AXI/FXI Limited Assurance Follow-up Review: Implementation of Recommendations

Purpose

In April 2024, Promontory Financial Group, a business unit of IBM Consulting ("Promontory") completed a limited assurance review of the Across-the-Curve Credit Spread Index ("AXI") and the Financial Conditions Credit Spread Index's ("FXI") (together, "the Benchmarks") degree of implementation of Principles 6, 7, and 9 of the International Organization of Securities Commission ("IOSCO") Principles for Financial Benchmarks ("IOSCO Principles" or "Principles"). Promontory issued a report titled, "AXI and FXI Limited Assurance Review: Principles 6, 7, and 9 of the IOSCO Principles for Financial Benchmarks" (the "Report"), which detailed the analysis conducted and conclusions drawn, and included a set of recommendations with respect to the degree of implementation of the IOSCO Principles included in the review.¹

Following the issuance of the Report, SOFR Academy, Inc. ("SOFR Academy"), the developer of the Benchmarks, and Invesco Indexing LLC's ("Invesco" or the "Administrator"), the benchmark administrator and calculation agent for AXI and FXI, undertook certain steps to address Promontory's recommendations to further implement the IOSCO Principles. This Memorandum summarizes Promontory's review and assessment of SOFR Academy and the Administrator's implementation of these recommendations. Based on the review performed, Promontory believes that the recommendations issued in the Report have been reasonably addressed by SOFR Academy and the Administrator.

Summary of Recommendations Issued in the Report

Promontory identified a total of five recommendations for enhancement in order to help SOFR Academy and Invesco to achieve further implementation of the IOSCO Principles included in the review. Of the recommendations provided:

- Two recommendations pertained to implementation of Principle 6 Benchmark Design. These
 included a recommendation to (i) further address the definition of benchmark fallbacks in the AXI
 and FXI Methodology documentation for scenarios where data is unavailable or below transaction
 volume thresholds for extended periods of time, and (ii) continue monitoring of AXI and FXI for
 potential inverted pyramid issues should market participants begin referencing the Benchmarks in
 financial contracts.
- Three recommendations pertained to Principle 9 Transparency of Benchmark Determinations. These included a recommendation to (i) enhance clarity of the transaction weighting approach for each of Unscaled AXI and FXI and their respective unscaled rate average maturity to the AXI and FXI Methodology, (ii) provide enhanced detail to clarify the definition of the unscaled rate average maturity, and (iii) define the transaction volume threshold below which transaction volumes would be deemed to be insufficient to publish new daily rates.



¹ AXI and FXI Limited Assurance Review: Principles 6, 7, and 9 of the IOSCO Principles for Financial Benchmarks, Promontory Financial Group, a Business Unit of IBM Consulting, April 2024.

Please refer to the Report for further detail regarding Promontory's analysis performed and the basis for the recommendations.

High-Level Description of Steps Taken to Address Recommendations

Following the delivery of the Report, SOFR Academy and the Administrator updated AXI and FXI methodology and procedure documents to address Promontory's recommendations. Refer to Appendix I of this memorandum for a mapping of the actions taken in response to the specific recommendations made.

Principle 6 – Benchmark Design:

SOFR Academy and the Administrator updated AXI and FXI methodology and procedure documents by:

- Defining benchmark fallbacks in the AXI and FXI Methodologies, Index Policy Section, Delayed Publication Sub-section (page 9 of each of the AXI and FXI Methodologies) to indicate that for scenarios where data is no longer available or below transaction volume thresholds on a permanent basis:
 - "AXI shall fall back to FXI minus the 5-year historical median of the difference between AXI and FXI of the unscaled index or the relevant tenor"; and
 - "FXI shall fall back to the 5-year historical median of FXI for the unscaled index or the relevant tenor".
- Introducing, on page 6 the AXI Python Process Code (Procedure) document, AXI/FXI annual review section, a potential approach for monitoring the volume of trading in the market referencing the Benchmarks. As there is currently no trading volume referencing the Benchmarks, SOFR Academy and the Administrator will need to further define the approach once the data becomes available.

Principle 9 – Transparency of Benchmark Determinations:

SOFR Academy and the Administrator updated AXI and FXI methodology and procedure documents by:

- Providing further detail in the AXI and FXI Methodologies, Index Overview Section, Transaction Weighting Sub-section (page 5 of each of the AXI and FXI Methodologies) concerning the weighting approach for each of Unscaled AXI and FXI and their respective daily unscaled maturity (also reported as unscaled rate average maturity as part of the enhanced transparency metrics table) by including their formulaic determinations; and
- Defining, in the AXI and FXI Methodologies, Index Calculation and the Role of the Calculation Agent Section, Potential Limitations of the Methodology and Benchmark Calculation Sub-section (page 8 of each of the AXI and FXI Methodologies), the minimum transaction volume threshold needed to calculate the short-term and long-term components of the Benchmarks and publish new daily rates.

Review Assessment

Based on a review of the documentation provided, Promontory believes that the recommendations previously issued in its Report as part of the limited assurance review have been reasonably addressed by SOFR Academy and the Administrator. AXI and FXI Methodology documentation and the AXI Python Process Code (Procedure) document have been updated to provide further detail into the fallbacks utilized

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when data is unavailable or below transaction volume thresholds, and to further enhance the transparency regarding the methodologies for daily benchmark calculations.

Based on the limited assurance review performed previously, and Promontory's conclusion that SOFR Academy and the Administrator appear to have reasonably addressed the recommendations in the Report, IOSCO Principles 6, 7, and 9 appear to be fully implemented for AXI and FXI.

Principle	AXI Determination	FXI Determination
Benchmark Design	Fully Implemented	Fully Implemented
Data Sufficiency	Fully Implemented	Fully Implemented
Transparency of Benchmark Determinations	Fully Implemented	Fully Implemented



	Observations and Recommendations			
		Principle 6 – Benchmark Design		
Торіс	Observations	Recommendations	Benchmarks Impacted	Action
Benchmark Fallbacks	The AXI and FXI Methodologies and the Administrator's documented procedures identified fallbacks for instances where there are short-term technical issues or where transaction volumes fall briefly below 50% of historical minimum daily trading volume (in notional dollars); however, there did not appear to be a defined plan for scenarios where data is unavailable or below transaction volume thresholds for multiple days or weeks.	Consider defining benchmark fallbacks in the AXI and FXI Methodologies for scenarios where data is unavailable or below transaction volume thresholds for extended periods of time.	AXI FXI	 Defined benchmark fallbacks in the AXI and FXI Methodologies, Index Policy Section, Delayed Publication Sub-section (page 9 of each of the AXI and FXI Methodologies) to indicate that for scenarios where data is no longer available or below transaction volume thresholds on a permanent basis: "AXI shall fall back to FXI minus the 5-year historical median of the difference between AXI and FXI of the unscaled index or the relevant tenor"; "FXI shall fall back to the 5-year historical median of FXI for the unscaled index or the relevant tenor".
Benchmark Monitoring	Financial benchmarks may experience the inverted pyramid problem when the volume of trading in the market referencing the benchmark dwarfs the underlying markets from which the benchmark is determined. We understand that market participants are considering using AXI and FXI within financial contracts as a credit spread add-on to SOFR. We further understand that the Administrator has an annual benchmark review process.	Continue monitoring AXI and FXI for potential inverted pyramid problems should market participants begin referencing AXI and FXI in financial contracts.	AXI FXI	Introduced, on page 6 the AXI Python Process Code (Procedure) document, AXI/FXI annual review section, a potential approach for monitoring the volume of trading in the market referencing the Benchmarks. As there is currently no trading volume referencing the Benchmarks, SOFR Academy and the Administrator will need to further define the approach once data becomes available.

