overall impacts, but those will not be made available at this point, due to the sensitive nature of the data.

[9] The sums in this formula are *telescopic* and allow for further simplification. We keep the full expression so as to establish the link with the text in the introduction to Section 3, under "Look-back methodology to guarantee a Bank's contribution."

The correlation of the rates (as measured by Pearson's correlation[10] coefficient), as well as their respective volatilities[11] are summarised in the table below. *Simulated rates* should be understood as the rates obtained as a result of applying the hybrid methodology of EURIBOR **with** the proposed Level 2.3 methodology (and thus **without** recourse to Level 3).

	1W	1M	3M	6M	12M
EURIBOR-Simulated Rates Pearson's correlation	0.99	0.99	0.99	0.99	0.99
Volatility (in bps) EURIBOR	2.4 bps	1.8 bp	1.9 bp	2.4 bps	3.3 bps
Volatility (in bps) Simulated Rates	2.4 bps	2.1 bps	2.0 bps	2.9 bps	4.2 bps

Table 2. Pearson's correlation and volatility difference

Correlation provides a snapshot of global synchrony. EMMI studied the correlation of EURIBOR rates with the series obtained using the Simulated Rates. The following chart depicts the scatterplot for these two data sets in the case of the 3 months tenor, to reveal the strength, direction and form of the relationship between both quantitative variables.

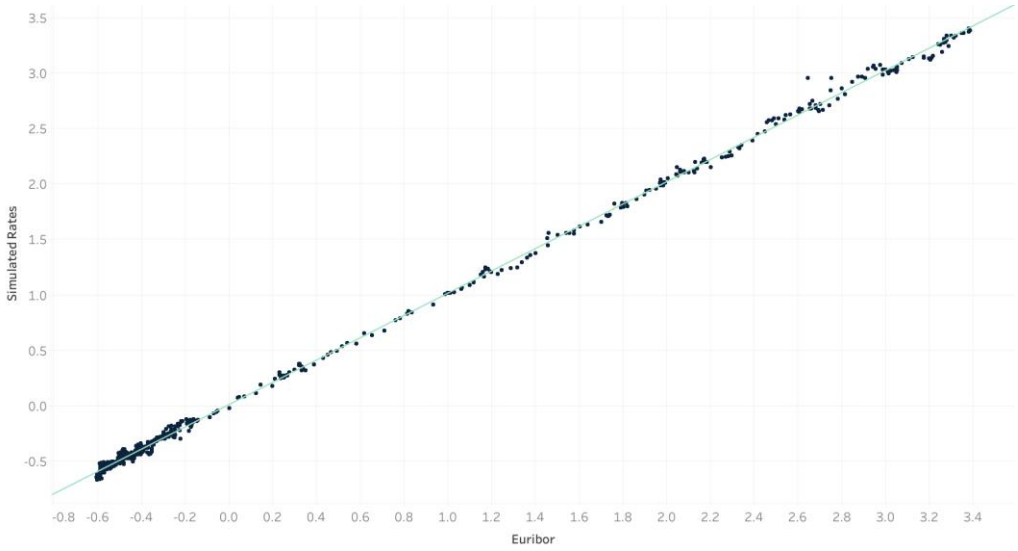

Figure 6. EURIBOR – Simulated Rates linear correlation

We can observe the strong relationship between EURIBOR and the rates obtained during the simulation of the methodology at the time of analysis.

[10] Pearson's correlation is a measure of the linear relationship between two variables. For the calculation of the coefficients, EMMI assumed homoskedasticity of the sample.

[11] Volatility is measured as the standard deviation of the series of daily rate changes over the observed period.

5. Discontinuation of Level 3

The suggested modifications in the calculation of Panel Banks' Level 2.3 contributions were considered as a good opportunity to reflect on the necessity of maintaining a third level in the hybrid methodology.

Level 3 contributions are determined individually by each Panel Bank and rely on input data and modelling techniques that reflect the Panel Bank's "particular circumstances and business patterns, funding and liquidity management" strategy (c.f. Section 13 of the COPB). While Panel Banks are not mandated to opt for a particular methodology for the determination of their contribution models, Section 13 of the COPB provides a series of guiding principles that should be respected. Level 3 contributions are closely monitored, and Panel Banks are required to put in place a strict control framework to protect their contributions' and, ultimately, EURIBOR's integrity.

