

Credit VIX Indices *Methodology*

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Introduction

Index Objective and Highlights

The Credit Volatility IndicesSM (or “Credit VIX Indices”) track North American and European credit uncertainty by measuring the market’s expectation of how volatile credit spreads of the following underlying five-year credit default swap (CDS) indices will be over various time horizons:

- CDX North American High Yield Index (CDX.NA.HY)
- CDX North American Investment Grade Index (CDX.NA.IG)
- iTraxx Europe Main Index
- iTraxx Europe Crossover Index

Using prices of at-the-money (ATM) and out-of-the-money (OTM) payer and receiver CDS index options produces an expected volatility number for the next one-month, three-months, and six-months quoted as a percentage volatility on spreads to calculate both the percentage volatility Credit VIX indices and basis point volatility Credit VIX indices.

For information on the underlying indices, please see the index methodologies [here](#).

CDS Index Pricing Data Source

S&P Global Market Intelligence’s CDS Pricing Teams is the source for CDS index pricing and analytics data used to calculate index levels.

For more information CDS pricing and analytics data, please refer [here](#).

Supporting Documents

This methodology is meant to be read in conjunction with supporting documents providing greater detail with respect to the policies, procedures and calculations described herein. References throughout the methodology direct the reader to the relevant supporting document for further information on a specific topic. The list of the main supplemental documents for this methodology and the hyperlinks to those documents is as follows:

Supporting Document	URL
S&P Dow Jones Indices’ Commodities Indices Policies & Practices Methodology	Commodities Indices Policies & Practices

This methodology was created by S&P Dow Jones Indices to achieve the aforementioned objective of measuring the underlying interest of each index governed by this methodology document. Any changes to or deviations from this methodology are made in the sole judgment and discretion of S&P Dow Jones Indices so that the index continues to achieve its objective.

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Index Eligibility and Construction

Index Universe

The table below details each Credit VIX Index and the corresponding underlying index:

Credit VIX Index	Underlying Index Universe
CDX/Cboe NA High Yield 1-Month Volatility Index CDX/Cboe NA High Yield 3-month Volatility Index CDX/Cboe NA High Yield 6-month Volatility Index	CDX North American High Yield Index
CDX/Cboe NA Investment Grade 1-Month Volatility Index CDX/Cboe NA Investment Grade 3-month Volatility Index CDX/Cboe NA Investment Grade 6-month Volatility Index	CDX North American Investment Grade Index
iTraxx/Cboe Europe Main 1-Month Volatility Index iTraxx/Cboe Europe Main 3-month Volatility Index iTraxx/Cboe Europe Main 6-month Volatility Index	iTraxx Europe Main Index
iTraxx/Cboe Europe Crossover 1-Month Volatility Index iTraxx/Cboe Europe Crossover 3-month Volatility Index iTraxx/Cboe Europe Crossover 6-month Volatility Index	iTraxx Europe Crossover Index

Index Eligibility

Option Expiration. Options must have at least eight calendar days to expiry.

Index Construction

The indices use the below general formula to produce an expected volatility number independent from any options pricing model or strike, with the indices' calculation based on a simplified option-implied pricing formula for a hypothetical variance swap contract on forward credit spreads:

$$\sigma^2 = \frac{2}{T \times RPV01} \left[\sum_{S(K_i) < S(K_0)} R(K_i) \frac{\Delta S(K_i)}{S(K_i)^2} + \frac{R(K_0) + P(K_0)}{2} \frac{\Delta S(K_0)}{S(K_0)^2} + \sum_{S(K_i) > S(K_0)} P(K_i) \frac{\Delta S(K_i)}{S(K_i)^2} \right] - \frac{1}{T} \left[\frac{CDSI}{S(K_0)} - 1 \right]^2$$

where:

$$\sigma = \frac{CreditVIX}{100}$$

T = Time to expiration (in years)

$RPV01$ = "Risky PV01", the default-adjusted expected present value per basis point of the underlying index

$CDSI$ = Forward CDS index spread

K_i = Strike price of the i -th out-of-the-money CDS index option

$S(K_i)$ = Effective strike spread of an out-of-the-money CDS index option with strike K_i

$S(K_0)$ = Effective strike spread value closest to $CDSI$ (denote the strike corresponding to this spread as K_0)

- $\Delta S(K_i)$ = Interval between effective strike spreads
- Highest OTM Strike K_i : $S(K_{i-1}) - S(K_i)$
 - Lowest OTM Strike K_i : $S(K_i) - S(K_{i+1})$
- Otherwise: $\frac{S(K_{i-1}) - S(K_{i+1})}{2}$
- $R(K_i)$ = The mid-price of a receiver option with strike K_i
- $P(K_i)$ = The mid-price of a payer option with strike K_i

Step 1: Select Relevant Options Expirations

VIXHYP, the representative North American high yield percentage volatility index of Credit VIX, measures the constant 30-day expected volatility of the credit default swap spread on the Markit CDX North American High Yield Index. The components of the VIXHYP Index are near- and next-term over-the-counter (OTC) options on the underlying CDS index with expiration dates that bracket a 30-day target timeframe.