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	Observations and Recommendations			
	Principle 9 – Transparency of Benchmark Determinations			
Торіс	Observations	Recommendations	Benchmarks Impacted	Action
Disclosure of Transaction Weighting	Unscaled AXI and FXI, in addition to their respective unscaled rate average maturity, are not simple weighted averages of the short-term and long-term component based on their transaction volumes. Rather, these metrics are transaction volume- and maturity-weighted averages. This approach is described in the AXI and FXI Methodologies; however, such descriptions are at a high-level and do not include supporting information, such as the underlying formulae.	Enhance the Transaction Weighting section of the AXI and FXI Methodologies by providing further detail concerning the weighting approach for each of Unscaled AXI and FXI and their respective unscaled rate average maturity, including by potentially adding their formulaic determinations shown below for illustrative purposes: $\frac{Unscaled AXI/FXI: ^{2}}{\underbrace{\sum_{t=1}^{21} \frac{\left((Spd_{ST}^{t} * Mat_{ST}^{t} * Vol_{ST}^{t}) + (Spd_{LT}^{t} * Mat_{LT}^{t} * Vol_{LT}^{t})\right)}{(Mat_{ST}^{t} * Vol_{ST}^{t}) + (Mat_{LT}^{t} * Vol_{LT}^{t})}}$ $\frac{\sum_{t=1}^{21} \frac{\left((Mat_{ST}^{t} * Mat_{ST}^{t} * Vol_{ST}^{t}) + (Mat_{LT}^{t} * Mat_{LT}^{t} * Vol_{LT}^{t})\right)}{(Mat_{ST}^{t} * Vol_{ST}^{t}) + (Mat_{LT}^{t} * Mat_{LT}^{t} * Vol_{LT}^{t})}}$ $\frac{\sum_{t=1}^{21} \frac{\left((Mat_{ST}^{t} * Mat_{ST}^{t} * Vol_{ST}^{t}) + (Mat_{LT}^{t} * Mat_{LT}^{t} * Vol_{LT}^{t})\right)}{(Mat_{ST}^{t} * Vol_{ST}^{t}) + (Mat_{LT}^{t} * Vol_{LT}^{t})}}$	AXI FXI	Provided further detail in the AXI and FXI Methodologies, Index Overview Section, Transaction Weighting Sub- section (page 5 of each of the AXI and FXI Methodologies) concerning the weighting approach for each of Unscaled AXI and FXI and their respective daily unscaled maturity (also reported as unscaled rate average maturity as part of the enhanced transparency metrics table) by including their formulaic determinations.
Metrics	The unscaled rate average maturity metric is not defined in the daily publication of the USD-AXI and USD-FXI Enhanced Transparency Metrics table.	 Undertake one of the following approaches regarding the daily reporting of the unscaled rate average maturity metric: Exclude the unscaled rate average maturity from the daily enhanced transparency metrics report; or Include further detail regarding how the metric is defined and calculated. 	AXI FXI	Provided further detail in the AXI and FXI Methodologies, Index Overview Section, Transaction Weighting Sub- section (page 5 of each of the AXI and FXI Methodologies) concerning the weighting approach for each of Unscaled AXI and FXI and their respective daily unscaled maturity (also reported as unscaled rate average maturity as part of the enhanced transparency metrics table) by including their formulaic determinations.

 2 Spd^t_{ST}: Short-term component average spread; Mat^t_{ST}: Short-term component average maturity; Vol^t_{ST}: Short-term component total daily volume (USD);

 Spd_{LT}^{t} : Long-term component average spread Mat_{LT}^{t} : Long-term component average maturity Vol_{LT}^{t} : Long-term component total daily volume (USD)

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	Observations and Recommendations			
Торіс	Observations	Recommendations	Benchmarks Impacted	Action
Disclosure of Transaction Volume Threshold	While the AXI Python Code Process document indicated that transaction volume for each of the short-term and long-term components is to be deemed insufficient for a given day when that corresponding volume fell below 50% of historical minimum daily trading volume used by AXI/FXI up to March 13, 2023 (in notional dollars), the AXI and FXI Methodologies did not present that detail.	Define in the AXI and FXI Methodologies the transaction volume threshold below which transaction volumes would be deemed to be insufficient to publish new daily rates.	AXI FXI	Defined, in the AXI and FXI Methodologies, Index Calculation and the Role of the Calculation Agent Section, Potential Limitations of the Methodology and Benchmark Calculation Sub-section (page 8 of each of the AXI and FXI Methodologies), the minimum transaction volume threshold needed to calculate the short-term and long- term components of the Benchmarks and publish new daily rates.







AXI and FXI Limited Assurance Review:

Principles 6, 7, and 9 of the IOSCO Principles for Financial Benchmarks

Prepared for

SOFR Academy, Inc.



April 2024

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1

1. Executive Summary

SOFR Academy, Inc. ("SOFR Academy") engaged Promontory Financial Group, a business unit of IBM Consulting ("Promontory"), to perform a limited assurance review of the Across-the-Curve Credit Spread Index ("AXI") and the Financial Conditions Credit Spread Index's ("FXI") (together, "the Benchmarks") degree of implementation of three International Organization of Securities Commissions' ("IOSCO") principles for financial benchmarks ("IOSCO Principles"):

- Principle 6 Benchmark Design
- Principle 7 Data Sufficiency
- Principle 9 Transparency of Benchmark Determinations³

AXI is a broad-based index measuring the aggregate recent average cost of wholesale unsecured debt funding for U.S. bank holding companies and their banking subsidiaries. AXI is calculated using a weighted average of the credit spreads of unsecured bank funding transactions with maturities ranging from overnight to five years over a 21-business day period, with weights that reflect both transaction and issuance notional volumes and maturity. FXI is an extension of AXI that observes data on transactions in debt instruments for all U.S. entities, including banks and corporations. AXI and FXI can be added to the Secured Overnight Financing Rate ("SOFR") (or other SOFR-based variants) to form a credit-sensitive interest rate benchmark for loans, derivatives, and other financial products. AXI and FXI are available only as benchmark credit spreads and therefore will not disrupt or replace SOFR. AXI and FXI were first conceived by Darrell Duffie⁴ at the Stanford Graduate School of Business, with Antje Berndt and Yichao Zhu at the Australian National University, and were officially launched on July 12, 2022 with reference data available dating back to June 30, 2016.

SOFR Academy is a U.S. based economic education and market information provider. SOFR Academy developed the Benchmarks through a multi-year, collaborative process that included extensive consultation and engagement with relevant industry associations, market participants, public sector representatives, and other relevant stakeholders.

Invesco Indexing LLC ("Invesco"), a subsidiary of Invesco Ltd., administers equity, fixed income, and multi-asset indexes in developed and emerging markets across the full market capitalization and credit rating ranges. Invesco is the benchmark administrator and calculation agent for AXI and FXI ("Administrator").

Promontory performed a limited assurance review of AXI and FXI's degree of implementation of IOSCO Principles 6, 7, and 9 using information gathered through meetings with relevant stakeholders and documentation and data provided by SOFR Academy and the Administrator. Promontory's limited assurance review did not include detailed testing reserved for reasonable or full assurance reviews. Further, Promontory did not assess AXI and FXI's degree of implementation of any IOSCO Principles besides Principles 6, 7, and 9.

³ Principles for Financial Benchmarks, IOSCO, July 2013.

⁴ Duffie is a co-author of the proposal for AXI and FXI but has no affiliation with SOFR Academy or the benchmark administrator. Mr. Duffie chaired the Market Participants Group, which was charged by the Financial Stability Board with recommending reforms to LIBOR and other interest rate benchmarks.

Our analysis and conclusions are based on the information provided by SOFR Academy and the Administrator as of February 29, 2024.

Overall Assessment

AXI and FXI fully implemented IOSCO Principles 6 and 7, and broadly implemented Principle 9. In accordance with IOSCO's ratings scale assessment methodology, discussed in Section 3, our view is that AXI and FXI have implemented Principles 6 and 7 without any significant deficiencies, and the shortcomings identified for Principle 9 do not substantially affect the Administrator achieving the intended outcome of Principle 9. Where applicable, we recommended enhancements to documentation and practices to further align with the IOSCO Principles. SOFR Academy and Invesco have demonstrated a commitment to addressing our recommendations.

