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# STOXX<sup>®</sup> STRATEGY INDEX GUIDE

Creating an Investment  
Intelligence Advantage

Qontigo.com

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# 1. INTRODUCTION TO THE STOXX INDEX GUIDES

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The STOXX index guides are separated into the following sub-sets:

- » The **STOXX Calculation guide** provides a general overview of the calculation of the STOXX equity indices, the dissemination, the index formulas and adjustments due to corporate actions
- » The **STOXX Index Methodology guide** contains the equity index specific rules regarding the construction and derivation of the portfolio based indices, the individual component selection process and weighting schemes
- » The **STOXX Strategy guide** contains the formulas and description of all non-equity/strategy indices
- » The **STOXX Dividend Points Calculation guide** describes the dividend points products
- » The **STOXX Distribution Points Calculation guide** describes the distribution points products
- » The **STOXX ESG guide** contains the index specific rules regarding the construction and derivation of the ESG indices, the individual component selection process and weighting schemes
- » The **iSTOXX guide** contains the index specific rules regarding the construction and derivation of the iSTOXX indices, the individual component selection process and weighting schemes
- » The **STOXX Reference Rates guide** contains the rules and methodologies of the reference rate indices
- » The **STOXX Statistical Calculations** guide provides a detailed view of definitions and formulas of the statistical calculations as utilized in the reports, factsheets, indices and presentations produced by STOXX
- » The **STOXX Bond Index guide** contains the bond index specific rules regarding the construction of the indices, the individual component selection process, weighting schemes and overview of the index and bond analytics formulas

All rule books are available for download on <http://www.stoxx.com/indices/rulebooks.html>

# 2. CHANGES TO THE GUIDE BOOK

## 2.1. HISTORY OF CHANGES TO THE STOXX STRATEGY GUIDE

- May 2012: Update of 8.3.4 Adjustments due to Extreme Market Movements
- December 2012: Update of 5. STOXX Short and Leverage
- February 2013: Update of 5. STOXX Short and Leverage
- May 2013: Introduction of EURO STOXX 50 BuyWrite (100%) index as sub-index of existing EURO STOXX 50 BuyWrite index
- August 2013: Detailed listing of RIC codes used for Interbank Rates in Chapter
- November 2013: Introduction of EURO STOXX 50 Futures Roll
- March 2014: Chapter 5. STOXX Short and Leverage
- April 2014: Reformulation of EURO STOXX 50 Volatility (VSTOXX) methodology
- June 2014: Addition of index flag description to EURO STOXX 50 Volatility (VSTOXX) methodology
- July 2014: Addition of chapter 3 GENERAL PRINCIPLES
- August 2014: Adjustment of Risk Control indices; correction of EURO STOXX 50 Volatility (VSTOXX) main indices formula; addition of components' weights calculation for EURO STOXX 50 Volatility (VSTOXX) main indices; addition of STOXX Global 3D Printing Tradable Daily Short
- September 2014: Clarification of return types of risk control indices
- November 2014: Adjustment of thresholds for reverse splits for STOXX Leverage and Short indices in chapter 8.3.5
- March 2015: Expansion of STOXX Currency Hedged index with the introduction of STOXX Daily Hedged indices
- May 2015: Clarification of distinction between implied and realized volatility in the calculation of EURO STOXX 50 Risk Control indices
- June 2015: Clarification on interest rates applied to Risk Control indices
- June 2015 (2): Clarification regarding real-time calculation of Currency Hedged indices
- July 2015: Clarification regarding the weight capping in the Risk Control indices
- July 2015(2): Introduction of EURO STOXX 50 Protective Put 80% 18m 6/3
- October 2015: Update of real-time calculation rule for Currency Hedged indices
- October 2015 (2): Introduction of EURO STOXX 50 Volatility of Volatility (V-VSTOXX); amendments to EURO STOXX 50 Volatility (VSTOXX)
- April 2016: Introduction of EURO STOXX 50 Traded Futures Roll and EURO STOXX 50 Futures Replication
- May 2016: Introduction of EURO STOXX 50 Multi-Asset indices
- July 2016: Addition of STOXX Futures Roll and Futures Replication indices to sections 20 and 21
- August 2016: Addition of STOXX Global Basket
- August 2016: Enhancement of the EURO STOXX 50 Multi-Asset index family – introduction of EURO STOXX 50 Multi-Asset Momentum Risk Cap indices
- September 2016: Clarification on the inclusion criteria for OESX options in VSTOXX index and OSX options in V-VSTOXX index
- March 2017: Introduction of VSTOXX Short-Term Futures Investable indices
- September 2017: V-VSTOXX: change to options on VSTOXX futures with OVS2 as data source
- October 2017: Addition of EURO STOXX 50 Realized Variance Index (RVSTOXX)

## 2. CHANGES TO THE GUIDE BOOK

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- November 2017: In line with the change to the STOXX Calculation Guide, addition of Dissemination Calendar to the following indices: EURO STOXX 50 BuyWrite, EURO STOXX 50 DVP Futures, EURO STOXX 50 Futures Roll, EURO STOXX 50 Investable Volatility, EURO STOXX 50 Protective Put 80% 18m 6/3, EURO STOXX 50 PutWrite, EURO STOXX 50 Quanto Futures Roll, EURO STOXX 50 Realized Variance (RVSTOXX), EURO STOXX 50 Traded Futures Roll, EURO STOXX 50 Volatility (VSTOXX), EURO STOXX 50 Volatility Mid-Term Futures, EURO STOXX 50 Volatility Short-Term Futures, EURO STOXX 50 Volatility-Balanced, EURO STOXX 50 Volatility-of-volatility (V-VSTOXX), EURO STOXX Banks Futures Roll, EURO STOXX Select Dividend 30 Futures Roll, STOXX Europe 600 Futures Roll, STOXX Global Select Dividend 100 Futures Roll, VSTOXX Short-Term Futures Inverse Investable, VSTOXX Short-Term Futures Investable
- November 2017 (2): Addition of index settlement value calculation for RVSTOXX (section 11)
- March 2018: VSTOXX: Correction of non-visible characters and harmonization of formula notations in section 8.5; V-VSTOXX: correction of section's 9.2.3 header and text to properly reflect V-VSTOXX peculiarities in contrast with VSTOXX.
- March 2018: STOXX Short and Leveraged Indices: rephrasing of negative leverage, correction of non-visible character in formula.
- May 2018: Addition of STOXX Decrement Indices calculation
- June 2018: Rule clarification: Section 7.3.2: Summation amended to include n
- August 2018: Addition of STOXX Local Currency Return Indices calculation
- October 2018: Effective December 3, 2018, removal of 2 and 9 month EURIBOR tenors from VSTOXX and V-VSTOXX indices due to discontinuation; effective December 3, 2018, replacement of "fast market" indicator with new "stressed market" indicator for VSTOXX indices
- December 2018: Addition of iSTOXX Increment Indices
- February 2019: Addition of EURO STOXX 50 Short Strangle Index
- October 2019: Clarifications relating to changes in the EONIA rate determination
- November 2019: Addition of EURO STOXX 50 Realized Dispersion Index
- December 2019: Addition of EURO iSTOXX 50 Short Strangle KWDC Index
- March 2020: Addition of details regarding the existing treatment of disruptions for the EURO STOXX 50 Investable Volatility Index
- April 2020: Addition of iSTOXX Single Stock Leveraged Indices
- April 2020 (2): Addition of EURO iSTOXX 50 Total Return Futures Index
- July 2020: Decommissioning of EURO STOXX 50 Futures Replication Index
- September 2020: Decommissioning of the BRIC-related STOXX equity indices
- October 2020: Clarification of description of Decrement and Increment indices
- February 2021: Adjustments related to the addition of new iSTOXX Single Stock Leveraged Indices
- February 2021 (2): Addition of EURO STOXX 50 Futures Roll 5D Indices
- April 2021: Addition of the extreme movement trigger value for -3x leverage for iSTOXX Single Stock Leveraged Indices
- July 2021: Addition of section 4 Input Data; enhancement of index rules description in sections 9 (VSTOXX) and 10 (V-VSTOXX)



# 3. GENERAL PRINCIPLES

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## 3.1. INDEX RATIONALE

STOXX defines the index rationale as the basis for applying a certain methodology in order to achieve the index objective. STOXX performs intensive research and may conduct conversations with market participants and third parties for this purpose. STOXX discloses the index objective in every case.

## 3.2. METHODOLOGY REVIEW POLICIES

STOXX constantly monitors the execution of the index calculation rules in order to ensure the validity of the index methodology. STOXX also conducts general methodology reviews in a periodic and ad-hoc basis, to reflect economic and political changes and developments in the investment industry. As result of these activities, STOXX introduces changes to the methodology books. Material changes are notified to subscribers and the media through the usual communication channels. Clarifications of the methodology are updated in the rulebook. All changes are tracked in the section 2.1 History of changes to the STOXX Strategy Guide.

## 3.3. INDEX TERMINATION POLICY

For the termination of an index or index family for which outstanding products are present in the market to the knowledge of STOXX, a market consultation with the involved clients will be initiated by STOXX to take into account their views and concerns related to the termination or transition. A consultation period will be opened. Its duration depends on the specific issue. After the consultation period and in case of further action needed, a notification will be issued and the process defined above will be followed. In the case of a transition, STOXX will launch the alternative index and will notify of its character as a suitable replacement for an existing index whose calculation should be discontinued in the future. This notification advises clients on the alternative recommended by STOXX as replacement. The timeframe in which both indices will be calculated in parallel will be disclosed in the notification's text and will be no shorter than three months.

For the termination of an index or index family for which, to the knowledge of STOXX, no listed financial products are issued in the market, a press release notification or e-mail notification to subscribers will be communicated at least three months before coming into force. Clients or third parties with interest in the index or index family are urged to communicate as soon as possible their concerns to STOXX. Based on the feedback collected, STOXX may alter the index termination decision. For the termination of an index without financial product issued on there will be no market consultation. Changes to the original notification will be communicated in the same manner.

# 4. INPUT DATA

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## 4.1. DERIVATIVES PRICES

The data hierarchy used to process derivatives prices and calculate the STOXX strategy indices are as follows (unless stated differently in the individual index methodologies).

The indices are calculated on the basis of exchange-traded derivative prices. In certain cases, however, it is deemed that the last available traded prices do not provide the best representation of the economic reality or market practices, e.g. due to less frequent trading, broader bid/ask spreads or preferred use of official settlement values. In such cases, the derivative instruments are evaluated on the basis of other levels of the input data hierarchy, such as best bid/ask quotes from the exchange order book or official exchange daily/final settlement prices, as detailed in the individual index methodology.

# 5. EURO STOXX 50 BUYWRITE

## 5.1. OVERVIEW

The EURO STOXX 50 BuyWrite Index reflects the so-called 'buy-write' option strategy. With this strategy, which is also referred to as covered call, an investor buys the EURO STOXX 50 index (price or total return indices) as an underlying instrument and simultaneously sells a EURO STOXX 50 call option.

The index is available as the original EURO STOXX 50 BuyWrite Index, with option struck at 105%, and the subsequently added EURO STOXX 50 BuyWrite Index (100%), with option struck at 100%.

The index is based on the EURO STOXX 50 price index or on the EURO STOXX 50 total return index and a EURO STOXX 50 call option traded at Eurex.

**Dissemination Calendar:** STOXX Eurex Calendar

## 5.2. BASIC DATA

| Index                                      | ISIN         | Symbol  |
|--------------------------------------------|--------------|---------|
| EURO STOXX 50 BuyWrite (Price)             | CH0029148886 | SX5EBP  |
| EURO STOXX 50 BuyWrite (Net Return)        | CH0026600970 | SX5EBW  |
| EURO STOXX 50 BuyWrite (100%) (Price)      | CH0211959595 | SX5EBP2 |
| EURO STOXX 50 BuyWrite (100%) (Net Return) | CH0211959603 | SX5EBW2 |

## 5.3. CALCULATION

### 5.3.1. INDEX FORMULA

Two versions of the indices are available, Total Return and Price.

#### Total Return

The Total Return version of the index combines the EURO STOXX 50 (Net Return) Index and a EURO STOXX 50 call option. On regular trading days the Total Return version is calculated as follows:

$$BW(TR)_t = \frac{\left[ \frac{ESTX50(NR)_t}{ESTX50(NR)_{EXP}} \cdot ESTX50(P)_{EXP} \right] - C_t}{ESTX50(P)_{EXP} - C_0} \cdot BW(TR)_{EXP}$$

The rolling is carried out monthly on every third Friday, i.e. on the expiry date (EXP).

# 5. EURO STOXX 50 BUYWRITE

$$BW(TR)_{EXP} = \frac{\left[ \frac{ESTX50(NR)_{EXP}}{ESTX50(NR)_{EXP-1}} \cdot ESTX50(P)_{EXP-1} \right] - C'_{EXP}}{ESTX50(P)_{EXP-1} - C'_0} \cdot BW(TR)_{EXP-1}$$

Where:

|                      |                                                                                                                                                                                                        |
|----------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| $BW(TR)_t$           | = EURO STOXX 50 BuyWrite index or EURO STOXX 50 BuyWrite (100%) index at time (t)                                                                                                                      |
| $BW(TR)_{EXP}$       | = Settlement value of EURO STOXX 50 BuyWrite index or EURO STOXX 50 BuyWrite (100%) index at the previous expiry date (EXP)                                                                            |
| $BW(TR)_{EXP-1}$     | = Settlement value of EURO STOXX 50 BuyWrite index or EURO STOXX 50 BuyWrite (100%) index at the last expiry date before the previous expiry date (EXP-1)                                              |
| $ESTX50(NR)_t$       | = Last price of EURO STOXX 50 (Net Return) index at time t                                                                                                                                             |
| $ESTX50(NR)_{EXP}$   | = Settlement price of EURO STOXX 50 (Net Return) index at the previous expiry date (EXP)                                                                                                               |
| $ESTX50(NR)_{EXP-1}$ | = Settlement price of EURO STOXX 50 (Net Return) index at the last expiry date before the previous expiry date (EXP-1)                                                                                 |
| $ESTX50(P)_{EXP}$    | = Settlement price of EURO STOXX 50 (Price) index at the previous expiry date (EXP)                                                                                                                    |
| $ESTX50(P)_{EXP-1}$  | = Settlement price of EURO STOXX 50 (Price) index at the last expiry date before the previous expiry date (EXP-1)                                                                                      |
| $C_t$                | = Last price of the EURO STOXX 50 call option at time t                                                                                                                                                |
| $C_0$                | = Inclusion price of the EURO STOXX 50 call option; i.e. averages of all best bids quoted on Eurex between 12:15 – 12:45 CET on the last expiry date (EXP)                                             |
| $C'_{EXP}$           | = Settlement price of old EURO STOXX 50 call option at the last expiry date (EXP)                                                                                                                      |
| $C'_0$               | = Inclusion price of the old EURO STOXX 50 call option; i.e. averages of all best bids quoted on Eurex between 12:15 – 12:45 CET on the last expiry date (EXP-1) before the previous expiry date (EXP) |

## Price

The Price version of the index combines the EURO STOXX 50 (Price) Index and a EURO STOXX 50 call option.

On regular trading days the Price version of the index is calculated as follows:

$$BW(P)_t = \frac{ESTX50(P)_t - C_t}{ESTX50(P)_{EXP} - C_0} \cdot BW(P)_{EXP}$$

The rolling is carried out monthly on every third Friday, i.e. on the expiry date (EXP).

$$BW(P)_{EXP} = \frac{ESTX50(P)_{EXP} - C'_{EXP}}{ESTX50(P)_{EXP-1} - C'_0} \cdot BW(P)_{EXP-1}$$

# 5. EURO STOXX 50 BUYWRITE

Where:

|                     |                                                                                                                                                                                                        |
|---------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| $BW(P)_t$           | = EURO STOXX 50 BuyWrite (Price) index or EURO STOXX 50 BuyWrite (100%) (Price) index at time (t)                                                                                                      |
| $BW(P)_{EXP}$       | = Settlement value of EURO STOXX 50 BuyWrite (Price) index or EURO STOXX 50 BuyWrite (100%) (Price) index at the previous expiry date (EXP)                                                            |
| $BW(P)_{EXP-1}$     | = Settlement value of EURO STOXX 50 BuyWrite (Price) index or EURO STOXX 50 BuyWrite (100%) (Price) index at the last expiry date before the previous expiry date (EXP-1)                              |
| $ESTX50(P)_{EXP}$   | = Settlement price of EURO STOXX 50 (Price) index at the previous expiry date (EXP)                                                                                                                    |
| $ESTX50(P)_{EXP-1}$ | = Settlement price of EURO STOXX 50 (Price) index at the last expiry date before the previous expiry date (EXP-1)                                                                                      |
| $C_t$               | = Last price of the EURO STOXX 50 call option at time (t)                                                                                                                                              |
| $C_0$               | = Inclusion price of the EURO STOXX 50 call option; i.e. averages of all best bids quoted on Eurex between 12:15 – 12:45 CET on the last expiry date (EXP)                                             |
| $C'_{EXP}$          | = Settlement price of old EURO STOXX 50 call option at the last expiry date (EXP)                                                                                                                      |
| $C'_0$              | = Inclusion price of the old EURO STOXX 50 call option; i.e. averages of all best bids quoted on Eurex between 12:15 – 12:45 CET on the last expiry date (EXP-1) before the previous expiry date (EXP) |

### 5.3.2. ROLLING

The EURO STOXX 50 BuyWrite index requires a monthly rollover procedure, whereby the old EURO STOXX 50 call option ceases trading at noon (12:00 CET) on the pre-determined expiry date, i.e. the third Friday of a month, and is replaced by a new EURO STOXX 50 call option whose last trading day falls on the next expiry date. The new one-month EURO STOXX 50 call option must have a remaining lifetime of one month, and must be 5 percent out-of-the-money (i.e. the highest strike price below or equal to the EURO STOXX 50 settlement price plus 5 percent). The EURO STOXX 50 BuyWrite (100%) index is subject to the same monthly rolling procedure, but the new one-month EURO STOXX 50 call option must be at-the-money (i.e. the highest strike price below or equal to the EURO STOXX 50 settlement price).

### 5.3.3. TRADING SUSPENSION

If there is a suspension of the EURO STOXX 50 Index (price or total return) or the EURO STOXX 50 call option that is included in the EURO STOXX 50 BuyWrite Index or EURO STOXX 50 BuyWrite (100%) index, the index will be calculated using the latest prices that were available.

If a suspension occurs on an expiry date during the averaging process, i.e. 12:15 - 12:45 CET, only bids made before the suspension will be considered.

In cases where the averaging procedure does not start at all (i.e. the suspension starts before 12:15 CET) then the averaging will be delayed until the end of the suspension on the same index business day. The averaging process will start 30 minutes after the end of the suspension and it will then take 30 minutes.

# 5. EURO STOXX 50 BUYWRITE

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If the suspension continues until the end of trading, then the averaging will be delayed until the next index business day at 12:15 CET.

# 6. EURO STOXX 50 PROTECTIVE PUT 80% 18M 6/3

## 6.1. OVERVIEW

The EURO STOXX 50 Protective Put 80% 18m 6/3 index aims to replicate a combined investment in the EURO STOXX 50 index and a long position in a put option on the same index. The investment objective of the replicated strategy is to profit from the appreciation of the EURO STOXX 50, while simultaneously limit the losses in falling markets through the put option.

The put option is rolled quarterly in March, June, September and December. On each roll date, the existing option is sold and replaced by a new one with 80% strike. Additionally, the options purchased in June and December will mature in 18 months, while those purchased in March and September in 15 months (i.e., they keep the same maturity of the existing option).

The index is based on the EURO STOXX 50 price index or on the EURO STOXX 50 net return index and a EURO STOXX 50 put option traded at Eurex.

**Dissemination Calendar:** STOXX Eurex Calendar

## 6.2. BASIC DATA

| Index                                                 | ISIN         | Symbol  |
|-------------------------------------------------------|--------------|---------|
| EURO STOXX 50 Protective Put 80% 18m 6/3 (Price)      | CH0283626957 | SX5PP8P |
| EURO STOXX 50 Protective Put 80% 18m 6/3 (Net Return) | CH0283626924 | SX5PP8T |

## 6.3. CALCULATION

Two versions of the indices are available, Net Return and Price.

### Net Return

The Net Return version of the index combines the EURO STOXX 50 (Net Return) Index and a EURO STOXX 50 put option.

On regular trading days the index is calculated as follows:

$$PP(NR)_t = \frac{\left[ \frac{ESTX50(NR)_t}{ESTX50(NR)_{ROLL}} \cdot ESTX50(P)_{ROLL} \right] + P_t}{ESTX50(P)_{ROLL} + P_0} \cdot PP(NR)_{ROLL}$$

On rolling days the index is calculated as follows:

$$PP(NR)_{ROLL} = \frac{\left[ \frac{ESTX50(NR)_{ROLL}}{ESTX50(NR)_{ROLL-1}} \cdot ESTX50(P)_{ROLL-1} \right] + P'_{ROLL}}{ESTX50(P)_{ROLL-1} + P'_0} \cdot PP(NR)_{ROLL-1}$$

# 6. EURO STOXX 50 PROTECTIVE PUT

## 80% 18M 6/3

### Price

The Price version of the index combines the EURO STOXX 50 (Price) Index and a EURO STOXX 50 put option.

On regular trading days the index is calculated as follows:

$$PP(P)_t = \frac{ESTX50(P)_t + P_t}{ESTX50(P)_{ROLL} + P_0} \cdot PP(P)_{ROLL}$$

On rolling days the index is calculated as follows:

$$PP(P)_{ROLL} = \frac{ESTX50(P)_{ROLL} + P'_{ROLL}}{ESTX50(P)_{ROLL-1} + P'_0} \cdot PP(P)_{ROLL-1}$$

Where:

|                       |                                                                                                                                                     |
|-----------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------|
| $PP(TR)_t$            | = EURO STOXX 50 Protective Put (Total Return) index at time (t)                                                                                     |
| $PP(NR)_{ROLL}$       | = Settlement value of EURO STOXX 50 Protective Put (Net Return) index at the previous rolling date (ROLL)                                           |
| $PP(NR)_{ROLL-1}$     | = Settlement value of EURO STOXX 50 Protective Put (Net Return) index at the last rolling date before the previous rolling date (ROLL-1)            |
| $PP(P)_t$             | = EURO STOXX 50 Protective Put (Price) index at time (t)                                                                                            |
| $PP(P)_{ROLL}$        | = Settlement value of EURO STOXX 50 Protective Put (Price) index at the previous rolling date (ROLL)                                                |
| $PP(P)_{ROLL-1}$      | = Settlement value of EURO STOXX 50 Protective Put (Price) index at the last rolling date before the previous rolling date (ROLL-1)                 |
| $ESTX50(NR)_t$        | = Last price of EURO STOXX 50 (Net Return) index at time t                                                                                          |
| $ESTX50(NR)_{ROLL}$   | = Settlement price of EURO STOXX 50 (Net Return) index at the previous rolling date (ROLL)                                                          |
| $ESTX50(NR)_{ROLL-1}$ | = Settlement price of EURO STOXX 50 (Net Return) index at the last rolling date before the previous rolling date (ROLL-1)                           |
| $ESTX50(P)_t$         | = Last price of EURO STOXX 50 (Price) index at time t                                                                                               |
| $ESTX50(P)_{ROLL}$    | = Settlement price of EURO STOXX 50 (Price) index at the previous rolling date (ROLL)                                                               |
| $ESTX50(P)_{ROLL-1}$  | = Settlement price of EURO STOXX 50 (Price) index at the last rolling date before the previous rolling date (ROLL-1)                                |
| $P_t$                 | = Mid price of the EURO STOXX 50 put option at time t during the day or Settlement price of the EURO STOXX 50 put option for end-of-day calculation |
| $P_0$                 | = Inclusion price of the EURO STOXX 50 put option on the last ROLL date (ROLL)                                                                      |
| $P'_{ROLL}$           | = Exit price of old EURO STOXX 50 put option at the last rolling date (ROLL)                                                                        |
| $P'_0$                | = Inclusion price of the old EURO STOXX 50 put option on the last rolling date (ROLL-1) before the previous rolling date (ROLL)                     |

Inclusion price ( $P_0$ ,  $P'_0$ ): VWAP of best ask quotes between 12:15:00 and 12:45:00



# 6. EURO STOXX 50 PROTECTIVE PUT

## 80% 18M 6/3

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Intraday price ( $P_t$ ): mid quote

End-of-day price ( $P_t$ ): settlement value

Exit price ( $P'_{\text{ROLL}}$ ): VWAP of best bid quotes between 12:15:00 and 12:45:00

### 6.3.1. ROLLING

The index requires a quarterly rollover procedure, on the pre-determined rolling date, i.e. the third Friday of March, June, September, December where the current option is sold and replaced by a new EURO STOXX 50 put option. If such a day is a non-trading day for EUREX, the preceding trading day is taken.