From a **methodological perspective**, Panel Banks' models have proven to adequately proxy their cost of funding. However, from an operational and organisational perspective, by accepting their role as contributors toward EURIBOR, Panel Banks are exposed to considerable operational and financial burden and risk, derived from strict three-level control models (c.f. Section 5 of the COPB), the obligation to implement an accountability framework and policies for independent review (c.f. Sections 9 and 14 of the COPB), or the development of specific IT control and contribution systems (c.f. Data Transmission and Validation under the Hybrid EURIBOR Methodology), among others.

In analysing the possibility of applying changes to Level 2.3, while discontinuing Level 3, EMMI had in mind the following two principles:

- Any changes should not put EURIBOR's representativeness at risk, nor its robustness and resilience or its reliability;
- Any changes should not affect EURIBOR's characteristics: a methodological change should simply provide an alternative way of measuring EURIBOR's Underlying Interest.

From a benchmark's **sustainability perspective**, the discontinuation of Level 3, hence eliminating the entry and periodic costs and burden derived from the considerations above, should provide an opportunity for the enlargement of the EURIBOR Panel.

The **proposed enhancements to the Level 2.3 guarantee the daily calculation of individual Panel Banks'** contribution, without the need for any further backstop level:

- On the one hand, using an algorithmic homogeneous approach which eliminates the recourse to assessments potentially based on subjective perceptions of the market; and
- On the other hand, setting up new controls at the level of the methodology (namely, the dynamic rate threshold test and the volume threshold test) to guarantee the use of representative data, while maintaining the strong control framework in the EMMI Benchmarks Application and System Software (EBASS) to validate the quality, accuracy, and reasonableness of the input data used toward the determination of EURIBOR.

The EU BMR requires benchmark administrators to periodically review their benchmarks' methodologies. As part of this regulatory requirement, EMMI will monitor the well-functioning of the proposed changes in order to guarantee EURIBOR's continued robustness, resilience, and representativeness of the underlying market it seeks to measure.

Question 9: Do you agree with EMMI's assessment that the proposed enhancements to Level 2.3 endow EURIBOR's hybrid methodology with enough mechanisms to allow for the discontinuation of Level 3?

6. Responding to the consultation and publication feedback and next steps

Throughout the text, EMMI placed several questions for which we would welcome stakeholders' feedback. It is crucial for EMMI to obtain the largest number of responses possible, with a preference for responses in which the rationale behind each answer is fully elaborated.

For the readers' convenience, all questions are included in a .doc file published on EMMI's website.

EMMI kindly asks respondents to submit their answers by e-mail to hybrid2023@emmi-benchmarks.eu specifying "Hybrid Euribor Consultation" on the subject line.

EMMI welcomes and encourages additional views or considerations regarding any issue discussed in this consultation paper, even if explicit questions are not included in the text.

EMMI would be thankful if all responses were submitted by Monday 11 December 2023.

A summary of stakeholder feedback will be made public by end of February 2024 in an aggregate form and in a manner where individual respondents cannot be readily identified. However, EMMI shall nonetheless retain the right to make public the stakeholder's name as part of a list of entities which provided feedback, unless the respondent requires anonymity.

After the conclusion of the consultation process, EMMI will provide its rationale for the acceptance, modification or rejection of recommendations made by respondents to the consultation.

Further details can be found in the Benchmarks Consultation Policy available on EMMI's website

On this date, EMMI intends also to communicate on the conclusions of the proposed enhancements in EURIBOR's methodology, as well as implementation plans.

Together with their responses, EMMI kindly asks respondents to submit the following minimum information:

- Full name of respondent;
- Position;
- Organisation and country;
- E-mail address;
- Contact telephone.

7. Annex

In this Annex we present three examples that will help respondents, and all interested parties, understand some aspects of the methodology, such as the Qualifying Criteria and the calculation of Level 2.3 contributions in case the Criteria are not satisfied. The data presented in this section is merely illustrative and it does not bear any relation to either real individual Panel Bank's submissions nor values of EURIBOR under the current or the enhanced version of Level 2.3.

7.1.1. Example 1

The first example shows the calculation of a Level 2.3 contribution in case the candidate rate to act as the "Panel Bank's cost of funding" component was performed at Level 2.3. In this case, the candidate rate is not subject to the tests in the Qualifying Criterion.