Principle	AXI Determination	FXI Determination
Benchmark Design	Fully Implemented	Fully Implemented
Data Sufficiency	Fully Implemented	Fully Implemented
Transparency of Benchmark Determinations	Broadly Implemented	Broadly Implemented

AXI and FXI fully implemented Principle 6 by seeking to observe broad transaction samples and eliminate factors that might distort the Benchmarks. Specifically, AXI and FXI's (i) reliance on transactions only, with no use of quotes or expert judgement, (ii) inclusion of debt instruments with maturities of overnight to five-years, and (iii) use of a 21-business day observation period, should result in wide transaction base that is representative of unsecured funding costs, difficult to manipulate, and less susceptible to the "inverted pyramid problem." We recommended that SOFR Academy and Invesco further define Benchmark fallbacks to provide additional clarity to market participants in circumstances where transaction data is unavailable or below volume thresholds for an extended period of time.

Regarding Principle 7, Promontory found that AXI and FXI appeared to maintain their robustness during the two most recent market stress events, namely the initial COVID-19 shutdown (March 2020) and the U.S. regional bank crisis (March 2023). The transaction notional volume troughs underlying daily published AXI and FXI during these periods were USD 290.8 billion for AXI and USD 1,347.2 billion for FXI.

Lastly, for Principle 9, Promontory found that SOFR Academy and Invesco disclosed the Invesco / SOFR Academy USD Across-the-Curve Credit Spread Index Methodology and the Invesco / SOFR Academy USD Financial Conditions Credit Spread Index Methodology (together, the "AXI and FXI Methodologies"), aggregate data for the calculation of daily rates, and related policies, FAQs, and other documentation. We recommended that the Administrator enhance the disclosure of AXI and FXI's weighting schema, which weight transactions based on both notional volume and maturity, rather than volume alone.

We wish to thank the management and staff of SOFR Academy and Invesco for their cooperation throughout our engagement.

2. Background

In July 2013, IOSCO published *Principles for Financial Benchmarks* in response to investigations and enforcement actions regarding attempted manipulation of major interest rate benchmarks (e.g., LIBOR, EURIBOR). Those investigations and enforcement actions raised concerns about the fragility of certain benchmarks – in terms of both their integrity and their continuity of provision – that have the potential to undermine market confidence, potentially harming both investors and the real economy. Benchmark administrators were expected to assess compliance with the Principles when developing financial benchmarks.

The Financial Stability Board's ("FSB") Official Sector Steering Group established a Market Participants Group in August 2013, chaired by Darrell Duffie, which was tasked with identifying alternative reference rates to LIBOR and recommending a potential transition path. In the U.S., the Federal Reserve Board and the Federal Reserve Bank of New York convened the Alternative Reference Rates Committee ("ARRC") in 2014 to identify an alternative to USD LIBOR that was a robust, IOSCO Principles-compliant, transaction-based rate derived from a deep and liquid market. In 2017, the ARRC selected the Secured Overnight Financing Rate ("SOFR") as the alternative to USD LIBOR. SOFR is based on overnight transactions in the USD Treasury repo market. National working groups in other jurisdictions similarly identified overnight, nearly risk-free rates like SOFR as their preferred alternatives.⁵

Some banks noted that SOFR, as a near-risk-free rate, does not reflect banks' underlying funding costs and advocated for the development of a credit-sensitive spread that could be added to SOFR to better reflect banks' funding costs for use in lending markets. For example, in a September 2019 letter to U.S. bank supervisors, a group of 10 regional banks stated:

During times of economic stress, SOFR (unlike LIBOR) will likely decrease disproportionately relative to other market rates as investors seek the safe haven of U.S. Treasury securities. In that event, the return on banks' SOFR-linked loans would decline, while banks' unhedged cost of funds would increase, thus creating a significant mismatch between bank assets (loans) and liabilities (borrowings). Moreover, banks' SOFR-linked lending commitments to their commercial customers will likely exacerbate this mismatch. Specifically, borrowers may find the availability of low cost credit in the form of SOFR-linked credit lines committed prior to the market stress very attractive and borrowers may draw-down those lines to "hoard" liquidity.

The natural consequence of these forces will either be a reduction in the willingness of lenders to provide credit in a SOFR-only environment, particularly during periods of economic stress, and/or an increase in credit pricing through the cycle. In a SOFR-only environment, lenders may reduce lending even in a stable economic environment, because of the inherent uncertainty regarding how to appropriately price lines of credit committed in stable times that might be drawn during times of economic stress. Moreover, in economically stressed times, these forces could increase pro-cyclicality, put pressure on lenders' liquidity, and generally exacerbate stress in the economy.⁶

⁵ A User's Guide to SOFR, The Alternative Reference Rates Committee, April 2019.

⁶ Letter to Randal Quarles, Joseph Otting and Jelena McWilliams, September 23, 2019

The statements by the 10 regional banks in their letter were subsequently supported by independent research.⁷

Also in September 2019, IOSCO issued a *Statement on Credit Sensitive Rates* in which it highlighted that alternative financial benchmarks to USD LIBOR will need to be compliant with the IOSCO Principles. IOSCO called for greater attention to Principles 6 and 7, in particular, advising administrators "to assess whether the systemic benchmarks that are used extensively are based on active markets with high volumes of transactions, representing the underlying interest they intend to measure and whether such benchmarks are resilient during times of stress." The statement also noted the importance of not undermining the transition from LIBOR and stated that, "Widespread use of and transition to credit sensitive rates, **instead of** (*emphasis added*) the US ARRC's preferred SOFR, may therefore pose risks to financial stability."⁸

In July 2023, IOSCO issued a *Statement on Alternatives to USD LIBOR* summarizing the results of its *Review of Alternatives to USD LIBOR*, which "assessed the extent to which four benchmarks developed as potential substitutes for USD LIBOR – two credit sensitive rates⁹ and two term SOFR rates – have implemented the IOSCO Principles in the areas of benchmark design (Principle 6), Data Sufficiency (Principle 7), and Transparency (Principle 9)." In short, IOSCO stated that its review confirmed concerns that certain credit sensitive rates currently in use exhibit some of the same "inverted pyramid" weakness as LIBOR and emphasized that market participants should proceed with caution if they are considering using credit sensitive rates.¹⁰ IOSCO did not include AXI and FXI in the scope of its July 2023 Statement.

Following IOSCO's July 2023 Statement, the administrator of BSBY, one of the two credit sensitive rates included in IOSCO's review, announced that it would cease publication of BSBY after a 12-month advance notice period.

⁷ Bank Funding Risk, Reference Rates, and Credit Supply, Cooperman, Duffie, Luck, Wang & Yang, February 2023

⁸ Statement on Credit Sensitive Rates, IOSCO, September 8, 2021.

⁹ The Bloomberg Short-Term Bank Yield Index ("BSBY") and the American Interbank Offered Rate Index ("AMERIBOR").

¹⁰ Statement on Alternatives to USD LIBOR, IOSCO, July 3, 2023.

3. Engagement Approach

Promontory conducted a limited assurance review of AXI and FXI's degree of implementation of IOSCO Principles 6, 7, and 9. This review was based on an analytic framework developed by Promontory using our experience and judgement in the benchmark field and grounded in relevant IOSCO publications.

Audit firms undertaking assurance engagements in the benchmark field typically refer to the IAASB International Standard on Assurance Engagements to guide their approach: ISAE 3000 (Revised) - Assurance Engagements Other than Audits or Reviews of Historical Financial Information ("ISAE 3000").

Promontory is not an audit firm and therefore does not formally subscribe to this standard. Nevertheless, Promontory's approach observed the general principles and professional standards set forth in this guidance.