On each roll date, the purchased EURO STOXX 50 put option must be 20 percent out-of-the-money or less (i.e. the lowest strike price higher than or equal to the settlement price of the EURO STOXX 50 Price index minus 20 percent).

On the roll dates of June and December, the replacing option will mature on the 18<sup>th</sup> following month; on the roll dates of March and September the maturity will be 15 months ahead.

# 7. EURO STOXX 50 PUTWRITE

## 7.1. OVERVIEW

The EURO STOXX 50 PutWrite Index replicates the performance of a collateralized put option strategy. The index is based on a quarterly scheme with monthly put option tranches, i.e.

- » the investment notional is invested into the three-month Euribor market;
- » monthly put options are written in three tranches;
- » intra-quarter put options are cash settled by borrowing in the one-month Euribor market if necessary.

The index is based on the EURO STOXX 50 put option traded at Eurex and Euribor.

**Dissemination Calendar:** STOXX Eurex Calendar

## 7.2. BASIC DATA

| Index                          | ISIN         | Symbol |
|--------------------------------|--------------|--------|
| EURO STOXX 50 PutWrite (Price) | CH0106231670 | SX5E3P |

## 7.3. CALCULATION

### 7.3.1. INDEX FORMULA

At time  $t$

Write a number  $N_t$  of puts with price  $p_t$  and strike  $K_t$

- » Invest  $I_t + p_t N_t$  at the three-month EURIBOR rate  $r_t^3$
- » The number of puts  $N_t$  is given by the condition of total cash collateralization at  $t+1$ :

$$\left( I_t + p_t N_t \right) \left( 1 + \frac{\Delta_{t,t+1}}{360} \cdot r_t^3 \right) = N_t K_t \Rightarrow N_t = \frac{I_t \left( 1 + \frac{\Delta_{t,t+1}}{360} \cdot r_t^3 \right)}{K_t - p_t \left( 1 + \frac{\Delta_{t,t+1}}{360} \cdot r_t^3 \right)}$$

Where:

$I_t$  = EURO STOXX 50 PutWrite index at time ( $t$ )

$\Delta_{t,t+1}$  = Actual number of calendar days of the first option tranche

The strike  $K_t$  is chosen 5 percent out-of-the-money, i.e. it represents the lowest strike of available EUREX put options that is above 95 percent of the EURO STOXX 50 settlement price.

# 7. EURO STOXX 50 PUTWRITE

## At time t+1

- » Write a number  $N_{t+1}$  of puts with price  $p_{t+1}$  and strike  $K_{t+1}$
- » Borrow/lend the cash balance

$$C_{t+1} = (N_{t+1}p_{t+1} - N_t p_t^s)$$

(can be positive or negative) from settling the  $N_t$  put options at price  $p_t^s$  (which is zero if the option matures out-of-the-money) of the previous tranche and writing the new tranche at the one-month Euribor market at rate  $r_{t+1}$ .

- » The number of put options  $N_{t+1}$  is given by the condition of total cash collateralization at t+2:

$$\begin{aligned} C_{t+1} \left( 1 + \frac{\Delta_{t+1,t+2}}{360} r_{t+1}^1 \right) + (I_t + p_t N_t) \left( 1 + \frac{\Delta_{t,t+2}}{360} \cdot r_t^3 \right) \\ = (N_{t+1}p_{t+1} - N_t p_t^s) \cdot \left( 1 + \frac{\Delta_{t+1,t+2}}{360} \cdot r_{t+1}^1 \right) + (I_t + p_t N_t) \cdot \left( 1 + \frac{\Delta_{t,t+2}}{360} \cdot r_t^3 \right) = N_{t+1}K_{t+1} \\ \Rightarrow N_{t+1} = \frac{-N_t p_t^s \left( 1 + \frac{\Delta_{t+1,t+2}}{360} \right) + (I_t + p_t N_t) \cdot \left( 1 + \frac{\Delta_{t,t+2}}{360} \cdot r_t^3 \right)}{K_{t+1} - p_{t+1} \left( 1 + \frac{\Delta_{t+1,t+2}}{360} \cdot r_{t+1}^1 \right)} \end{aligned}$$

Where:

- $\Delta_{t+1,t+2}$  = Actual number of calendar days of the second option tranche
- $\Delta_{t,t+2}$  = Actual number of calendar days of the first and second option tranche
- The strike  $K_{t+1}$  is chosen 5 percent out-of-the-money, i.e. it represents the lowest strike of available EUREX put options that is above 95 percent of the EURO STOXX 50 settlement price.

At t+1 the index level reads:

$$I_{t+1} = (I_t + p_t N_t) \left( 1 + \frac{\Delta_{t,t+1}}{360} \cdot r_t^3 \right) - N_t p_t^s$$

# 7. EURO STOXX 50 PUTWRITE

## At time t+2

- » Write a number  $N_{t+2}$  of puts with price  $p_{t+2}$  and strike  $K_{t+2}$
- » Borrow/lend the cash balance

$$C_{t+2} = (N_{t+2}p_{t+2} - N_{t+1}p_{t+1}^s) + C_{t+1} \left( 1 + \frac{\Delta_{t+1,t+2}}{360} \cdot r_{t+1}^1 \right)$$

(can be positive or negative) from settling the  $N_{t+1}$  put options at price  $p_{t+1}$ s (which is zero if the option matures out-of-the-money) of the previous tranche and writing the new tranche at the one-month EURIBOR market at rate  $r_{t+2}^1$ .

- » The number of option  $N_{t+2}$  is given by the condition of total cash collateralization at t+3:

$$\begin{aligned} C_{t+2} \left( 1 + \frac{\Delta_{t+2,t+3}}{360} \cdot r_{t+2}^1 \right) + (I_t + p_t N_t) \left( 1 + \frac{\Delta_{t,t+3}}{360} \cdot r_t^3 \right) &= N_{t+2} K_{t+2} \\ \Leftrightarrow \left( (N_{t+2}p_{t+2} - N_{t+1}p_{t+1}^s) + C_{t+1} \left( 1 + \frac{\Delta_{t+1,t+2}}{360} \cdot r_{t+1}^1 \right) \right) \left( 1 + \frac{\Delta_{t+2,t+3}}{360} \cdot r_{t+2}^1 \right) &+ (I_t + p_t N_t) \cdot \left( 1 + \frac{\Delta_{t,t+3}}{360} \cdot r_t^3 \right) \\ = N_{t+2} K_{t+2} \\ \Rightarrow N_{t+2} = \frac{\left( -N_{t+1}p_{t+1}^s + C_{t+1} \left( 1 + \frac{\Delta_{t+1,t+2}}{360} \cdot r_{t+1}^1 \right) \right) \cdot \left( 1 + \frac{\Delta_{t+2,t+3}}{360} \cdot r_{t+2}^1 \right) + (I_t + p_t N_t) \cdot \left( 1 + \frac{\Delta_{t,t+3}}{360} \cdot r_t^3 \right)}{K_{t+2} - p_{t+2} \left( 1 + \frac{\Delta_{t+2,t+3}}{360} \cdot r_{t+2}^1 \right)} \end{aligned}$$

Where:

- $\Delta_{t+2,t+3}$  = Actual number of calendar days of the second option tranche
  - $\Delta_{t,t+3}$  = Actual number of calendar days of the first, second and third option tranche
- The strike  $K_{t+2}$  is chosen 5 percent out-of-the-money, i.e. it represents the lowest strike of available EUREX put options that is above 95 percent of the EURO STOXX 50 settlement price.

At t+2 the index level reads:

$$I_{t+2} = (I_t + p_t N_t) \cdot \left( 1 + \frac{\Delta_{t,t+2}}{360} \cdot r_t^3 \right) + C_{t+1} \left( 1 + \frac{\Delta_{t+1,t+2}}{360} \cdot r_{t+1}^1 \right) - N_{t+1}p_{t+1}^s$$

# 7. EURO STOXX 50 PUTWRITE

## At time $t+3$

The new index level reads (with  $p_{t+2}^s$  denoting the settlement price of the third option tranche  $N_{t+2}$ ):

$$I_{t+3} = (I_t + p_t N_t) \cdot \left( 1 + \frac{\Delta_{t,t+3}}{360} \cdot r_t^3 \right) + C_{t+2} \left( 1 + \frac{\Delta_{t+2,t+3}}{360} \cdot r_{t+2}^1 \right) - N_{t+2} p_{t+2}^s$$

Afterwards, the scheme is applied iteratively.

### 7.3.2. ROLLING

The EURO STOXX 50 PutWrite index requires a monthly rollover procedure, whereby the old EURO STOXX 50 put option ceases trading at noon (12:00 CET) on the pre-determined expiry date, i.e. the third Friday of a month, and is replaced by a new EURO STOXX 50 put option whose last trading falls on the next expiry date. The new one-month EURO STOXX 50 put option must have a remaining lifetime of one month, and must be 5 percent out-of-the-money (i.e. the lowest strike price above or equal to the EURO STOXX 50 settlement price minus 5 percent).

### 7.3.3. TRADING SUSPENSION/ NON-TRADING DAYS

If there is a suspension of the EURO STOXX 50 put option which is included in the EURO STOXX 50 PutWrite index, the index will be calculated using the latest prices available.

If a suspension occurs on an expiry date during the averaging process, i.e. 12:15 - 12:45 CET only bids made before the suspension will be considered.

In cases where the averaging procedure does not start at all (i.e. the suspension starts before 12:15 CET), the averaging will be delayed until the end of the suspension on the same index business day. The averaging process will start 30 minutes after the end of the suspension and it will then take 30 minutes.

If the suspension continues until the end of the trading, the averaging will be delayed until the next index business day at 12:15 CET.

Interest is accrued on all calculation dates of the EURO STOXX 50 PutWrite Index.

# 8. STOXX SHORT AND LEVERAGED INDICES

## 8.1. OVERVIEW

Leveraged indices are linked to the changes in the underlying index, applying a leverage factor to movements in the underlying index. Therefore, a positive change of the underlying index will result in the corresponding leveraged performance of leveraged indices compared to the closing level from the last rebalancing.

Short indices are linked inversely to the changes in the underlying index, applying a negative leverage factor to movements in the underlying index. Therefore, investing in short indices yields the reverse performance of the underlying index, compared to the closing level from the last rebalancing.

The leverage effect causes a disproportionate change in capital employed during positive and negative market movements. This effect can be achieved by raising additional capital and reinvesting into the underlying index (positive leverage) or by selling the shares in the index and receiving interest from lending the capital received (negative leverage). Investors can make use of this opportunity to employ a profitable investment strategy with low initial capital in order to multiply the chances of profit considerably. On the other hand, this leverage effect carries the inherent risk of a disproportionate capital loss ('downside risk').

## 8.2. BASIC DATA

| Index                                                            | ISIN                    | Symbol   | Leverage |
|------------------------------------------------------------------|-------------------------|----------|----------|
| EURO STOXX 50 Daily Leverage (Price)                             | CH0029194906            | SX5EL    | 2        |
| EURO STOXX 50 Daily Leverage (Net Return)                        | DE000A0Z3K43            | SX5TL    | 2        |
| EURO STOXX 50 Daily Short (Gross Return)                         | CH0029194971            | SX5TS    | -1       |
| EURO STOXX 50 Daily Double Short (Gross Return)                  | CH0048222092            | SX5T2S   | -2       |
| EURO STOXX 50 Optimal Daily Leverage (Net Return)                | CH0123471655            | SX5ODLEN | L*       |
| EURO STOXX <Supersector> Daily Leverage x3 (Gross Return)        | <see Vendor Code sheet> |          | 3        |
| EURO STOXX <Supersector> Daily Short x3 (Gross Return)           | <see Vendor Code sheet> |          | -3       |
| STOXX Europe 600 Daily Short (Gross Return)                      | CH0108503878            | SXXGRS   | -1       |
| STOXX Europe 600 Daily Double Short (Gross Return)               | CH0048222100            | SXXR2S   | -2       |
| STOXX Europe 600 <Supersector> Daily Short (Gross Return)        | <see Vendor Code sheet> |          | -1       |
| STOXX Europe 600 <Supersector> Daily Double Short (Gross Return) | <see Vendor Code sheet> |          | -2       |
| EURO STOXX 50 Monthly Leverage (Net Return)                      | CH0116915999            | SX5TLM   | 2        |
| EURO STOXX 50 Monthly Double Short (Gross Return)                | CH0116916005            | SX5GT2SM | -2       |
| STOXX Global 3D Printing Tradable Daily Short (Gross Return)     | CH0252377509            | STG3DPS  | -1       |
| <further indices as listed in the STOXX vendor code sheet>       |                         |          |          |

# 8. STOXX SHORT AND LEVERAGED INDICES

## 8.3. CALCULATION

### 8.3.1. THE STOXX SHORT / LEVERAGE INDEX FORMULA

The Daily Leverage indices are calculated as follows:

$$\text{LevIDX}_t = \text{LevIDX}_T \cdot \left[ \underbrace{1 + L \cdot \left( \frac{\text{IDX}_t}{\text{IDX}_T} - 1 \right)}_{\text{LEVERAGE TERM}} + \underbrace{((1-L) \cdot \text{IR}_T + L \cdot c_M) \cdot \frac{d}{360}}_{\text{FINANCE/INTEREST TERM}} \right]$$

Where:

LevIDX = Leverage index

IDX = Underlying index

IR = Interest rate (IR):

For daily leverage indices, the interest rate term consists of an overnight interest rate plus a liquidity-spread<sup>1</sup>.

For daily short and optimal leverage indices, an overnight interest rate is applied.

For monthly leveraged indices, 1 - monthly interest rates are applied

The actual interest rate applied depends on the respective region. An overview of the interest rates can be found in the tables below.

$c_M$  = Cost to borrow (considered for European short indices only)

$t$  = Time of calculation

$T$  = Time of last rebalancing day prior to  $t$  (last trading day for the daily and third Friday for the monthly indices)

$d$  = Number of calendar days between  $t$  and  $T$

$L$  = Leverage Factor (for details please consult the table on the previous page)

<sup>1</sup> The liquidity Spread is updated on a monthly basis. It is determined using the average over the liquidity spreads of five index calculation days ranging from 5th-last to the last calculation day prior to each monthly rebalancing date (3rd Friday). To calculate the liquidity spread, the closing values of the respective swap rates are taken.

The 'leverage term' describes the effect of Price index movements on the leveraged index portfolio.

The 'financing term' indicates the costs of raising capital and reinvesting in the index portfolio (positive leverage)

The 'interest term' indicates the interest received from lending capital and the cost to borrow the index portfolio (negative leverage)

The interest rate depends on the region:

| Region / Country | Interest rate | RICs        |
|------------------|---------------|-------------|
| Americas         | USD LIBOR ON  | USDLIBORON= |

# 8. STOXX SHORT AND LEVERAGED INDICES

|                    |   |                                     |             |
|--------------------|---|-------------------------------------|-------------|
| Europe<br>Eurozone | / | EONIA (€STR + 8.5 bps) <sup>1</sup> | EONIA=      |
| UK                 |   | GBP-LIBOR ON                        | GBPLIBORON= |
| Oceania            |   | AUD Domestic Interest Rate          | AUCASH=RBA  |
| Asia               |   | USD LIBOR ON                        | USDLIBORON= |
| Latam              |   | USD LIBOR ON                        | USDLIBORON= |
| Global             |   | USD LIBOR ON                        | USDLIBORON= |

Liquidity spreads as added for leveraged indices:

| Region / Country   | Liquidity spread                   | RICs                       |
|--------------------|------------------------------------|----------------------------|
| Americas           | USD LIBOR 1Y – USD 1Y ON Swap Rate | USDLIBOR1Y= -<br>USD1YOIS= |
| Europe<br>Eurozone | / EURIBOR 1Y – EUR 1Y ON Swap Rate | EURIBOR1YD= -<br>EUREON1Y= |
| UK                 | GBP LIBOR 1Y – GBP 1Y ON Swap Rate | GBPLIBOR1Y= -<br>GBP1YOIS= |
| Oceania            | AUD LIBOR 1Y – AUD 1Y Swap Rate    | AUD1YD= - AUD1YOIS=        |
| Asia               | USD LIBOR 1Y – USD 1Y ON Swap Rate | USDLIBOR1Y= -<br>USD1YOIS= |
| Latam              | USD LIBOR 1Y – USD 1Y ON Swap Rate | USDLIBOR1Y= -<br>USD1YOIS= |
| Global             | USD LIBOR 1Y – USD 1Y ON Swap Rate | USDLIBOR1Y= -<br>USD1YOIS= |

## 8.3.2. COST OF BORROWING

The STOXX Daily Short indices are designed to ensure a high degree of tradability and replicability.

Calculation:

$$c_M = \sum_{i=1}^n w_{i,M} \cdot c_{i,M}$$

Where:

- $n$  = Number of shares in the index
- $c_M$  = Cost of borrowing the index at time  $M$
- $c_{i,M}$  = Cost of borrowing of company  $i$  at time  $M$
- $w_{i,M}$  = Weight of the share  $i$  in the index

The cost of borrowing will be updated on a monthly basis after the close on the third Friday.

Data source: The data is provided to STOXX by data explorers, the aggregator of stock lending information.

<sup>1</sup> In case EONIA is used in the calculation, the index will be calculated using EONIA that is published on day T in respect of day T-1.



# 8. STOXX SHORT AND LEVERAGED INDICES

## 8.3.3. CALCULATION OF THE OPTIMAL LEVERAGE FACTOR

The optimal leverage factor  $L^*$  is determined every month based on the risk-return profile of the underlying index. Relevant factors are the growth rate of the underlying index and the volatility reflected by the VSTOXX index.

$$L^* = L_T^* = \min\left(4; \max\left(\frac{1}{2}; \frac{1}{2} + \frac{\mu - r}{\sigma^2}\right)\right)$$

Where:

$$r = IR_T$$

$$\mu = \text{growth rate of the underlying index; } \mu = \left(\frac{IDX_T}{IDX_0}\right)^{\frac{365}{T-T_0}} - 1$$

$$\sigma = \text{volatility of the underlying index; } \sigma = \begin{cases} \text{implied volatility: if available} \\ \max\{\text{Vol}(20); \text{Vol}(60)\}: \text{else} \end{cases}$$

$$\text{Vol}(n) = \text{realized volatility over } n \text{ days; } \text{Vol}(n) = \sqrt{\frac{252}{n-1} \cdot \sum_{k=T-n+1}^T \left(\ln \frac{IDX_k}{IDX_{k-1}}\right)^2}$$

For the European STOXX indices the implied volatility as measured by the VSTOXX index is considered in the calculation of the optimal leverage.

## 8.3.4. ADJUSTMENTS DUE TO EXTREME MARKET MOVEMENTS

**Daily Leverage and Daily Short Indices:** The rebalancing is based on the calculation of average index values over a time window of 10 minutes. The time window to calculate the average starts 5 minutes after and ends 15 minutes after the trigger event occurs. The rebalancing is triggered when the underlying index loses more than x% (leverage indices) or appreciates by more than x% (short indices) compared to its previous day's close. The breach of the trigger is checked on a tick-by-tick basis. During this time window, the average of both the underlying index (IDX) and the Leveraged / Short (LevIDX) index are calculated. The two averages then substitute respectively  $IDX_T$  and  $LevIDX_T$  in the index calculation formula.

The respective trigger values (x) are given in the following table:

| Leverage factor | Trigger value |
|-----------------|---------------|
| 2               | x = -25,00%   |
| 3               | x = -16,66%   |
| 4               | x = -12,50%   |
| 5               | x = -10,00%   |
| 6               | x = -10,00%   |
| 7               | x = -10,00%   |
| 8               | x = -10,00%   |
| -1              | x = 50,00%    |
| -2              | x = 25,00%    |
| -3              | x = 16,66%    |

# 8. STOXX SHORT AND LEVERAGED INDICES

|    |            |
|----|------------|
| -4 | x = 12,50% |
| -5 | x = 10,00% |
| -6 | x = 10,00% |
| -7 | x = 10,00% |
| -8 | x = 10.00% |

Over the course of the 10 minute period in which the average is determined, the index is not disseminated. The index dissemination ends 5 minutes after the trigger event and is resumed with an index level equal to the determined average 15 minutes after the trigger event.

Should the intraday rebalancing be triggered less than 15 minutes prior to the end of the index calculation day, the regular overnight rebalancing is carried out.

If the strategy index reaches a value of 0 or below over the course of the 15, the index is set to a value of 0 and its calculation / dissemination is discontinued

**Monthly Leverage Indices:** If the reference index (closing value) rises or falls by more than 40% in the course of the month, the monthly leveraged and short indices will be subject to an extraordinary adjustment. If a breach occurs, the calculation of the leveraged index is suspended for that day. The index levels  $IDX_T$  and  $LevIDX_T$  for the next day are set equal to the respective closing values on the day on which the breach occurred. . Herewith the risk of a potential total loss is minimized. The monthly leveraged and short indices have a floor value of zero.

**Optimal Leverage Indices:** If daily leveraged or short indices drop by more than 50 percent at the time of calculation  $t$  in comparison to the closing prices on the last adjustment day  $T$  then the leverage will be adjusted. During the adjustment those prices are considered which were received last before time  $t$ . No additional refinancing costs ("Financing Term") are calculated and no additional interests are credited ("Interest Term").

The rebalancing will be carried out by simulating a new day:

$t$  :=  $T$  (i.e.  $IDX_T = IDX_t$  and  $LevIDX_T = LevIDX_t$ )  
 $d$  := 0

## 8.3.5. REVERSE SPLIT

If the closing value of a daily leverage or daily short index drops below 100 index points, a reverse split is carried out. The affected leverage or short index is multiplied with a factor of 1000.

The reverse split is carried out based on the index close ten trading days after the index initially dropped below a closing value of 100 points, notwithstanding whether the index rises above a level of 100 points in the meantime.

For optimal leverage indices as well as for monthly adjusted leverage and short indices, no reverse split is carried out.

## 8.3.6. TRADING SUSPENSION

The STOXX leverage and short indices are calculated on the same days and during the same time as the underlying STOXX indices are calculated.

If there is suspension of the underlying index, the leveraged and short indices will be calculated with the latest prices available.

# 9. EURO STOXX 50 VOLATILITY (VSTOXX)

## 9.1. OVERVIEW

### 9.1.1. CONCEPT

Volatility is a measure of the level of uncertainty prevailing in certain markets. In principle, there are two different approaches to estimate volatility. Historical volatility involves measuring the standard deviation of historical closing prices for any particular security over a given period of time. Implied volatility, on the other hand, is derived from option values. This kind of volatility represents the estimates and assumptions of market participants involved in a trade, on the basis of a given option value.

The EURO STOXX 50 Volatility Index (VSTOXX) does not measure implied volatilities of at-the-money EURO STOXX 50 options, but the implied variance across all options of a given time to expiry. The option contracts on the EURO STOXX 50 are among the Eurex products with highest trading volume.

The VSTOXX model has been jointly developed by Goldman Sachs and Deutsche Börse. It offers great advantages in terms of trading, hedging and introducing derivative products on this index.