In this example, Bank A is making its 1 week contribution on 11 May 2023, in respect of activity from the previous TARGET day, 10 May 2023. The bank had no eligible transactions on the previous day to allow it to make either a Level 1 or Level 2.2 contribution.[12] Under these circumstances, the hybrid methodology requires the calculation of a contribution at Level 2.3. The following table presents the information, recorded in EMMI's database, which is relevant for the example.

Date	Contribution Rate	Volume (in mio)	Contribution Level	μ_T	σ_T	EURIBOR	EFTERM
8 May							3.136
9 May	3.48					3.078	3.137
10 May	3.51	-	2.3			3.096	3.140
11 May	?		**2.3**				

The calculation proceeds as follows:

1. To determine the 'Bank's cost of funding' component, we consider the Level under which the previous day's submission was performed. In this case, our database shows that on 10 May, the Bank's contribution was performed under Level 2.3, with a (candidate) rate of 3.51%. Being a Level 2.3 contribution, it has no associated notional volume.

2. As per the formula in Section 3.2 of the Consultation Paper, we can now calculate the Level 2.3 contribution for 11 May as follows:[13]

$$Cont^{2.3}_{11\,\text{May}} = Cont^{2.3}_{10\,\text{May}} + \left(EFT_{10\,\text{May}} - EFT_{9\,\text{May}}\right) + \left[\left(EUR_{10\,\text{May}} - EFT_{9\,\text{May}}\right) - \left(EUR_{9\,\text{May}} - EFT_{8\,\text{May}}\right)\right]$$

$$= 3.51 + (3.140 - 3.137) + [(3.096 - 3.137) - (3.078 - 3.136)] = \mathbf{3.53\%}$$

[12] Note that under the hybrid methodology, Level 2.1 is not applicable to the 1 week tenor.

[13] Note that the term $\left(EFT_{10\,\text{May}} - EFT_{9\,\text{May}}\right)$ in the calculation represents the interest rate change component in the MAF, while the term $\left[\left(EUR_{10\,\text{May}} - EFT_{9\,\text{May}}\right) - \left(EUR_{9\,\text{May}} - EFT_{8\,\text{May}}\right)\right]$ is the credit risk change component.

7.1.2. Example 2

This second example shows the calculation of a Level 2.3 contribution, in the case when the candidate rate to act as the 'Panel Bank's cost of funding' component does not pass the Dynamic Rate Threshold Test, but does satisfy the Volume Threshold Test.

In this example, Bank A is making its 1 week contribution on 11 May 2023, in respect of activity from the previous TARGET day, 10 May 2023. The bank had no eligible transactions on the previous day to allow it to make either a Level 1 or Level 2.2 contribution.[14] Under these circumstances, the hybrid methodology dictates that a Level 2.3 contribution should be calculated. The following table presents the information, recorded in EMMI's database, which is relevant for the example.

Date	Contribution Rate	Volume (in mio)	Contribution Level	μ_T	σ_T	EURIBOR	EFTERM
8 May							3.136
9 May	3.48					3.078	3.137
10 May	3.80	100	2.2	4.44	3.70	3.096	3.140
11 May	?		**2.3**				

The calculation proceeds as follows:

1. To determine the 'Bank's cost of funding' component, we consider the Level under which the previous day's submission was performed. In this case, our database shows that on 10 May, the Bank's contribution was performed under Level 2.2, with a (candidate) rate of 3.80%, which has an associated volume of EUR 100 mio.

2. The Qualifying Criterion dictates that for this candidate rate to be valid input, either the rate follows the bank's contribution pattern (Dynamic Rate Threshold Test) or the notional volume associated to the candidate rate is considered as sufficient (Volume Threshold Test):

   - **Dynamic Rate Threshold Test:** according to the available data, it is observed that the average day-on-day change in the spreads of Panel Bank's contributions against EFTERM over the last 21 days is $\mu_{10\ May}$ = 4.44 bps. The standard deviation of these day-on-day spreads is $\sigma_{10\ May}$= 3.70 bps. In turn, the day-on-day change in spread of the candidate rate versus EFTERM (in bps) is

$$[(Cont^{2.3}_{10\ May} - EFT_{9\ May}) - (Cont_{9\ May} - EFT_{8\ May})] \times 100 = [(3.80 - 3.137) - (3.48 - 3.136)] \times 100 = 31.90$$

Calculating now the absolute value of the difference between the day-on-day change in spread of the candidate rate with respect to the previous day and the average day-on-day change, and dividing it by the standard deviation of the day-on-day spreads,[15] we obtain

$$\frac{|31.90 - \mu_{10\ May}|}{\sigma_{10\ May}} = 7.42$$

[14] Note that under the hybrid methodology, Level 2.1 is not applicable to the 1 week tenor.