Specifically, we conducted our assessment to a "Limited Assurance" standard, as described in ISAE 3000. Accordingly, we based our work on reviews of documentation (policies, procedures, methodologies, governance and control frameworks, and reporting, in addition to other materials) and meetings with key stakeholders from SOFR Academy, Invesco, academia and industry, complemented with high-level benchmark data analysis. However, consistent with this level of assurance, we did not perform any detailed testing of the accuracy or completeness of any information, reports, or operational processes as part of our assessment. Further, while Promontory reviewed information provided by third parties and data providers during the course of this engagement, Promontory's work did not extend to evaluating the activities of these third parties. As per the Financial Stability Oversight Council's annual report, market participants willing to use a rate other than SOFR should conduct a comprehensive evaluation of that alternative rate, focusing on assessing the rate's "fit-for-purpose" for their intended use case and adequate representation of the market.¹¹

Separately, Invesco previously engaged an independent accounting firm to conduct a limited assurance engagement over the policies, processes and control activities placed in operation by Invesco with respect to equity, fixed income and multi-asset index families as of April 6, 2023 to address the IOSCO Principles. As stated in that assurance report, the AXI and FXI indexes were not included within the scope of their engagement; however, Invesco noted that "the AXI and FXI indexes were developed by the same organization and using similar processes and standards as other in-scope indexes."

Refer to Appendix I - List of Documents Reviewed for the list of documentation provided by SOFR Academy and Invesco and Appendix II - List of Interviews for the list of interviews with stakeholders from SOFR Academy, Invesco, academia and industry.

Assessment Ratings

The IOSCO Principles are intended to promote the reliability of benchmark determinations and address benchmark governance, quality, and accountability mechanisms. Each covered benchmark was assessed against the in-scope Principles: Principles 6, 7, and 9 relevant to the Quality of the Benchmark.

¹¹ Financial Stability Oversight Council Annual Report 2023, Financial Stability Oversight Council, 2023.

Consistent with IOSCO guidance, ratings fall into one of four categories – "Fully Implemented," "Broadly Implemented," "Partially Implemented," and "Not Implemented" – as outlined below.

Rating Scale as defined in IOSCO Assessment Methodology ¹²			
Fully Implemented	A Principle is considered to be "Fully Implemented" when all Key Indicia ¹³ are implemented without any significant deficiencies.		
Broadly Implemented	A Principle is considered to be "Broadly Implemented" when the assessment demonstrates shortcomings in implementation of the Key Indicia by the Administrator and those shortcomings did not, in the judgement of the assessor, substantially affect the Administrator achieving the intended outcome of the Principle.		
Partly Implemented	A Principle is considered to be "Partly Implemented" when the assessment demonstrates shortcomings in implementation of the Key Indicia by the Administrator and those shortcomings, in the judgement of the assessor, substantially affect the Administrator achieving the intended outcome of the Principle.		
Not Implemented	A Principle is considered to be "Not Implemented" when the assessment demonstrates no implementation of any of the Key Indicia by the Administrator or, where there is some implementation, the implementation is manifestly ineffective in achieving the intended outcome of the Principle.		

Using this rating scale, Promontory rated AXI and FXI's degree of implementation of each in-scope IOSCO Principle.

¹² Review of the Implementation of IOSCO's Principles for Financial Benchmarks by Administrators of Euribor, Libor and Tibor, IOSCO, July 2014.

¹³ Key Indicia for each IOSCO Principle refer to the minimum policies, procedures and practices that a reviewer would expect to see if an administrator had implemented that Principle.

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4. Assessment by Principle

a. Principle 6 - Benchmark Design

From the IOSCO Principle:

The design of the Benchmark should seek to achieve, and result in an accurate and reliable representation of the economic realities of the Interest it seeks to measure, and eliminate factors that might result in a distortion of the price, rate, index or value of the Benchmark.

Benchmark design should take into account the following generic non-exclusive features, and other factors should be considered, as appropriate to the particular Interest:

- a) Adequacy of the sample used to represent the Interest;
- b) Size and liquidity of the relevant market (for example whether there is sufficient trading to provide observable, transparent pricing);
- c) Relative size of the underlying market in relation to the volume of trading in the market that references the Benchmark;
- d) The distribution of trading among Market Participants (market concentration); and
- e) Market dynamics (e.g., to ensure that the Benchmark reflects changes to the assets underpinning a Benchmark).

Discussion

In our opinion, AXI and FXI fully implemented Principle 6 of IOSCO's Principles for Financial Benchmarks.

Benchmark	Degree of Implementation	
AXI	Fully Implemented	
FXI	Fully Implemented	

AXI is designed to measure the aggregate recent average cost of wholesale unsecured debt funding for U.S. bank holding companies and their U.S. banking subsidiaries ("AXI Interest"). The AXI Interest is measured by observing transactions in unsecured debt instruments with maturities ranging from overnight to five years over a rolling 21-business day period (one calendar month). The unscaled AXI credit spread is then calculated as a weighted average of the transaction notional volumes and maturities of such instruments.

FXI is designed to measure the aggregate recent average cost of wholesale unsecured debt funding for U.S. entities more broadly, including banks and corporations ("FXI Interest"). The FXI Interest is measured by observing transactions in unsecured debt instruments with maturities ranging from overnight to five years over a rolling 21-business day period. The unscaled FXI credit spread is then calculated as a weighted average of the transaction notional volumes and maturities of such instruments.

Exhibit 1 below highlights the key design features of AXI and FXI.

Exhibit 1 - AXI and FXI Key Design Features

Key Design Features	AXI	FXI	
Allowable inputs	Transactions only		
Instrument Horizon	Overnight to five-years		
Instrument Types	Commercial Paper ("CP"), Certificates of Deposit ("CD"), Bonds		
Observation Period	21 business days		
Contributor Base	U.S. bank holding companies and their banking subsidiaries U.S. entities (inclusive of contributors to AXI)		
Average Dollar Transaction Volume ¹⁴	Short Term: USD 435.4bn Long Term: USD 16.5bn TOTAL: USD 451.9bn	Short Term: USD 1,426.7bn Long Term: USD 92.4bn TOTAL: USD 1,519.1bn	

Sample Adequacy and Unique Benchmark Design Features

AXI and FXI seek to observe broad samples and eliminate factors that might distort the spreads by employing the following design features:

- **Transactions only** The AXI and FXI Methodologies prohibit the use of expert judgement and quotes, and instead allow inclusion of executed transactions only.
- **Regulated sources of input data** The primary underlying input data source is obtained from Financial Industry Regulatory Authority's ("FINRA") Trade Reporting and Compliance Engine ("TRACE"). TRACE is a mandatory post-trade transparency requirement, and the data therefore benefits from the nature of checks and monitoring in place, as well as regulatory oversight. The long-term bond component (maturities out to five years) is supplemented by a short-term component obtained from the Depository Trust & Clearing Corporation ("DTCC").
- Overnight to five-year instrument horizon AXI and FXI observe debt instruments with maturities from
 overnight up to five-years, which (i) widens the base of transactions used to calculate the credit spreads,
 as compared to more narrowly focused benchmarks; (ii) reduces the impact of market factors in any specific
 instrument-type or duration; and (iii) makes the indices more responsive to changes in U.S. bank or entity
 funding patterns.
- **21-business day observation period** AXI and FXI observe transactions over the previous 21 business days, which results in the spreads being calculated based on a larger base of transactions.
- Removal of top and bottom 2.5% spreads The AXI and FXI Methodologies exclude the 2.5% largest and 2.5% smallest instrument spreads, thereby removing transactions that may be impacted by idiosyncratic events (e.g., distressed entities seeking to fund themselves) and potentially manipulative activities.

¹⁴ Average Dollar Transactions Volumes for AXI and FXI are based on data from June 30, 2016 to February 26, 2024. Data provided by the Administrator.

Three of the more unique features of AXI and FXI are the 21-business day observation period, use of transactions across the maturity spectrum, and the weighting methodology. Regarding the 21-business day observation period, individuals we spoke with identified this as a deliberate choice that seeks to carefully address a tradeoff in the design of the Benchmarks. The extended observation period makes AXI and FXI less reactive to market shocks that may occur over a day or week period, thereby "smoothing" the rates. However, this same smoothing effect means that the rates do not adjust instantaneously to unsecured debt funding rates experienced by U.S. banks and entities. Antje Berndt, Darrell Duffie, and Yichao Zhu in their paper, *Across-the-Curve Credit Spread Indices*, discuss the tradeoff between an observation period that is too short, "which would imply a much noisier index, having greater susceptibility to manipulation," and a longer observation period that may result in "a very stale index, like 11th District COFI."¹⁵ The AXI and FXI Methodologies seek to strike a compromise by employing a 21-business day observation period.

