Variance Futures on Eurex Exchange

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- Trade examples

Product concept

Underlying

- Realized variance of the EuroStoxx 50 ® index over
  - Three months
  - One year
  - Two years

Trading convention

- In notional vega at volatility strikes
- Variance recording starts at the close of the day of the trade

Clearing convention

- In Variance Futures at Variance Futures prices
- Vega is converted into an equivalent futures quantity
- Vol strikes are converted into futures prices that include past realized variance and NPV effects

Booking process

- Intraday, futures positions are booked at preliminary futures prices
- End of day, futures positions are re-booked at final futures prices→ variance recording starts with the end of day booking

Margining

- Based on Vega exposure and time to maturity
- Margin offsets versus EuroStoxx 50 ® options and VSTOXX® derivatives

Market Snapshot

Market participants quote and trade in volatility and vega in the orderbook

notional Vega

volatility strike

Market

evar | Edit | Up to: Expiry | Strike | +/- | S | C | = Type

FM	CPhase	TrdUnit	CPrevSetlPrc	CVol	CBQty	CBid	CAsk	CAQty	CLst	
⊞	Cont	1.0000	15.280000		50,000	**14.4500**	**15.2500**	50,000		**EVAR Feb17**
⊞	Cont	1.0000	17.090000		50,000	**16.6000**	**17.4000**	50,000		**EVAR Mar17**
⊞	Cont	1.0000	18.500000		50,000	**17.8000**	**18.6500**	50,000		**EVAR Apr17**
⊞	Cont	1.0000	20.520000		50,000	**20.7000**	**21.6500**	50,000		**EVAR Jun17**
⊞	Cont	1.0000	21.610000		50,000	**21.5500**	**22.6000**	50,000		**EVAR Sep17**
⊞	Cont	1.0000	22.350000		50,000	**22.2000**	**23.2500**	50,000		**EVAR Dec17**
⊞	Cont	1.0000	23.520000		50,000	**23.4000**	**24.7500**	50,000		**EVAR Jun18**
⊞	Cont	1.0000	23.880000		50,000	**23.7500**	**25.2000**	50,000		**EVAR Dec18**

Bloomberg	VETA <INDEX> CT
thomsonreuters	<0#EVAR:>

The Math

Converting Vega to futures and the vola strike to futures price

- During the day, the product trades in notional Vega at volatility strikes
- On trade match, the notional Vega of the trade will be converted into a position in Variance Futures and the traded volatility strike will be converted into a Futures price, HOW:

Converting Volatility Strike to Price:

1. Traded volatility strike is converted into variance and adjusted for the historical variance of the (running) standard Futures:

$$traded\ variance\ strike(\boldsymbol{\sigma_t})^2 = \frac{traded\ vol\ strike^2 * (Total\ days\ - elapsed\ days) + realized\ variance * elapsed\ days}{Total\ days}$$

2. Traded strike will now be converted into the standard Futures:

$$\boldsymbol{traded\ Futures\ price}(\boldsymbol{F_t}) = DiscountFactor^{*} * \left(\boldsymbol{traded\ variance\ strike}(\boldsymbol{\sigma_t})^2 - \boldsymbol{standard\ strike}(\bar{\sigma})^2\right) - ARMVM^{*} + \mathbf{3000(C^{**})}$$

Converting Vega to Futures:

1. Notional vega will be converted into Futures adjusted for the history of the (running) standard Futures. The amount is dependent on the traded price