[15] Note that we are standardising the distribution of day-on-day changes in spreads (or calculating the z-value of yesterday's day-on-day change in spread).

In other words, the day-on-day change of the candidate rate with respect to the previous day is more than 7 standard deviations away from the mean of the distribution. We therefore consider the candidate rate to fail the Dynamic Rate Threshold Test.

- **Volume Threshold Test:** according to the available data, it is observed that the volume underlying the Level 2.2. contribution on 10 May was of EUR 100 mio. As this value is above the EUR 20 mio threshold, the candidate rate passes the Volume Threshold Test, thus considering it as a valid 'Bank's cost of funding' component for the calculation of the Level 2.3 contribution.

3. As per the formula in Section 3.2 of the Consultation Paper, we can now calculate the Level 2.3 contribution for 11 May as follows:[16]

$$Cont^{2.3}_{11\,May} = Cont^{2.2}_{10\,May} + \left(EFT_{10\,May} - EFT_{9\,May}\right) + \left[\left(EUR_{10\,May} - EFT_{9\,May}\right) - \left(EUR_{9\,May} - EFT_{8\,May}\right)\right]$$

$$= 3.80 + (3.140 - 3.137) + [(3.096 - 3.137) - (3.078 - 3.136)] = \mathbf{3.82}\%$$

7.1.3. Example 3

This third example shows the calculation of a Level 2.3 contribution in case the candidate rate to act as the 'Panel Bank's cost of funding' does not pass either of the tests in the Qualifying Criteria. The algorithm then requires going back further in time until a contribution satisfying either of the tests in the Qualifying Criteria is encountered.

In this example, Bank A is making its 1 week contribution on 11 May 2023, in respect of activity from the previous TARGET day, 10 May 2023. The bank had no eligible transactions on the previous day to allow it to make either a Level 1 or Level 2.2 contribution.[17] Under these circumstances, the hybrid methodology dictates that a Level 2.3 contribution should be calculated. The following table presents the information, recorded in EMMI's database, which is relevant for the example.

Date	Contribution Rate	Volume (in mio)	Contribution Level	μ_T	σ_T	EURIBOR	EFTERM
5 May							3.102
8 May	3.44	15	1			3.012	3.136
9 May	3.48	10	2.2	4.72	3.10	3.078	3.137
10 May	3.62	5	1	4.44	3.70	3.096	3.140
11 May	?		**2.3**				

The calculation proceeds as follows:

1. To determine the 'Bank's cost of funding' component, we consider the Level under which the previous day's submission was performed. In this case, our database shows that on 10 May, the Bank's contribution was performed under Level 1, with a (candidate) rate of 3.62%, which has an associated volume of EUR 5 mio.

2. The Qualifying Criterion dictates that for this candidate rate to be valid input, either the rate follows the bank's contribution pattern (Dynamic Rate Threshold Test) or

[16] Note that the term $(EFT_{10\,May} - EFT_{9\,May})$ in the calculation represents the interest rate change component in the MAF, while the term $[(EUR_{10\,May} - EFT_{9\,May}) - (EUR_{9\,May} - EFT_{8\,May})]$ is the credit risk change component.

[17] Note that under the hybrid methodology, Level 2.1 is not applicable to the 1 week tenor.

the notional volume associated to the candidate rate is considered as sufficient (Volume Threshold Test):

- **Dynamic Rate Threshold Test:** according to the available data, it is observed that the average day-on-day change in the spreads of Panel Bank's contributions against EFTERM over the last 21 days is $\mu_{10\ May}$ = 4.44 bps. The standard deviation of these day-on-day spreads is $\sigma_{10\ May}$= 3.70 bps. In turn, the day-on-day change in spread of the candidate rate versus EFTERM (in bps) is

$$(Cont^{1}_{10\ May} - EFT_{9\ May}) - (Cont^{2.2}_{9\ May} - EFT_{8\ May}) \times 100 = (3.62 - 3.137) - (3.48 - 3.136) = 13.90$$

Calculating now the absolute value of the difference between the day-on-day change in spread of the candidate rate with respect to the previous day and the average day-on-day change, and dividing it by the standard deviation of the day-on-day spreads,[18] we obtain

$$\frac{|13.90 - \mu_{10\ May}|}{\sigma_{10\ May}} = 2.56$$

In other words, the day-on-day change of the candidate rate with respect to the previous day is more than 2 standard deviations away from the mean of the distribution. We therefore consider the candidate rate to fail the Dynamic Rate Threshold Test.