**Dissemination Calendar:** STOXX Eurex Calendar

### 9.1.2. BASIC DATA

| Index           | Code    | ISIN         |
|-----------------|---------|--------------|
| VSTOXX          | V2TX    | DE000A0C3QF1 |
| VSTOXX 60 days  | VSTX60  | DE000A1A4LU0 |
| VSTOXX 90 days  | VSTX90  | DE000A1A4LV8 |
| VSTOXX 120 days | VSTX120 | DE000A1A4LW6 |
| VSTOXX 150 days | VSTX150 | DE000A1A4LX4 |
| VSTOXX 180 days | VSTX180 | DE000A1A4LY2 |
| VSTOXX 210 days | VSTX210 | DE000A1A4LZ9 |
| VSTOXX 240 days | VSTX240 | DE000A1A4L00 |
| VSTOXX 270 days | VSTX270 | DE000A1A4L18 |
| VSTOXX 300 days | VSTX300 | DE000A1A4L26 |
| VSTOXX 330 days | VSTX330 | DE000A1A4L34 |
| VSTOXX 360 days | VSTX360 | DE000A1A4L42 |
| VSTOXX 1M       | V6I1    | DE000A0G87B2 |
| VSTOXX 2M       | V6I2    | DE000A0G87C0 |
| VSTOXX 3M       | V6I3    | DE000A0G87D8 |
| VSTOXX 6M       | V6I4    | DE000A0G87E6 |
| VSTOXX 9M       | V6I5    | DE000A0G87F3 |
| VSTOXX 12M      | V6I6    | DE000A0G87G1 |
| VSTOXX 18M      | V6I7    | DE000A0G87H9 |
| VSTOXX 24M      | V6I8    | DE000A0G87J5 |

### 9.1.3. VSTOXX MAIN INDICES AND SUB-INDICES

The 12 VSTOXX main indices are calculated for rolling 30, 60, 90, 120, 150, 180, 210, 240, 270, 300, 330 and 360 days to expiry via linear interpolation of the suiting sub-indices. The VSTOXX main indices are therefore independent of a specific time to expiry, i.e. they do not expire.

Apart from the VSTOXX main indices, 8 sub-indices are calculated and distributed, covering the EURO STOXX 50 option expiries ranging from one month to two years. For options with longer time to expiry, no such sub-indices are currently available.

# 9. EURO STOXX 50 VOLATILITY (VSTOXX)

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The VSTOXX sub-indices are calculated on the basis of all options available in the Eurex system.

## 9.2. CALCULATION OF INDEX TICKS

The model for VSTOXX aims at making pure volatility tradable - i.e. it should be possible to replicate the indices with an options portfolio which does not react to price fluctuations, but to changes in volatility only. This is not achieved through direct replication of volatility, but rather of variance. A portfolio of EURO STOXX 50 options with different strike levels and weighting meets this goal: the implied volatilities of all eligible options with a given time to expiry are considered.

### 9.2.1. INPUT DATA

During the calculation hours for the VSTOXX and the eight corresponding sub-indices (09:15 to 17:30 CET), the following data is used via snapshots every five seconds:

|               |                                                                                                                                                                                                                                                                              |
|---------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| EURO STOXX 50 | - EURO STOXX 50 Index                                                                                                                                                                                                                                                        |
| OESX          | - Best bid, best ask, last trade and settlement price of all EURO STOXX 50 options - STOXX will exclude from their indices all options as soon as their delisting becomes known to STOXX (e.g. direct notification from the market, or unavailability of a settlement price) |
| EONIA         | - Euro Overnight Index Average - overnight interest rate, calculated as the European short-term rate (€STR) + 8.5 bps.                                                                                                                                                       |
| EURIBOR       | - EURIBOR - Euro Interbank Offered Rates – money market reference rates (calculated once a day, 11:00 CET, by the European Banking Federation)                                                                                                                               |
| REX           | - Yield of the 2-year REX as the longer-term interest rate                                                                                                                                                                                                                   |

#### 9.2.1.1. PREPARATION OF OPTION INCLUSION PRICES

First, the trade price, the mid quote and settlement price of each option and corresponding timestamps are identified. A filter is applied in that any trade price, mid quote or settlement price below 0.5 points is ignored.

The mid quote is only calculated if the following requirements are fulfilled:

- a. both the bid and ask quotes are available and
- b. both the bid and ask quotes are equal to or greater than 0.1 points and
- c. the bid-ask spread does not exceed the following thresholds:
  - i. normal market: 8% of bid quote, with a minimum of 1.2 points and a maximum of 18 points and
  - ii. stressed market: 16%, with a minimum value of 2.4 points and a maximum of 36 points.

If there are two or more options with different strikes and mid quotes that exactly equal the minimum value of 0.5, only the one closer to the at-the-money point is taken into consideration.

For each option used in the calculation of a sub-index, the Inclusion Price is then defined as the most recent among:

- a. trade price, or
- b. mid quote, or
- c. settlement price.

# 9. EURO STOXX 50 VOLATILITY (VSTOXX)

If both a trade price and a mid quote exist with identical timestamp, preference is given to the trade price.

Example:

| Strike | Settlement | Bid (time)    | Ask (time)    | Mid (time)    | Last-traded (time) | Price |
|--------|------------|---------------|---------------|---------------|--------------------|-------|
| 4050   | 76.70      | -             | -             | -             | -                  | 76.70 |
| 4100   | 53.71      | -             | -             | -             | 54.01 (09:05)      | 54.01 |
| 4150   | 37.51      | 33.70 (09:04) | 34.40 (09:05) | 34.05 (09:05) | -                  | 34.05 |
| 4200   | 22.54      | 17.29 (09:04) | 19.53 (09:05) | 18.41 (09:05) | 20.21 (09:01)      | 18.41 |

## 9.2.1.2. DISCOUNT RATES

| Discount Rate            | Period    | Code | ISIN         |
|--------------------------|-----------|------|--------------|
| EONIA <sup>2</sup>       | 1 day     | EU1D | EU0009659945 |
| EURIBOR 1 month          | 1 month   | EU1M | EU0009659937 |
| EURIBOR 3 months         | 3 months  | EU3M | EU0009652783 |
| EURIBOR 6 months         | 6 months  | EU6M | EU0009652791 |
| EURIBOR 12 months        | 12 months | EU12 | EU0009652809 |
| REX 2-year (Price index) | 2 years   | REX2 | DE0008469149 |

## 9.2.2. CALCULATION OF VSTOXX MAIN INDICES

Twelve VSTOXX main indices are calculated with fixed time to expiry.

The main indices are calculated by linear interpolation of the sub-indices whose times to maturity better represent the targeted fixed time to expiry.

If two sub-indices exist whose time to maturity bracket the time to maturity targeted by the main index, then the main index is calculated as interpolation of the two sub-indices.

When the maturity of two sub-indices used in the calculation of a main index approaches, the respective time to maturities may not bracket the fixed time to maturity of the main index: in this case, the algorithm extrapolates between the two sub-indices.

However, as time passes by, as soon as an interpolation between two other sub-indices becomes possible, the algorithm switches to the new sub-index pair.

Each VSTOXX main index is calculated as a time-weighted average of two VSTOXX sub-indices, as shown in the following formula:

$$\text{MainIndex}_{tm} = 100 \cdot \sqrt{\left[ \frac{T_{st}}{T_{365}} \cdot \left( \frac{\text{SubIndex}_{st}}{100} \right)^2 \cdot \frac{T_{lt}-T_{tm}}{T_{lt}-T_{st}} + \frac{T_{lt}}{T_{365}} \cdot \left( \frac{\text{SubIndex}_{lt}}{100} \right)^2 \cdot \frac{T_{tm}-T_{st}}{T_{lt}-T_{st}} \right] \cdot \frac{T_{365}}{T_{tm}}}$$

where:

tm = Fixed time to maturity, expressed as number of days, targeted by the main index.

MainIndex<sub>tm</sub> = VSTOXX main index with fixed time to maturity of tm days.

SubIndex<sub>st</sub> = VSTOXX sub-index with shorter maturity used in the inter(extra)polation.

<sup>2</sup> Calculated as the European short-term rate (€STR) + 8.5 bps.

# 9. EURO STOXX 50 VOLATILITY (VSTOXX)

|                        |                                                                           |
|------------------------|---------------------------------------------------------------------------|
| SubIndex <sub>it</sub> | = VSTOXX sub-index with longer maturity used in the inter(extra)polation. |
| T <sub>st</sub>        | = Seconds to expiry of SubIndex <sub>st</sub> .                           |
| T <sub>lt</sub>        | = Seconds to expiry of SubIndex <sub>lt</sub> .                           |
| T <sub>tm</sub>        | = Seconds in tm (1 day = 86,400 sec.).                                    |
| T <sub>365</sub>       | = Seconds in a standard year of 365 days (31,536,000 sec.).               |

If one of or both the sub-indices required for the calculation of a main index are not available, the main index is not calculated.

## 9.2.3. CALCULATION OF VSTOXX SUB-INDICES

Each of the eight VSTOXX sub-indices is calculated according to the formula shown below:

$$\text{SubIndex}_i = 100 \cdot \sqrt{\sigma_i^2}$$

where:

|                              |                                                                                                                                                                                                                                                                                                                                                                                                            |
|------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| i                            | = i <sup>th</sup> sub-index (i = 1,...,8).                                                                                                                                                                                                                                                                                                                                                                 |
| $\sigma_i^2$                 | = Implied variance for the the i <sup>th</sup> OESX expiry date:<br>$\sigma_i^2 = \frac{2}{T_i/T_{365}} \cdot \sum_j \frac{\Delta K_{i,j}}{K_{i,j}^2} \cdot R_i \cdot M_{K_{i,j}} - \frac{1}{T_i/T_{365}} \cdot \left( \frac{F_i}{K_{i,0}} - 1 \right)^2$                                                                                                                                                  |
| T <sub>i</sub>               | = Seconds to the i <sup>th</sup> OESX expiry date.                                                                                                                                                                                                                                                                                                                                                         |
| F <sub>i</sub>               | = Forward at-the-money price for the i <sup>th</sup> OESX expiry date, derived from exercise price for which the absolute difference between call and put prices is smallest. If multiple pairs of calls and puts exist with identical price differences, a forward price will be calculated as the simple average of the corresponding implied forward prices:<br>$F_i = K_{\min C-P } + R_i \cdot (C-P)$ |
| K <sub>i,0</sub>             | = Highest exercise price not exceeding F <sub>i</sub> .                                                                                                                                                                                                                                                                                                                                                    |
| K <sub>i,j</sub>             | = Exercise price of the j <sup>th</sup> out-of-the-money option, after sorting the options by their exercise prices in ascending order (i.e. call options for exercise prices above K <sub>i,0</sub> , put options otherwise).                                                                                                                                                                             |
| ΔK <sub>i,j</sub>            | = Average distance between the exercise prices of the two options struck respectively immediately above and immediately below K <sub>i,j</sub> . On the boundaries, the simple distance between the highest (lowest) and second-highest (lowest) exercise price for call (put) options is used:<br>$\Delta K_{i,j} = \frac{1}{2} \cdot (K_{i,j+1} - K_{i,j-1})$                                            |
| M <sub>K<sub>i,j</sub></sub> | = Inclusion price of the out-of-the-money option with exercise price K <sub>i,j</sub> .                                                                                                                                                                                                                                                                                                                    |
| M <sub>K<sub>i,0</sub></sub> | = Simple arithmetic average of put and call prices of the option with exercise price K <sub>i,0</sub> .                                                                                                                                                                                                                                                                                                    |
| R <sub>i</sub>               | = Refinancing factor for the i <sup>th</sup> OESX expiry date:<br>$R_i = e^{r_i \cdot T_i/T_{365}}$                                                                                                                                                                                                                                                                                                        |
| r <sub>i</sub>               | = Interpolated risk-free interest rate valid for the i <sup>th</sup> OESX expiry date:<br>$r_i = \frac{T_{lt} - T_{tm}}{T_{lt} - T_{st}} \cdot r_{st} + \frac{T_{tm} - T_{st}}{T_{lt} - T_{st}} \cdot r_{lt}$                                                                                                                                                                                              |

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If less than five options can be used for the calculation of a sub-index, that sub-index is not calculated.

The sub-indices are calculated up to two days prior to expiry. Each new sub-index, i.e. an index calculated with newly issued options, is disseminated for the first time on the second trading day of the relevant EURO STOXX 50 options.

## Example:

$$T_i = 0.0605022831$$

$$r_i = 1.41296\%$$

$$R_i = e^{1.41296\% \times 0.0605022831} = 1.0008552403$$

| $K_{i,j}$ | $\Delta K_{i,j}$ | Call   | Put    | Call-Put | $M_{K_{i,j}}$ | $\frac{\Delta K_{i,j}}{K_{i,j}^2} \cdot R_i \cdot M_{K_{i,j}}$ |
|-----------|------------------|--------|--------|----------|---------------|----------------------------------------------------------------|
| 2350      | 50               | 472.00 | 0.60   | 471.40   | 0.60          | 0.0000054370                                                   |
| 2400      | 50               | 422.30 | 1.00   | 421.30   | 1.00          | 0.0000086880                                                   |
| 2450      | 50               | 372.80 | 1.50   | 371.30   | 1.50          | 0.0000125055                                                   |
| 2500      | 50               | 322.40 | 2.30   | 320.10   | 2.30          | 0.0000184157                                                   |
| 2550      | 50               | 273.50 | 3.30   | 270.20   | 3.30          | 0.0000253966                                                   |
| 2600      | 50               | 225.15 | 4.60   | 220.55   | 4.60          | 0.0000340528                                                   |
| 2650      | 50               | 177.85 | 6.70   | 171.15   | 6.70          | 0.0000477446                                                   |
| 2700      | 50               | 132.40 | 12.00  | 120.40   | 12.00         | 0.0000823749                                                   |
| 2750      | 50               | 90.90  | 21.00  | 69.90    | 21.00         | 0.0001389617                                                   |
| 2800      | 50               | 57.90  | 35.40  | 22.50    | 46.65         | 0.0002977672                                                   |
| 2850      | 50               | 29.50  | 58.25  | 28.75    | 29.50         | 0.0001817497                                                   |
| 2900      | 50               | 13.10  | 92.00  | 78.90    | 13.10         | 0.0000779501                                                   |
| 2950      | 50               | 5.00   | 134.10 | 129.10   | 5.00          | 0.0000287520                                                   |
| 3000      | 50               | 1.50   | 180.90 | 179.40   | 1.50          | 0.0000083405                                                   |
| 3050      | 50               | 0.70   | 229.55 | 228.85   | 0.70          | 0.0000037656                                                   |
| 3100      | 50               | 0.60   | 230.00 | 229.40   | 0.60          | 0.0000031244                                                   |

$$K_{i,\min|C-P|} = 2800$$

$$F_i = 2800 + 1.0008552403 \times (57.90 - 35.40) = 2822.51924290675$$

$$K_{i,0} = 2800$$

$$\sigma_i^2 = \frac{2}{0.0605022831} \cdot 0.0009750263 - \frac{1}{0.0605022831} \cdot \left( \frac{2822.51924290675}{2800} - 1 \right)^2 = 0.0311619545863044$$

$$\text{SubIndex}_i = 100 \cdot \sqrt{0.0311619545863044} = 17.65274896$$

## 9.3. CALCULATION OF INDEX SETTLEMENT LEVEL

# 9. EURO STOXX 50 VOLATILITY (VSTOXX)

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A Settlement Day is defined, for each main index, as the 30<sup>th</sup> calendar day preceding the expiry of the EURO STOXX 50 options.

The Settlement Level of each main index is calculated on the Settlement Day as the average of all valid ticks that index produced during an expanding time window starting at 11:30:00 CET up to the current calculation time and not later than 12:00:00 CET:

$$\text{Settle}_{\text{index}} = \frac{1}{n_t} \sum_{i=1}^{n_t} \text{tick}_{\text{index},i}$$

where  $\text{tick}_{\text{index},i}$  indicates the  $i^{\text{th}}$  tick for the relevant main index up to calculation time  $t$ .

Interim settlement values, i.e. values calculated on the expanding window before 12:00:00 CET, are disseminated with an “V” flag.

The final settlement value is marked as “F”.

## 9.4. CERIFICATION OF INDEX TICKS

With reference to both sub- and main indices, each index tick is verified before being published. The process will result in the addition of a flag to the individual index tick, showing its status. Status flags are updated at every index tick, i.e. they reflect the status of the tick they are associated to.

A tick can be flagged as either “A” (for “Approved” tick) or “U” (for “Unapproved” tick).

Any tick exceeding a certain deviation tolerance limit from the previous tick is flagged as “U”. The maximum deviation allowed is set respectively to  $\pm 20\%$  for sub- and  $\pm 8\%$  for main indices.

A sub-index tick flagged as “U” will still be used in the calculation of any derived main index. Any main index derived from an “Unapproved” sub-index will inherit the “U” status flag.

Index ticks flagged as “U” are displayed for information purpose only and are not meant to be considered as valid values.

However, main index ticks marked as “U” are used in the calculation of the respective index settlement level.

## 9.5. CALCULATION OF COMPONENT WEIGHTS

The weight of the individual options composing a VSTOXX main index can be obtained by simply expanding the index formula and rearranging its terms.

By neglecting the AtM adjustment term in the sub-index formula, variance can be approximated as:



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$$\sigma_i^2 \approx \frac{2}{T_i/T_{365}} \cdot \sum_j \frac{\Delta K_{i,j}}{K_{i,j}^2} \cdot R_i \cdot M_{K_{i,j}} = \frac{2}{T_i/T_{365}} \cdot S_{K_{i,j}}$$

This expression can be plugged in the main index formula to obtain:

$$\text{MainIndex}_{tm} \approx 100 \cdot \sqrt{\left[ \frac{T_{st}}{T_{365}} \cdot \frac{2}{T_{st}/T_{365}} \cdot S_{K_{st,j}} \cdot \frac{T_{lt}-T_{tm}}{T_{lt}-T_{st}} + \frac{T_{lt}}{T_{365}} \cdot \frac{2}{T_{lt}/T_{365}} \cdot S_{K_{lt,j}} \cdot \frac{T_{tm}-T_{st}}{T_{lt}-T_{st}} \right] \cdot \frac{T_{365}}{T_{tm}}}$$

which simplifies in:

$$\text{MainIndex}_{tm} \approx 100 \cdot \sqrt{2 \cdot \left[ S_{K_{st,j}} \cdot \frac{T_{lt}-T_{tm}}{T_{lt}-T_{st}} + S_{K_{lt,j}} \cdot \frac{T_{tm}-T_{st}}{T_{lt}-T_{st}} \right] \cdot \frac{T_{365}}{T_{tm}}}$$

By defining:

$$WS_{st} = \frac{T_{st}}{T_{tm}} \cdot \left( \frac{T_{lt} - T_{tm}}{T_{lt} - T_{st}} \right)$$

$$WS_{lt} = \frac{T_{lt}}{T_{tm}} \cdot \left( \frac{T_{tm} - T_{st}}{T_{lt} - T_{st}} \right)$$

and

$$RS_{j \in st} = 2 \cdot R_{st} \cdot \left( \frac{\Delta K_{st,j}}{K_j^2} \cdot M_{K_{i,j}} \right) \cdot WS_{st} \cdot \frac{T_{365}}{T_{st}}$$

$$RS_{j \in lt} = 2 \cdot R_{lt} \cdot \left( \frac{\Delta K_{lt,j}}{K_j^2} \cdot M_{K_{i,j}} \right) \cdot WS_{lt} \cdot \frac{T_{365}}{T_{lt}}$$

the main index approximation can be restated as:

$$\text{MainIndex}_{tm} \approx 100 \cdot \sqrt{RS_{st} + RS_{lt}}$$

Terms  $RS_{st}$  and  $RS_{lt}$  represent the value of the two sub-portfolios of options in the main index: the main index is given by the time-weighted sum of all options' market values.

The contribution of each  $j^{\text{th}}$  option to the total market value of the portfolio is simply the portion of that option's  $RS_j$  over the total  $RS_{st} + RS_{lt}$ :

$$RS_{j \in st} = 2 \cdot R_{st} \cdot \left( \frac{\Delta K_{st,j}}{K_j^2} \cdot S_{K_j} \right) \cdot WS_{st} \cdot \frac{T_{365}}{T_{st}}$$

$$RS_{j \in lt} = 2 \cdot R_{lt} \cdot \left( \frac{\Delta K_{lt,j}}{K_j^2} \cdot S_{K_j} \right) \cdot WS_{lt} \cdot \frac{T_{365}}{T_{lt}}$$

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and an individual option's weight is then obtained as:

$$w_j = \frac{RS_j}{RS_{st} + RS_{lt}}.$$

# 10. EURO STOXX 50 VOLATILITY OF VOLATILITY (V-VSTOXX)

## 10.1. OVERVIEW

### 10.1.1. CONCEPT

The EURO STOXX 50 Volatility of Volatility Index (V-VSTOXX) measures the implied volatility of the option contracts on the VSTOXX futures, traded on the Eurex Exchange. In general terms, the algorithm is the same as the one applied in the calculation of the VSTOXX index, but some differences exist, reflecting the specifications of the underlying contracts. For instance, the sub- and main indices cover different maturities and the options' price filters are applied with different thresholds. The following paragraphs will refer to the VSTOXX methodology and differentiate where required.

**Dissemination Calendar:** STOXX Eurex Calendar

### 10.1.2. BASIC DATA

| Index             | Code     | ISIN         |
|-------------------|----------|--------------|
| V-VSTOXX          | VV2TX    | DE000A13PCG9 |
| V-VSTOXX 60 days  | VVSTX60  | DE000A13PCH7 |
| V-VSTOXX 90 days  | VVSTX90  | DE000A13PCJ3 |
| V-VSTOXX 120 days | VVSTX120 | DE000A13PCK1 |
| V-VSTOXX 150 days | VVSTX150 | DE000A13PCL9 |
| V-VSTOXX 180 days | VVSTX180 | DE000A13PCM7 |
| V-VSTOXX 210 days | VVSTX210 | DE000A13PCN5 |
| V-VSTOXX 1 month  | VV6I1    | DE000A13PCQ8 |
| V-VSTOXX 2 months | VV6I2    | DE000A13PCR6 |
| V-VSTOXX 3 months | VV6I3    | DE000A13PCS4 |
| V-VSTOXX 4 months | VV6I4    | DE000A13PCT2 |
| V-VSTOXX 5 months | VV6I5    | DE000A13PCU0 |
| V-VSTOXX 6 months | VV6I6    | DE000A13PCV8 |
| V-VSTOXX 7 months | VV6I7    | DE000A13PCW6 |
| V-VSTOXX 8 months | VV6I8    | DE000A13PCX4 |

### 10.1.3. V-VSTOXX MAIN INDICES AND SUB-INDICES

The 7 V-VSTOXX main indices are calculated for rolling 30, 60, 90, 120, 150, 180, 210 days to expiry via linear interpolation of the suiting sub-indices. The V-VSTOXX main indices are therefore independent of a specific time to expiry, i.e. they do not expire. This helps to eliminate effects that typically result in strong volatility fluctuations close to expiry.

Apart from the VSTOXX main indices, 8 sub-indices are calculated and distributed, covering the VSTOXX option expiries ranging from one month to eight months.

The V-VSTOXX sub-indices are calculated on the basis of all options available in the Eurex system.

## 10.2. CALCULATION OF INDEX TICKS

Please refer to VSTOXX methodology.

### 10.2.1. INPUT DATA

During the calculation hours for the V-VSTOXX sub- and main indices (09:15 to 17:30 CET), the following data is used via snapshots every five seconds:

# 10. EURO STOXX 50 VOLATILITY OF VOLATILITY (V-VSTOXX)

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|         |                                                                                                                                                                                                                                                                               |
|---------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| OVS2    | - Best bid, best ask, last trade and settlement price of all VSTOXX futures options - STOXX will exclude from their indices all options as soon as their delisting becomes known to STOXX (e.g. direct notification from the market, or unavailability of a settlement price) |
| EONIA   | - Euro Overnight Index Average - overnight interest rate, calculated as the European short-term rate (€STR) + 8.5 bps.                                                                                                                                                        |
| EURIBOR | - EURIBOR - Euro Interbank Offered Rates – money market reference rates (calculated once a day, 11:00 CET, by the European Banking Federation)                                                                                                                                |

## 10.2.1.1. PREPARATION OF OPTION INCLUSION PRICES

First, the trade price, the mid quote and settlement price of each option and corresponding timestamps are identified. A filter is applied in that any trade price, mid quote or settlement price below 0.1 points is ignored.