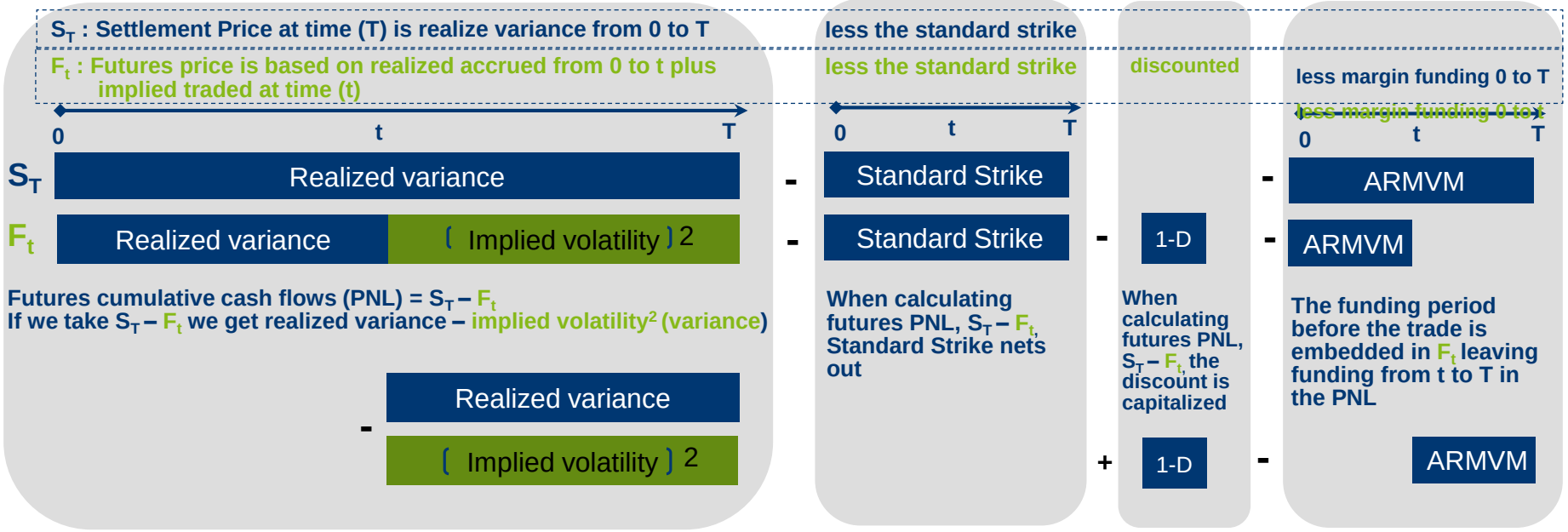
$$amount\ of\ Futures = \frac{notional\ Vega}{2 * traded\ vol\ strike(\sigma_K)} * \frac{Total\ Days(T)}{(Total\ Days - elapsed\ days(t))}$$

Variance Futures are implemented using T= amount of Variance observations
$T^{\text{Variance Futures}} = (\text{Total Days-1})^{\text{Variance Swap}}$

* Discount Factor and Accumulated Return on Modified Variation Margin (ARMVM) account for NPV effects when buying into an existing contract
** The constant keeps the Futures price out of negative territory

Illustration: How Variance Futures mimic the OTC Variance Swap PNL

- OTC Variance Swaps PNL is made in one payment at the end of the lifetime of the contract based on the realized variance over the lifetime of the swap less traded implied.
- Variance Futures PNL is made in daily variation margins. The cumulative payments of variation margin at the end of the lifetime of the contract nets out to equal the OTC pay out.



Futures P&L = Variance Swap settlement + discount - Variation margin funding P&L

Contract specifications – Overview

	EURO STOXX 50® Variance futures (EVAR)
Contract value	1 € per Variance Futures point
Contract terms	Variance Futures are available for trading at Eurex Exchange until one day before the final settlement day of each of the following terms: up to and in each case including the final settlement day of the next, the second and the third succeeding calendar month and the next three succeeding quarter-end months (March, June, September, December) and the next two succeeding half-year expiration days (June and December) thereafter
Minimum price change	0.0001 Variance Futures points
Tick value	0.0001 €
Settlement	Cash settlement
Final settlement price/ expiration day	Based on the average of the EURO STOXX 50® index calculations between 11:50 until 12:00 CET on the third Friday of the maturity month
Final settlement day	Next trading day following the last trading day
Last trading day	One business day before the third Friday of the maturity month
Continuous trading	09:00 – 17:30 CET
Eurex Trade Entry Services	9:00 – 21:00 CET
Eurex Trade Entry Services minimum size	1 contract
Trading calendar	Variance Futures will be tradable on each Eurex trading day. The maturing contract month will not be tradable on its maturity day
Trade matching/ Block Trade Entry Service	• Variance Futures are traded on-exchange in terms of notional vega at volatility. Upon matching notional vega and volatility are converted into Variance Futures at Variance Futures prices. The corresponding conversion formulas and parameters are published by the exchange. • Block trades are entered in Variance Futures at FINAL Variance Futures prices
Order maintenance	• Notional vega at volatility • Minimum order size = 1 vega • Minimum price change = 0.05 volatility points