“Near-term” options are defined to be the options expiring closest to and before the 30-day target. If no options under these conditions are found, then near-term options are defined to be options expiring closest to and after the 30-day target. “Next-term” options are defined to be the options expiring closest to and after the near-term options expiration date. When the next-term options have exactly 30 days to expiration, they roll to become the near-term options. For three-month and six-month indices, when the next-term options have exactly 93/184 days to expiration, the indices roll to become the near-term options. The options expiring one month later then become the next-term options.

Step 2: Select Calculation Strikes

The selected strikes are out-of-the-money payer and receiver options centered around an at-the-money (ATM) strike price, K_0 , with effective strike spread $S(K_0)$. In standard quotation, the Markit CDX North American High Yield Index is quoted on a price basis while the Markit CDX North American Investment Grade Index, iTraxx Europe Main Index, and iTraxx Europe Crossover Index are all quoted on a spread basis. When pricing CDS index options that reference indices quoted on a price basis, standard market practice is to first convert price-based strikes to equivalent spread-based strikes and then apply the same model that is used to price spread-based options. The S&P Global MI Pricing Team provides converted spread-based values for calculation purposes.

Note that as volatility rises and falls, the strike price and spread range of selected options tends to expand and contract. As a result, the number of options used in the calculation may vary from month-to-month and day-to-day.

For each contract month, the procedure is as follows:

- Calculate T , the time to expiration in years.
- Using S&P Global MI Pricing Team data, identify the forward CDS index spread, $CDSI$.
- Using S&P Global MI Pricing Team data, identify the effective strike spread value $S(K_0)$ at which the absolute difference between each effective strike spread and $CDSI$ is smallest. Denote the strike corresponding to this minimum difference as K_0 . If there are two effective strike spreads equidistant from $CDSI$, select the higher effective strike spread.
- Select out-of-the-money receiver options with effective strike spreads less than $S(K_0)$. Start with the receiver option that has a spread immediately lower than $S(K_0)$ and move to successively lower spreads. Exclude any receiver option where the absolute value of the spot receiver delta value is less than or equal to 0.05 or the absolute value of the spot payer delta value is less than or equal to 0.05.

- Select out-of-the-money payer options with effective strike spreads greater than $S(K_0)$. Start with the payer option that has a spread immediately higher than $S(K_0)$ and move to successively higher spreads. Exclude any payer option where the absolute value of the spot receiver delta value is less than or equal to 0.05 or the absolute value of the spot payer delta value is less than or equal to 0.05.
- Finally, select both the receiver and payer option with spread $S(K_0)$. Notice that two options are selected here, while a single option, either a receiver or payer option, is used for every other strike.

Step 3: Calculate Near and Next-term Variance

The calculation combines the information reflected in the prices of all the selected options from Step 2. The contribution of a single option is proportional to $\Delta S(K)$ and the price of that option, and inversely proportional to the square of the option's effective strike spread.

Calculate the near- and next-term variance as follows:

Determine $\Delta S(K)$ for each effective strike spread included in the calculation. Generally, $\Delta S(K_i)$ is half the difference between the spreads on either side of K_i . At the upper and lower edges of any given strip of options, $\Delta S(K_i)$ is simply the difference between $S(K_i)$ and the adjacent spread.

Compute the contribution by strike for each included option.

- For all receiver strikes K_i with $S(K_i) < S(K_0)$, the contribution is given by $R(K_i) \times \frac{\Delta S(K_i)}{S(K_i)^2}$.
- For all payer strikes K_i with $S(K_i) > S(K_0)$, the contribution is $P(K_i) \times \frac{\Delta S(K_i)}{S(K_i)^2}$.
- For the strike K_0 , average the receiver and payer mid-prices to produce a single value, and calculate the contribution as $\frac{R(K_0)+P(K_0)}{2} \times \frac{\Delta S(K_0)}{S(K_0)^2}$.