The second unique feature of AXI and FXI is that they rely upon a broad set of transactions from across the maturity spectrum. This allows the spreads to benefit from deeper pools of longer-term debt issuance across the yield curve.

The third unique feature is the weighting applied to AXI and FXI. AXI and FXI combine short-term transactions (i.e., duration of less than a year) with long-term transactions (i.e., transactions with maturities of one to five years) by weighting transactions based on both notional volume and maturity. The effect of this weighting methodology is that long-term debt instruments typically receive a greater relative weighting within the spread determination than short-term debt instruments.

An alternative approach would be to limit AXI and FXI to short-term instruments only given that short-term instruments, on average, account for 96% and 94% of AXI and FXI average dollar transaction notional volumes, respectively. The downside of limiting AXI and FXI to short-term instruments would be:

- a decrease in observable transaction volumes;
- benchmarks that are more susceptible to liquidity risks in the CP and CD markets under periods of stress, as identified by IOSCO in its Statement on Alternatives to USD LIBOR; and
- benchmarks that are less responsive to changes to U.S. bank and entity funding patterns (such as the lengthening of bank liabilities following the global financial crisis), thus negating the fundamental premise underlying AXI and FXI.

Yet another alternative weighting approach would be to consider transaction volume only, thereby treating equal notional sized instruments equally regardless of duration (e.g., a USD 100mn one-week CD would receive equal weighting as a USD 100mn five-year bond). Finally, a dollar duration or DV01 approach that considers the maturity of instruments, results in an average weighting of roughly 50% for the long-term component.

With respect to these unique features – the 21-business day observation, use of transactions across the maturity spectrum, and the weighting methodology – reasonable minds may debate how best to measure AXI and FXI's Interests. We highlight these features so that readers, and in particular potential bank users of AXI and FXI, can

¹⁵ Across-the-Curve Credit Spread Indices, Berndt, Duffie, Zhu, April 2, 2023

assess whether the Benchmarks are fit for purpose for their specific institution considering their business model and funding needs.

Concept of proportionality and the inverted pyramid problem

Principle 6 requires consideration of the relative size of the underlying market in relation to the volume of trading in the market that references the benchmark. This is sometimes called the concept of proportionality or – where the volume of trading in the market referencing the benchmark dwarfs the underlying markets from which the benchmark is determined – the inverted pyramid problem.

Focusing first on the base of the pyramid, AXI and FXI consider debt instruments with overnight to five-year maturities over a 21-business day observation period. As shown in Exhibit 2 below, these design features result in AXI and FXI observing a large pool of transactions with a longer maturity profile relative to LIBOR, which was submission-based, and BSBY. In addition, AXI and FXI are designed to be credit spread add-ons to SOFR, which means that SOFR volumes also may be considered when assessing the base of transactions underlying AXI and FXI.



Exhibit 2 - Comparison of LIBOR, BSBY, and AXI/FXI Transaction Volume¹⁶

Please note that the exhibit above shows average notional transaction volumes. Refer to Principle 7 for discussion of AXI and FXI's performance under stressed financial conditions.

The size of the top of the pyramid – i.e., the size of the markets referencing AXI and FXI – is prospective. AXI and FXI were officially launched on July 12, 2022, and the largest licensee is an American global systemically important

¹⁶ Data on BSBY obtained from *Bloomberg Short-Term Bank Yield Index Bulletin (Underlying Volumes, Resiliency in Periods of Stress and Current Landscape),* Bloomberg, July 2023.

bank ("G-SIB"); to our knowledge the Benchmarks have not yet been referenced in financial instruments by any financial institution as of the time of this report. Stakeholders we interviewed anticipated AXI and FXI has the potential to be added to SOFR for rates for revolving lines of credit. Stakeholders also discussed the potential development of futures and swaps markets to allow for hedging and risk management.

We note that AXI and FXI are not proxies for any interest rate because they are available only as credit spreads supplements. It is therefore reasonable to assume that market usage of AXI and FXI will likely be substantially smaller than SOFR. Further, the introduction of AXI and FXI will not impact existing SOFR market liquidity because financial instruments referencing AXI and FXI can trade separately from SOFR.

In conclusion, while the size of the relative size of the markets underlying AXI and FXI seem reasonable in relation to the volume of trading in the anticipated markets that will reference the benchmarks, we suggest that SOFR Academy and the Administrator continue to monitor transaction volumes should market participants begin referencing AXI and FXI in financial contracts and under other use cases.

Market concentration and dynamics

AXI's contributor base includes U.S. bank holding companies and their banking subsidiaries. FXI's contributor base is wider than AXI's and includes all U.S. entities. Data from the DTCC Money Market Kinetics and FINRA TRACE contains CUSIP information that allowed us to identify the largest instruments issued in the long-term component of AXI and FXI for a small sample of specific dates. We did not conduct a full review of contributors over a longer period. Refer to the discussion in *Principle 7*.

Regarding market dynamics, AXI and FXI's across-the-curve design feature allows the benchmarks to be responsive to changes in the duration of unsecured funding by U.S. banks and entities. For example, should U.S. banks continue shifting their unsecured funding to longer duration instruments, AXI would capture these data points in its spread calculation.

Observations and recommendations

While our opinion was that AXI and FXI fully implemented Principle 6, we observed the following opportunities for enhancement, which we understand SOFR Academy and the Administrator are in the process of addressing:

Observations and Recommendations			
Торіс	Observations	Recommendations	Benchmarks Impacted
Benchmark Fallbacks	The AXI and FXI Methodologies and the Administrator's documented procedures identified fallbacks for instances where there are short-term technical issues or where transaction volumes fall briefly below 50% of historical minimum daily trading volume (in notional dollars); however, there did not appear to be a defined plan for scenarios where data is unavailable or below transaction volume thresholds for multiple days or weeks.	Consider defining benchmark fallbacks in the AXI and FXI Methodologies for scenarios where data is unavailable or below transaction volume thresholds for extended periods of time.	AXI FXI

Observations and Recommendations			
Торіс	Observations	Recommendations	Benchmarks Impacted
Benchmark Monitoring	Financial benchmarks may experience the inverted pyramid problem when the volume of trading in the market referencing the benchmark dwarfs the underlying markets from which the benchmark is determined. We understand that market participants are considering using AXI and FXI within financial contracts as a credit spread add-on to SOFR. We further understand that the Administrator has an annual benchmark review process.	Continue monitoring AXI and FXI for potential inverted pyramid problems should market participants begin referencing AXI and FXI in financial contracts.	AXI FXI

b. Principle 7 – Data Sufficiency

From the IOSCO Principle:

The data used to construct a Benchmark determination should be sufficient to accurately and reliably represent the Interest measured by the Benchmark and should:

- a) Be based on prices, rates, indices or values that have been formed by the competitive forces of supply and demand in order to provide confidence that the price discovery system is reliable; and
- b) Be anchored by observable transactions entered into at arm's length between buyers and sellers in the market for the Interest the Benchmark measures in order for it to function as a credible indicator of prices, rates, indices or values.

This Principle requires that a Benchmark be based upon (i.e., anchored in) an active market having observable Bona Fide, Arms-Length Transactions. This does not mean that every individual Benchmark determination must be constructed solely of transaction data. Provided that an active market exists, conditions in the market on any given day might require the Administrator to rely on different forms of data tied to observable market data as an adjunct or supplement to transactions. Depending upon the Administrator's Methodology, this could result in an individual Benchmark determination being based predominantly, or exclusively, on bids and offers or extrapolations from prior transactions. This is further clarified in Principle 8.