Double booking in eVar

Realized variance is calculated between index closing prices

$\sigma^2_{realized}(0,t)$ + $\sigma^2_{implied}(t,T)$ = $E[\sigma^2_{realized}(0,T)]$

The cut off between implied and realized is the **closing price of the index** at the day of the trade

- The index closing price is not known at the time of the trade → the realized variance cannot be calculated and so the traded futures price F_t
- In order to represent the futures booking in real time, Eurex Clearing sends two trade confirmations

1. 2500 Variance Futures @ 3050 PRELIMINARY → in real time
2. 2500 Variance Futures @ 3055 FINAL → at 18:30 CET

- The FINAL price of 3055 includes the end of day index close in the realized variance component

- Clients are free to ignore the PRELIMINARY trade confirmation: it is marked as such and can be filtered out

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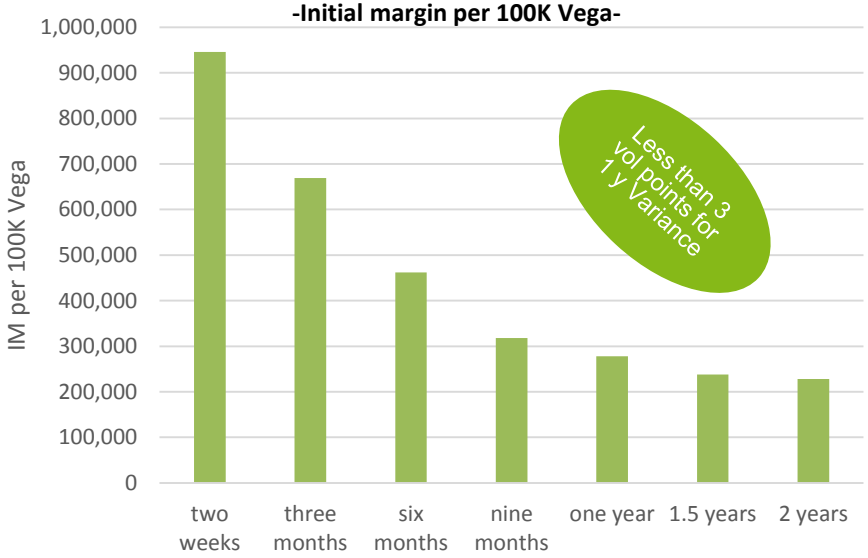
Margining in Variance Futures

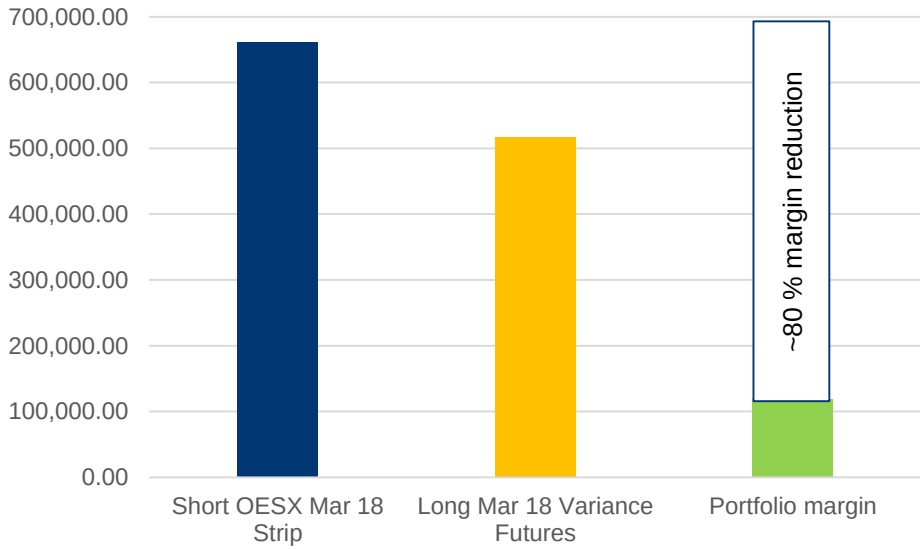
Indicative margin requirement for Variance Futures
-Initial margin per 100K Vega-



