SOFR Academy

Information on the Robustness, Sustainability and Application of USD Invesco / SOFR Academy Across-the-Curve Credit Spread Indices (AXI)

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About AXI: In the event, that banks choose to include a variable bank credit spread component to their floating-rate loan terms in order to hedge changes in their funding costs, AXI is a representative and robustly determined credit spread index, which depends on a broad set of debt issuances with maturities ranging from short term to multiple years (Berndt, Duffie, Zhu, 2020). AXI is a robustly defined, forward looking credit spread that automatically adapts to changes in bank funding compositions and can be used in conjunction with SOFR. AXI was first introduced to the private and public sector at the Credit Sensitivity Group (CSG) workshops hosted by the FRBNY. The CSG workshops "explored methodologies to develop a robust lending framework that considers a credit sensitive rate/spread that could be added to the SOFR". The CSG workshops were separate from and supportive of the work of the Alternative Reference Rates Committee (ARRC), which is a group of private-market participants convened by the Federal Reserve Board of Governors and the FRBNY to help ensure a successful transition from U.S. dollar (USD) LIBOR to its recommended alternative, SOFR. SOFR plus a robustly defined across-the-curve credit spread index is referred to as SOFRx in loan and derivatives documentation. AXI can be used in conjunction with any form of SOFR. Further information about AXI including education materials is available at SOFR.org/AXI

Acknowledgement: SOFR Academy is grateful to the team of leading academics that authored the paper[1] in which the Across-the-Curve Credit Spread Index (AXI)™ and the Financial Conditions Credit Spread Index (FXI)™ were conceived. Antje Berndt is a Professor of Finance at the College of Business and Economics, Australian National University. Darrell Duffie[2] is the Adams Distinguished Professor of Management and a Professor of Finance at the Graduate School of Business, Stanford University, as well as a research fellow of the National Bureau of Economic Research. Yichao Zhu is a Senior Lecturer in finance at the College of Business and Economics, Australian National University. Professor Duffie chaired a Market Participants Group on Reforming Interest Rate Benchmarks (or the Market Participants Group on Reference Rate Reform). The group was established by the Financial Stability Board (Market Participants Group (2014)).

AXI's Administrator: Invesco Indexing LLC as the index provider of the Invesco / SOFR Academy Across-the-Curve Credit Spread Index (AXI). Invesco Indexing is an independent index provider owned by Invesco Ltd. (NYSE: IVZ). Invesco Indexing is a recognized benchmark administrator with over 180 as et December 31, 2021. To request AXI licensing documentation please email IndexSupport@Invesco.com.

A message from the CME Group: Any prospective user of AXI that would intend to also use CME Term SOFR in developing an interest rate for Cash Market Financial Products or OTC Derivative Products would require a license with CME Group for use of CME Term SOFR.

[1] Berndt, Antje and Duffie, James Darrell and Zhu, Yichao, Across-the-Curve Credit Spread Indices (July 23, 2020). Stanford University Graduate School of Business Research Paper No. 3884, Available at SSRN: https://ssrn.com/abstract=3662770 or http://dx.doi.org/10.2139/ssrn.3662770

[2] Professor Duffie is not involved in the operationalization of AXI.

The IOSCO principles: AXI was designed consistent with the spirit in which the internationally created and agreed Principles for Financial Benchmarks[3] were developed by the International Organization of Securities Commissions (IOSCO). Adopting an across-the-curve methodology ensures that the maximum number of transactions are captured within the index. Creating an index that is adaptable to future changes in bank funding composition allows for the alignment of the index with the IOSCO principles to be sustained through time. The academic architects of AXI recognized the importance of the IOSCO principles in their approach and found that a useful credit-spread index should meet the basic criteria described in Table 1.

