EQUITIES & EQUITY DERIVATIVES RISK ENGINE

Decorrelation risk add-on

Methodological notes

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1 Introduction

Decorrelation risk is the risk that observed risk factor correlations which underlie the what-if margin calculation actually break down when the CCP has to operate on the market. In that case, the CCP may find itself 'stuck' with *Initial Margins* which are quantified based on these correlations while the market conditions it faces are actually different. The add-on is aimed at tackling this risk.

Decorrelation can be imagined at various aggregation levels. For our purposes, the relevant aggregation level is the underlying asset one, in line with the 'Portfolio margining' rule set by EU RTS 153/2013 art. 27. This means that all the cash and derivative positions (potentially in multiple product currencies) linked to the same underlying asset will form a 'decorrelation sub-portfolio'. *Initial Margins* will be computed (also) at this 'decorrelation sub-portfolio' level and the results will be employed in the add-on calculation.

This document describes the methodology to compute the 'decorrelation sub-portfolio' *Initial Margins* and the *decorrelation risk* add-on.

The same methodology applies also in case a Clearing Member chooses to have separate margin calculations for cash and derivative positions. The only difference is that the calculations will be performed on each 'margining sub-portfolio' separately.

2 'Decorrelation sub-portfolio' margining

The portfolio *Initial Margins* are a diversified risk measure, meaning that they are computed on the margined portfolio as a whole, fully exploiting diversification benefits.

The sum of all 'decorrelation sub-portfolio' *Initial Margins* will instead lead to an undiversified risk measure, with no diversification benefits across underlying asset 'clusters'.

2.1 Reprise of *Inital Margins* calculation steps

First, the various products in the Clearing Member's portfolio are priced in the current, neutral scenario (current values of risk factors) and in the revaluation scenarios (scenario values of risk factors, which in turn are a function of current values and their returns).

Table 1: Clearing Member's portfolio's (re)valued products

Scenario	Product 1 value	Product 2 value	…	Product *n* value
Current, neutral	$P_{1,\ current}$	$P_{2,\ current}$	…	$P_{n,\ current}$
Revaluation 1	$P_{1,\ 1}$	$P_{2,\ 1}$	…	$P_{n,\ 1}$
Revaluation 2	$P_{1,\ 2}$	$P_{2,\ 2}$	…	$P_{n,\ 2}$
…	…	…	…	…
…	…	…	…	…
Revaluation LP – 1	$P_{1,\ LP-1}$	$P_{2,\ LP-1}$	…	$P_{n,\ LP-1}$
Revaluation LP	$P_{1,\ LP}$	$P_{2,\ LP}$	…	$P_{n,\ LP}$

FX rates are necessary to convert product prices (current and revalued) in the relevant clearing currency(ies). FX rates are risk factors themselves, thus are subject to revaluation as well. Current product prices are converted employing current FX rates while revalued product prices are converted employing revalued FX rates.

Table 2: (Re)valued FX rates (*m* various product currencies for a given clearing currency *xxx*)

Scenario	FX rate 111/*xxx*	FX rate 222/*xxx*	…	FX rate *mmm*/*xxx*
Current, neutral	$FX_{111/xxx,\ current}$	$FX_{222/xxx,\ current}$	…	$FX_{mmm/xxx,\ current}$
Revaluation 1	$FX_{111/xxx,\ 1}$	$FX_{222/xxx,\ 1}$	…	$FX_{mmm/xxx,\ 1}$
Revaluation 2	$FX_{111/xxx,\ 2}$	$FX_{222/xxx,\ 2}$	…	$FX_{mmm/xxx,\ 2}$
…	…	…	…	…
…	…	…	…	…
Revaluation LP - 1	$FX_{111/xxx,\ LP-1}$	$FX_{222/xxx,\ LP-1}$	…	$FX_{mmm/xxx,\ LP-1}$
Revaluation LP	$FX_{111/xxx,\ LP}$	$FX_{222/xxx,\ LP}$	…	$FX_{mmm/xxx,\ LP}$

Table 3: Clearing Member's portfolio's (re)valued products in clearing currency *xxx*