Product	Series	Size	Vega
OESX	MAR18 1500 to 3500 Put options	Variance replicating strip 6,256 options $\Delta K/K^2$ weighting	~100.000 short
OESX	MAR18 3600 to 4500 Call options		
EVAR	MAR18	6,690 long	~ 100.000 long

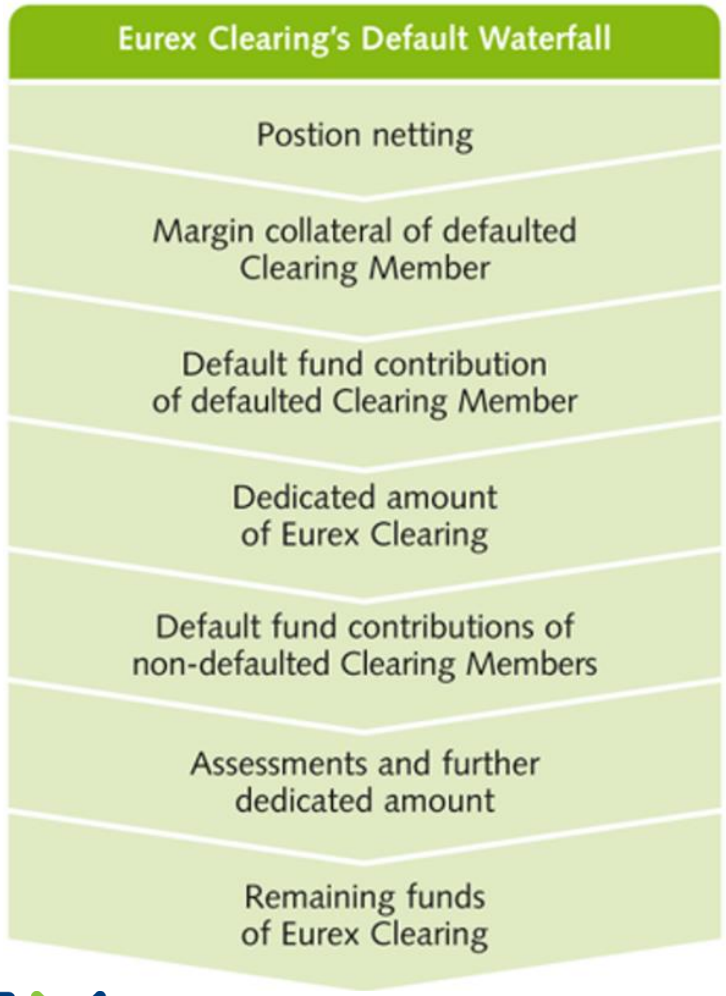
- Variance Futures are portfolio margined with
  - EuroStoxx 50® options
  - VSTOXX® Futures
  - Options on VSTOXX® Futures and VSTOXX® options
- Vega offsetting positions can generate substantial margin efficiencies

EuroStoxx options hedged with Variance Futures
-Initial margin, separate and combined-