Table 1: Criteria of a useful credit spread index

Criteria	Description	IOSCO Principle
1. Hedging effectiveness	Highly correlated with bank cost of funds, as determined by recent market credit spreads for wholesale unsecured issues of banks.	**Principle 6: Benchmark Design** 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.
2. Robustness	Computed from a large enough pool of market transactions that the index can underly actively traded derivatives instruments used by banks and their borrowing customers to hedge their floating-rate exposures, with minimum risk of statistical corruption or manipulation.	**Principle 7: Data Sufficiency** The data used to construct a Benchmark determination should be sufficient to accurately and reliably represent the Interest measured by the Benchmark.
3. Adaptable to changes in issuance patterns	The index should maintain the first two properties even as banks change the maturity and instrument composition of their issuances in response to changes in regulation and market conditions.	**IOSCO Statement (September 2021)[4]** "Benchmark administrators should be mindful that demonstrating compliance with the IOSCO Principles is not a one-time exercise and alternative benchmarks should be IOSCO compliant at all times."

Approach to AXI operationalization: In a June 21, 2021 letter (Burnett, 2021) to ARRC leadership, SOFR Academy committed to operationalizing AXI in a considered and measured

[3] https://www.iosco.org/library/pubdocs/pdf/IOSCOPD415.pdf
[4] https://www.iosco.org/library/pubdocs/pdf/IOSCOPD683.pdf

way that incorporates feedback and from a wide range of stakeholders. We believe that leaders at Financial Institutions should be able to explain their financial benchmark selection to employees, regulators, counterparts, auditors, investors, and shareholders. To help market participants achieve that goal, we are pleased to provide the following information and hope it is useful for market participants. The information in Table 2 is an example only and was produced exclusively by SOFR Academy.

Table 2: Information on the Robustness, Sustainability and Application of the USD Invesco / SOFR Academy Across-the-Curve Credit Spread Index (AXI)

Objective: Did Bank management plan for and identify appropriate replacement rates and spread adjustment methodologies? Consider in your assessment:	
1. Has management developed appropriate strategies to identify replacement rates and spread adjustments and modify new and existing contracts, as necessary? Consider in your assessment:	SOFR Academy supports SOFR. We also support Across-the-Curve Credit Spread Indices (AXI). Both SOFR and AXI are well-designed and grounded in market transactions. In the event, that banks choose to include a variable bank credit spread component to their floating-rate loan terms in order to hedge changes in their funding costs, AXI is a representative and robustly determined credit spread index, which depends on a broad set of debt issuances with maturities ranging from short term to multiple years (Berndt, Duffie, Zhu, 2020). AXI is being operationalized as robustly defined, forward-looking spread add-ons to SOFR. Neither AXI nor FXI will be made available as all-in standalone credit sensitive rates. SOFR Academy does not wish to create a path for banks to circumvent SOFR. SOFR plus a robustly defined across-the-curve credit spread index is referred to as SOFRx in loan documentation. The primary goal of operationalizing AXI and FXI is to help facilitate the smooth transition away from USD LIBOR in the U.S. lending markets. This approach is consistent with the original intent of the New York Federal Reserve Credit Sensitivity Group Workshops which “explored methodologies to

	develop a robust lending framework that considers a credit sensitive rate/spread that could be added to the Secured Overnight Financing Rate (SOFR)." (FRBNY, 2020).
a. Have strategies addressed replacement rate availability, suitability, and appropriateness?	AXI will be published by benchmark administrator Invesco Indexing LLC and made available in a similar way that other major indices are. AXI will be published on the Administrators website, on SOFR Academy's website (SOFR.org) and AXI will also be available through standard market data redistributor platforms, via AXI administrator's standard Application Programming Interface (API) and File Transfer Protocol (FTP). AXI licensing will be made available at reasonable commercial cost. The robustness and sustainability of the AXI indices, plus their usage of SOFR in any of its variants (Term, simple, etc.), make them suitable and appropriate for a variety of situations and non-retail customers in lending markets.
b. Have strategies addressed uncertainty of alternative rates market liquidity and availability and management's strategies to mitigate the risks associated with illiquid or unavailable alternative rates markets?	The Financial Conditions Credit Spread Index (FXI) is constructed using the same methodology as AXI but expanding the scope to include all financials and corporate bonds. FXI scales up the dollar transaction volume of covered transactions over the period by approximately 500%. FXI is essentially the most robust credit sensitive spread that is possible to construct. AXI and FXI are highly correlated, especially over the past few years (Berndt, Duffie, Zhu, 2020). "Fallback language" refers to the legal provisions in a contract that apply if the underlying reference rate in the product (e.g., AXI) is discontinued, non-representative, or unavailable. The OSSG recommended that market participants both understand their contractual fallback arrangements and ensure that those arrangements are robust enough to prevent potentially serious market disruptions in an AXI cessation event (ARRC, 2021).