- **Volume Threshold Test:** according to the available data, it is observed that the volume underlying the Level 1 contribution on 10 May was of EUR 5 mio. As this value is below the EUR 20 mio threshold, the candidate rate fails the Volume Threshold Test, thus not qualifying as a 'Bank's cost of funding' component for the calculation of the Level 2.3 contribution.

3. The enhanced Level 2.3 methodology now considers as a candidate rate the rate submitted by the Panel Bank on 9 May. Our database shows that the Bank's contribution was performed under Level 2.2, with a (candidate) rate of 3.48%, with an associated volume of EUR 10 mio.

4. As before, for this candidate rate to be valid input, either the rate follows the bank's contribution pattern (Dynamic Rate Threshold Test) or the notional volume associated to the candidate rate is considered as sufficient (Volume Threshold Test):

- **Dynamic Rate Threshold Test:** according to the available data, it is observed that the average day-on-day change in the spreads of Panel Bank's contributions against EFTERM over the last 21 days is $\mu_{9\ May}$ = 4.72 bps. The standard deviation of these day-on-day spreads is $\sigma_{9\ May}$= 3.10 bps. In turn, the day-on-day change in spread of the candidate rate versus EFTERM (in bps) is

$$[(Cont^{1}_{9\ May} - EFT_{8\ May}) - (Cont^{2.2}_{8\ May} - EFT_{5\ May})] \times 100 = [(3.48 - 3.136) - (3.44 - 3.102)] \times 100 = 0.6$$

Calculating now the absolute value of the difference between the day-on-day change in spread of the candidate rate with respect to the previous day and

[18] Note that we are standardising the distribution of day-on-day changes in spreads (or calculating the z-value of yesterday's day-on-day change in spread).

the average day-on-day change, and dividing it by the standard deviation of the day-on-day spreads,[19] we obtain

$$\frac{|0.60 - \mu_{9\ \text{May}}|}{\sigma_{9\ \text{May}}} = 1.33$$

In other words, the day-on-day change of the candidate rate with respect to the previous day is within 2 standard deviations away from the mean of the distribution, thus considering it as a valid 'Bank's cost of funding' component for the calculation of the Level 2.3 contribution

5. As per the formula in Section 3.2 of the Consultation Paper, we can now calculate the Level 2.3 contribution for 11 May as follows:

$$\begin{aligned} Cont^{2.3}_{11\ \text{May}} &= Cont^{2.2}_{9\ \text{May}} + \sum_{i=1}^{2}\left(EFT_{T-i} - EFT_{T-(i+1)}\right) + \sum_{i=1}^{2}\left[\left(EUR_{T-i} - EFT_{T-(i+1)}\right) - \left(EUR_{T-(i+1)} - EFT_{T-(i+2)}\right)\right] \\ &= Cont^{2.2}_{9\ \text{May}} + \left(EFT_{10\ \text{May}} - EFT_{8\ \text{May}}\right) + \left(EFT \quad - EFT_{8\ \text{May}}\right) \\ &+ \left[\left(EUR_{10\ \text{May}} - EFT_{9\ \text{May}}\right) - \left(EUR_{9\ \text{May}} - EFT_{8\ \text{May}}\right)\right] \\ &+ \left[\left(EUR_{9\ \text{May}} - EFT_{8\ \text{May}}\right) - \left(EUR_{8\ \text{May}} - EFT_{5\ \text{May}}\right)\right] \end{aligned}$$

Substituting the values in our database and realising the sums are telescopic:

$$Cont^{2.3}_{11\ \text{May}} = 3.48 + (3.140 - 3.136) + (3.096 - 3.137) - (3.012 - 3.102) = \mathbf{3.53\%}$$

[19] Note that we are standardising the distribution of day-on-day changes in spreads (or calculating the z-value of yesterday's day-on-day change in spread).