Margin calculations as of 5 October 2017 ~ 6 months to maturity

The default waterfall



- In case of the default of a Clearing Member and the occurrence of a termination event with respect to such Clearing Member, Eurex Clearing primarily uses the financial resources provided by such defaulted Clearing Member (its margin collateral and its contribution to the Default Fund) to cover resulting losses
- If the defaulted Clearing Member's resources are insufficient to cover all losses, Eurex Clearing's own contribution to the default waterfall, the so-called dedicated amount, is applied
- If the dedicated amount is insufficient to cover all remaining losses, non-defaulted Clearing Members' contributions to the Default Fund are utilized
- If the pre-funded contributions to the Default Fund are insufficient to cover all remaining losses, Clearing Members are required to provide Eurex Clearing with additional financial resources, so-called assessments. Simultaneously to Clearing Members providing assessments, Eurex Clearing provides additional financial resources as well, the so-called further dedicated amount
- Finally, Eurex Clearing's equity capital is applied to cover any remaining losses. In addition, Deutsche Börse AG has issued a letter of comfort in favour of Eurex Clearing, according to which Deutsche Börse AG will provide Eurex Clearing with financial funding to enable Eurex Clearing to comply with its obligations

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Brexit: VSTOXX® and eVar in practice

A case study of trading strategies in response to an event

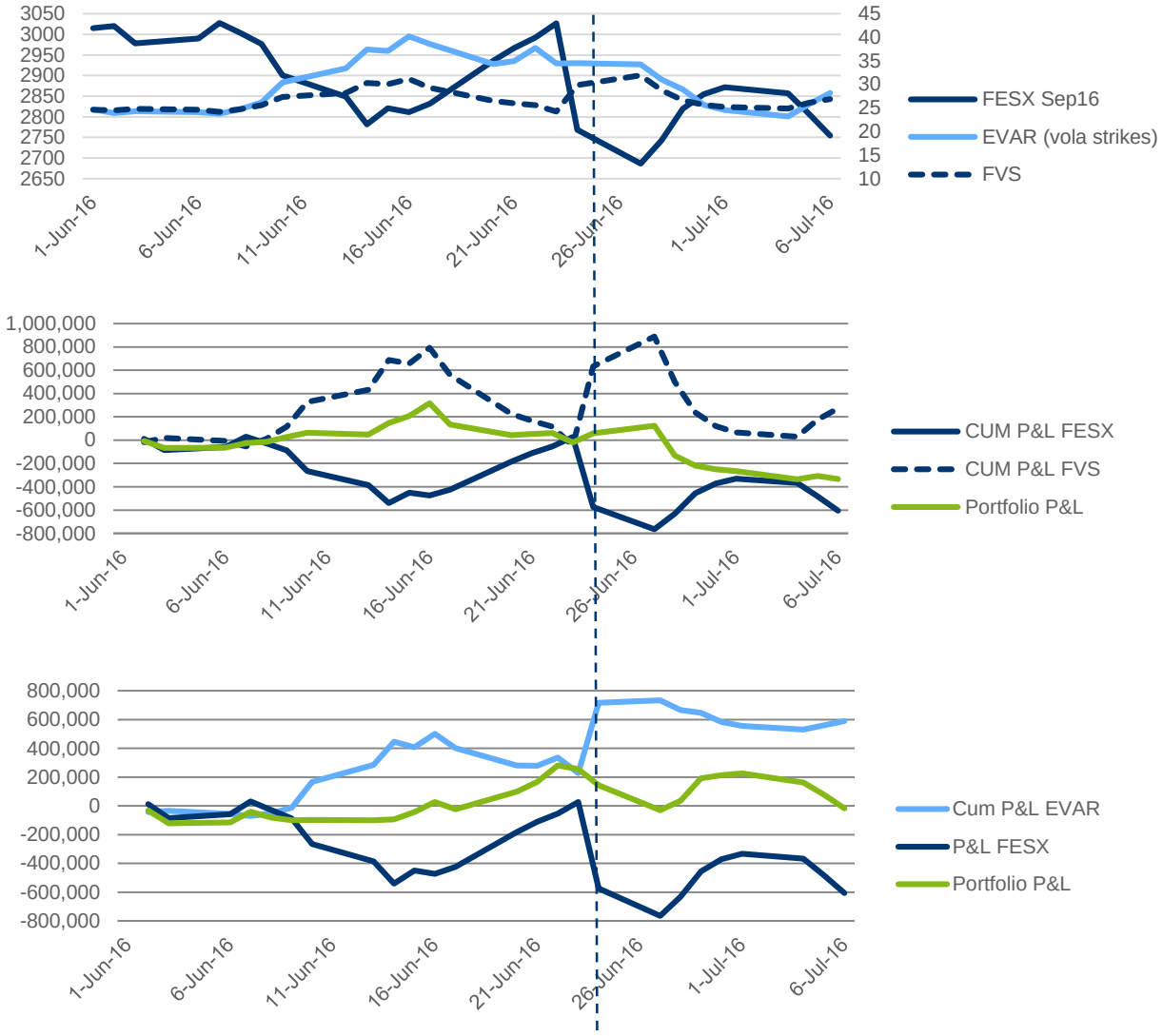
As expected, volatility and variance futures are inversely correlated with the underlying market