$$\sigma_{near}^2 = \frac{2}{T_{near} \times RPV01_{near}} \left[\sum_{S(K_i) < S(K_0)} R(K_i) \frac{\Delta S(K_i)}{S(K_i)^2} + \frac{R(K_0) + P(K_0)}{2} \frac{\Delta S(K_0)}{S(K_0)^2} + \sum_{S(K_i) > S(K_0)} P(K_i) \frac{\Delta S(K_i)}{S(K_i)^2} \right] - \frac{1}{T_{near}} \left[\frac{CDSI_{near}}{S(K_{0,near})} - 1 \right]^2$$

$$\sigma_{next}^2 = \frac{2}{T_{next} \times RPV01_{next}} \left[\sum_{S(K_i) < S(K_0)} R(K_i) \frac{\Delta S(K_i)}{S(K_i)^2} + \frac{R(K_0) + P(K_0)}{2} \frac{\Delta S(K_0)}{S(K_0)^2} + \sum_{S(K_i) > S(K_0)} P(K_i) \frac{\Delta S(K_i)}{S(K_i)^2} \right] - \frac{1}{T_{next}} \left[\frac{CDSI_{next}}{S(K_{0,next})} - 1 \right]^2$$

Step 4: Calculate Credit VIX Using a Time-Weighted Average

VIXHYP Index level is 100 multiplied by the square root of the 30-day weighted average of σ_{near}^2 and σ_{next}^2

$$VIXHYP = 100 \times \sqrt{\left[T_{near} \sigma_{near}^2 \left(\frac{D_{next} - M}{D_{next} - D_{near}} \right) + T_{next} \sigma_{next}^2 \left(\frac{M - D_{near}}{D_{next} - D_{near}} \right) \right] \times \frac{365}{M}}$$

where:

- M = Number of calendar days to maturity
- D_{near} = Number of calendar days to expiration of the near-term options
- D_{next} = Number of calendar days to expiration of the next-term options

Step 5: Basis Point Credit VIX Indices Calculation

To calculate the basis point Credit VIX indices, modify Step 3 of the above percentage volatility methodology, specifically the contribution by strike for each included option.

For all receiver strikes K_i with $S(K_i) < S(K_0)$, the contribution is given by $\frac{R(K_i)}{100} \times \frac{\Delta S(K_i)}{100}$.

For all payer strikes K_i with $S(K_i) > S(K_0)$, the contribution is $\frac{P(K_i)}{100} \times \frac{\Delta S(K_i)}{100}$.

For the strike K_0 , average the receiver and payer mid-prices to produce a single value, and calculate the contribution as $\frac{R(K_0)+P(K_0)}{2} \times \frac{\Delta S(K_0)}{100}$.

Calculate the near-term and next-term option-implied variances for basis point volatility:

$$\sigma_{BP, near}^2 = \frac{2}{T_{near} \times RPV01_{near}} \left[\sum_{S(K_i) < S_{K_0}} \frac{R(K_i)}{100} \frac{\Delta S(K_i)}{100} + \frac{R(K_0) + P(K_0)}{2 \times 100} \frac{\Delta S(K_0)}{100} + \sum_{S(K_i) > S_{K_0}} \frac{P(K_i)}{100} \frac{\Delta S(K_i)}{100} \right] - \frac{1}{T_{near}} \left[\frac{CDSI_{near}}{100} - \frac{S(K_{0, near})}{100} \right]^2$$

$$\sigma_{BP, next}^2 = \frac{2}{T_{next} \times RPV01_{next}} \left[\sum_{S(K_i) < S_{K_0}} \frac{R(K_i)}{100} \frac{\Delta S(K_i)}{100} + \frac{R(K_0) + P(K_0)}{2 \times 100} \frac{\Delta S(K_0)}{100} + \sum_{S(K_i) > S_{K_0}} \frac{P(K_i)}{100} \frac{\Delta S(K_i)}{100} \right] - \frac{1}{T_{next}} \left[\frac{CDSI_{next}}{100} - \frac{S(K_{0, next})}{100} \right]^2$$

The basis point VIXHYP Index level is 100 multiplied by the square root of the 30-day weighted average of $\sigma_{BP, near}^2$ and $\sigma_{BP, next}^2$

$$VIXHYP_{BP} = 100 \times \sqrt{\left[T_{near} \sigma_{BP, near}^2 \left(\frac{D_{next} - M}{D_{next} - D_{near}} \right) + T_{next} \sigma_{BP, next}^2 \left(\frac{M - D_{near}}{D_{next} - D_{near}} \right) \right]} \times \frac{365}{M}$$

Index Governance

Index Committee

An Index Committee maintains the indices. The Committee meets regularly. At each meeting, the Committee reviews any significant market events. In addition, the Committee may revise index policies, including all matters relating to index construction, maintenance, or other matters.