The mid quote is only calculated if the following requirements are fulfilled:

- d. both the bid and ask quotes are available and
- e. both the bid and ask quotes are equal to or greater than 0.05 points and
- f. the bid-ask spread does not exceed the following thresholds:
  - iii. normal market: 20% of bid quote, with a minimum of 0.4 points and a maximum of 4 points and
  - iv. stressed market: 40%, with a minimum value of 0.8 points and a maximum of 8 points.

If there are two or more options with different strikes and mid quotes that exactly equal the minimum value of 0.1, only the one closer to the at-the-money point is taken into consideration.

For each option used in the calculation of a sub-index, the Inclusion Price is then defined as the most recent among:

- d. trade price, or
- e. mid quote, or
- f. settlement price.

If both a trade price and a mid quote exist with identical timestamp, preference is given to the trade price.

## 10.2.1.2. DISCOUNT RATES

Please refer to VSTOXX methodology.

## 10.2.2. CALCULATION OF V-VSTOXX MAIN INDICES

Please refer to VSTOXX methodology.

## 10.2.3. CALCULATION OF V-VSTOXX SUB-INDICES

The calculation of the V-VSTOXX sub-indices follows the same procedure as the VSTOXX sub-indices.

The sub-indices are calculated up to three days prior to expiry. Each new sub-index, i.e. an index calculated with newly issued options, is disseminated for the first time on the second trading day of the relevant VSTOXX futures options.

# 10. EURO STOXX 50 VOLATILITY OF VOLATILITY (V-VSTOXX)

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## 10.3. CALCULATION OF INDEX SETTLEMENT LEVEL

Please refer to VSTOXX methodology.

## 10.4. VERIFICATION OF INDEX TICKS

Please refer to VSTOXX methodology.

## 10.5. CALCULATION OF COMPONENT WEIGHTS

Please refer to VSTOXX methodology.

# 11. EURO STOXX 50 VOLATILITY-BALANCED

## 11.1. OVERVIEW

The EURO STOXX 50 Volatility-Balanced index aims to provide superior risk-adjusted returns relative to the EURO STOXX 50 Index by coupling a base investment in EURO STOXX 50 with a dynamic allocation to equity volatility (VSTOXX Short-Term Futures Index) depending on the prevailing volatility regime.

The index is based on the EURO STOXX 50 Net Return (Symbol: SX5T) and the VSTOXX Short-Term Futures Excess Return Index (Symbol: VST1ME).

The volatility regime on any index business day is determined on the basis of Realised Volatility for the period of past 20-days ("RV") and 1-month Implied Volatility 1-month back ("IV") as reflected by the VSTOXX Index. The current volatility regime determines the Equity and Volatility Exposure.

| Daily Indicator                  | Volatility Regime               | Equity Exposure | Volatility Exposure |
|----------------------------------|---------------------------------|-----------------|---------------------|
| $RV < IV - 1\%$                  | Stable Volatility Regime        | 97.5%           | 2.5%                |
| $IV - 1\% \leq RV \leq IV + 1\%$ | Unpredictable Volatility Regime | 90%             | 10%                 |
| $RV > IV + 1\%$                  | Increasing Volatility Regime    | 70%             | 30%                 |

In addition, a stop-loss criterion is applied: if the weekly performance of the Excess Return Index shows a loss of 5% or more, both equity and volatility allocations are moved completely into a cash position.

**Dissemination Calendar:** STOXX Eurex Calendar

## 11.2. BASIC DATA

| Index                                          | ISIN         | Symbol  |
|------------------------------------------------|--------------|---------|
| EURO STOXX Volatility-Balanced (Excess Return) | CH0128045587 | SX5EVBE |
| EURO STOXX Volatility-Balanced (Total Return)  | CH0128045595 | SX5EVBT |

## 11.3. CALCULATION

The EURO STOXX 50 Volatility-Balanced index is calculated as excess and total return index on every Index Business Day ("t") where an Index Business Day is each Eurex VSTOXX futures trading day which is also a EURO STOXX 50 Index Publication Day.

### 11.3.1. INDEX FORMULAS

#### Excess Return Index ("ERI")

$$ERI(t) = ERI(t-1) \cdot \left[ 1 + EE(t-2) \cdot \left( \frac{EI(t)}{EI(t-1)} - 1 - RI(t-1) \cdot \frac{d}{360} \right) + VE(t-2) \cdot \left( \frac{VI(t)}{VI(t-1)} - 1 \right) \right]$$

Where:

EI = equity index (EURO STOXX 50)

# 11. EURO STOXX 50 VOLATILITY-BALANCED

|    |                                                                |
|----|----------------------------------------------------------------|
| VI | = volatility index (VSTOXX Short-Term Futures index)           |
| EE | = Equity Exposure                                              |
| VE | = Volatility Exposure                                          |
| RI | = Interest Rate (1 month Euribor)                              |
| d  | = number of calendar days between index business day t-1 and t |

## Total Return Index ("TRI")

$$TRI(t) = TRI(t-1) \cdot \left[ \frac{ER(t)}{ER(t-1)} + RI(t-1) \cdot \frac{d}{360} \right]$$

### 11.3.2. EQUITY AND VOLATILITY EXPOSURE

#### Current 1-month Implied Volatility („CIV“)

$$CIV(t) = \frac{VSTOXX(t)}{100}$$

Where:

VSTOXX = VSTOXX index

#### Current 1-month Realised Volatility („CRV“)

$$CRV(t) = \sqrt{\frac{252}{20} \cdot \sum_{j=0}^{19} \left[ \ln \left( \frac{EI(t-j)}{EI(t-j-1)} \right)^2 \right]}$$

#### Target Volatility Exposure („TVE“)

$$TVE(t) = \begin{cases} 2.5\% & : CRV(t) < CIV(t-20) - 1\% \\ 30\% & : CRV(t) > CIV(t-20) + 1\% \\ 10\% & : \text{else} \end{cases}$$

#### Stop loss

$$SL(t) = \begin{cases} 1 & : \frac{ER(t)}{ER(t-5)} - 1 \leq -5\% \\ 0 & : \text{else} \end{cases}$$

#### Volatility Exposure

$$VE(t) = \begin{cases} \max[0, VE(t-1) - 10\%] & : SL(t) = 1 \\ \max[TVE(t), VE(t-1) - 10\%] & : SL(t) = 0 \wedge TVE(t) < VE(t-1) \\ \min[TVE(t), VE(t-1) + 10\%] & : SL(t) = 0 \wedge TVE(t) \geq VE(t-1) \end{cases}$$

#### Equity Exposure

$$EE(t) = \begin{cases} 1 - VE(t) & : SL(t) = 0 \\ 0 & : \text{else} \end{cases}$$

# 12. EURO STOXX 50 REALIZED VARIANCE (RVSTOXX)

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## 12.1. INDEX CONCEPT

The EURO STOXX 50 Realized Variance (RVSTOXX) accrues the realized variance of the EURO STOXX 50 index on a daily basis.

**Index types and currencies:** Price in EUR

**Base values and dates:** 100 as of the 30<sup>th</sup> of August 2017

**Dissemination Calendar:** STOXX Eurex Calendar

## 12.2. CALCULATIONS

$$I_t = I_{t-1} + \ln^2 \left( \frac{S_t}{S_{t-1}} \right) * 10000$$

Where

$S_t$  EURO STOXX 50 Price EUR (SX5E) index value at time t.

$S_{t-1}$  EURO STOXX 50 Price EUR (SX5E) index close as of the last trading day without market disruptions

The index carries forward only daily closing prices. Intraday,  $S_t$  is the current EURO STOXX 50 Price EUR (SX5E). At the end of the day, the last index value is calculated using the EURO STOXX 50 EUR (SX5E) closing price which becomes  $S_{t-1}$  on the following day.

## 12.3. INDEX SETTLEMENT VALUES

On each Settlement Day, a realized variance index price is calculated at 12:00 CET that serves as final settlement price for the expiring futures. A Settlement Day is defined as the third Friday of a maturity month (March, June, September, December). The Settlement Value is calculated on the Settlement Day using the following formula:

$$ISV_t = I_{t-1} + \ln^2 \left( \frac{S_{set}}{S_{t-1}} \right) * 10000$$

Where

$ISV_t$  RVSTOXX Index Settlement Value at time t (12:00 CET)

$I_{t-1}$  RVSTOXX Index last closing value

$S_{t-1}$  EURO STOXX 50 Price EUR (SX5E) index close as of the last trading day without market disruptions

$S_{set}$  EURO STOXX 50 Price EUR (SX5E) Settlement value calculated as the average of all valid SX5E ticks during an expanding time window starting at 11:50:00 CET up to the current calculation time and not later than 12:00:00 CET



# 12. EURO STOXX 50 REALIZED VARIANCE (RVSTOXX)

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## 12.4. MARKET DISRUPTION EVENTS

If one of the conditions below apply, the realized variance index is updated using

$$S_t = S_{t-1}$$

**Trading Disruption:**

EURO STOXX 50 index futures or index options are not available for trading any time during the last hour of trading (from 16:30 to 17:30 CET).

**Exchange Disruption:**

Eurex is down any time during the last hour of trading (from 16:30 to 17:30 CET).

# 13. EURO STOXX 50 DVP FUTURES

## 13.1. OVERVIEW

Dividends offer new opportunities to investors – either asset or retail managers – as they:

- » are considered on a long-dated horizon as one of the main sources of performance in a portfolio;
- » are considered as a good hedge against inflation;
- » offer on a long-dated horizon some diversification against pure equity exposure;
- » offer an attractive upside due to a structural imbalance in flows: the longer end of the curve tends to be under the net selling pressure coming from the issuance of structured products;
- » tend to exhibit lower volatility than equities.

With the EURO STOXX 50 DVP Futures Index, STOXX Ltd. provides investors with synthetic exposure to the gross return (including income from interest) of the EURO STOXX 50 DVP futures listed for trading on Eurex.

The EURO STOXX 50 DVP Futures Index is designed to benefit from the characteristics of the dividends cycle and the dividends market.

- » From the December expiry of year (n - 1) to the December expiry of year n, the index notional is invested in equal numbers of EURO STOXX 50 DVP futures corresponding to the years n, n+1, n+2, n+3, n+4, (Fn, Fn+1, Fn+2, Fn+3, Fn+4).
- » The cash position is invested at EONIA, calculated as the European short-term rate (€STR) + 8.5 bps.
- » In December of year n, when the future Fn expires, the index notional would be invested in the contract Fn+5, such that the adjusted numbers of contracts of Fn+1, Fn+2, Fn+3, Fn+4, Fn+5 are the same. For instance, in December 2010, when all the 2010 dividends have been paid, the index will get a new exposure to 2015 dividends.
- » In line with the expiry structure of the EURO STOXX 50 DVP Futures, each of the five future contracts is assigned to a specific expiry. Ten maturities are available for dividend futures. The index only considers the five nearest maturities simultaneously.

**Dissemination Calendar:** STOXX Eurex Calendar

## 13.2. BASIC DATA

| Index                             | ISIN         | Symbol  |
|-----------------------------------|--------------|---------|
| EURO STOXX 50 DVP Futures (Price) | CH0109185402 | SX5EDFT |

## 13.3. CALCULATION

### 13.3.1. INPUT DATA

During the calculation hours of the EURO STOXX 50 DVP Futures Index, the following data is used via snapshots every 15 seconds:

# 13. EURO STOXX 50 DVP FUTURES

- » Eurex futures prices (first five year contracts) on the EURO STOXX 50 DVP
- » EONIA - overnight interest rate - money market investment

If one or more Eurex DVP futures included in the index is no longer listed, STOXX Ltd. may decide on the appropriate measures in consultation with the STOXX management board and notify at that time.

## 13.3.2. INDEX FORMULA

From the December expiry of year (n-1) to the December expiry of year n:

$$\text{Index}_t = \text{Index}_{t-1} \left[ 1 + \text{EONIA}(t-1)/360 \cdot d \right] + N_t \left[ \begin{array}{l} F_n(t) - F_n(t-1) + F_{n+1}(t) - F_{n+1}(t-1) + \\ F_{n+2}(t) - F_{n+2}(t-1) + F_{n+3}(t) - F_{n+3}(t-1) + \\ F_{n+4}(t) - F_{n+4}(t-1) \end{array} \right]$$

Where:

- t = Time of calculation
- d = Number of calendar days between t and t-1
- n = Maturity tranche
- F = Trade price of the futures contracts
- EONIA = Overnight interest rate\*
- N<sub>t</sub> = index<sub>t-1</sub> / [F<sub>n</sub>(t-1) + F<sub>n+1</sub>(t-1) + F<sub>n+2</sub>(t-1) + F<sub>n+3</sub>(t-1) + F<sub>n+4</sub>(t-1)] is the numbers of contracts

## 13.3.3. ROLLING

On December expiry of year n, the number of contracts has to be adjusted by a rolling factor RF<sub>N-N+1</sub> so that the index notional is invested in a new number of contracts in the next five EURO STOXX 50 DVP futures after the roll. The rolling factor RF<sub>N-N+1</sub> is calculated as follows:

$$\text{RF}_{N-N+1} = \frac{F_n(t) + F_{n+1}(t) + F_{n+2}(t) + F_{n+3}(t) + F_{n+4}(t)}{F_{n+1}(t) + F_{n+2}(t) + F_{n+3}(t) + F_{n+4}(t) + F_{n+5}(t)}$$

Consequently, on the roll date in December, the switch of contract has no impact on the value of the index:

$$\begin{aligned} \text{Index}_t &= \text{EONIA} + N_t \cdot [F_n(t) + F_{n+1}(t) + F_{n+2}(t) + F_{n+3}(t) + F_{n+4}(t)] \text{ with EONIA} \\ &= \text{Index}_{t-1} \cdot \text{EONIA}(t-1)/360 \cdot d \\ &= \text{EONIA} + \text{RF}_{N-N+1} \cdot N_t \cdot [F_{n+1}(t) + F_{n+2}(t) + F_{n+3}(t) + F_{n+4}(t) + F_{n+5}(t)] \end{aligned}$$

On the following day, the index is computed normally, invested in year n+1 to n+5, thus we have entered a new period until the next expiry.

\*Euro Overnight index Average (EONIA) is the effective reference rate computed daily as the European short-term rate (€STR) + 8.5 bps...

# 13. EURO STOXX 50 DVP FUTURES

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For instance, let's assume that the final close of the index on December expiry of year  $n$  is 500, EONIA is zero and that each of the DVP futures corresponding to the years  $n$ ,  $n+1$ ,  $n+2$ ,  $n+3$ ,  $n+4$  is equal to 100:

$F_n(t) = F_{n+1}(t) = F_{n+2}(t) = F_{n+3}(t) = F_{n+4}(t) = 100$  i.e. this means  $N_t = 1$

On this particular date, the index switches its indexation from the DVP futures corresponding to the year  $n$  to the indexation of year  $n+5$ . If we assume that  $F_{n+5}(t) = 50$ , we have a rolling factor equal to

$$RF_{N-N+1} = \frac{500}{450}$$

## 13.3.4. CONSEQUENCES OF AN INDEX DISRUPTION EVENT

If an index disruption event in relation to the Eurex futures contract occurs on index dissemination days, then STOXX Ltd. will calculate the value of the index based on the most recent prior futures prices published by the Eurex.

If an exchange fails to open due to unforeseen circumstances, STOXX Ltd. may determine not to publish the index for that day.

In situations where an exchange introduces a holiday during the month of the index calculation, the index will not be published on such a holiday.

# 14. STOXX VOLATILITY FUTURES

## 14.1. OVERVIEW

The EURO STOXX 50 Volatility (VSTOXX) Short-Term Futures Index replicates the performance of a long position in constant-maturity one-month forward, one-month implied volatilities on the underlying EURO STOXX 50 Index. The EURO STOXX 50 Volatility Mid-Term Futures Index replicates a constant 5-month forward, one-month implied volatility.

Both indices constantly roll over each month on a daily basis: the EURO STOXX 50 Volatility Short-Term Futures Index from the first month of the Eurex VSTOXX Futures contract to the second month, and the EURO STOXX 50 Volatility Mid-Term Futures Index from the fourth month to the seventh month..

The VSTOXX Short-Term Futures index is intended to provide a return of a long position in constant-maturity one-month forward one-month implied volatilities on the underlying EURO STOXX 50 Index.

The VSTOXX Short-Term Futures Index comprises the following:

**VSTOXX Short-Term/Mid-Term Futures Excess Return Index:** VSTOXX Short-Term Futures Index ER returns are calculated from a long Eurex VSTOXX futures position that is continuously rolled over the period between the first and second or fourth and seventh month Eurex VSTOXX Futures contracts.

**VSTOXX Short-Term/Mid-Term Futures Total Return Index:** VSTOXX Short-Term Futures Index TR returns are calculated from a long Eurex VSTOXX futures position that is continuously rolled over the period between the first and second or fourth and seventh month Eurex VSTOXX futures contracts. The VSTOXX Short-Term Futures Index TR also incorporates interest accrual on the notional value and reinvestment into the index.

**Dissemination Calendar:** STOXX Eurex Calendar

## 14.2. BASIC DATA

| Index                                                       | ISIN         | Symbol |
|-------------------------------------------------------------|--------------|--------|
| EURO STOXX 50 Volatility Mid-Term Futures (Total Return)    | CH0115971191 | VMT5MT |
| EURO STOXX 50 Volatility Mid-Term Futures (Excess Return)   | CH0115971233 | VMT5ME |
| EURO STOXX 50 Volatility Short-Term Futures (Total Return)  | CH0109515863 | VST1MT |
| EURO STOXX 50 Volatility Short-Term Futures (Excess Return) | CH0110459747 | VST1ME |

## 14.3. CALCULATION

### 14.3.1. INPUT DATA

If one or more Eurex VSTOXX futures included in the index are no longer listed, STOXX Ltd. may decide on appropriate measures in consultation with the STOXX management board and notify at that time.

# 14. STOXX VOLATILITY FUTURES

## 14.3.2. INDEX FORMULAS

### Excess Return Calculation

$$\text{IndexER}_t = \text{IndexER}_{t-1} \cdot \frac{\sum_{i=1}^2 w_{i,t-1} \cdot F_{i,t}}{\sum_{i=1}^2 w_{i,t-1} \cdot F_{i,t-1}}$$

Where:

|                      |                                                                               |
|----------------------|-------------------------------------------------------------------------------|
| IndexER <sub>t</sub> | = VSTOXX Short-Term Futures Excess Return Index value on index business day t |
| T                    | = index business day on which the index is computed                           |
| w <sub>i,t</sub>     | = Weight of the i <sup>th</sup> futures contract on index business day t      |
| F <sub>i,t</sub>     | = Middle price of i <sup>th</sup> futures contract on index business day t    |
| Index Business Day   | = A Eurex VSTOXX futures business day                                         |

### Total Return Calculation

$$\text{IndexTR}_t = \text{IndexTR}_{t-1} \cdot \left[ \frac{\sum_{i=1}^2 w_{i,t-1} \cdot F_{i,t}}{\sum_{i=1}^2 w_{i,t-1} \cdot F_{i,t-1}} + \frac{d}{360} \cdot \text{EONIA}_{t-1} \right]$$

Where:

|                      |                                                                                                                                                                  |
|----------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| IndexTR <sub>t</sub> | = VSTOXX Short-Term Futures Total Return Index value on index business day t                                                                                     |
| d                    | = Number of calendar days between index business day t and preceding index business day t-1                                                                      |
| EONIA <sub>t-1</sub> | = The Euro Overnight Index Average (EONIA) is the effective reference rate (expressed as a percentage) computed daily as the European short-term rate + 8.5 bps. |

## 14.3.3. ROLLING

The VSTOXX Short-Term Futures Index rolls futures positions on a daily basis. The roll period starts from, and includes, the monthly EUREX VSTOXX futures settlement date and runs up to, but excludes, the subsequent monthly Eurex VSTOXX futures settlement date.

Rolling between the first month future (F1) and the second month future (F2) takes place over n index business days. The weights allocated to each F1 and F2 on any given index business day t are determined as follows:

$$w_{1,t} = 100 \cdot \frac{p_t}{n}$$

$$w_{2,t} = 100 \cdot \frac{n-p_t}{n}$$

Where:

|                |                                                                                                                                                                  |
|----------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Roll period    | = The period from, and including, the most recent Eurex VSTOXX futures settlement date up to, but excluding, the subsequent Eurex VSTOXX futures settlement date |
| n              | = The total number of index business days in the current roll period                                                                                             |
| p <sub>t</sub> | = The number of index business days remaining in the current roll period, starting with the following index business date up to and including the last           |

# 14. STOXX VOLATILITY FUTURES

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index business day in the current roll period (Note:, on the last index business date of the period,  $p_t = 0$ )

At the close of the last index business day of any roll period (the index business day immediately preceding a Eurex VSTOXX futures settlement date) all of the weight is allocated to the second month Eurex VSTOXX futures contract. On the Eurex VSTOXX futures settlement date, the second month contract position becomes the first month contract at settlement. On the Eurex VSTOXX futures settlement date and on each subsequent index business day of the new roll period, a fraction of the first month contract is sold and an equal notional amount of the second month Eurex VSTOXX futures contract is bought. This way the allocation to the first month contract is progressively rolled into the following month contract over the roll period.

#### 14.3.4. CONSEQUENCES OF AN INDEX DISRUPTION EVENT

If an index disruption event in relation to the Eurex futures contract occurs on index dissemination days, then the following applies:

STOXX Ltd. will calculate the value of the index based on the most recent middle futures prices published by Eurex and the roll for that day will be carried to the next index business day, as described in the roll period section.

If an exchange fails to open due to unforeseen circumstances, STOXX Ltd. may determine not to publish the index for that day.

In situations where an exchange introduces a holiday during the month of the index calculation, the index will not be published and the roll for that day will be carried to the next index business day, as described in the roll period section.

# 15. VSTOXX SHORT-TERM FUTURES INVESTABLE INDICES

## 15.1. VSTOXX SHORT-TERM FUTURES INVESTABLE INDEX

### 15.1.1. OVERVIEW

The VSTOXX Short-Term Futures Investable Index replicates the performance of a long position in constant-maturity one-month forward, one-month implied volatilities on the underlying EURO STOXX 50 Index taking into account the bid-ask spread in the roll procedure.

The index continuously rolls over on a daily basis from the first month VSTOXX Futures contract to the second month contract.

**Dissemination Calendar:** STOXX Eurex Calendar

### 15.1.2. BASIC DATA

| Index                                                    | ISIN         | Symbol  |
|----------------------------------------------------------|--------------|---------|
| VSTOXX Short-Term Futures Investable EUR (Excess Return) | CH0354759968 | VST1MSE |
| VSTOXX Short-Term Futures Investable USD (Excess Return) | CH0354873926 | VST1MSL |

### 15.1.3. CALCULATION

#### 15.1.3.1. INDEX FORMULA

The daily index level is defined as

$$IV_t = C_{1t}^{Post} P_{1t}^M + C_{2t}^{Post} P_{2t}^M$$

where

$C_{xt}^{Post}$  = number of contracts of future x held at the end of day t after the roll<sup>3</sup>  
 $P_{xt}^M$  = mid-price of future x on day t based on last bid and ask at 17:30:00 CET

The index base value is 10'000 as of December 30, 2016.

#### 15.1.3.2. ROLL PROCEDURE

The roll period starts from, and includes, the monthly Eurex VSTOXX futures settlement date and runs up to, but excludes, the subsequent monthly Eurex VSTOXX futures settlement date.

The daily roll has to satisfy both the target allocation constraint and the self-financing constraint, as explained below:

**Target allocation constraint (I)**

$$w_{1t} = \frac{C_{1t}^{Post}}{C_{1t}^{Post} + C_{2t}^{Post}}$$

After the roll, the number of contracts of each future has to satisfy the target weights with  $w_{1t} + w_{2t} = 1$ .