Provided that subparagraphs (a) and (b) above are met, Principle 7 does not preclude Benchmark Administrators from using executable bids or offers as a means to construct Benchmarks where anchored in an observable market consisting of Bona Fide, Arms-Length transactions. [fn. 23 For example this approach might be appropriate in a market where overall transaction volume is high over sustained periods, though on any given day there might be more firm bids and offers than posted transactions taking place."]

From IOSCO's Statement on Credit Sensitive Rates, September 2021, and Statement on Alternatives to USD LIBOR, July 2023

- IOSCO supports the Financial Stability Board's recent remarks that 'to ensure financial stability, benchmarks which are used extensively must be especially robust'. Widespread use of and transition to credit sensitive rates, **instead of** (emphasis added) the US Alternative Reference Rates Committee's preferred Secured Overnight Financing Rate (SOFR), may therefore pose risks to financial stability.
- Regulators are concerned that some of LIBOR's shortcomings may be replicated through the use of credit sensitive rates that lack sufficient underlying transaction volumes. The disproportionality between the low/modest volume of transactions underlying credit sensitive rates and the increasingly higher volumes of activity in markets referencing them - the so-called inverted pyramid problem - raises concerns about market integrity, conduct risks and financial stability risks. The decline in the underlying activity of some of the credit sensitive rates during stress periods, such as the COVID-19 pandemic, raises additional regulatory concern.
- Further, gaps in data and volatility related to reliance on a very small number of transactions mean that USD LIBOR alternatives based on these markets are unlikely to sufficiently implement the IOSCO's Principles relating to benchmark design...During stressed conditions, market liquidity tends to decline further. Low transaction volumes, coupled with the use of quotations, could not only cause deviation from rates that might be available to participants in the markets if they chose to transact, but can also increase the risk of benchmark manipulation.

Discussion

AXI and FXI fully implemented Principle 7 of IOSCO's Principles for Financial Benchmarks.

Benchmark	Degree of Implementation
AXI	Fully Implemented
FXI	Fully Implemented

AXI and FXI short-term and long-term spreads are fully based on observable, bona fide, arms-length transactions. Indicative bids/offers, executable bids/offers or estimates of any type are <u>not</u> used in constructing AXI/FXI spreads.

The transaction data used to construct AXI and FXI spreads is sourced from established, independent data repositories subject to well-defined reporting requirements and regulatory oversight (DTCC Money Market Kinetics and FINRA TRACE).

AXI and FXI spreads are not an alternative to SOFR and thus would not undermine or threaten SOFR's current widespread use. Rather, AXI and FXI spreads can be **added to SOFR** to form a credit sensitive index for bank loans.

AXI and FXI spreads, published daily, are calculated based on the rolling average of transactions over the prior 21 business days. The use of a 21-day rolling period results in a large transaction volume that appears to mitigate the risk of manipulation of the index and the inverted pyramid problem. For example, as stated in an October 2023 presentation prepared for third parties,¹⁷ the dollar volume of transactions ("transaction volume") underlying the daily published AXI and FXI spreads between June 2016 and June 2023 were as follows:

Exhibit 3 - Transaction Volume Underlying Daily Published AXI Spread (June 2016 – June 2023)

Summary Statistics – AXI (In USD thousands)	ST	LT	Total
Mean	426,936,446	16,972,841	443,909,287
Median	378,325,261	16,987,579	399,654,830
High	670,984,609	32,788,141	684,520,642
Low	251,477,156	7,642,495	265,416,781

Exhibit 4 - Transaction Volume Underlying Daily Published FXI Spread (June 2016 – June 2023)

Summary Statistics – FXI (In USD thousands)	ST	LT	Total
Mean	1,406,172,153	92,792,945	1,498,965,098
Median	1,404,708,431	91,556,546	1,492,509,906
High	1,888,765,628	146,236,928	1,998,290,336
Low	959,475,782	55,589,019	1,052,838,109

¹⁷ Invesco/SOFR Academy Statistical Data Transparency Presentation, Invesco, October 2023

Similarly, based on data provided by the Administrator for the period June 1, 2022 – February 26, 2024, Promontory calculated the number of transactions ("transaction count") underlying the daily published AXI and FXI spreads for the period as follows:

Exhibit 5 - Transaction Count Underlying Daily Published AXI Spread (June 1, 2022 – February 26, 2024)

Summary Statistics – AXI	ST	LT	Total
Mean	16,074	99,906	115,980
Median	15,883	99,283	115,166
High	18,830	143,107	161,937
Low	14,150	78,577	92,727

Exhibit 6 - Transaction Count Underlying Daily Published FXI Spread (June 1, 2022 – February 26, 2024)

Summary Statistics – FXI	ST	LT	Total
Mean	81,115	647,648	728,763
Median	81,393	645,854	727,246
High	87,892	771,323	859,215
Low	71,693	520,499	592,192

To evaluate the concern about the decline in transaction volumes typically observed in times of market stress, Promontory analyzed AXI transaction volumes underlying daily published spreads for the two most recent stress events (COVID-19 initial shutdown in March 2020 and U.S. regional bank stress in March 2023) using data provided by the Administrator. For both stress events, Promontory analyzed transaction data over a 90-day period (February 15 – May 15) to capture activity that preceded and followed the stress events.¹⁸

As seen in Exhibit 7, AXI (ST) transaction volume underlying daily published AXI (ST) spreads declined modestly to USD 268 billion in the third week of March 2020 before recovering steadily throughout April 2020. Even at its low point, transaction volume remained at a level sufficient to allow for daily calculation of AXI (ST) spreads in accordance with its estabilished methodology. AXI (LT) transaction volume underlying daily published AXI (LT)

¹⁸ The World Health Organization declared COVID-19 a pandemic on March 11, 2020, and commencing on March 15, 2020 individual U.S states began to implement shutdowns to prevent its spread. The Federal Reserve and U.S. Treasury announced a series of interventions to support the U.S economy and market functioning in the second half of March 2020, and the CARES Act was signed into law on March 27, 2020, after which financial markets stabilized.

The 2023 U.S. regional bank stress was precipitated by the failure of Silicon Valley Bank ("SVB") on March 10, 2023, after a run on the bank that commenced several days earlier, along with the voluntary liquidation of Silvergate Bank announced on March 8, 2023. These events were quickly followed by the failure of Signature Bank on March 12, 2023, and concern about the viability of First Republic Bank, which ultimately was resolved by its government-assisted sale to J.P Morgan Chase & Co. on May 1, 2023. The FDIC's blanket guarantee of all insured deposits (including amounts in excess of the FDIC's deposit guarantee limit) in connection with its resolutions of SVB and Signature Bank, along with the government assistance to facilitate the sale of First Republic Bank, served to lower concerns of a fast-moving regional banking crisis.

spreads declined to USD 17.6 billion in the second week of March before recovering steadily throughout the remainder of March and April 2020 as seen in Exhibit 8.





Exhibit 8 - Long-Term Component Transaction Volume (in USD) Underlying Daily Published AXI during 2020 Market Stress Period (COVID-19 initial shutdown)



As seen in Exhibit 9, AXI (ST) transaction volume underlying daily published AXI (ST) spreads fluctuated between a low of USD 545 billion and a high of 591 USD billion throughout the Regional Bank Crisis. Even at its low point, transaction volume remained at a level sufficient to allow for daily calculation of AXI (ST) spreads in accordance with its estabilished methodology. AXI (LT) transaction volume underlying daily published AXI (LT) spreads jumped from USD 11.6 billion to USD 16.0 billion in the second week of March. This was followed by a drop back to USD 9.6 billion in the second week of April, after which transaction volume remained steady throughout the rest of April and the first two weeks of May. Consistent with AXI (ST), transaction volume remained at a level sufficient to allow for daily calculation of AXI (LT) spreads in accordance with its estabilished methodology.