Using VSTOXX® futures as a hedge

- Trading VSTOXX® Index Futures in an event is more tactical. The trade needs to unwind directly after the event in order to realize the PNL of the expected trade.
- If the trade is held to expiry, implied volatility returns to pre-event levels erasing any profits
- Trade example:
  - € 7 Million notional FESX Sep16
  - € 3 Million notional VSTOXX® Futures (FVS) Jul16

Using Variance Futures as a hedge

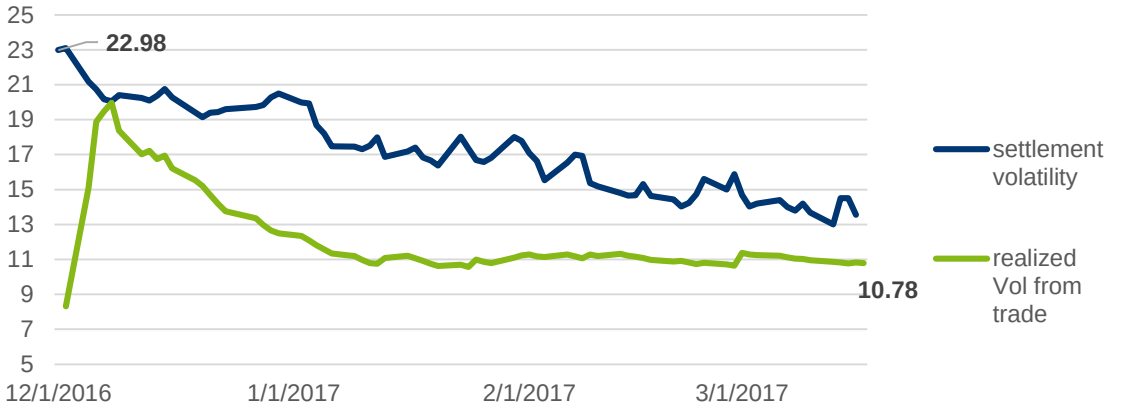
- Trading Variance Futures in an event is more strategic. The trade can be held to expiry
  - € 7 Million notional FESX Sep16
  - 40 Thousand Vega in Variance Futures (EVAR) Jul16