The target weight after the roll on day t of contract 1,  $w_{1t}$ , is defined as  $\frac{d}{T}$  where

<sup>3</sup> On final settlement days the first and second futures refer to the contracts with one month and two months to expiration respectively.



# 15. VSTOXX SHORT-TERM FUTURES INVESTABLE INDICES

- $d$  = number of index business days between  $t$  and the next settlement date excluding day  $t$  and excluding the next settlement date
- $T$  = the total number of index business days in the current roll period including the previous final settlement date and excluding the next

The futures' final settlement dates are as defined by Eurex<sup>4</sup>:

Final settlement day is 30 calendar days prior to the expiration day of the underlying options (i.e. 30 days prior to the third Friday of the expiration month of the underlying options, if this is an exchange day). This is usually the Wednesday prior to the second last Friday of the respective maturity month, if this is an exchange day; otherwise the exchange day immediately preceding that day.

## Self-financing constraint (II)

$$C_{1t}^{Post} P_{1t}^M + C_{2t}^{Post} P_{2t}^M = C_{1t}^{Pre} P_{1t}^M + C_{2t}^{Pre} P_{2t}^M - (C_{1t}^{Post} - C_{1t}^{Pre})(P_{1t}^B - P_{1t}^M) - (C_{2t}^{Post} - C_{2t}^{Pre})(P_{2t}^A - P_{2t}^M)$$

The post-roll index level has to be equal to the pre-roll index level minus the cost of trading (selling contract 1 at bid and buying contract 2 at ask).

- $C_{xt}^{Pre}$  = number of contracts of future  $x$  held at the end of day  $t$  before the roll; equivalent to number of contracts of the same futures contract held on day  $t-1$  post roll
- $P_{xt}^B$  = bid price, last available at 17:30:00 CET
- $P_{xt}^A$  = ask price, last available at 17:30:00 CET

## Determination of the Number of Contracts

The target allocation (I) and self-financing (II) constraint equations can be solved for the post-roll number of contracts:

$$C_{1t}^{Post} = \frac{C_{1t}^{Pre} P_{1t}^B + C_{2t}^{Pre} P_{2t}^A}{P_{1t}^B + \frac{1 - w_{1t}}{w_{1t}} P_{2t}^A}$$

$$C_{2t}^{Post} = \frac{C_{1t}^{Pre} P_{1t}^B + C_{2t}^{Pre} P_{2t}^A}{\frac{w_{1t}}{1 - w_{1t}} P_{1t}^B + P_{2t}^A}$$

At the close of the last index business day of any roll period (the index business day immediately preceding a Eurex VSTOXX futures settlement date) all of the weight is allocated to the second month Eurex VSTOXX futures contract:

$$C_{1t}^{Post} = 0$$

$$C_{2t}^{Post} = \frac{C_{1t}^{Pre} P_{1t}^B + C_{2t}^{Pre} P_{2t}^A}{P_{2t}^A}$$

<sup>4</sup> See <http://www.eurexchange.com/exchange-en/products/vol/vstox/vstox-futures-and-options/VSTOXX-Futures/14566>, subject to any change by Eurex

# 15. VSTOXX SHORT-TERM FUTURES INVESTABLE INDICES

On the Eurex VSTOXX futures settlement date, the second month contract position becomes the first month contract at settlement. On the settlement date the post-roll number of contracts is calculated by:

$$C_{1t}^{Post} = \frac{C_{1t}^{Pre} P_{1t}^B}{P_{1t}^B + \frac{1 - w_{1t}}{w_{1t}} P_{2t}^A}$$

$$C_{2t}^{Post} = \frac{C_{1t}^{Pre} P_{1t}^B}{\frac{w_{1t}}{1 - w_{1t}} P_{1t}^B + P_{2t}^A}$$

On the final settlement date,  $C_{1t}^{Pre}$  refers to the Eurex VSTOXX future which at the end of the settlement date is the contract with one-month to expiration which on the prior day had been the second month contract,  $C_2$ .

## 15.2. VSTOXX SHORT-TERM FUTURES INVERSE INVESTABLE INDEX

### 15.2.1. OVERVIEW

The VSTOXX Short-Term Futures Inverse Investable Index replicates the performance of a short position in constant-maturity one-month forward, one-month implied volatilities on the underlying EURO STOXX 50 Index taking into account the bid-ask spread in the roll procedure.

The index continuously rolls over on a daily basis from a short position in the first month VSTOXX Futures contract to a short position in the second month contract.

**Dissemination Calendar:** STOXX Eurex Calendar

### 15.2.2. BASIC DATA

| Index                                                            | ISIN         | Symbol   |
|------------------------------------------------------------------|--------------|----------|
| VSTOXX Short-Term Futures Inverse Investable EUR (Excess Return) | CH0354760123 | VST1MISE |
| VSTOXX Short-Term Futures Inverse Investable USD (Excess Return) | CH0354874031 | VST1MISL |

### 15.2.3. CALCULATION

#### 15.2.3.1. INDEX FORMULA

The daily index level is defined as

$$IV_t^{Post} = -(C_{1t}^{Post} P_{1t}^M + C_{2t}^{Post} P_{2t}^M)$$

where

$C_{xt}^{Post}$  = number of contracts of future x held at the end of day t after the roll<sup>5</sup>  
 $P_{xt}^M$  = mid-price of future x on day t based on last bid and ask at 17:30:00 CET

The index is available in EUR and USD.

<sup>5</sup> On final settlement days the first and second futures refer to the contracts with one month and two months to expiration respectively.

# 15. VSTOXX SHORT-TERM FUTURES INVESTABLE INDICES

The index base value is 10'000 as of December 30, 2016.

The pre-roll index level is calculated to replicate the performance of a hypothetical short selling of the contracts as

$$IV_t^{Pre} = IV_{t-1}^{Post} + C_{1t}^{Pre}(P_{1t}^M - P_{1,t-1}^M) + C_{2t}^{Pre}(P_{2t}^M - P_{2,t-1}^M)$$

$C_{xt}^{Pre}$  = number of contracts of future x held at the end of day t before the roll; equivalent to number of contracts of the same futures contract held on day t-1 post roll

Substituting the post-roll index level formula, using the identity  $C_{xt-1}^{Post} = C_{xt}^{Pre}$ , and reordering yields:

$$IV_t^{Pre} = -C_{1t}^{Pre}(2P_{1,t-1}^M - P_{1t}^M) - C_{2t}^{Pre}(2P_{2,t-1}^M - P_{2t}^M)$$

## 15.2.3.2. ROLL PROCEDURE

The roll period starts from, and includes, the monthly Eurex VSTOXX futures settlement date and runs up to, but excludes, the subsequent monthly Eurex VSTOXX futures settlement date.

The daily roll has to satisfy both the target allocation constraint and the self-financing constraint, as explained below:

### Target allocation constraint (I)

$$w_{1t} = \frac{C_{1t}^{Post}}{C_{1t}^{Post} + C_{2t}^{Post}}$$

After the roll, the number of contracts of each future has to satisfy the target weights with  $w_{1t} + w_{2t} = 1$ .

The target weight after the roll on day t of contract 1,  $w_{1t}$ , is defined as  $\frac{d}{T}$  where

- d = number of index business days between t and the next settlement date excluding day t and excluding the next settlement date
- T = the total number of index business days in the current roll period including the previous final settlement date and excluding the next

The futures' final settlement dates are as defined by Eurex<sup>6</sup>:

Final settlement day is 30 calendar days prior to the expiration day of the underlying options (i.e. 30 days prior to the third Friday of the expiration month of the underlying options, if this is an exchange day). This is usually the Wednesday prior to the second last Friday of the respective maturity month, if this is an exchange day; otherwise the exchange day immediately preceding that day.

### Self-financing constraint (II)

$$IV_t^{Post} = IV_t^{Pre} - (C_{1t}^{Post} - C_{1t}^{Pre})(P_{1t}^* - P_{1t}^M) - (C_{2t}^{Post} - C_{2t}^{Pre})(P_{2t}^* - P_{2t}^M)$$

<sup>6</sup> See <http://www.eurexchange.com/exchange-en/products/vol/vstox/vstox-futures-and-options/VSTOXX--Futures/14566>, subject to any change by Eurex

# 15. VSTOXX SHORT-TERM FUTURES INVESTABLE INDICES

The post-roll index level has to be equal to the pre-roll index level minus cost the of trading. Hereby  $P_{xt}^*$  refers to either the bid price  $P_{xt}^B$  or ask price  $P_{xt}^A$  depending on whether the corresponding contract has to be bought (at ask) or sold (at bid); details at the end of this section.

$P_{xt}^B$  = bid price, last available at 17:30:00 CET  
 $P_{xt}^A$  = ask price, last available at 17:30:00 CET

Substituting the post-roll index into the self-financing constraint (II) and reordering yields:

$$C_{1t}^{Post}(2P_{1t}^M - P_{1t}^*) + C_{2t}^{Post}(2P_{2t}^M - P_{2t}^*) = C_{1t}^{Pre}(2P_{1,t-1}^M - P_{1t}^*) + C_{2t}^{Pre}(2P_{2,t-1}^M - P_{2t}^*)$$

## Determination of the Number of Contracts

The above equation together with the target allocation constraint (I) can be solved for the post-roll number of contracts:

$$C_{1t}^{Post} = \frac{C_{1t}^{Pre}(2P_{1,t-1}^M - P_{1t}^*) + C_{2t}^{Pre}(2P_{2,t-1}^M - P_{2t}^*)}{(2P_{1t}^M - P_{1t}^*) + \frac{1 - w_{1t}}{w_{1t}}(2P_{2t}^M - P_{2t}^*)}$$

$$C_{2t}^{Post} = \frac{C_{1t}^{Pre}(2P_{1,t-1}^M - P_{1t}^*) + C_{2t}^{Pre}(2P_{2,t-1}^M - P_{2t}^*)}{\frac{w_{1t}}{1 - w_{1t}}(2P_{1t}^M - P_{1t}^*) + (2P_{2t}^M - P_{2t}^*)}$$

At the close of the last index business day of any roll period (the index business day immediately preceding a Eurex VSTOXX futures settlement date) all of the weight is allocated to the second month Eurex VSTOXX futures contract:

$$C_{1t}^{Post} = 0$$

$$C_{2t}^{Post} = \frac{C_{1t}^{Pre}(2P_{1,t-1}^M - P_{1t}^*) + C_{2t}^{Pre}(2P_{2,t-1}^M - P_{2t}^*)}{(2P_{2t}^M - P_{2t}^*)}$$

On the Eurex VSTOXX futures settlement date, the second month contract position becomes the first month contract at settlement. On the settlement date the post-roll number of contracts is calculated by:

$$C_{1t}^{Post} = \frac{C_{1t}^{Pre}(2P_{1,t-1}^M - P_{1t}^*)}{(2P_{1t}^M - P_{1t}^*) + \frac{1 - w_{1t}}{w_{1t}}(2P_{2t}^M - P_{2t}^*)}$$

$$C_{2t}^{Post} = \frac{C_{1t}^{Pre}(2P_{1,t-1}^M - P_{1t}^*)}{\frac{w_{1t}}{1 - w_{1t}}(2P_{1t}^M - P_{1t}^*) + (2P_{2t}^M - P_{2t}^*)}$$

On the final settlement date,  $C_{1t}^{Pre}$  refers to the Eurex VSTOXX future which at the end of the settlement date is the contract with one-month to expiration which on the prior day had been the second month contract,  $C_2$ .

# 15. VSTOXX SHORT-TERM FUTURES INVESTABLE INDICES

One has to note that in above formulas  $P_{x,t-1}$  and  $P_{xt}$  refer to the futures prices on different days of contracts with identical expiration dates.

In order to determine whether bid or ask prices are to be used  $C_{1t}^{Post}$  and  $C_{2t}^{Post}$  are calculated for all four scenarios by using the appropriate bid and ask prices in above formulas.

| Scenario                                    | Self-financing constraint                                                                                                              | Feasible if resulting                                                              |
|---------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------|
| Buy 1 <sup>st</sup> /Sell 2 <sup>nd</sup>   | $IV_t^{Post} = IV_t^{Pre} - (C_{1t}^{Post} - C_{1t}^{Pre})(P_{1t}^A - P_{1t}^M) - (C_{2t}^{Post} - C_{2t}^{Pre})(P_{2t}^B - P_{2t}^M)$ | $C_{1t}^{Post} - C_{1t}^{Pre} \geq 0$ and<br>$C_{2t}^{Post} - C_{2t}^{Pre} \leq 0$ |
| Buy 1 <sup>st</sup> /Buy 2 <sup>nd</sup>    | $IV_t^{Post} = IV_t^{Pre} - (C_{1t}^{Post} - C_{1t}^{Pre})(P_{1t}^A - P_{1t}^M) - (C_{2t}^{Post} - C_{2t}^{Pre})(P_{2t}^A - P_{2t}^M)$ | $C_{1t}^{Post} - C_{1t}^{Pre} \geq 0$ and<br>$C_{2t}^{Post} - C_{2t}^{Pre} \geq 0$ |
| Sell 1 <sup>st</sup> / Sell 2 <sup>nd</sup> | $IV_t^{Post} = IV_t^{Pre} - (C_{1t}^{Post} - C_{1t}^{Pre})(P_{1t}^B - P_{1t}^M) - (C_{2t}^{Post} - C_{2t}^{Pre})(P_{2t}^B - P_{2t}^M)$ | $C_{1t}^{Post} - C_{1t}^{Pre} \leq 0$ and<br>$C_{2t}^{Post} - C_{2t}^{Pre} \leq 0$ |
| Sell 1 <sup>st</sup> /Buy 2 <sup>nd</sup>   | $IV_t^{Post} = IV_t^{Pre} - (C_{1t}^{Post} - C_{1t}^{Pre})(P_{1t}^B - P_{1t}^M) - (C_{2t}^{Post} - C_{2t}^{Pre})(P_{2t}^A - P_{2t}^M)$ | $C_{1t}^{Post} - C_{1t}^{Pre} \leq 0$ and<br>$C_{2t}^{Post} - C_{2t}^{Pre} \geq 0$ |

On most days the inverse index roll procedure will have the first contract bought and the second contract sold. On a few occasions other trading scenarios might be required though (e.g. buy first contract and buy second contract). In those cases, the self-financing constraint needs to be adjusted and the correct bid or ask prices have to be used as one always buys at ask and sells at bid.

The second column shows each scenario's respective self-financing constraint that has to be used to derive the post-roll amount of contracts.

We say that a solution is feasible if the trading it implies is consistent with the scenario's assumption. For example, in the sell/sell scenario the solution is feasible if the calculated post-roll contracts imply that both contracts have to be sold.

In the case that there is more than one feasible solution we pick out of all feasible solutions the one that has the least negative cost (i.e. causes the highest post-roll index value).

## 15.3. CONSEQUENCES OF AN INDEX DISRUPTION EVENT

If an index disruption event in relation to the Eurex futures contract occurs on index dissemination days, then the following applies:

STOXX Ltd. will repeat the end of day index value of the previous day and the roll for that day will be postponed to the next index business day (i.e. the number of contracts held of each contract remains unchanged).

Valid quotes not being available is considered an index disruption event.

If an exchange fails to open due to unforeseen circumstances, STOXX Ltd. may determine not to publish the index for that day.

In situations where an exchange introduces a holiday during the month of the index calculation, the index will not be published, and the roll for that day will be carried to the next index business day, as described in the roll procedure section.

# 16. EURO STOXX 50 RISK CONTROL

## 16.1. OVERVIEW

With STOXX Risk Control indices a target volatility concept is applied to the EURO STOXX 50 Index and other STOXX indices. Whereas the risk profile of a standard index like the EURO STOXX 50 Index is the outcome of the existing market-cap weighted index concept, the EURO STOXX 50 Risk Control Index supervises the risk up to a defined target volatility level. In order to control for risk, the index shifts between a money market and a risky investment (measured by the EURO STOXX 50 Index).

If on a daily basis the risk of the current EURO STOXX 50 Risk Control Index composition is below the targeted risk, the allocation will be adjusted towards the risky asset. If the current risk profile is above the targeted level, the allocation will be adjusted towards the money market component.

- » To avoid extreme leveraged positions, a maximum exposure of 150 percent towards the risky asset is introduced.
- » A tolerance level of 5 percent around the target volatility is implemented to avoid high allocation turnover due to minimal deviations from the targeted risk level.
- » To control for outliers, an average volatility level is used.
- » The indices are offered both as implied volatility and realized volatility based versions, the latter being distinguished by the “RV” wording in the name.

## 16.2. BASIC DATA

| Index                                                      | ISIN         | Symbol   |
|------------------------------------------------------------|--------------|----------|
| EURO STOXX 50 Risk Control 10% (Total Return)              | CH0118856118 | RC10IVTR |
| EURO STOXX 50 Risk Control 10% (Excess Return)             | CH0118856126 | RC10IVER |
| EURO STOXX 50 Risk Control 12% (Total Return)              | CH0118856134 | RC12IVTR |
| EURO STOXX 50 Risk Control 12% (Excess Return)             | CH0118856142 | RC12IVER |
| EURO STOXX 50 Risk Control 15% (Total Return)              | CH0117326766 | RC15IVTR |
| EURO STOXX 50 Risk Control 15% (Excess Return)             | CH0117326758 | RC15IVER |
| EURO STOXX 50 Risk Control 20% (Total Return)              | CH0116915981 | SX5TRCTR |
| EURO STOXX 50 Risk Control 20% (Excess Return)             | CH0116915973 | SX5TRCER |
| EURO STOXX 50 Risk Control 5% (Total Return)               | CH0118856159 | RC05IVTR |
| EURO STOXX 50 Risk Control 5% (Excess Return)              | CH0118856167 | RC05IVER |
| EURO STOXX 50 Risk Control 10% RV (Excess Return)          | CH0147246760 | SX5R10EE |
| <further indices as listed in the STOXX vendor code sheet> |              |          |

# 16. EURO STOXX 50 RISK CONTROL

## 16.3. CALCULATION

### 16.3.1. INDEX FORMULA

$$\text{IndexTR}_t = \text{IndexTR}_{t-1} \times \left[ 1 + w_{t-1} \times \left( \frac{\text{SX5T}_t}{\text{SX5T}_{t-1}} - 1 \right) + (1 - w_{t-1}) \times \left( (IR_{t-1} + x) \frac{\text{Diff}(t-1, t)}{360} \right) \right]$$

$$\text{IndexER}_t = \text{IndexER}_{t-1} \times \left( 1 - IR_{t-1} \frac{\text{Act}(t-1, t)}{360} \right) \times \left[ 1 + w_{t-1} \left( \frac{\text{SX5T}_t}{\text{SX5T}_{t-1}} - 1 \right) + (1 - w_{t-1}) \left( (IR_{t-1} + x) \frac{\text{Diff}(t-1, t)}{360} \right) \right]$$

where:

|                      |   |                                                                           |
|----------------------|---|---------------------------------------------------------------------------|
| IndexER <sub>t</sub> | = | Excess Return Index level on index level determination date t             |
| IndexTR <sub>t</sub> | = | Net Return Index level on index level determination date t                |
| w <sub>t</sub>       | = | Equity Weight on index level determination date t                         |
| SX5T <sub>t</sub>    | = | Level of the EuroStoxx50 Net Return on index level determination date t   |
| IR <sub>t</sub>      | = | Money-market rate on the index level determination date t                 |
| x                    | = | Cost of borrowing: $w_{t-1} \leq 1$ x=0 otherwise x=50 Basis Points       |
| Diff(t-1,1)          | = | Difference between determination date t-1 and t measured in calendar days |

While EONIA (calculated as the European short-term rate (€STR) + 8.5 bps)<sup>7</sup> rate will typically be applied as money-market rate to the EURO STOXX 50 Risk Control indices, some variants may adopt a different rate. Please refer to the individual index composition data for more details.

### 16.3.2. DETERMINATION OF THE TARGET WEIGHT (TGTW) USING IMPLIED VOLATILITY

On any index level determination date t, the target weight is to be determined as follows:

$$\text{Tgtw}_t = \frac{\text{TgtVol}}{\text{Max}_{i \in [t-19, t]} [\text{AverageVSTOXX}_{3,i}]}$$

where:

|                                                             |   |                                                                                             |
|-------------------------------------------------------------|---|---------------------------------------------------------------------------------------------|
| TgtVol                                                      | = | targeted volatility level                                                                   |
| Average VSTOXX <sub>3,i</sub>                               | = | average of the close values of the VSTOXX for index level determination date i-2, i-1 and i |
| VSTOXX                                                      | = | close value of the VSTOXX index as published by STOXX under the symbol V2TX                 |
| $\text{Max}_{i \in [t-19, t]} [\text{AverageVSTOXX}_{3,i}]$ | = | maximum value of average VSTOXX <sub>3,i</sub> for i ranging from t-19 to t.                |

### 16.3.3. DETERMINATION OF THE TARGET WEIGHT (TGTW) USING REALIZED VOLATILITY

On any Index Level Determination Date t, the Target Weight shall be determined as follows:

<sup>7</sup> In case EONIA is used in the calculation, the index will be calculated using EONIA that is published on day T in respect of day T-1.

# 16. EURO STOXX 50 RISK CONTROL

$$Tgtw_t = \frac{TgtVol}{MaxRealizedVol_{t,(20,60)}}$$

where:

TgtVol = targeted volatility level

MaxRealizedVol<sub>20,60</sub> = maximum of the realized volatilities measured over 20 days and 60 days

$$RealizedVol_{t,n} = \sqrt{\frac{252}{n} \cdot \sum_s \left[ \ln \left( \frac{STOXX_s}{STOXX_{s-1}} \right) \right]^2}$$

where:

n = 19 (59)

s = ranging from t-18 to t (t-58 to t)

## 16.3.4. DETERMINATION OF EQUITY WEIGHT (W) AND INDEX REBALANCING DAYS

The equity weight on the index start date is to be equal to the target weight at the index start date,

$$w_0 = \text{Min}(\text{Cap}, Tgtw_0)$$

On any index level determination date t subsequent to the index start date, the equity weight is to be determined as follows:

$$(i) \text{ If } \left| 1 - \frac{w_{t-1}}{Tgtw_{t-1}} \right| > \text{Tolerance}$$

then that index level determination date t will be an index rebalancing day and

$$w_t = \text{Min}(\text{Cap}, Tgtw_{t-1})$$

(ii) Otherwise, index level determination date t will not be an index rebalancing day and

$$w_t = w_{t-1}$$

Tolerance = 5%

w<sub>t</sub> = Equity weight on index level determination date t

Tgtw<sub>t</sub> = Target weight on index level determination date t

Cap = 150%



# 17. STOXX RISK CONTROL INDICES

## 17.1. OVERVIEW

A target volatility concept is applied to the STOXX Risk Control Indices. Whereas the risk profile of the underlying index is the uncontrolled outcome of the existing market-cap weighted index concept, the Risk Control Indices controls for risk by aiming for a defined target volatility level. In order to control for risk, the index shifts between a risk free money market investment and a risky asset (measured by the respective underlying equity index).

## 17.2. BASIC DATA

Various versions of the STOXX Risk Control indices are available for a broad number of countries and target volatility levels. For more details please consult the Data Vendor Code sheet on the STOXX website<sup>8</sup>.