Exhibit 10 - Long-Term Component Transaction Volume (in USD) Underlying Daily Published AXI during 2023 Market Stress Period (Regional Bank Crisis)



Another way of examining transaction volumes during market stress events is to determine whether the relationship between SOFR daily transaction volumes and AXI transaction volumes underlying daily published AXI spreads changed materially during such periods. Promontory used data provided by the Administrator for the February 15 – May 15 periods in 2020 and 2023, along with SOFR data available on the the Federal Reserve Bank of New York's website, to perform such an analysis. As seen in Exhibit 11, in the 2020 stress event the multiple of SOFR to AXI (ST) transaction volume briefly increased by roughly 20% in mid-March 2020, from 4x to nearly 5x, before quickly returning to the pre-shutown multiple of 4x and then falling further to between 2x and 3x for the remainder

of the observation period. In the 2023 stress event, the multiple of SOFR to AXI (ST) transaction volume was relatively constant, remaining between roughly 2x and 2.75x throughout the observation period.

Exhibit 11 - Daily SOFR Transaction Volume to AXI Short-Term Component Transaction Volume Ratio during 2020 Market Stress Period (COVID Pandemic)



Exhibit 12 - Daily SOFR Transaction Volume to AXI Short-Term Component Transaction Volume Ratio during 2023 Market Stress Period (Regional Bank Crisis)



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In addition, when analyzing transaction data from the 2020 and 2023 market stress events, Promontory also examined how AXI spreads over SOFR performed. Consistent with a key argument of those advocating for a credit-sensitive add-on to SOFR, AXI spreads over SOFR indeed widened in the stress periods (reflecting the "flight to quality"), as seen in Exhibit 13.



Exhibit 13 - Unscaled AXI (spread over SOFR)

Finally, while transaction volumes and transaction counts appear sufficiently large to eliminate the risk of manipulation, the risk of manipulation would exist if transactions were concentrated in the instruments of a very small number of issuers. To assess this risk, one would need information on the unique issuers associated with transaction volumes and transaction counts. Berndt, Duffie, and Zhu considered this question in their April 2023 paper, *Across-the Curve Credit Spread Indices*, focusing on AXI (LT) given its lower notional transaction volume relative to AXI (ST) and FXI. The authors employed filtering techniques using additional data sources (Enhanced TRACE, Merchant FISD, and Center for Research in Security Prices) and calculated the following for 2018 (the last full year for which data was available):

Exhibit 14 - Contributors Underlying AXI Long-Term Transactions Spread (2018)

Contributors	Issuers	Issues	Trades	Average Trade Size
Bank Holding Companies and Commercial Banks	57	255	70,000	USD 2,000,000

In addition, the Administrator provided data on the top 20 securities (i.e., CUSIP) as a percentage of total securities included in the AXI and FXI published daily transaction volumes for February 29, 2024 and March 30, 2020. Promontory analyzed the data for the Long-Term component of both Benchmarks given its lower notional transaction volume relative to the Short-Term component. For AXI (LT), Promontory found that:

- No single issue represented more than 2.74% of total transaction volume;
- No single issuer in aggregate represented more than 7.11% of total transaction volume; and
- The top 20 issues in aggregate represented 12.8% of total transaction volume for March 30, 2020, and 20.30% for February 29, 2024.

Similarly, for FXI (LT), Promontory found that:

- No single issue represented more than 0.92% of total transaction volume;
- No single issuer in aggregate represented more than 1.97% of total transaction volume; and
- The top 20 issues in aggregate represented 5.82% of total transaction volume for March 30, 2020, and 2.93% for February 29, 2024.

Taken together, the analysis by Berndt, Duffie, and Zhu and the Top 20 CUSIP data provided by the Administrator support the conclusion that transaction concentration does not appear to pose the risk of manipulation or statistical corruption.

c. Principle 9 – Transparency of Benchmark Determinations

From the IOSCO Principle:

The Administrator should describe and publish with each Benchmark determination, to the extent reasonable without delaying an Administrator publication deadline:

- a) A concise explanation, sufficient to facilitate a Stakeholder's or Market Authority's ability to understand how the determination was developed, including, at a minimum, the size and liquidity of the market being assessed (meaning the number and volume of transactions submitted), the range and average volume and range and average of price, and indicative percentages of each type of market data that have been considered in a Benchmark determination; terms referring to the pricing Methodology should be included (i.e., transaction-based, spread-based or interpolated/extrapolated);
- b) A concise explanation of the extent to which and the basis upon which Expert Judgment if any, was used in establishing a Benchmark determination.

Discussion

AXI and FXI broadly implemented Principle 9 of IOSCO's Principles for Financial Benchmarks.

Benchmark	Degree of Implementation	
AXI	Broadly Implemented	
FXI	Broadly Implemented	

Administrator Publication Transparency

The Administrator publishes as part of each daily determination of AXI and FXI:

- Unscaled AXI and FXI
- Term AXI and FXI: ON, 1M, 3M, 6M, 12M
- Average AXI and FXI: 30D, 90D and 180D

The Administrator also publishes daily key underlying statistical metrics for AXI and FXI, a sample of which is shown below in Exhibit 15.

Promontory understands that the Administrator maintains a "changes to benchmark methodology policy" document and that additional information is being added to the calculation and fallback guidelines to the AXI and FXI Methodologies, consistent with the recommendations below.

Exhibit 15 - Sample of Daily Published Key Underlying Metrics for AXI and FXI¹⁹

USD-AXI and USD-FXI enhanced transparency metrics table The following table reflects key underlying metrics of USD-AXI and USD-FXI				
Benchmark USD-AXI USD-FXI				
Reference date		05-Mar-2024	05-Mar-2024	
Unscaled rate average maturity (years) 1.72639 2.34351			2.34351	
Short term component	Transaction volume (USD millions)	595,550	1,678,931	
	Maturity (years)	0.04419	0.04606	
	Number of transactions	15,562	80,490	
	Capped transaction volume (USD millions)*	10,082	96,640	
Long term component	Uncapped transaction volume multiplier**	1.26485	1.26204	
	Maturity (years)	3.09742	2.97389	
	Number of transactions	77,867	685,630	

* FINRA TRACE established dissemination protocols that included certain caps. The size disseminated is the total par value of the trade, subject to the limits of the applicable dissemination cap. For investment grade TRACE-eligible securities and agency debt securities, the current dissemination cap is \$5 million. For non-investment grade TRACE-eligible securities, the current dissemination cap is \$1 million. The uncapped transaction sizes are reported in the Enhanced TRACE dataset which is released to the public with several months of delay.

** The uncapped transaction volume multiplier (UTVM) can be multiplied with the Long term component capped transaction data to approximate the actual traded volumes for the long term component. The UTVM is calculated by comparing the most recent quarter of uncapped data available to the equivalent capped data.

In Promontory's view, this daily publication, as well as the publicly available AXI and FXI Methodologies, AXI FAQs that detail specific aspects of the Benchmarks and their calculation, and governance documents surrounding the administration of the benchmarks, allow market participants to largely understand how the Benchmarks were developed and how daily calculations were determined.

However, Promontory noted that unscaled AXI and FXI, as well as the unscaled rate average maturity, are not simple weighted averages of the short-term and long-term component based on their transaction volumes. Rather, these metrics are **transaction volume- and maturity-weighted** averages. While this approach is described at a high-level in the AXI and FXI Methodologies, Promontory recommended further detailing these calculation processes in the AXI and FXI Methodologies.

¹⁹ Invesco / SOFR Academy USD Across-the-Curve Credit Spread Indexes (AXI) Webpage (https://www.invescosofracademyaxi.com/#resources), Invesco, March 5, 2024.

Application of Expert Judgment

As described in the AXI and FXI Methodologies, no discretion or expert judgement is exercised by the Administrator in the daily determination of AXI and FXI. The AXI and FXI Methodologies (Index Policy section) assert that in circumstances giving rise to a delay in publication (e.g., due to technology issues or a lack of input data availability), the Administrator will publish the prior business day's Benchmark spreads. Upon successful resolution of the underlying issue, the Benchmark spreads will be restated retroactively.²⁰ Promontory noted that while the Administrator's *AXI Python Code Process* document indicated that transaction volume for each of the short-term and long-term components is to be deemed insufficient for a given day when that corresponding volume fell below 50% of historical minimum daily trading volume used by AXI and FXI up to March 13, 2023 (in notional dollars), the AXI and FXI Methodologies did not present that detail.