S&P Dow Jones Indices considers information about changes to its indices and related matters to be potentially market moving and material. Therefore, all Index Committee discussions are confidential.

S&P Dow Jones Indices' Index Committees reserve the right to make exceptions when applying the methodology if the need arises. In any scenario where the treatment differs from the general rules stated in this document or supplemental documents, clients will receive sufficient notice, whenever possible.

In addition to the daily governance of indices and maintenance of index methodologies, at least once within any 12-month period, the Index Committee reviews the methodology to ensure the indices continue to achieve the stated objectives, and that the data and methodology remain effective. In certain instances, S&P Dow Jones Indices may publish a consultation inviting comments from external parties.

For information on Quality Assurance and Internal Reviews of Methodology, please refer to S&P Dow Jones Indices' Commodities Indices Policies & Practices Methodology.

Index Policy

Announcements

Announcements of the daily index values are made before the open of the next trading day.

For information on Calculations and Pricing Disruptions, Expert Judgment, Data Hierarchy, and Unexpected Exchange Closures, please refer to S&P Dow Jones Indices' Commodities Indices Policies & Practices.

Holiday Schedule

Please refer [here](#).

Contact Information

For questions regarding an index, please contact: index_services@spglobal.com.

Index Dissemination

Historical index returns are available through S&P Dow Jones Indices' index data group via subscription.

Tickers

The table below lists headline indices covered by this document. All versions of the below indices that may exist are also covered by this document. Please refer to the [S&P DJI Methodology & Regulatory Status Database](#) for a complete list of indices covered by this document.

Index	BBG	RIC
CDX/Cboe NA High Yield 1-Month Volatility Index (% Volatility)	VIXHYP	--
CDX/Cboe NA High Yield 1-Month Volatility Index (BP Volatility)	VIXHY	--
CDX/Cboe NA Investment Grade 1-Month Volatility Index (% Volatility)	VIXIGP	--
CDX/Cboe NA Investment Grade 1-Month Volatility Index (BP Volatility)	VIXIG	--
ITraxx/Cboe Europe Main 1-Month Volatility Index (% Volatility)	VIXIEP	--
ITraxx/Cboe Europe Main 1-Month Volatility Index (BP Volatility)	VIXIE	--
ITraxx/Cboe Europe Crossover 1-Month Volatility Index (% Volatility)	VIXXOP	--
ITraxx/Cboe Europe Crossover 1-Month Volatility Index (BP Volatility)	VIXXO	--
CDX/Cboe NA High Yield 3-month Volatility Index (% Volatility)	VIXHY3MP	--
CDX/Cboe NA High Yield 3-month Volatility Index (BP Volatility)	VIXHY3M	--
CDX/Cboe NA Investment Grade 3-month Volatility Index (% Volatility)	VIXIG3MP	--
CDX/Cboe NA Investment Grade 3-month Volatility Index (BP Volatility)	VIXIG3M	--
ITraxx/Cboe Europe Main 3-month Volatility Index (% Volatility)	VIXIE3MP	--
ITraxx/Cboe Europe Main 3-month Volatility Index (BP Volatility)	VIXIE3M	--
ITraxx/Cboe Europe Crossover 3-month Volatility Index (% Volatility)	VIXXO3MP	--
ITraxx/Cboe Europe Crossover 3-month Volatility Index (BP Volatility)	VIXXO3M	--
CDX/Cboe NA High Yield 6-month Volatility Index (% Volatility)	VIXHY6MP	--
CDX/Cboe NA High Yield 6-month Volatility Index (BP Volatility)	VIXHY6M	--
CDX/Cboe NA Investment Grade 6-month Volatility Index (% Volatility)	VIXIG6MP	--
CDX/Cboe NA Investment Grade 6-month Volatility Index (BP Volatility)	VIXIG6M	--
ITraxx/Cboe Europe Main 6-month Volatility Index (% Volatility)	VIXIE6MP	--
ITraxx/Cboe Europe Main 6-month Volatility Index (BP Volatility)	VIXIE6M	--
ITraxx/Cboe Europe Crossover 6-month Volatility Index (% Volatility)	VIXXO6MP	--
ITraxx/Cboe Europe Crossover 6-month Volatility Index (BP Volatility)	VIXXO6M	--

Index Data

Daily index level data is available via subscription.

For product information, please contact S&P Dow Jones Indices, www.spglobal.com/spdji/en/contact-us.

Web site

For further information, please refer to S&P Dow Jones Indices' Web site at www.spglobal.com/spdji/.