## 17.3. CALCULATION

### 17.3.1. INDEX FORMULA

$$\text{STOXXTR}_t = \text{STOXXTR}_{t-1} \times \left[ 1 + w_{t-1} \left( \frac{\text{STOXX}_t}{\text{STOXX}_{t-1}} - 1 \right) + (1 - w_{t-1}) \left( \text{IR}_{t-1} \frac{\text{Diff}(t-1, t)}{360} \right) \right]$$

$$\text{STOXXER}_t = \text{STOXXER}_{t-1} \times \left( 1 - \text{IR}_{t-1} \frac{\text{Diff}(t-1, t)}{360} \right) \times \left[ 1 + w_{t-1} \left( \frac{\text{STOXX}_t}{\text{STOXX}_{t-1}} - 1 \right) + (1 - w_{t-1}) \left( \text{IR}_{t-1} \frac{\text{Diff}(t-1, t)}{360} \right) \right]$$

where:

|                         |                                                                                  |
|-------------------------|----------------------------------------------------------------------------------|
| $\text{STOXXTR}_t$ =    | Total Return STOXX Risk Control index level on index level determination date t  |
| $\text{STOXXER}_t$ =    | Excess Return STOXX Risk Control index level on index level determination date t |
| $w_t$ =                 | Equity Weight on index level determination date t                                |
| $\text{STOXX}_t$ =      | Level of the underlying STOXX index on index level determination date t          |
| $\text{IR}_t$ =         | Money-market rate on index level determination date t                            |
| $\text{Diff}(t-1, t)$ = | Difference between t-1 and t measured in calendar days                           |

The indices exist in different variants, given by the combination of the underlying index return type (P, NR, GR) and the risk control return type (ER, TR).

The money-market rate applicable to each individual index is typically chosen on the basis of the region / country covered by the underlying index, as represented in the below table; however, some variants may adopt a different rate. Please refer to the individual index composition data for more details.

<sup>8</sup> <http://www.stoxx.com/>

# 17. STOXX RISK CONTROL INDICES

| Region / Country           | Interest rate (currency)                |
|----------------------------|-----------------------------------------|
| Americas                   | USD-LIBOR                               |
| Europe / Eurozone / Nordic | EUR-EONIA (€STR + 8.5 bps) <sup>9</sup> |
| UK                         | GBP-LIBOR                               |
| Oceania                    | AUD-LIBOR                               |
| Asia                       | USD-LIBOR                               |
| LatAm                      | USD-LIBOR                               |
| Global                     | USD-LIBOR                               |

## 17.3.2. DETERMINATION OF THE TARGET WEIGHT

On any Index Level Determination Date  $t$ , the Target Weight shall be determined as follows:

$$Tgtw_t = \frac{TgtVol}{MaxRealizedVol_{t,(20,60)}}$$

where:

$TgtVol$  = predetermined level of volatility

$MaxRealizedVol_{20,60}$  is the maximum of the realized volatilities measured over 20 and 60 days

$$RealizedVol_{t,n} = \sqrt{\frac{252}{n} \cdot \sum_s \left[ \ln \left( \frac{STOXX_s}{STOXX_{s-1}} \right) \right]^2}$$

where:

$n$  = 19 (59)

$s$  = ranging from  $t-18$  to  $t$  ( $t-58$  to  $t$ )

## 17.3.3. DETERMINATION OF THE EQUITY WEIGHT AND INDEX REBALANCING DAYS

The Equity Weight on the Index Start Date shall be equal to the Target Weight at the Index Start Date,

$$w_0 = \text{Min}(Cap, Tgtw_0)$$

On any Index Level Determination Date  $t$  subsequent to the Index Start Date, the Equity Weight shall be determined as follows:

$$(i) \text{ If } \left| 1 - \frac{w_{t-1}}{Tgtw_{t-1}} \right| > \text{Tolerance}$$

then the Index Level Determination Date  $t$  will be an Index Rebalancing Day and

$$w_t = \text{Min}(Cap, Tgtw_{t-1})$$

<sup>9</sup> In case EONIA is used in the calculation, the index will be calculated using EONIA that is published on day  $T$  in respect of day  $T-1$ .

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(ii) Otherwise, Index Level Determination Date  $t$  will not be an Index Rebalancing Day and

$$w_t = w_{t-1}$$

where:

Tolerance = allows a predefined deviation from the target weight, set to 5% and subject to the exceptions listed in the following table

$w_t$  = Equity Weight on Index Level Determination Date  $t$

$Tgtw_t$  = Target Weight on Index Level Determination Date  $t$

Cap = the maximum portion that can be given to the risky asset, set to 150% and subject to the exceptions listed in the following table.

| Index                                             | Tolerance | Cap  |
|---------------------------------------------------|-----------|------|
| STOXX Europe Large 200 Risk Control Index         | 5%        | 100% |
| STOXX Nordic Strong Quality 20 Risk Control Index | 5%        | 100% |

# 18. EURO STOXX 50 INVESTABLE VOLATILITY

## 18.1. OVERVIEW

Volatility is a measure of the level of uncertainty prevailing in certain markets. In principle, there are two different approaches to estimating volatility. Historical volatility involves measuring the standard deviation of historical closing prices for any particular security over a given period of time. Implied volatility is derived from option prices; this kind of volatility represents the estimates and assumptions of market participants involved in a trade, on the basis of a given option price.

The VSTOXX index (calculated by STOXX) is a measure of current implied volatility, as measured using EURO STOXX 50 index options. Because the VSTOXX index is calculated using spot implied volatility levels, however, the returns of the VSTOXX index are not directly replicable.

The EURO STOXX 50 Investable Volatility index is a volatility index which provides exposure to forward implied volatility in a form which can be directly replicated. The EURO STOXX 50 Investable Volatility index is designed as a rolling index which targets a constant 3-month (90-day) forward, 3-month maturity volatility exposure. The index is calculated entirely using VSTOXX sub-index levels calculated and published by STOXX.

The model for the EURO STOXX 50 Investable Volatility index aims at making volatility tradable – i.e. the daily returns of the index should be replicable through holding a portfolio of liquid derivative instruments. As a result, rather than linking the index level to current spot implied variance levels, as in the calculation of the main VSTOXX index, the EURO STOXX 50 Investable Volatility index returns on a daily basis are linked to the movement in forward volatility levels between EURO STOXX 50 option expiries determined using the spot implied variance level to each option expiry (as implied by the VSTOXX sub-index level for each expiry.)

The EURO STOXX 50 Investable Volatility index has been jointly developed by Bank of America Merrill Lynch and STOXX. It offers great advantages in terms of transparency and the trading and hedging of tracking products linked to the index.

**Dissemination Calendar:** STOXX Eurex Calendar

## 18.2. BASIC DATA

| Index                                               | ISIN         | Symbol  |
|-----------------------------------------------------|--------------|---------|
| EURO STOXX 50 Investable Volatility (Total Return)  | CH0116915965 | IVSTXTR |
| EURO STOXX 50 Investable Volatility (Excess Return) | CH0117221314 | IVSTXER |

## 18.3. CALCULATION

### 18.3.1. INPUT DATA

During the calculation time for the EURO STOXX 50 Investable Volatility index the following data are used (via snapshots every 60 seconds):

# 18. EURO STOXX 50 INVESTABLE VOLATILITY

- VSTOXX - EURO STOXX 50 Volatility index levels for the first, second and third month expiry and the second and third quarterly expiries.
- EONIA - Euro Overnight Index Average – overnight interest rate, calculated as the European short-term rate (€STR) + 8.5 bps.

| Index Name | Expiry         | Code   | ISIN         |
|------------|----------------|--------|--------------|
| VSTOXX 1M  | First month    | VSTX1M | DE000A0G87B2 |
| VSTOXX 2M  | Second month   | VSTX2M | DE000A0G87C0 |
| VSTOXX 3M  | Third month    | VSTX3M | DE000A0G87D8 |
| VSTOXX 6M  | Second quarter | VSTX6M | DE000A0G87E6 |
| VSTOXX 9M  | Third quarter  | VSTX9M | DE000A0G87F3 |

## 18.3.2. UNDERLYING VSTOXX SUB-INDICES

Apart from the main VSTOXX index (which has no specific time to expiry), sub-indices for each time to expiry of the EURO STOXX 50 options, ranging from one month to two years, are calculated and distributed. The various VSTOXX sub-indices are calculated on the basis of all options available. The calculations are based on the best bid and best ask available for these options in the Eurex system.

The EURO STOXX 50 Investable Volatility index is calculated using forward implied volatility levels between quarterly EURO STOXX 50 option expiry dates by directly referencing VSTOXX sub-index levels representing spot implied volatility for each option expiry date.

## 18.3.3. COMPOSITE VSTOXX 3M

The VSTOXX 3M Composite represents a quarterly rolling 'front quarter' variance contract, which rolls on the EURO STOXX 50 quarterly option expiry date in line with the VSTOXX 6M and VSTOXX 9M sub-indices.

The VSTOXX 3M Composite is calculated according to the formulas shown below:

- (1)  $VSTOXX\ 3M\ Comp.\ (t) = VSTOXX\ 1M^*\ (t); \text{ if } t \leq 1M \text{ before the next quarterly expiry date}$
- $VSTOXX\ 2M\ (t); \text{ if } 1M < t \leq 2M \text{ before the next quarterly expiry date}$
- $VSTOXX\ 3M\ (t); \text{ if } 2M < t \leq 3M \text{ before the next quarterly expiry date}$

and:

- »  $VSTOXX\ 1M^*\ (t)$  is equal to  $VSTOXX\ 1M^*\ (t-1)$  where  $t \leq 2D$  before the next quarterly expiry date
- »  $VSTOXX\ 1M^*\ (t)$  is equal to  $VSTOXX\ 1M\ (t)$  otherwise

## 18.3.4. FORWARD-STARTING IMPLIED VOLATILITY LEVELS

3-month forward-starting implied volatility levels for the period between the first quarter and second quarter, and second quarter and third quarter

- (2)  $FSV_{3M-6M}(t) = \sqrt{\frac{TM_{6M}(t) \times VSTOXX\ 6M^2(t) - TM_{3M}(t) \times VSTOXX\ 3M\ Comp^2(t)}{TM_{6M}(t) - TM_{3M}(t)}}$
- (3)  $FSV_{6M-9M}(t) = \sqrt{\frac{TM_{9M}(t) \times VSTOXX\ 9M^2(t) - TM_{6M}(t) \times VSTOXX\ 6M^2(t)}{TM_{9M}(t) - TM_{6M}(t)}}$

# 18. EURO STOXX 50 INVESTABLE VOLATILITY

and:

- » TM3M (t) is the number of calendar days remaining until the next quarterly EURO STOXX 50 options expiry date (in March, June, September or December).
- » TM6M (t) is the number of calendar days remaining until the subsequent quarterly EURO STOXX 50 options expiry date.

## 18.3.5. WEIGHTINGS

The weightings applied to each of the forward-volatility levels are calculated on the basis of the number of days to the forward-start date of each, with the target of a 3-month weighted average time to maturity, according to the formulas shown below.

$$(4) \quad \omega_{3M-6M}(t) = \frac{TM_{6M}(t) - ATM}{TM_{6M}(t) - TM_{3M}(t)}; \text{ where } TM_{3M}(t) \geq 7 \text{ days}$$

$$(5) \quad \omega_{3M-6M}(t) = 0\%; \text{ otherwise}$$

$$(6) \quad \omega_{6M-9M}(t) = 100\% - \omega_{3M-6M}(t)$$

$$(7) \quad U_{3M-6M}(t) = \frac{IV(t) \times \omega_{3M-6M}(t)}{FSV_{3M-6M}(t)};$$

$$(8) \quad U_{6M-9M}(t) = [U_{6M-9M}(t-1) - U_{3M-6M}(t)] \times \frac{FSV_{3M-6M}(t)}{FSV_{6M-9M}(t) \times (1 + 0.75\%)}; \text{ if } t-1 \text{ was a quarterly option expiry}$$

date

$$U_{6M-9M}(t) = U_{6M-9M}(t-1) + [U_{3M-6M}(t-1) - U_{3M-6M}(t)] \times \frac{FSV_{3M-6M}(t)}{FSV_{6M-9M}(t) \times (1 + 0.75\%)}; \text{ otherwise}$$

and:

- » ATM=90 days (the target time to expiry);
- » TM3M (t) is the number of calendar days remaining until the next quarterly EURO STOXX 50 options expiry date (in March, June, September or December);
- » TM6M (t) is the number of calendar days remaining until the subsequent quarterly EURO STOXX 50 options expiry date;
- » IV(t) is the EURO STOXX 50 Investable Volatility index base index level, calculated as described below (where IV(0) = 100 as at the index inception date).

## 18.3.6. INDEX CALCULATION

The EURO STOXX 50 Investable Volatility index levels are calculated according to the formulas shown below.

$$(9) \quad IV(t) = U_{6M-9M}(t-1) \times FSV_{3M-6M}(t); \text{ if } t-1 \text{ was a quarterly option expiry date}$$

$$IV(t) = U_{3M-6M}(t-1) \times FSV_{3M-6M}(t) + U_{6M-9M}(t-1) \times FSV_{6M-9M}(t); \text{ otherwise}$$

$$(10) \quad IVSTX\ ER(t) = IVSTX\ ER(t-1) \times \left( 1 + 1.5 \times \left[ \left( \frac{IV(t)}{IV(t-1)} - 1 \right) \right] \right)$$

# 18. EURO STOXX 50 INVESTABLE VOLATILITY

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$$(11) \quad \text{IVSTX TR}(t) = \text{IVSTX TR}(t-1) \times \left( \frac{\text{IVSTX ER}(t)}{\text{IVSTX ER}(t-1)} + \text{EONIA}(t-1) \times \frac{\text{DC}(t)}{360} \right)$$

$$(12) \quad \text{IVSTXVOL} = \omega_{3M-6M}(t) \cdot \text{FSV}_{3M-6M}(t) + \omega_{6M-9M}(t) \cdot \text{FSV}_{6M-9M}(t)$$

and:

- » IVSTX ER(0) = 100 as at the index inception date
- » IVSTX TR(0) = 100 s at the index inception date
- » DC(t) is the number of calendar days from (and including) day t-1 to (but excluding) day t
- » EONIA (t-1) is the daily Effective Overnight Index Average (EONIA) fixing<sup>10</sup> for day t-1

## 18.3.7. INDEX DISRUPTIONS

In order to account for abnormal market conditions (e.g. mistrades) a suspension mechanism is applied.

The index dissemination is suspended in the following cases:

- one of the relevant VSTOXX sub-index is disseminated as Unapproved (“U” flag), or
- the calculated index value deviates by more than 10% from the preceding value (intraday),  
or
- the calculated index value deviates by more than 20% from the last End of Day value.

The index is resumed if:

- the relevant VSTOXX sub-indices resume being disseminated as Approved (“A” flag”) and calculated index value does not exceed any of the 10% or 20% deviation thresholds any longer, or
- the disruption, both in the underlying sub-indices and calculated indices, is considered to be caused by regular market conditions.

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<sup>10</sup> Calculated as the European short-term rate (€STR) + 8.5 bps.

# 19. STOXX CURRENCY HEDGED

## 19.1. OVERVIEW

A currency-hedged index is designed to represent returns for global index investment strategies that involve hedging currency risk, but not the underlying constituent risk. The currency-hedged strategy indices eliminate the risk of currency fluctuations at the cost of potential currency gains.

An investor who will receive a payment in a foreign currency at a future date and expects the domestic (hedged) currency to appreciate against that foreign currency, can enter a forward contract to sell the foreign currency in the future at a predefined exchange rate. If, at the maturity of the forward contract, the domestic currency has appreciated against foreign currency, the investor can make a profit by selling the payment proceeds (in foreign currency) at a lower rate than the one prevailing on the market.

STOXX offers two types of currency-hedged indices: accordingly, the reset of hedge notional and currency exposures occurs either on a daily or monthly basis.

While all currency hedged indices are calculated as end-of-day, some may be updated intraday. For the indices updated intraday, only the value of the underlying -unhedged- index is updated, based on its calculation frequency, while the currency rates remain fixed throughout the day. More specifically, the previous day's WM fixings for spot and forward rates are used. The current day's WM fixings for spot and forward rates are only applied in the calculation of the end-of-day index calculation.

The STOXX currency-hedged indices are typically available in the following versions:

- AUD Hedged
- CHF Hedged
- EUR Hedged
- GBP Hedged
- JPY Hedged
- USD Hedged

Other versions are available upon request.

## 19.2. BASIC DATA

| Index                                                | ISIN | Symbol |
|------------------------------------------------------|------|--------|
| < indices as listed in the STOXX vendor code sheet > |      |        |



# 19. STOXX CURRENCY HEDGED

## 19.3. CALCULATION

### 19.3.1. DEFINITIONS

The following definitions will be used throughout the chapter:

|             |                                                                  |
|-------------|------------------------------------------------------------------|
| $H\_IDX_t$  | = hedged index for day t                                         |
| $UH\_IDX_t$ | = unhedged reference index (in hedged currency) for day t        |
| $t=0$       | = last calculation day of preceding month (reset date)           |
| $t$         | = day of index calculation / number of calendar days since $t=0$ |
| $T$         | = number of calendar days in current month                       |
| $C$         | = number of foreign currencies in the unhedged index             |
| $AF_t$      | = notional adjustment factor for day t                           |
| $HR_{c,t}$  | = hedge ratio of currency c for day t                            |
| $FX_{c,t}$  | = spot currency rate for day t                                   |
| $FF_{c,t}$  | = 1-month forward currency rate for day t                        |
| $IFF_{c,t}$ | = interpolated forward currency rate for day t                   |
| $R_t$       | = return from hedging for day t                                  |

All currency rates are expressed as units of foreign currency c per one unit of domestic (hedged) currency.

The adjustment factor  $AF_t$  reflects the changes in the notional value to be hedged between the  $t=0$  and t:

$$AF_t = \frac{UH\_IDX_t}{UH\_IDX_0}$$

The hedge ratio  $HR_{c,t}$  can be varied to arrive at index portfolios that are over- or under-hedged to varying degrees. Furthermore, it can be used to hedge multi-currency portfolios.

To fully hedge a multi-currency portfolio, the hedge ratio of each currency is calculated as the sum of weights of the securities quoted in that currency:

$$HR_{c,t} = \sum_{i:ccy_i=c} w_{i,t}$$

The interpolated forward currency rate  $IFF_{c,t}$  corrects the 1-month forward rate – traded with a fixed 1-month maturity – to reflect the progressively closer expiry ( $t=T$ ) of the hedge. In other words, the interpolated 1-month forward rate linearly converges to the spot rate as  $t=T$  approaches:

$$IFF_{c,t} = FX_{c,t} + \left(1 - \frac{t}{T}\right) \cdot (FF_{c,t} - FX_{c,t})$$

From the above definition, it follows that  $IFF_{c,0} = FF_{c,0}$  and  $IFF_{c,T} = FX_{c,T}$ .

# 19. STOXX CURRENCY HEDGED

For each currency  $c$ , the contribution of hedging to the index return is defined as the product of the relevant hedge ratio by the return on the forward currency trade.

For instance, an investor knows in  $t=0$  that she will receive a payment of 1 unit of foreign currency in  $t=T$ . She could wait and convert it at the then prevailing spot rate  $FX_{c,T}$  and obtain  $1/FX_{c,T}$  units of domestic currency. Alternatively, she could enter a forward trade in  $t=0$  to sell the foreign currency in  $t=T$  at  $FF_{c,0}$ , thus obtaining  $1/FF_{c,0}$  units of domestic currency.

The P&L from the forward trade, as compared to a spot conversion, is thus  $P\&L_{c, [0,T]} = \frac{1}{FF_{c,0}} - \frac{1}{FX_{c,T}}$ .

By expressing the forward trade P&L as percentage of the payment value in domestic currency in  $t=0$  and rearranging the terms, the returns on the forward trade can be expressed as  $\frac{FX_{c,0}}{FX_{c,T}} - \frac{FF_{c,0}}{FF_{c,0}}$ .

The expression for forward trade returns can then be generalized as:

$$R_t = \sum_{c=1}^C HR_{c,t-1} \cdot \left( \frac{FX_{c,0}}{FF_{c,t-1}} - \frac{FX_{c,0}}{FF_{c,t}} \right)$$

## 19.3.2. DAILY HEDGED INDICES

With daily hedged indices, the hedging trade is entered at the end of each calendar month. From that day onwards, the returns of the underlying, unhedged index are integrated by the returns from hedging. Moreover, the notional amount being hedged and the weight of the individual underlying currencies are adjusted on a daily basis.

At the cost of an increased trading activity, the daily hedging aims to timely and precisely offset the currency exposures of the index and is thus particularly suited to volatile markets.

The daily currency hedged indices are thus calculated as:

$$H\_IDX_t = H\_IDX_0 \cdot \left( \frac{UH\_IDX_t}{UH\_IDX_0} + \sum_{d=1}^t AF_{d-1} \cdot R_d \right)$$

An alternative, but mathematically identical, formulation, which expresses the index level of a day as function of the previous day's level, can be obtained as follows.

First, the index formula can be rewritten as:

$$H\_IDX_t = \frac{H\_IDX_0}{UH\_IDX_0} \cdot \left( UH\_IDX_t + \sum_{d=1}^t UH\_IDX_{d-1} \cdot R_d \right)$$

which can be expanded as:

# 19. STOXX CURRENCY HEDGED

$$H\_IDX_t = \frac{H\_IDX_0}{UH\_IDX_0} \cdot \left( UH\_IDX_t + UH\_IDX_{t-1} \cdot R_t + \sum_{d=1}^{t-1} UH\_IDX_{d-1} \cdot R_d \right)$$

By noting that:

$$H\_IDX_{t-1} = \frac{H\_IDX_0}{UH\_IDX_0} \cdot \left( UH\_IDX_{t-1} + \sum_{d=1}^{t-1} UH\_IDX_{d-1} \cdot R_d \right)$$

The index formula can finally be rewritten as:

$$H\_IDX_t = H\_IDX_{t-1} + \frac{H\_IDX_0}{UH\_IDX_0} \cdot [UH\_IDX_t - UH\_IDX_{t-1} \cdot (1 - R_t)]$$

or equivalently as:

$$H\_IDX_t = H\_IDX_{t-1} + H\_IDX_0 \cdot \frac{UH\_IDX_t - UH\_IDX_{t-1}}{UH\_IDX_0} - H\_IDX_0 \cdot AF_{t-1} \cdot \sum_{c=1}^C HR_{c,t-1} \cdot \left( \frac{FX_0}{IFF_t} - \frac{FX_0}{IFF_{t-1}} \right)$$

### 19.3.3. MONTHLY HEDGED INDICES

In the monthly hedged version, the forward hedge is set up once a month and remains unchanged until the next reset: the currency weights are fixed at each reset, as well as the notional hedge amount.

The monthly currency hedged indices are thus calculated as:

$$H\_IDX_t = H\_IDX_0 \cdot \left[ \frac{UH\_IDX_t}{UH\_IDX_0} + \sum_{c=1}^C HR_{c,0} \cdot \left( \frac{FX_{c,0}}{FF_{c,0}} - \frac{FX_{c,t}}{IFF_{c,t}} \right) \right]$$

The expression can be directly derived from the formula for daily currency hedged indices, by setting  $AF_t = AF_0 = 1$  and  $HR_{c,t} = HR_{c,0} \square t$ .

The expression of the monthly indices can also be rewritten as a function of the previous day's value as:

$$H\_IDX_t = H\_IDX_{t-1} + H\_IDX_0 \cdot \frac{UH\_IDX_t - UH\_IDX_{t-1}}{UH\_IDX_0} - H\_IDX_0 \cdot AF_0 \cdot \sum_{c=1}^C HR_{c,0} \cdot \left( \frac{FX_0}{IFF_t} - \frac{FX_0}{IFF_{t-1}} \right)$$

which simplifies to:

$$H\_IDX_t = H\_IDX_{t-1} + H\_IDX_0 \cdot \frac{UH\_IDX_t - UH\_IDX_{t-1}}{UH\_IDX_0} - H\_IDX_0 \cdot \sum_{c=1}^C HR_{c,0} \cdot \left( \frac{FX_0}{IFF_t} - \frac{FX_0}{IFF_{t-1}} \right)$$

# 20. STOXX FUTURES ROLL INDICES

## 20.1. OVERVIEW

The STOXX Futures Roll indices are designed to reflect the returns generated over time through notional investments in a long position in a series of STOXX index futures contracts.

The excess return index replicates the financial outcome of a portfolio rolling the 1<sup>st</sup> nearby STOXX index futures contract into the 2<sup>nd</sup> nearby contract; the total return index, in addition, replicates the remuneration of the cash component at risk-free rate.