	Fallback language pertaining to AXI is documented in the draft Term SOFR + AXI concept credit agreement produced with permission from the LSTA – a copy of the document can be obtained here. Fallback language has been drafted by legal counsel (a major American international law firm). Market participants should consult their legal advisers before using the documentation.
2. Has management identified appropriate replacement rates and adjustment methodologies that do not result in customer harm or expose the bank to unwarranted compliance and reputation risks?	Large banks no longer fund themselves at LIBOR in the same way that they used to, and there are not enough transactions with which to calculate LIBOR. Over time, LIBOR "became more of an arbitrary and sometimes self-interested announcement of what banks simply wished to charge for funds" (Quarles, 2021). Both AXI and FXI are highly correlated with bank funding costs. In contrast to other replacement rate proposals, neither AXI nor FXI are highly correlated with LIBOR. This is because the primary input data for AXI and FXI are the actual funding transactions that tend to occur further out the yield curve. In times of market stress, the underlying volume of transactions for LIBOR drop even further (School-Latter, 2020). This would imply that the threshold for satisfactorily explaining to customers and regulators just cause for charging LIBOR-like rates should be especially high.
3. If management has identified replacement rates, can the bank's systems accommodate the rates?	Major loan systems providers have the functionality to price loans off a base rate comprised of multiple variable rates such as SOFR + AXI. There has been some industry discussion around including a bank funding spread in the overall lending margin specific to a borrower[5]. We have observed that American businesses feel that changes to their respective margins are generally associated with a credit event specific to that borrower, and that

[5] See *Solving the SOFR credit-spread problem: The path forward for leading banks* https://sofracademy.com/solving-the-sofr-credit-spread-problem-the-path-forward-for-leading-banks-2/

	lending margins over a base rate benchmark reflect their creditworthiness as a borrower. Therefore, allowing lenders to reference a funding margin produced by an independent third party that is highly correlated with their funding costs may enhance transparency and fairness for American businesses including both the lender and the borrower. In the event, that banks choose to include a variable bank credit spread component to their floating-rate loan terms in order to hedge changes in their funding costs, AXI is a representative and robustly determined credit spread index, which depends on a broad set of debt issuances with maturities ranging from short term to multiple years.
4. Are the identified replacement rates sufficiently robust? Consider in your assessment:	AXI is robustly defined. This is because the primary input data for AXI is the longer-term pool of bond funding transactions that occur further out the yield curve. Taking an across-the-curve approach including short-term and long-term transactions captures the maximum number of transactions. Further, AXI automatically adapts to future changes in bank funding composition[6], thereby ensuring the index retains it robustness and representativeness throughout time. Consistent with the original AXI academic paper, a one-month observation period was selected for commercial implementation AXI. Reliance on a smaller daily sample would produce a more volatile index with greater susceptibility to manipulation. A bank's recent cost of funds is determined by the yields of its recently issued stack of liabilities, most of which are issued on a range of past dates (Berndt, Duffie, Zhu, 2020). Both AXI and FXI are variable credit spreads that can be used in conjunction with SOFR, leveraging