Appendix I

Index Inputs

Underlying Index	Currency	CDS Index Pricing Snap	CDS Index Option Pricing Snap	Holiday Calendar
CDX.NA.IG	USD	5:00 PM ET	5:30 PM ET	New York
CDX.NA.HY	USD	5:00 PM ET	5:30 PM ET	New York
iTraxx Europe Main	EUR	5:00 PM London Time	5:30 PM London Time	London
iTraxx Europe Crossover	EUR	5:00 PM London Time	5:30 PM London Time	London

Disclaimer

Performance Disclosure/Back-Tested Data

Where applicable, S&P Dow Jones Indices and its index-related affiliates (“S&P DJI”) defines various dates to assist our clients in providing transparency. The First Value Date is the first day for which there is a calculated value (either live or back-tested) for a given index. The Base Date is the date at which the index is set to a fixed value for calculation purposes. The Launch Date designates the date when the values of an index are first considered live: index values provided for any date or time period prior to the index’s Launch Date are considered back-tested. S&P DJI defines the Launch Date as the date by which the values of an index are known to have been released to the public, for example via the company’s public website or its data feed to external parties. For Dow Jones-branded indices introduced prior to May 31, 2013, the Launch Date (which prior to May 31, 2013, was termed “Date of introduction”) is set at a date upon which no further changes were permitted to be made to the index methodology, but that may have been prior to the Index’s public release date.

Please refer to the methodology for the Index for more details about the index, including the manner in which it is rebalanced, the timing of such rebalancing, criteria for additions and deletions, as well as all index calculations.

Information presented prior to an index’s launch date is hypothetical back-tested performance, not actual performance, and is based on the index methodology in effect on the launch date. However, when creating back-tested history for periods of market anomalies or other periods that do not reflect the general current market environment, index methodology rules may be relaxed to capture a large enough universe of securities to simulate the target market the index is designed to measure or strategy the index is designed to capture. For example, market capitalization and liquidity thresholds may be reduced. In addition, forks have not been factored into the back-test data with respect to the S&P Cryptocurrency Indices. For the S&P Cryptocurrency Top 5 & 10 Equal Weight Indices, the custody element of the methodology was not considered; the back-test history is based on the index constituents that meet the custody element as of the Launch Date. Back-tested performance reflects application of an index methodology and selection of index constituents with the benefit of hindsight and knowledge of factors that may have positively affected its performance, cannot account for all financial risk that may affect results and may be considered to reflect survivor/look ahead bias. Actual returns may differ significantly from, and be lower than, back-tested returns. Past performance is not an indication or guarantee of future results.

Typically, when S&P DJI creates back-tested index data, S&P DJI uses actual historical constituent-level data (e.g., historical price, market capitalization, and corporate action data) in its calculations. As ESG investing is still in early stages of development, certain datapoints used to calculate certain ESG indices may not be available for the entire desired period of back-tested history. The same data availability issue could be true for other indices as well. In cases when actual data is not available for all relevant historical periods, S&P DJI may employ a process of using “Backward Data Assumption” (or pulling back) of ESG data for the calculation of back-tested historical performance. “Backward Data Assumption” is a process that applies the earliest actual live data point available for an index constituent company to all prior historical instances in the index performance. For example, Backward Data Assumption inherently assumes that companies currently not involved in a specific business activity (also known as “product involvement”) were never involved historically and similarly also assumes that companies currently involved in a specific business activity were involved historically too. The Backward Data Assumption allows the hypothetical back-test to be extended over more historical years than would be feasible using only actual data. For more information on “Backward Data Assumption” please refer to the FAQ. The methodology and factsheets of any index that employs backward assumption in the back-tested history will explicitly state so. The methodology will include an Appendix with a table setting forth the specific

data points and relevant time period for which backward projected data was used. Index returns shown do not represent the results of actual trading of investable assets/securities. S&P DJI maintains the index and calculates the index levels and performance shown or discussed but does not manage any assets.

Index returns do not reflect payment of any sales charges or fees an investor may pay to purchase the securities underlying the Index or investment funds that are intended to track the performance of the Index. The imposition of these fees and charges would cause actual and back-tested performance of the securities/fund to be lower than the Index performance shown. As a simple example, if an index returned 10% on a US \$100,000 investment for a 12-month period (or US \$10,000) and an actual asset-based fee of 1.5% was imposed at the end of the period on the investment plus accrued interest (or US \$1,650), the net return would be 8.35% (or US \$8,350) for the year. Over a three-year period, an annual 1.5% fee taken at year end with an assumed 10% return per year would result in a cumulative gross return of 33.10%, a total fee of US \$5,375, and a cumulative net return of 27.2% (or US \$27,200).

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