The futures contracts series is not amended between roll dates. Rolling period refers to the length of transition from the 1<sup>st</sup> nearby futures contract into the 2<sup>nd</sup> contract. The futures roll is completed on the date preceding the last trading day of each futures contract series.

**Dissemination Calendar:** STOXX Eurex Calendar

## 20.2. BASIC DATA

| Index                                               | ISIN         | Index symbol | Futures symbol     | Rolling Period (days) |
|-----------------------------------------------------|--------------|--------------|--------------------|-----------------------|
| EURO STOXX 50 Futures Roll EUR Excess Return        | CH0230373265 | SX5EFEER     | FESX               | 4                     |
| EURO STOXX 50 Futures Roll EUR Total Return         | CH0226976477 | SX5EFETR     | FESX               | 4                     |
| EURO STOXX 50 Traded Futures Roll EUR Excess Return | CH0313264233 | SX5ETFER     | FESX               | 5                     |
| EURO STOXX 50 Traded Futures Roll EUR Total Return  | CH0313264225 | SX5ETFTR     | FESX               | 5                     |
| EURO STOXX 50 Futures Roll 5D EUR Excess Return     | CH0596712205 | SX5EF5ER     | FESX               | 5                     |
| EURO STOXX 50 Futures Roll 5D EUR Total Return      | CH0596712130 | SX5EF5TR     | FESX               | 5                     |
| EURO STOXX 50 Quanto Futures Roll USD Excess Return | CH0328366148 | SX5HFEER     | FESQ <sup>11</sup> | 4                     |

<sup>11</sup> The EURO STOXX 50 Index Quanto Futures (FESQ) are calculated and distributed by EUREX Exchange since 17 March 2016. The historical data of the EURO STOXX 50 Quanto Futures Roll indices for the period between 2 January 2001 and 16 March 2016 was calculated using simulated values for the futures FESQ series, which were derived as follows:

$$FESQ_t = FESX_t \cdot \left( 1 - \rho(SX5E, EURUSD) \cdot V6I3 \cdot EURUSD3mV \cdot \frac{d}{365} \right)$$

Where:

$FESQ_t$  = EURO STOXX 50 Index Quanto Futures on day (t)

$FESX_t$  = EURO STOXX 50 Index Futures on day (t)

$\rho(SX5E, EURUSD)$  = Correlation of 90 days of EURO STOXX 50 index (SX5E) returns and EURUSD exchange rate returns

$V6I3$  = EURO STOXX 50 Volatility index (VSTOXX 3 months)

$EURUSD3mV$  = EURUSD exchange rate 3 month at-the-market (ATM) implied volatility

$d$  = number of calendar days between (t) and the expiry date of the FESX contract

# 20. STOXX FUTURES ROLL INDICES

|                                                                 |              |           |                   |   |
|-----------------------------------------------------------------|--------------|-----------|-------------------|---|
| EURO STOXX 50 Quanto Futures Roll USD Total Return              | CH0328366155 | SX5HFETR  | FESQ <sup>2</sup> | 4 |
| EURO STOXX Select Dividend 30 Futures Roll EUR Excess Return    | CH0328366064 | SD3EFEER  | FEDV              | 4 |
| EURO STOXX Select Dividend 30 Futures Roll EUR Total Return     | CH0328366072 | SD3EFETR  | FEDV              | 4 |
| STOXX Global Select Dividend 100 Futures Roll EUR Excess Return | CH0328366080 | SDGPFEEER | FGDV              | 4 |
| STOXX Global Select Dividend 100 Futures Roll EUR Total Return  | CH0328366098 | SDGPFETR  | FGDV              | 4 |
| STOXX Europe 600 Futures Roll EUR Excess Return                 | CH0328366106 | SXXPFEEER | FXXP              | 4 |
| STOXX Europe 600 Futures Roll EUR Total Return                  | CH0328366114 | SXXPFETR  | FXXP              | 4 |
| EURO STOXX Banks Futures Roll EUR Excess Return                 | CH0328366122 | SX7EFEER  | FESB              | 4 |
| EURO STOXX Banks Futures Roll EUR Total Return                  | CH0328366130 | SX7EFETR  | FESB              | 4 |

## 20.3. CALCULATION

$$I_t^{ER} = I_{t-1}^{ER} \cdot \left( \sum_{k=1}^{N+1} w_{k,t-1} \cdot \frac{F_{k,t}}{F_{k,t-1}} \right)$$

$$I_t^{TR} = I_{t-1}^{TR} \cdot \left( \sum_{k=1}^{N+1} w_{k,t-1} \cdot \frac{F_{k,t}}{F_{k,t-1}} + \frac{d}{360} \cdot R_{f,t-1} \right)$$

where:

$I_t^{ER}$  = excess return index value on day (t)

$I_t^{TR}$  = total return index value on day (t)

$w_{k,t}$  = weight of contract k on close of day (t)

$F_{k,t}$  = settlement value of futures contract k on day (t)

d = number of actual days between day (t) and day (t-1)

$R_{f,t}$  = fixing of risk-free rate on day (t). USD LIBOR ON is used as risk-free rate for EURO

STOXX 50 Quanto Futures Roll and EONIA<sup>12</sup> for the rest of indices

### Weights calculation for the STOXX Futures Roll indices (except EURO STOXX 50 Traded Futures Roll indices):

The futures contracts weights  $w_{k,t}$  are determined as follows:

<sup>12</sup> Calculated as European short-term rate (€STR) + 8.5 bps.

# 20. STOXX FUTURES ROLL INDICES

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$$w_{k,t-1} = \begin{cases} \frac{R-r}{R} \cdot \frac{1}{N} = \left(1 - \frac{r}{R}\right) \cdot \frac{1}{N} & :k = 1 \\ \frac{r}{R} \cdot \frac{1}{N} = \frac{1}{N} - w_{1,t-1} & :k = N + 1 \\ \frac{1}{N} & : \text{else} \end{cases}$$

where:

R=length of roll period

r=r<sup>th</sup> roll day (0 if not in roll period)

N=number of futures contracts permanently in the index (1)

## Weights calculation for the EURO STOXX 50 Traded Futures Roll indices:

The futures contracts weights  $w_{k,t}$  are determined as follows:

$$w_{k,t-1} = \begin{cases} w_{k,t-2} - \left[ 10\% + \left( 7\% - \frac{r-2}{100} \right) \cdot (r-1) \right] \cdot \frac{1}{N} & :k = 1 \\ \frac{1}{N} - w_{1,t-1} & :k = N + 1 \\ \frac{1}{N} & : \text{else} \end{cases}$$

where:

$w_1 = 1/N$  when  $r = 0$

R=length of roll period (5)

r=r<sup>th</sup> roll day (0 if not in roll period)

N=number of futures contracts permanently in the index (1)

# 21. STOXX FUTURES REPLICATION INDICES

## 21.1. OVERVIEW

The STOXX Futures Replication indices aim to replicate the performance of STOXX Indices by simulating an investment into the a STOXX Futures Roll Total Return index, adjusted for dividends.

### Index types, currencies, base values and dates:

| Index                                                | Types                       | Currency | Base value and date  |
|------------------------------------------------------|-----------------------------|----------|----------------------|
| EURO STOXX 50 Quanto Futures Replication             | Price, net and gross return | USD      | 100 as of 02.01.2001 |
| EURO STOXX Select Dividend 30 Futures Replication    | Price, net and gross return | EUR      | 100 as of 12.07.2007 |
| STOXX Global Select Dividend 100 Futures Replication | Price, net and gross return | EUR      | 100 as of 16.07.2015 |
| STOXX Europe 600 Futures Replication                 | Price, net and gross return | EUR      | 100 as of 20.07.2010 |
| EURO STOXX Banks Futures Replication                 | Price, net and gross return | EUR      | 100 as of 19.03.2001 |

## 21.2. BASIC DATA

| Index                                                                 | ISIN         | Symbol   |
|-----------------------------------------------------------------------|--------------|----------|
| EURO STOXX 50 Quanto Futures Replication Price USD                    | CH0328366288 | SX5HPREP |
| EURO STOXX 50 Quanto Futures Replication Net Return USD               | CH0328366296 | SX5HNREP |
| EURO STOXX 50 Quanto Futures Replication Gross Return USD             | CH0328366304 | SX5HGREP |
| EURO STOXX Select Dividend 30 Futures Replication Price EUR           | CH0328366163 | SD3EREP  |
| EURO STOXX Select Dividend 30 Futures Replication Net Return EUR      | CH0328366171 | SD3TREP  |
| EURO STOXX Select Dividend 30 Futures Replication Gross Return EUR    | CH0328366189 | SD3GTREP |
| STOXX Global Select Dividend 100 Futures Replication Price EUR        | CH0328366197 | SDGPREP  |
| STOXX Global Select Dividend 100 Futures Replication Net Return EUR   | CH0328366205 | SDGRREP  |
| STOXX Global Select Dividend 100 Futures Replication Gross Return EUR | CH0328366213 | SDGGRREP |
| STOXX Europe 600 Futures Replication Price EUR                        | CH0328366221 | SXXPREP  |
| STOXX Europe 600 Futures Replication Net Return EUR                   | CH0328366239 | SXXRREP  |
| STOXX Europe 600 Futures Replication Gross Return EUR                 | CH0328366247 | SXXGRREP |
| EURO STOXX Banks Futures Replication Price EUR                        | CH0328366254 | SX7EREP  |
| EURO STOXX Banks Futures Replication Net Return EUR                   | CH0328366262 | SX7TREP  |
| EURO STOXX Banks Futures Replication Gross Return EUR                 | CH0328366270 | SX7GTREP |

## 21.3. CALCULATION

The STOXX Futures Replication indices are calculated by using the performance of the STOXX Futures Roll Total Return Index. The Price and Net Return version are being adjusted for dividends by using the performance of the corresponding STOXX Price, Net Return and Gross Return indices as follows:

# 21. STOXX FUTURES REPLICATION INDICES

| Futures Replication Index                            | Indices symbols for dividend adjustment                 |
|------------------------------------------------------|---------------------------------------------------------|
| EURO STOXX 50 Quanto Futures Replication             | Price: SX5HUP; net return: SX5HUN; gross return: SX5HUG |
| EURO STOXX Select Dividend 30 Futures Replication    | Price: SD3E; net return: SD3T; gross return: SD3GT      |
| STOXX Global Select Dividend 100 Futures Replication | Price: SDGP; net return: SDGR; gross return: SDGGR      |
| STOXX Europe 600 Futures Replication                 | Price: SXXP; net return: SXXR; gross return: SXXGR      |
| EURO STOXX Banks Futures Replication                 | Price: SX7E; net return: SX7T; gross return: SX7GT      |

$$PR\_REP_t = PR\_REP_{t-1} \times \left( \frac{STX\_FTR_t}{STX\_FTR_{t-1}} - \frac{GR_t}{GR_{t-1}} + \frac{PR_t}{PR_{t-1}} \right)$$

$$NR\_REP_t = NR\_REP_{t-1} \times \left( \frac{STX\_FTR_t}{STX\_FTR_{t-1}} - \frac{GR_t}{GR_{t-1}} + \frac{NR_t}{NR_{t-1}} \right)$$

$$GR\_REP_t = GR\_REP_{t-1} \times \left( \frac{STX\_FTR_t}{STX\_FTR_{t-1}} \right)$$

With:

|                      |                                                                                                                                                       |
|----------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------|
| PR <sub>t</sub>      | STOXX Futures Replication Price Index at time t                                                                                                       |
| NR <sub>t</sub>      | STOXX Futures Replication Net Return Index at time t                                                                                                  |
| GR <sub>t</sub>      | STOXX Futures Replication Gross Return Index at time t                                                                                                |
| STX_FTR <sub>t</sub> | STOXX Futures Roll Total Return Index at time t. The EURO STOXX 50 Futures Replications index uses the EURO STOXX 50 Traded Futures Roll Total Return |
| PR <sub>t</sub>      | STOXX Price index for dividend adjustment at time t                                                                                                   |
| NR <sub>t</sub>      | STOXX Net Return index for dividend adjustment at time t                                                                                              |
| GR <sub>t</sub>      | STOXX Gross Return index for dividend adjustment at time t                                                                                            |



# 22. EURO STOXX 50 MULTI-ASSET

## 22.1. FIXED ALLOCATION INDICES

### 22.1.1. OVERVIEW

The EURO STOXX 50 Multi-Asset Indices with fixed allocation reflect the performance of a cross-asset strategy by allocating weights in accordance with a pre-defined scheme. The indices are comprised of equity and bond exposure, using the EURO STOXX 50 and EURO STOXX 50 Corporate Bond indices. The different combinations of both indices offer efficient portfolios to investors, accordingly to their individual preferences:

|                                    | High Growth | Growth | Balanced | Stability | High Stability |
|------------------------------------|-------------|--------|----------|-----------|----------------|
| EURO STOXX 50 Corporate Bond Index | 20%         | 40%    | 50%      | 60%       | 80%            |
| EURO STOXX 50 Equity Index         | 80%         | 60%    | 50%      | 40%       | 20%            |

**Rebalancing:** Indices are rebalanced to target weights on a quarterly basis. The new weights are implemented on the last trading day of March, June, September and December and effective on the following calculation day.

**Index types and currencies:** Price, total return<sup>13</sup> in EUR.

**Base values and dates:** 100 as of December 31, 2010

### 22.1.2. BASIC DATA

| Index                                                           | ISIN         | Symbol   |
|-----------------------------------------------------------------|--------------|----------|
| EURO STOXX 50 Multi-Asset High Growth Price Index EUR           | DE000A2BLEC7 | SX5MHGPI |
| EURO STOXX 50 Multi-Asset High Growth Total Return Index EUR    | DE000A2BLED5 | SX5MHGTR |
| EURO STOXX 50 Multi-Asset Growth Price Index EUR                | DE000A2BLEE3 | SX5MGPI  |
| EURO STOXX 50 Multi-Asset Growth Total Return Index EUR         | DE000A2BLEF0 | SX5MGTR  |
| EURO STOXX 50 Multi-Asset Balanced Price Index EUR              | DE000A2BLEG8 | SX5MBPI  |
| EURO STOXX 50 Multi-Asset Balanced Total Return Index EUR       | DE000A2BLEH6 | SX5MBTR  |
| EURO STOXX 50 Multi-Asset Stability Price Index EUR             | DE000A2BLEJ2 | SX5MSPI  |
| EURO STOXX 50 Multi-Asset Stability Total Return Index EUR      | DE000A2BLEK0 | SX5MSPTR |
| EURO STOXX 50 Multi-Asset High Stability Price Index EUR        | DE000A2BLEL8 | SX5MHSPI |
| EURO STOXX 50 Multi-Asset High Stability Total Return Index EUR | DE000A2BLEM6 | SX5MHSTR |

### 22.1.3. CALCULATION

The EURO STOXX 50 Multi-Asset indices with fixed allocation involve proportional long positions into the EURO STOXX 50 and EURO STOXX 50 Corporate Bond indices at each quarterly rebalancing.

<sup>13</sup> Total return version comprised of EURO STOXX 50 Corporate Bond Total Return and EURO STOXX 50 Gross Return versions

## 22. EURO STOXX 50 MULTI-ASSET

$$IV_t = IV_{reb} \times \sum_{i=1}^2 w_{reb,i} \times \frac{U_{t,i}}{U_{reb,i}}$$

With:

|             |                                                                                                                   |
|-------------|-------------------------------------------------------------------------------------------------------------------|
| $w_{reb,i}$ | Target weight of sub-index i at rebalancing date                                                                  |
| $U_{reb,i}$ | Close value of sub-index i at rebalancing date                                                                    |
| $U_{t,i}$   | Value of sub-index i at time t                                                                                    |
| $IV_t$      | Value of EURO STOXX 50 Multi-Asset index at time t                                                                |
| $IV_{reb}$  | Value of EURO STOXX 50 Multi-Asset index at rebalancing date                                                      |
| reb         | Rebalancing date of the EURO STOXX 50 Multi-Asset index (last trading day of March, June, September and December) |

### 22.2. DYNAMIC ALLOCATION – MOMENTUM RISK CAP INDICES

#### 22.2.1. OVERVIEW

The EURO STOXX 50 Multi-Asset Momentum Risk Cap Indices reflect the performance of a strategy which dynamically allocates the weights of different asset types in accordance with the historical performance and risk profile of the relevant index. The indices are a blend of equity and bond exposure, constructed using the EURO STOXX 50 and EURO STOXX 50 Corporate Bond indices. The different versions offer efficient portfolios combining a momentum allocation strategy and simultaneously capping volatility at 5%, 7.5%, 10%, 15% or 20%.

**Rebalancing:** Indices are rebalanced on a quarterly basis. The new weights are implemented on the last trading day of March, June, September and December and effective on the following calculation day. Index weights are calculated by using the momentum of both underlying indices and considering the accordant predefined maximum volatility level.

**Extraordinary weight changes:** At any other calculation day, a daily volatility level control procedure is applied in order to react to substantial changes in the portfolio volatility as they may arise between two regular rebalancing events. In case the portfolio volatility exceeds the risk cap by more than 20%, the weights can be changed accordingly on a daily basis. The 20% buffer is applied to avoid excessive turnover. For example, in case of 10% risk cap, a recalculation of the weight will be only triggered if the portfolio volatility exceeds 12%.

**Index types and currencies:** Price, total return<sup>14</sup> in EUR.

**Base values and dates:** 100 as of March 31, 2011

#### 22.2.2. BASIC DATA

| Index                                                          | ISIN         | Symbol  |
|----------------------------------------------------------------|--------------|---------|
| EURO STOXX 50 Multi-Asset Momentum 5% Risk Cap Price Index EUR | DE000A2BLFR2 | SX5M5PI |

<sup>14</sup> Total return version comprised of EURO STOXX 50 Corporate Bond Total Return and EURO STOXX 50 Gross Return versions

# 22. EURO STOXX 50 MULTI-ASSET

|                                                                         |              |          |
|-------------------------------------------------------------------------|--------------|----------|
| EURO STOXX 50 Multi-Asset Momentum 5% Risk Cap Total Return Index EUR   | DE000A2BLFL5 | SX5M5TR  |
| EURO STOXX 50 Multi-Asset Momentum 7.5% Risk Cap Price Index EUR        | DE000A2BLFS0 | SX5M75PI |
| EURO STOXX 50 Multi-Asset Momentum 7.5% Risk Cap Total Return Index EUR | DE000A2BLFM3 | SX5M75TR |
| EURO STOXX 50 Multi-Asset Momentum 10% Risk Cap Price Index EUR         | DE000A2BLFT8 | SX5M10PI |
| EURO STOXX 50 Multi-Asset Momentum 10% Risk Cap Total Return Index EUR  | DE000A2BLFN1 | SX5M10TR |
| EURO STOXX 50 Multi-Asset Momentum 15% Risk Cap Price Index EUR         | DE000A2BLFU6 | SX5M15PI |
| EURO STOXX 50 Multi-Asset Momentum 15% Risk Cap Total Return Index EUR  | DE000A2BLFP6 | SX5M15TR |
| EURO STOXX 50 Multi-Asset Momentum 20% Risk Cap Price Index EUR         | DE000A2BLFV4 | SX5M20PI |
| EURO STOXX 50 Multi-Asset Momentum 20% Risk Cap Total Return Index EUR  | DE000A2BLFQ4 | SX5M20TR |

## 22.2.3. CALCULATION

The EURO STOXX 50 Multi-Asset Momentum Risk Cap indices involve dynamically allocated long positions into the EURO STOXX 50 and EURO STOXX 50 Corporate Bond indices (called sub-indices).

### Rebalancing:

#### STEP 1

Calculate the historical price momentum of both sub-indices:

$$Momentum_{reb,i} = \frac{U_{reb-1,i}}{U_{reb-60,i}} - 1$$

#### STEP 2

Rank the sub-indices by momentum in ascending order.

#### STEP 3

Case I: If  $RealizedVol_{t,rank1} \leq RiskCap$ , set  $w_{rank1} = 1$ ,  $w_{rank2} = 0$ .

$$RealizedVol_{t,i} = \sqrt{\frac{252}{59} * \sum_s \left[ \ln \left( \frac{U_{s,i}}{U_{s-1,i}} \right) \right]^2}$$

Case II: If  $RealizedVol_{t,rank1} > RiskCap$ :

a. if  $RealizedVol_{t,rank2} \leq RiskCap$ , set  $PortfolioVol_{t,MA} = RiskCap$  and solve for  $w_{rank1}$ , where:

$$PortfolioVol_{t,MA} =$$

$$= \sqrt{w_{rank1}^2 * RealizedVol_{rank1}^2 + w_{rank2}^2 * RealizedVol_{rank2}^2 + 2 * w_{rank1} * w_{rank2} * RealizedCov_{rank1,rank2}}$$

$$w_{rank1} + w_{rank2} = 1$$

$$w_{rank1}, w_{rank2} \leq 1$$

$$w_{rank1}, w_{rank2} \geq 0$$

# 22. EURO STOXX 50 MULTI-ASSET

$$RealizedCov_{t,rank1,rank2} = \frac{252}{59} * \sum_s \left[ \ln \left( \frac{U_{s,rank1}}{U_{s-1,rank1}} \right) * \ln \left( \frac{U_{s,rank2}}{U_{s-1,rank2}} \right) \right]$$

b. if  $RealizedVol_{t,rank2} > RiskCap$ , use 100% weight for the sub-index with the lower  $RealizedVol$ .

## STEP 4

Assign  $w_{rank1}$  and  $w_{rank2}$  to the relevant  $w_{reb,i}$ .

### Extraordinary weight changes:

At any other calculation day recalculate  $PortfolioVol_{t,MA}$  and check whether it breaches the RiskCap adjusted with 20% tolerance buffer:

- if  $PortfolioVol_{t,MA} \leq 1,2 * RiskCap$ , no changes required, use previous weights;
- if  $PortfolioVol_{t,MA} > 1,2 * RiskCap$ , set  $PortfolioVol_{t,MA} = RiskCap$ , solve for  $w_{rank1}$  (refer to formulas in Case II a.) and assign the new calculated weights  $w_{rank1}$  and  $w_{rank2}$  to the relevant  $w_{reb,i}$ .

At any calculation time t, the value of a EURO STOXX 50 Multi-Asset Momentum Risk Cap index value is calculated as follows:

$$IV_t = IV_{reb} \times \sum_{i=1}^2 w_{reb,i} \times \frac{U_{t,i}}{U_{reb,i}}$$

With

|                             |                                                                                                                                                                    |
|-----------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| $U_{t,i}$                   | Value of sub-index i (bond or equity) at time t, rounded to four decimal places for EURO STOXX 50 Corporate Bond index and to two decimal places for EURO STOXX 50 |
| s                           | t-59 to t-1                                                                                                                                                        |
| $RealizedVol_{t,i}$         | Realized volatility measured over 60 days for sub-index i at day t                                                                                                 |
| RiskCap                     | Predefined maximum level of volatility (i.e. 5%, 7,5%, 10%, 15% or 20%)                                                                                            |
| $RealizedCov_{rank1,rank2}$ | Covariance of the bond and equity sub-indices                                                                                                                      |
| $RealizedVol_{t,MA}$        | Realized volatility measured over 60 days for multi-asset index i at time t                                                                                        |
| $w_{reb,i}$                 | Weight of sub-index i at rebalancing date or intra-monthly weight change date                                                                                      |
| $U_{reb,i}$                 | Close value of sub-index i at rebalancing date or intra-monthly weight change date                                                                                 |
| $IV_t$                      | Index value at time t, rounded to four decimal places                                                                                                              |
| $IV_{reb}$                  | Index close value at last rebalancing date or extraordinary weight change date, rounded to four decimal places                                                     |
| reb                         | Last ordinary rebalancing date of the index or extraordinary weight change date                                                                                    |

## 23. STOXX GLOBAL BASKET

### 23.1. OVERVIEW

The STOXX Global Basket Select & Diversification Select EUR Index aims to invest a fixed proportion into each STOXX Regional Select & Diversification Select EUR Index.