Observations and recommendations

We observed the following opportunities for enhancement, which we understand SOFR Academy and the Administrator are in the process of addressing:

Observations and Recommendations				
Торіс	Observations	Recommendations	Benchmarks Impacted	
Disclosure of Transaction Weighting	Unscaled AXI and FXI, in addition to their respective unscaled rate average maturity, are not simple weighted averages of the short-term and long-term component based on their transaction volumes. Rather, these metrics are transaction volume- and maturity-weighted averages. This approach is described in the AXI and FXI Methodologies; however, such descriptions are at a high-level and do not include supporting information, such as the underlying formulae.	$\begin{split} & \frac{\text{Enhance the Transaction Weighting section of the}{\text{AXI and FXI Methodologies by providing further}}{\text{detail concerning the weighting approach for each} \\ & \text{of Unscaled AXI and FXI and their respective} \\ & \text{unscaled rate average maturity, including by} \\ & \text{potentially adding their formulaic determinations} \\ & \text{shown below for illustrative purposes:} \\ \hline & \frac{\text{Unscaled AXI/FXI:}^{21}}{(Spd_{ST}^{t} * Mat_{ST}^{t} * Vol_{ST}^{t}) + (Spd_{LT}^{t} * Mat_{LT}^{t} * Vol_{LT}^{t}))}{(Mat_{ST}^{t} * Vol_{ST}^{t}) + (Mat_{LT}^{t} * Vol_{LT}^{t})}{21}} \\ & \frac{\sum_{t=1}^{21} \frac{\left((Mat_{ST}^{t} * Mat_{ST}^{t} * Vol_{ST}^{t}) + (Mat_{LT}^{t} * Mat_{LT}^{t} * Vol_{LT}^{t})\right)}{(Mat_{ST}^{t} * Vol_{ST}^{t}) + (Mat_{LT}^{t} * Mat_{LT}^{t} * Vol_{LT}^{t})}{21}}{21} \end{split}$	AXI FXI	

²⁰ Invesco / SOFR Academy USD Across-the-Curve Credit Spread Index Methodology, Invesco, July 2022.

Invesco / SOFR Academy USD Financial Conditions Credit Spread Index Methodology, Invesco, March 2023.

²¹ Spd_{ST}^{t} : Short-term component average spread; Mat_{ST}^{t} : Short-term component average maturity; Vol_{ST}^{t} : Short-term component total daily volume (USD); Spd_{LT}^t : Long-term component average spread Mat_{LT}^t : Long-term component average maturity Vol_{LT}^t : Longt-term component total daily volume (USD)

Observations and Recommendations				
Торіс	Observations	Recommendations	Benchmarks Impacted	
Metrics	The unscaled rate average maturity metric is not defined in the daily publication of the USD-AXI and USD-FXI Enhanced Transparency Metrics table.	 Undertake one of the following approaches regarding the daily reporting of the unscaled rate average maturity metric: Exclude the unscaled rate average maturity from the daily enhanced transparency metrics report; or Include further detail regarding how the metric is defined and calculated. 	AXI FXI	
Disclosure of Transaction Volume Threshold	While the AXI Python Code Process document indicated that transaction volume for each of the short-term and long-term components is to be deemed insufficient for a given day when that corresponding volume fell below 50% of historical minimum daily trading volume used by AXI/FXI up to March 13, 2023 (in notional dollars), the AXI and FXI Methodologies did not present that detail.	Define in the AXI and FXI Methodologies the transaction volume threshold below which transaction volumes would be deemed to be insufficient to publish new daily rates.	AXI FXI	

Appendix I – List of Documents Reviewed

List of Documents Reviewed
Policies and Procedures
Changes to Benchmark Methodology and Cessation Policy
Invesco Indexing Recalculation Policy
Third Party Risk Management Policy
Recordkeeping Policy
Complaints-handling Policy
Conflicts of Interest Policy
Information Barrier Policy
Calculation Quality Assurance ("QA") Procedure
Methodology
Invesco Indexing Investable Universe Methodology
Invesco / SOFR Academy USD Across-the-Curve Credit Spread Index Methodology
Invesco / SOFR Academy USD Financial Conditions Credit Spread Index Methodology
Notification of Technical Enhancement to AXI Scaling Methodology
Governance and Control Frameworks
Indexing Control and Accountability Framework
Index Oversight Committee Charter
Materials from last three Index Oversight Committee meetings
Index Advisory Committee Charter
Reporting and Other Materials
QA Reports related to calculation of AXI/FXI
AXI scaling factor calculation example
Invesco / SOFR Academy USD Across-the-Curve Credit Spread Index (AXI) and the USD Financial Conditions Credit Spread Index (FXI) Statistical Data Transparency Presentation

Invesco AXI Brochure

Across-the-Curve Credit Spread Indices - Berndt, Duffie & Zhu (2023)

Invesco Indexing LLC Report on Management's Statement of Adherence to the International Organization of Securities Commissions ("IOSCO") Principles for Financial Benchmarks (As of February 28, 2022)

Invesco Indexing LLC Report on the Senior Management's Statement of Adherence to the International Organization of Securities Commissions ("IOSCO") Principles for Financial Benchmarks (As of April 6, 2023)

AXI Technical Whitepaper

Financial Stability Considerations in connection with the Invesco / SOFR Academy AXI and Invesco / SOFR Academy FXI

AXI FAQ

Short-Term Rate Benchmarks: The Post-LIBOR Regime (Tuckman)

Fed's Statement of Compliance for SOFR for IOSCO

ARRC FAQ re SOFR

IOSCO Review of Libor, Euribor, Tibor

IOSCO Second Review of Libor, Euribor, Tibor

IOSCO Statement on Alternatives to USD Libor

Invesco's Note on IOSCO's Statement on Alternatives to USD Libor

USD-AXI and USD-FXI Enhanced Transparency Metrics Table

IOSCO Statement on Credit Sensitive Rates - Sept 2021

SEC Chair Gensler's Prepared Remarks Before the Financial Stability Oversight Council - LIBOR (June 2021)

SEC Chair Gensler's Prepared Remarks Before the Financial Stability Oversight Council - LIBOR (December 2021)

SEC Chair Gensler's Prepared Remarks Before the Financial Stability Oversight Council - LIBOR (July 2023)

Financial Stability Oversight Council Annual Report 2023

Joint statement on Reference Rates for Loans - FRB/FDIC/OCC

Information on the Robustness, Sustainability and Application of AXI

Research by Alex Roever – What are AXI and FXI telling markets about current financial conditions?

Letter from Regional Bank Treasurers to FRB/OCC/FDIC on Credit Sensitivity (September 2019)

Note from Samim Ghamami on Unintended Impact of LIBOR-SOFR Transition on Credit Markets and Economic Activity

Sample Benchmark Data (e.g., transaction volumes, transaction counts, spreads)

Appendix II – List of Interviews

Promontory met with the following individuals:

Name	Firm / Affiliation	Title
Marcus Burnett	SOFR Academy	CEO
Darrell Duffie	Stanford GSB	Professor
Alex Peever	CFA Institute	Senior Director
Alex Roevel	SOFR Academy	Senior Advisor
Blaise Warren	Invesco	Chief Operating Officer – Multi- Asset Strategies
S. Jeremy Koziol	Invesco	Director of Operations
Eric Cheng	Invesco	Director Of Index Research
Bella Wang	Invesco	Senior Index Research Analyst
Melanie Zimdars	Invesco	Chief Compliance Officer
Derek Maxwell	Invesco	Compliance Manager
Mike Verdeschi	Citigroup (formerly)	Treasurer
	SOFR Academy	Senior Advisor
Samim Ghamami	New York University	Adjunct Professor
	University of California, Berkeley	Senior Researcher





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