[6] See Risk.net article: "Stanford's Duffie shakes up SOFR credit race with AXI index" https://www.risk.net/derivatives/7661851/stanfords-duffie-shakes-up-sofr-credit-race-with-axi-index

	the approximately $1 trillion in daily transactions volumes that underpin SOFR.
a. During a stress period, will the rates reflect competitive forces of supply and demand from a sufficient number of arms-length transactions?	In a September 2020 letter to U.S. regulators, a group of regional banks stated: "We believe inclusion of a credit risk premium is essential to addressing the concerns outlined above and will make the banking system and, in turn, the U.S. economy more resilient during times of economic stress and facilitate the transition of lending markets from LIBOR." Regulators have expressed concern with credit sensitive rates that behave very similarly to LIBOR and are based on the same short-term wholesale bank funding markets as LIBOR (Wuerffel, 2021). AXI does not behave similarly to LIBOR and the primary input data are the actual bank funding transactions that occur further out the yield curve. AXI does not necessarily correlate highly with LIBOR. Taking into account a greater number of transactions from across-the-curve ensures that AXI reflects competitive forces of supply and demand from a sufficient number of arms-length transactions, even during times of stress. AXI is constructed using a wide range of underlying constituents and is not concentrated among a few large dealers.
b. Can market participants independently confirm the rates published by the benchmark administrator?	The input data for AXI is obtained only from publicly available sources. Therefore, markets participants can independently source and confirm the transactions and rates. The long end component data comes from Financial Industry Regulatory Authority (FINRA) Trade Reporting and Compliance Engine (TRACE). AXI's short end component in obtained from Depository Trust & Clearing Corporation (DTCC) Money Market Kinetics. This provides a single, daily feed of anonymized CP and CD secondary settlement transactions data. No proprietary data is

	used in the construction of AXI or FXI (an advantage of the index). The AXI White Paper details the construction methodology available for free at SOFR.org (SOFR Academy, 2021). The original academic paper in which AXI was conceived is available at Stanford Graduate School of Business (Berndt, Duffie, Zhu, 2020). Market participants can register to receive updates on AXI at SOFR Academy's AXI webpage.
c. Is the market for financial instruments that use the rate deep and liquid enough to allow the bank to easily manage the market risk of assets and liabilities that use the rate?	Markets in all alternative rates including near risk-free rates, credit sensitive rates, and credit sensitive spreads, are still in their relative infancy and associated markets are under development. Conversations have commenced to include Rate Options for AXI, variations of SOFR plus AXI. For example, Average SOFRx, Simple Daily SOFRx, Compound SOFRx, etc.
d. Do the underlying data span at least one full economic cycle?	Enhanced Historical Corporate Bond Data is available from FINRA TRACE inception (July 1, 2002). End of day files are made available by approximately 7.15 PM ET but may arrive earlier[7]. DTCC Money Market Kinetics data is available from November of 2014 and end of day file delivery occurs at approximately 5:10 PM ET, containing all transactions for the day[8]. SOFR is calculated as a volume-weighted median of transaction-level tri-party repo data collected from the Bank of New York Mellon as well as GCF Repo transaction data and data on bilateral Treasury repo transactions cleared through FICC's DVP service, which are obtained from DTCC Solutions LLC, an affiliate of the Depository Trust & Clearing Corporation.[9]

[7] https://www.finra.org/filing-reporting/trace/content-licensing/end-day-file-layout-and-agreement
[8] https://www.dtcc.com/-/media/Files/Downloads/Data-Services/dtccdata/Money_Market_Kinetics_Fact_Sheet_REV.pdf
[9] https://www.newyorkfed.org/markets/reference-rates/sofr