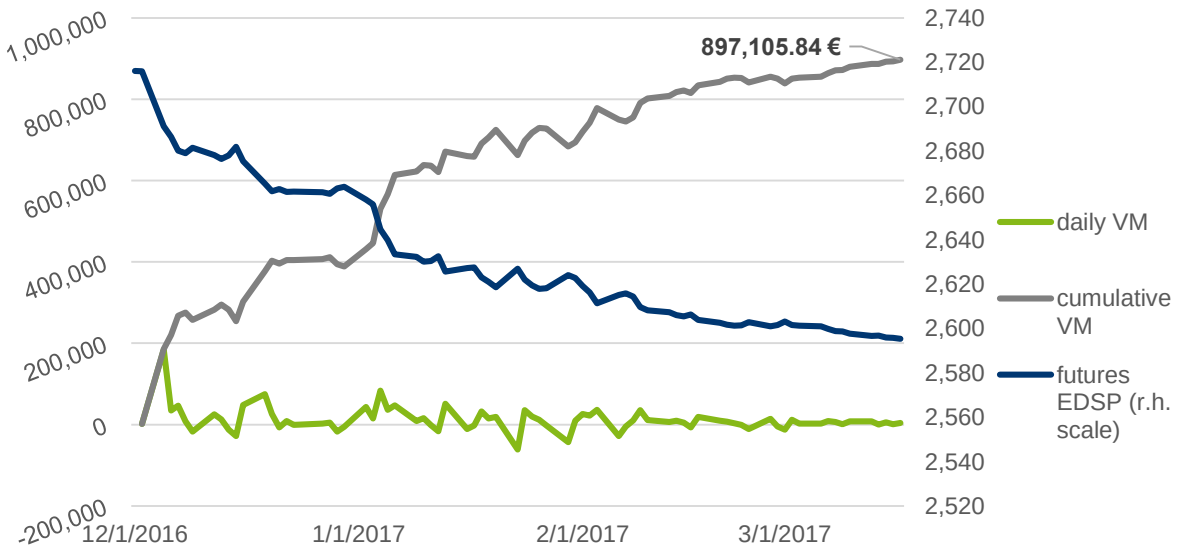


Italian referendum to French election: eVar in practice

A case study of selling variance in quiet market periods

- When implied volatility is high but markets are anticipated to be quiet in the foreseeable future, selling variance captures the difference between implied and realized volatility
- Variance futures quote in implied vol as price
- Trade example:
  - Sell 100,000 vega at 22.98% volatility
  - Translates to 7,427 futures at 2716.0849
  - Realize vol at expiry is 10.78%
  - Translates to 2595.2951
  - (2716.0849 – 2595.2951)*(7,427) = €897,105.84
- Due to convexity of variance, long positions over proportionally benefit from realized being above implied and under proportionally suffer from realized being below implied
- Short positions (the example above) vice versa





Appendix

NPV effects

- Accumulated return on modified variation margin (ARMVM) is defined as:

$$ARMVM = ARMVM_{t-1} * e^{(r(\frac{\Delta t}{365}))} + (F_{t-1} - C) * (e^{(r(\frac{\Delta t}{365})}\text{-}1)$$

  - The second term captures the daily cost of carry of the economic value of the swap. This represents the cost of carry of margin payments as the initial value of a swap is zero and hence the price of the (non) standard futures is zero. Therefore, the constant has to be removed, as well

    → At first trading day of the standard futures contract ARMVM = 0
  - The first term compounds this daily cost of carry over time
  - ARMVM aligns the OTC P&L with the Variance Futures P&L:

OTC	Variance Futures
(realized variance – variance strike)	(realized variance – variance strike) – carry profits from variation margin payment + carry losses from variation margin payments

ARMVM

- The discount factor "NPVs" the expected value of the "standard" swap between today and **maturity**

$$Discount\ factor_{\ t} = e^{(\frac{-r\ (T-t)}{365})}$$

Special – First trading day of a new contract

- On the first trading day of a new contract month there are no conversion parameters from the previous day that can be used for the preliminary conversion, intraday
- The futures starts with
  - ARMVM = 0
  - Realized variance ($\sigma^2_{realized}$) = 0
- Using settled implied volatility at the end of the day = standard strike for the new contract month creates a starting point of the new futures of 3000:

$$\textbf{Futures settlement}\ (S_t) = Discountfactor^{*} * \left(\textbf{settled implied variance}(\sigma_t)^2 - \textbf{standard strike}(\bar{\sigma})^2\right) - ARMVM^{*} + \mathbf{3000}$$

$\left(\textbf{settled implied variance}(\sigma_t)^2 - \textbf{standard strike}(\bar{\sigma})^2\right)$ = =0

$ARMVM^{*}$ = =0

- The preliminary prices that are matched during the day will all be set to 3000, the settlement price in the futures
- During the end of day conversion, the final trade prices will be calculated, using the settlement volatility as a standard strike