The STOXX Global Basket Select EUR index invests 40% into the STOXX North America Select 50 EUR Index, 30% into the STOXX Asia/Pacific Select 50 EUR Index and 30% into the STOXX Europe Select 50 EUR Index at each quarterly review.

The STOXX Global Basket Diversification Select EUR index invests 40% into the STOXX North America Diversification Select 50 EUR Index, 30% into the STOXX Asia/Pacific Diversification Select 50 EUR Index and 30% into the STOXX Europe Diversification Select 50 EUR Index at each quarterly review.

**Index types and currencies:** price, net return and gross return in EUR, rebalanced on a quarterly basis.

**Base values and dates:** The following base values and dates apply: 100 on June 21, 2004

### 23.2. BASIC DATA

| Index                                                       | ISIN         | Symbol    |
|-------------------------------------------------------------|--------------|-----------|
| STOXX Global Basket Select EUR Price                        | CH0321426923 | SXW1BSEE  |
| STOXX Global Basket Select EUR Net Return                   | CH0321426980 | SXW1BSER  |
| STOXX Global Basket Select EUR Gross Return                 | CH0321427038 | SXW1BSEG  |
| STOXX Global Basket Diversification Select EUR Price        | CH0321427079 | SXW1BDSE  |
| STOXX Global Basket Diversification Select EUR Net Return   | CH0321427129 | SXW1BDSR  |
| STOXX Global Basket Diversification Select EUR Gross Return | CH0321427145 | SXW1BD SG |

### 23.3. CALCULATION

The index values are calculated as following:

$$IV_t = IV_{reb} \times \sum_{i=1}^3 w_i \times \frac{U_{t,i}}{U_{reb,i}}$$

With

|            |                                               |
|------------|-----------------------------------------------|
| $w_i$      | target weight of sub-index i                  |
| $U_{reb}$  | close value of sub-index i on rebalancing day |
| $IV_t$     | Index value                                   |
| $IV_{reb}$ | Index value on rebalancing day                |

# 23.STOXX GLOBAL BASKET

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| <b>STOXX Europe Basket Select EUR index</b> | <b>weight</b> |
|---------------------------------------------|---------------|
| STOXX North America Select 50 EUR Index     | 40%           |
| STOXX Europe Select 50 EUR Index            | 30%           |
| STOXX Asia/Pacific Select 50 EUR Index      | 30%           |

  

| <b>STOXX Europe Basket Diversification Select EUR index</b> | <b>weight</b> |
|-------------------------------------------------------------|---------------|
| STOXX North America Diversification Select 50 EUR Index     | 40%           |
| STOXX Europe Select Diversification 50 EUR Index            | 30%           |
| STOXX Asia/Pacific Diversification Select 50 EUR Index      | 30%           |

# 24. STOXX DECREMENT INDICES

## 24.1. OVERVIEW

STOXX Decrement Indices replicate the performance of their underlying index assuming a constant deduction per annum. The performance deduction accrues constantly on a daily basis (using an Actual/365 Fixed day count convention). The amount of deduction can either be a performance deduction, in which case it is expressed in percentage points, or it can be an index points deduction in which case it is expressed in index points. Please see the STOXX Quality Charter on <http://www.stoxx.com/indices/rulebooks.html> for further information on STOXX Decrement Indices.

## 24.2. BASIC DATA

| Index                                              | ISIN | Symbol |
|----------------------------------------------------|------|--------|
| <indices as listed in the STOXX vendor code sheet> |      |        |

## 24.3. CALCULATION

### 24.3.1. DECREMENT INDEX CALCULATION (DECREMENT IN INDEX POINTS)

The Decrement Index calculation (when the decrement is expressed in index points) for each calculation day t is as follows:

$$IV_t = \left( IV_{t-1} \times \frac{U_t}{U_{t-1}} \right) - \left( D \frac{Act(t-1, t)}{365} \right)$$

where:

- $IV_t$  = The value of the Decrement Index for calculation day t
- $IV_{t-1}$  = The value of the Decrement Index for the day immediately preceding calculation day t
- $IV_0$  = The value of the Decrement Index for the base date
- $U_t$  = The value of the Underlying Index for calculation day t
- $U_{t-1}$  = the value of the Underlying Index for calculation day t-1
- $Act(t-1, t)$  = The number of calendar days between calculation day t-1 and calculation day t
- $D$  = The Decrement Amount expressed in index points

### 24.3.2. DECREMENT INDEX CALCULATION (DECREMENT IN PERCENTAGE POINTS)

The Decrement Index calculation (when the decrement is expressed in percentage points) for each calculation day t is as follows:

$$IV_t = IV_{t-1} \times \left( \frac{U_t}{U_{t-1}} - D \frac{Act(t-1, t)}{365} \right)$$

where:

# 24. STOXX DECREMENT INDICES

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- $IV_t$  = The value of the Decrement Index for calculation day  $t$   
 $IV_{t-1}$  = The value of the Decrement Index for the day immediately preceding calculation day  $t$   
 $IV_0$  = Value of the Decrement Index on the base date  
 $U_t$  = Value of the Underlying Index on calculation day  $t$   
 $U_{t-1}$  = Value of the Underlying Index for calculation day  $t-1$   
 $Act(t-1,t)$  = Number of calendar days between calculation day  $t-1$  and calculation day  $t$   
 $D$  = The Decrement amount expressed in percentage points



# 25. STOXX LOCAL CURRENCY RETURN INDICES

## 25.1. OVERVIEW

A local currency return index is a theoretical index designed to represent hypothetical returns for global index investment strategies by considering only the underlying constituent local return and excludes any impact from currency movements.

STOXX can calculate local currency return indices on a price, net return and gross return basis.

## 25.2. BASIC DATA

| Index                                                | ISIN | Symbol |
|------------------------------------------------------|------|--------|
| < indices as listed in the STOXX vendor code sheet > |      |        |

## 25.3. CALCULATION

The following definitions will be used throughout the chapter:

|                     |                                                                                                                                                             |
|---------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------|
| t-1                 | = previous index calculation date                                                                                                                           |
| t                   | = current index calculation date                                                                                                                            |
| LC_IDX <sub>t</sub> | = local currency index for time (t)                                                                                                                         |
| RF_IDX <sub>t</sub> | = reference index for time (t)                                                                                                                              |
| N                   | = Number of companies in the reference index                                                                                                                |
| adjp <sub>it</sub>  | = Adjusted closing price of company (i) at time (t) in local currency reflecting a stock's corporate action that will be effective the next calculation day |
| p <sub>it</sub>     | = Closing price of company (i) at time (t) in local currency                                                                                                |
| s <sub>it</sub>     | = Number of shares of company (i) at time (t)                                                                                                               |
| ff <sub>it</sub>    | = Free float factor of company (i) at time (t)                                                                                                              |
| cf <sub>it</sub>    | = Weighting cap factor of company (i) at time (t)                                                                                                           |
| x <sub>it</sub>     | = Exchange rate from local currency into reference index currency for company (i) at time (t)                                                               |
| InitM <sub>t</sub>  | = Initial Free float market capitalization of the index at time (t) in the reference index currency                                                         |
| LocalM <sub>t</sub> | = Free float market capitalization of the index at time (t) in the reference index currency converted using the initial exchange rate, x <sub>it-1</sub>    |

The local currency return index is calculated as follows:

$$LC\_IDX_t = LC\_IDX_{t-1} * \left( \frac{\sum_{i=1}^n (p_{it} \cdot s_{it} \cdot ff_{it} \cdot cf_{it} \cdot x_{it-1})}{\sum_{i=1}^n (adjp_{it-1} \cdot s_{it} \cdot ff_{it} \cdot cf_{it} \cdot x_{it-1})} \right) = LC\_IDX_{t-1} * \left( \frac{LocalM_t}{InitM_t} \right)$$

where the companies that go into the calculation of the index are derived from the reference index at time t, RF\_IDX<sub>t</sub>.

# 26. ISTOXX INCREMENT INDICES

## 26.1. OVERVIEW

iSTOXX Increment Indices replicate the performance of their Underlying Index assuming a constant addition per annum. The addition accrues constantly on a daily basis (using an Actual/365 Fixed day count convention). The increment amount is a performance addition and is expressed in percentage points.

## 26.2. BASIC DATA

| Index                                               | ISIN         | Symbol |
|-----------------------------------------------------|--------------|--------|
| EURO iSTOXX 50 NR Increment 0.69% EUR Net Return    | CH0313264704 | ISX5NI |
| iSTOXX Europe 600 NR Increment 0.38% EUR Net Return | CH0313264712 | ISXRNI |

## 26.3. CALCULATION

The Increment Index calculation for each calculation day  $t$  is as follows:

$$IV_t = IV_0 \times \left( \frac{U_t}{U_0} \right) \times (1 + D)^{\frac{ACT(0,t)}{365}}$$

where:

- $IV_t$  = The value of the Increment Index on day  $t$
- $IV_0$  = The base value of the Increment Index (value on the base date)
- $U_t$  = The value of the Underlying Index on day  $t$
- $U_0$  = The value of the Underlying Index on the base date
- $Act(0,t)$  = The number of calendar days between calculation day  $t$  and the base date
- $D$  = The Increment amount expressed in percentage points

The index is disseminated in 2 decimal digits.

# 27. EURO STOXX 50 SHORT STRANGLE

## 27.1. OVERVIEW

The EURO STOXX 50 Short Strangle Index reflects the performance of a strategy which sells EURO STOXX 50 call and put options, each with 5% out of the money strikes, while the investment notional is invested at the EONIA rate.

## 27.2. BASIC DATA

**Index types and currencies:** Excess and Total Return in EUR

**Base values and dates:** 10,000 as of January 18, 2008

**Dissemination calendar:** STOXX Eurex Calendar

## 27.3. CALCULATION

**Excess return:**

$$1 + R_{ER,t} = \frac{S_{exp} + (C_{exp} - C_t) + (P_{exp} - P_t)}{S_{exp} + (C_{exp} - C_{t-1}) + (P_{exp} - P_{t-1})}$$

$$IV_{ER,t} = IV_{ER,t-1} \cdot (1 + R_{ER,t})$$

**Total Return:**

$$IV_{TR,t} = IV_{TR,t-1} \cdot \left( \frac{IV_{ER,t}}{IV_{ER,t-1}} + \frac{EONIA_{t-2}}{360} \cdot d \right)$$

where:

- $IV_{ER,t}$  = index value on day  $t$  of excess return version
- $EONIA_t$  = Euro OverNight Index Average on day  $t$
- $d$  = number of calendar days between  $t$  and  $t-1$
- $C_t$  = call option daily settlement price on day  $t$
- $P_t$  = put option daily settlement price on day  $t$
- $S_{exp}$  = 12:00 CET value of EURO STOXX 50 EUR Price on previous expiry date
- $C_{exp}$  = call option inclusion price on previous expiry date (VWAP of best bid prices from 12:15 – 12:45 CET)
- $P_{exp}$  = put option inclusion price on previous expiry date (VWAP of best bid prices from 12:15 – 12:45 CET)

On expiration days the index return reflects the return of the position of expiring options until settlement and the return of newly sold options until end-of-day:

$$1 + R_{ER,t} = \frac{S_{exp} + (C_{exp} - C_{settlement}) + (P_{exp} - P_{settlement})}{S_{exp} + (C_{exp} - C_{t-1}) + (P_{exp} - P_{t-1})} \cdot \frac{S_{new.exp} + (C_{new.exp} - C_{new.t}) + (P_{new.exp} - P_{new.t})}{S_{new.exp}}$$

# 27.EURO STOXX 50 SHORT STRANGLE

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where:

|                  |                                                                                                           |
|------------------|-----------------------------------------------------------------------------------------------------------|
| $C_{settlement}$ | = call option settlement price on expiry date                                                             |
| $P_{settlement}$ | = put option settlement price on expiry date                                                              |
| $S_{new.exp}$    | = 12:00 CET value EURO STOXX 50 EUR Price on current expiration day                                       |
| $C_{new.exp}$    | = new call option inclusion price on current expiry date (VWAP of best bid prices from 12:15 – 12:45 CET) |
| $P_{new.exp}$    | = new put option inclusion price on current expiry date (VWAP of best bid prices from 12:15 – 12:45 CET)  |
| $C_{new.t}$      | = new call option daily settlement price on day $t$                                                       |
| $P_{new.t}$      | = new put option daily settlement price on day $t$                                                        |

When written in an equivalent form, the portfolio can be thought of as combination of a cash position, premia from option sales ( $C_{exp} + P_{exp}$ ), and a short option position ( $-(C_t + P_t)$ ).

$$IV_t = IV_{exp} + \frac{IV_{exp}}{S_{exp}} \cdot [(C_{exp} + P_{exp}) - (C_t + P_t)]$$

$\frac{IV_{exp}}{S_{exp}}$  determines the number of option contracts to be sold. The ratio relates the index level to the underlying.

## Rolling

The EURO STOXX 50 Short Strangle Index requires a monthly rollover procedure, whereby the old EURO STOXX 50 call and put option cease trading at noon (12:00 CET) on the pre-determined expiry date, i.e. typically the third Friday of a month, and are replaced by a new EURO STOXX 50 call and put option whose last trading day falls on the next expiry date. The new one-month EURO STOXX 50 call and put option must have a remaining lifetime of one month, and must be 5 percent out-of-the-money (i.e. the lowest (highest) strike price above (below) or equal to the EURO STOXX 50 12:00 CET value plus (minus) 5 percent for the call (put)).

## History

Before November 28, 2011  $S_{exp}$  was the end-of-day index value of the EURO STOXX 50 EUR Price Index. Before the September 2018 rolling, the call and put option inclusion prices were the daily settlement prices on the expiry date established by Eurex.

## Trading Suspension

If there is a suspension of the EURO STOXX 50 Index or the EURO STOXX 50 call or put option that are included in the EURO STOXX 50 Short Strangle Index, the index will be calculated using the latest prices that were available.

If a suspension occurs on an expiry date during the averaging process, i.e. 12:15 - 12:45 CET, only bids made before the suspension will be considered.

In cases where there is no valid bid-price in the averaging period the last available bid-price is used.

In case there is no such price the previous day's settlement price is used.

# 28. EURO STOXX 50 REALIZED DISPERSION

## 28.1. OVERVIEW

The EURO STOXX 50 Realized Dispersion Index measures the difference between the market-cap weighted sum of the index constituents' absolute returns and the absolute index return. The index is reset annually.

Absolute returns serve as a measure for daily realized volatility and the index represents a long position in a series of at-the-money straddles with one day to maturity on the components of the EURO STOXX 50 Index and a short position in at-the-money straddles on the EURO STOXX 50 Index. At-the-money straddles are traditionally used to trade volatility.

## 28.2. BASIC DATA

**Index types and currencies:** Price return in EUR

**Dissemination calendar:** STOXX Europe calendar

**Base values and dates:** 100 as of December 19, 2008

**Reset dates:** First dissemination date following the third Friday in December.

## 28.3. CALCULATION

On any Dissemination Day  $t$  the index value is calculated as follows:

$$\begin{cases} IV_t = 100 & \text{if } t \text{ is base date} \\ IV_t = IV_{t-1} + 100 * r_{disp,t} & \text{if } t \text{ is not a reset date} \\ IV_t = 100 + 100 * r_{disp,t} & \text{if } t \text{ is a reset date} \end{cases}$$

$$r_{disp,t} = \left( \sum_{i=1}^n w_{i,t-1} \cdot |r_{i,t}| \right) - |r_{idx,t}|$$

Where:

- $IV_t$  = index value on day  $t$  (unrounded)
- $r_{disp,t}$  = dispersion return on day  $t$
- $w_{i,t}$  = adjusted close weight of EURO STOXX 50 component  $i$  on day  $t$
- $r_{i,t}$  = log gross return of EURO STOXX 50 component  $i$  on day  $t$   
The return is adjusted for corporate actions affecting the gross return index.  
The log return is capped/floored at +/-15%.
- $r_{idx,t}$  = log return of the EURO STOXX 50 Gross Return Index  
The log return is capped/floored at +/-15%.
- $n$  = number of components of the EURO STOXX 50 index

The adjusted close weights are calculated based on the EURO STOXX 50 Price index (SX5E) component data:

# 28.EURO STOXX 50 REALIZED DISPERSION

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$$w_{i,t} = \frac{mc_{i,t}^a}{MC_t^a}$$

where:

$mc_{i,t}^a$  = adjusted close index market cap units for stock  $i$  on day  $t$  in SX5E  
 $MC_t^a$  = adjusted close index market cap units on day  $t$  of SX5E

The index is calculated in real-time every 15 seconds. The daily end of day index value is the index value rounded to two decimals.

## 28.4. MARKET DISRUPTION EVENTS

If one of the conditions below apply, the end of day index level is updated using  $IV_t = IV_{t-1}$ :

### Trading Disruption:

EURO STOXX 50 index futures or index options are not available for trading any time during the last hour of trading (from 16:30 to 17:30 CET) except on a Eurex holiday.

### Exchange Disruption:

Eurex is down any time during the last hour of trading (from 16:30 to 17:30 CET) except on a Eurex holiday.

# 29. EURO ISTOXX 50 SHORT STRANGLE KWCDC INDEX

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## 29.1. OVERVIEW

The EURO iSTOXX 50 Short Strangle KWCDC Index reflects the performance of a strategy which sells EURO STOXX 50 call and put options, each with 5% out of the money strikes, while the investment notional is invested at the Korean 3-Month CD rate. The index is not meant to be used as benchmark under the definition of ESMA Benchmark Regulation.

## 29.2. BASIC DATA

**Index types and currencies:** Total Return in EUR

**Base values and dates:** 10,000 as of January 18, 2008

**Dissemination calendar:** STOXX Eurex Calendar

## 29.3. CALCULATION

$$IV_t = IV_{t-1} \cdot \left( \frac{IV_{ER,t}}{IV_{ER,t-1}} + \frac{KWCDC_{t-1}}{360} \cdot d \right)$$

where:

- $IV_{ER,t}$  = Value of the EURO STOXX 50 Short Strangle ER Index (SX5ESSE) on day t
- $KWCDC_t$  = Korean 3-Month Certificate of Deposit rate (RIC: KRCD3M=KFIA)<sup>15</sup> on day t
- $d$  = number of calendar days between t and t-1

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<sup>15</sup> KRCD3M=KFIA is a submission-based benchmark

# 30. ISTOXX SINGLE STOCK LEVERAGED INDICES

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## 30.1. OVERVIEW

The objective of the iSTOXX Single Stock Leveraged Indices is to replicate the return of a daily leveraged investment strategy. The indices consider interest earned on the index notional as well as brokerage margin fee and stock borrowing fee. UK stocks are represented by their US-traded ADRs.

## 30.2. BASIC DATA

**Index types and currencies:** Net Total Return in the currency of the underlying stock.

**Base values and dates:** See Vendor Code Sheet

**Dissemination calendar:** Respective Stock Exchange calendar of the underlying stock

## 30.3. CALCULATION

### 30.3.1. CALCULATION FORMULA

$$IV_t = \max\left(IV_{t-1} \cdot \left(1 + L \cdot r_t + ((1 - L) \cdot (IR_{t-2} + BMF) + IND \cdot L \cdot COB_{t-2}) \cdot d\right), 0\right)$$

where:

|         |                                                                                                                                          |
|---------|------------------------------------------------------------------------------------------------------------------------------------------|
| $IV_t$  | = Index value on day t                                                                                                                   |
| $L$     | = Leverage                                                                                                                               |
| $r_t$   | = Net return of underlying stock on day t, calculated as unadjusted stock price on day t over the net-dividend adjusted price of day t-1 |
| $IR_t$  | = Interest Rate <sup>16</sup> on day t                                                                                                   |
| $BMF$   | = Brokerage Margin Fee (1% for leveraged indices, -1% for inverse leveraged)                                                             |
| $COB_t$ | = Cost of Borrowing on day t                                                                                                             |
| $IND$   | = Inverse Indicator (0 for leveraged indices, 1 for inverse leveraged)                                                                   |
| $d$     | = number of calendar days between t and t-1                                                                                              |

### 30.3.2. ADJUSTMENTS DUE TO EXTREME MARKET MOVEMENTS

Rebalancing is based on the calculation of average index values over a time window of 10 minutes. The time window to calculate the average starts 5 minutes after and ends 15 minutes after the trigger event occurs. The rebalancing is triggered when the underlying index loses more than x% (leverage indices) or appreciates by more than x% (short indices) compared to its previous day's close. The breach of the trigger is checked on a tick-by-tick basis. During this time window, the average of both the underlying index and the Leveraged / Short index are calculated. The two averages are then used to calculate respectively  $r_{t,t}$  and  $IV_t$  in the index calculation formula.

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<sup>16</sup> US Fed Funds rate (USONFFE=) for USD-denominated stocks, EONIA (EONIA=, calculated as €STR+8.5 bps) for EUR-denominated stocks



# 30.ISTOXX SINGLE STOCK LEVERAGED INDICES

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The respective trigger values (x) are given in the following table:

| Leverage factor | Trigger value |
|-----------------|---------------|
| 2               | x = -25,00%   |
| 3               | x = -16,66%   |
| -1              | x = 50,00%    |
| -2              | x = 25,00%    |
| -3              | x = 16,66%    |

Over the course of the 10-minute period in which the average is determined, the index is not disseminated. The index dissemination ends 5 minutes after the trigger event and is resumed with an index level equal to the determined average 15 minutes after the trigger event.

Should the intraday rebalancing be triggered less than 15 minutes prior to the end of the index calculation day, the regular overnight rebalancing is carried out.

If the strategy index reaches a value of 0 or below over the course of the 15, the index is set to a value of 0 and its calculation / dissemination is discontinued

### 30.3.3. REVERSE SPLIT

If the closing value of a daily leverage or daily short index drops below 10 index points, a reverse split is carried out. The affected leverage or short index is multiplied with a factor of 100.

The reverse split is carried out based on the index close ten trading days after the index initially dropped below a closing value of 10 points, notwithstanding whether the index rises above a level of 10 points in the meantime.

### 30.3.4. TRADING SUSPENSION

The STOXX leverage and short indices are calculated on the same days and during the same time as the underlying STOXX indices are calculated.

If there is suspension of the underlying index, the leveraged and short indices will be calculated with the latest prices available.

# 31. EURO ISTOXX 50 TOTAL RETURN FUTURES INDEX

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## 31.1. OVERVIEW

The EURO iSTOXX 50 Total Return Futures Index is designed to replicate the level of the hypothetical instrument underlying the EURO STOXX 50 Total Return Futures (TESX). The purpose of the replication is to enable futures traders with a benchmark for the settlement value of the TESX contract. In order to achieve this, the EURO iSTOXX 50 Total Return Futures Index combines the value of the EURO STOXX 50 Price index with the value of the EURO STOXX 50 Distribution index, so that the returns from both the price appreciation of the underlying constituents and their overall distributions to shareholders are reflected, while at the same time deducting on a daily basis the funding cost of the futures contract to account for the cost of funding of the futures position. The base value of the index is such that the index level equates the one of the EURO STOXX 50 Price index on the base date.

## 31.2. BASIC DATA

**Index types and currencies:** Total Return in EUR

**Base values and dates:** 3015.13 as of December 2, 2016

**Dissemination calendar:** STOXX Eurex Calendar

## 31.3. CALCULATION

$$IL_t = SX5E_t + SX5EDD_t - SX5EDD_{t_0} - \sum_{i=t_0}^{t-1} SX5E_i * (\epsilon STR_i + 8.5 \text{ bps})^{17} * \frac{ACT(i+2, i+3)^{18}}{360}$$

where:

- $t_0$  = December 2<sup>nd</sup>, 2016
- $SX5E_t$  = Value of the EURO STOXX 50 (PR) EUR index on day t
- $SX5EDD_t$  = Value of the EURO STOXX 50 Distribution Points index on day t
- $\epsilon STR_t$  = Value of the European Short-Term Rate on day t

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<sup>17</sup> Same as EONIA

<sup>18</sup> The offset in the ACT calculation is implemented to reflect the fact that the EURO STOXX 50 Total Return Futures are settled on a t+2 basis.