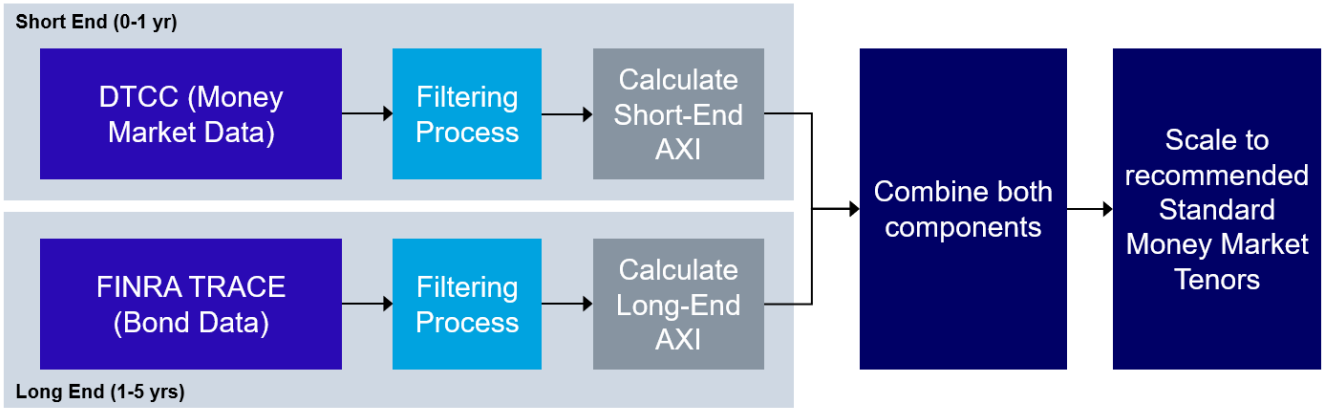
	The US government agency which acts as the ultimate regulator of the US securities industry, including FINRA and the DTCC, is the US Securities and Exchange Commission (SEC).
5. Has management made available sufficient education and training on the Replacement Rate or Spread adjustment?	SOFR Academy intends to make available a free self-paced online learning course regarding AXI hosted on SOFR Academy's Learning Management Software (LMS) platform. Bank employees, clients, counterparts and other stakeholders can enroll in the course. To download the course overview please click here. To pre-enroll in the course market participants should email learn@SOFR.org and include the number of learners and organization name.

AXI construction summary

SOFR Academy supports the Secured Overnight Financing Rate (SOFR). Given that liquidity in many SOFR linked markets has now picked up, we believe that the time is now appropriate to introduce a robustly defined dynamic credit spread add-ons to SOFR, such as AXI. The index is a weighted average of the credit spreads of unsecured bank funding transactions with maturities out to five years, with weights that reflect both transactions volumes and issuance volumes.

AXI is calculated as a single number that is then scaled down to standard tenors, e.g., overnight, 1-month, 3-months, 6-months etc. AXI is then added to SOFR—for example, CME Term SOFR[10], simple daily SOFR, SOFR compounded in arrears, or other SOFR variants—to form a credit-sensitive interest rate for loans, and eventually derivatives and other products.

Exhibit 3: AXI construction summary



[10] A message from the CME: any prospective user of AXI that would intend to also use CME Term SOFR in developing an interest rate for Cash Market Financial Products or OTC Derivative Products would require a license with CME Group for use of CME Term SOFR

About SOFR Academy

SOFR Academy, Inc. provides financial education and market data to empower corporations, financial institutions, governments, and individuals to make better decisions. The Firm's panel of advisors includes academics from Harvard University, the University of California Berkeley, New York University, Oxford University and Tsinghua University, as well as experienced financial services professionals. SOFR Academy is also driving the operationalizing of AXI and FXI as credit spread add-ons for SOFR for use in lending and derivative markets. SOFR Academy is a member of the American Economic Association (AEA), the Loan Syndications and Trading Association (LSTA), the International Swaps and Derivatives Association (ISDA), the Asia Pacific Loan Market Association (APLMA), the Bankers Association for Finance and Trade (BAFT) which is a wholly owned subsidiary of the American Bankers Association (ABA) and the U.S. Chamber of Commerce (USCC). For more information, please visit SOFR.org.

Contact information

For additional information, questions, or to request a consultation, please visit SOFR.org, or call our New York office on +1 855 236 6106.