Special – Last trading day & maturity

- The futures settles the last time against the EURO STOXX 50® final settlement price at 12:00 CET on the third Friday of the maturity month
- On that day, trading in the futures will NOT be possible, because:
  - The equivalent Variance Swap would start and end with the same price point
  - The quantity conversion from vega to futures would lead to an error:

$$amount\ of\ Futures = \frac{Notional\ vega}{2 * traded\ vol\ strike(\sigma_K)} * \frac{Total\ days(T)}{(Total\ days - elapsed\ days(t))}$$

$(Total\ days - elapsed\ days(t)) = 0$

- Note there will be no trade/position adjustments possible until Post-Trading Full phase

Interest rate interpolation

- Linear interpolation is used in order to determine the risk free interest rate
- Inputs are the EURIBOR rates surrounding the maturity of the Variance Futures:
  - T_{K+1} – maturity of the EURIBOR rate later than the futures maturity
  - T_K – maturity of the EURIBOR rate before the futures maturity
  - T_i – maturity of the futures

$$r_i = r(T_i) = \frac{T_{k+1} - T_i}{T_{k+1} - T_k} r(T_k) + \frac{T_i - T_k}{T_{k+1} - T_k} r(T_{k+1}) \qquad T_k \le T_i < T_{k+1}$$

Variance recording at the close

- Trading and Clearing in different notations involves **conversions** from Vega to Futures and from volatility strikes to Futures prices
- Variance Futures Prices contain two major elements:
  - The realized variance from the start day of the contract until the trade day
  - The implied variance resulting from the traded volatility strike
- In order to replicate a Variance Swap trade that starts with the first underlying price observation at the end of the trading day, trades need to be converted twice from volatility to Futures prices:
  1. Intraday after a trade match: → into PRELIMINARY Futures prices
  2. End of day: → into FINAL Futures prices that **include the realized variance until the end of the trading day**
- At Eurex, these conversions are done by the Trading System “T7”
- Matched trades are reported to the **clearing** system **in Futures only**; the clearing and position keeping takes place in Futures only

Trade Example

Trade in an OTC Variance Swap on 30 May 2016

- 100,000 Vega at 22.68% volatility
  - Settlement on 19 August 2016
  - 2,205 Variance units
  - 514.38 Variance strike
  - SX5E at 3,090.01
- At settlement on 19 August 2016:
  - Final realized Variance: 766.94 (27.69% volatility)
  - Equity amount: (766.94 – 514.38) * 2,205 = **556,774.50€***
  - SX5E at 2,970.53 (12:00 EDSP)

Trade in Variance Futures on 30 May 2016

- 100,000 Vega at 22.68% volatility
  - 2,391 AUG16 Variance Futures
  - at a price of 2,974.9939

The Futures:

- **Total life time : 64 variance observations**
- **Accrued variance observations : 5**
- **Remaining life time: 59 variance observations**
- **Standard strike : 23.20%**

- At settlement on 19 August 2016:

  Final settlement price = 3,208.0365

  Cumulative variation margins:

  (3,208.0365 -2,974.9939) * 2391 = 557,301.53

  + Cumulative ARMVM

  $(ARMVM_T – ARMVM_t) * 2,391$ = -490.86**

  - Discount of the “standard” swap in t: $(1-D_t)$*(traded variance – standard strike) * number of futures

  = 36.18**

  Total P&L: = **556,774.49€***

»The difference between implied and realized volatility of 5.01% points results into a 557K € profit

*P&L is calculated using non-rounded amounts of futures/ variance units

** Negative interest rates create inverse NPV effects

Further information

Contact us

Product Development

Sascha Semroch

Eurex Frankfurt AG
Mergenthalerallee 61
65760 Eschborn
Germany

T: +49 (0)69 211 150 78

sascha.semroch@eurexchange.com

Eurex Sales

Megan Morgan

Eurex
233 S Wacker Suite 2450
Chicago, IL 60606
USA

T:+1.312.544.1083

megan.morgan@eurexchange.com