Scenario	Product 1 value in clearing currency	Product 2 value in clearing currency	…	Product *n* value in clearing currency *xxx*

	xxx	***xxx***		
Current, neutral	$P_{1, current, xxx} =$ $P_{1, current} * FX_{1/xxx, current}$	$P_{2, current, xxx} =$ $P_{2, current} * FX_{2/xxx, current}$		$P_{n, current, xxx} =$ $P_{n, current} * FX_{n/xxx, current}$
Revaluation 1	$P_{1, 1, xxx} =$ $P_{1, 1} * FX_{1/xxx, 1}$	$P_{2, 1, xxx} =$ $P_{2, 1} * FX_{2/xxx, 1}$	…	$P_{n, 1, xxx} =$ $P_{n, 1} * FX_{n/xxx, 1}$
Revaluation 2	$P_{1, 2, xxx} =$ $P_{1, 2} * FX_{1/xxx, 2}$	$P_{2, 2, xxx} =$ $P_{2, 2} * FX_{2/xxx, 2}$	…	$P_{n, 2, xxx} =$ $P_{n, 2} * FX_{n/xxx, 2}$
…	…	…	…	…
…	…	…	…	…
Revaluation LP - 1	$P_{1, LP-1, xxx} =$ $P_{1, LP-1} * FX_{1/xxx, LP-1}$	$P_{2, LP-1, xxx} =$ $P_{2, LP-1} * FX_{2/xxx, LP-1}$	…	$P_{n, LP-1, xxx} =$ $P_{n, LP-1} * FX_{n/xxx, LP-1}$
Revaluation LP	$P_{1, LP, xxx} =$ $P_{1, LP} * FX_{1/xxx, LP}$	$P_{2, LP, xxx} =$ $P_{2, LP} * FX_{2/xxx, LP}$	…	$P_{n, LP, xxx} =$ $P_{n, LP} * FX_{n/xxx, LP}$

A product P&L scenario distribution is obtained subtracting current (converted) price from scenario (converted) prices and applying product multiplier:

(1) $\widetilde{P/L}_{product,scenario} = (\tilde{P}_{product,scenario} * \widetilde{FX}_{scenario} - P_{product,current} * FX_{current}) * multiplier_{product}$

for *option* and cash products,

while subtracting current price from scenario prices, converting and applying product multiplier:

(2) $\widetilde{P/L}_{product,scenario} = (\tilde{P}_{product,scenario} - P_{product,current}) * \widetilde{FX}_{scenario} * multiplier_{product}$

for *futures*.

The difference is due to the fact that *futures* positions are subject to daily posting of *Variation margins* and do not imply any outflows/inflows at trade inception, as opposed to *options* and cash products. This has implications in terms of close-out trades, which in turn result in the above difference in formulas.

The formula for *option* and cash products also applies to physically delivered *futures* that have expired but have not settled yet and to exercised/assigned *options*, with due modifications illustrated here below.

Positions in physically delivered futures that have expired but have not settled yet

$\tilde{P}_{product,scenario}$ and $P_{product,current}$ are intended to be those of the underlying asset.

$multiplier_{product}$ is that of the *futures*.

Positions in exercised/assigned options

$\tilde{P}_{product,scenario}$ and $P_{product,current}$ are intended to be:

- *call options*: $(\tilde{P}_{underlying\_asset,scenario} - K)$ and $(P_{underlying\_asset,current} - K)$;

- *put options*: $(K - \tilde{P}_{underlying\_asset,scenario})$ and $(K - P_{underlying\_asset,current})$.

$multiplier_{product}$ is that of the *option*.

Table 4: Clearing Member's portfolio of products' P&L in clearing currency *xxx*

Scenario	Product 1 P/L in clearing currency *xxx*	Product 2 P/L in clearing currency *xxx*	…	Product *n* P/L in clearing currency *xxx*
Revaluation 1	$P/L_{1,1,xxx} = (P_{1,1,xxx} - P_{1,current,xxx}) * multiplier_1$	$P/L_{2,1,xxx} = (P_{2,1,xxx} - P_{2,current,xxx}) * multiplier_2$	…	$P/L_{n,1,xxx} = (P_{n,1,xxx} - P_{n,current,xxx}) * multiplier_n$
Revaluation 2	$P/L_{1,2,xxx} = (P_{1,2,xxx} - P_{1,current,xxx}) * multiplier_1$	$P/L_{2,2,xxx} = (P_{2,2,xxx} - P_{2,current,xxx}) * multiplier_2$	…	$P/L_{n,2,xxx} = (P_{n,2,xxx} - P_{n,current,xxx}) * multiplier_n$
…	…	…	…	…
…	…	…	…	…
Revaluation LP - 1	$P/L_{1,LP-1,xxx} = (P_{1,LP-1,xxx} - P_{1,current,xxx}) * multiplier_1$	$P/L_{2,LP-1,xxx} = (P_{2,LP-1,xxx} - P_{2,current,xxx}) * multiplier_2$	…	$P/L_{n,LP-1,xxx} = (P_{n,LP-1,xxx} - P_{n,current,xxx}) * multiplier_n$
Revaluation LP	$P/L_{1,LP,xxx} = (P_{1,LP,xxx} - P_{1,current,xxx}) * multiplier_1$	$P/L_{2,LP,xxx} = (P_{2,LP,xxx} - P_{2,current,xxx}) * multiplier_2$	…	$P/L_{n,LP,xxx} = (P_{n,LP,xxx} - P_{n,current,xxx}) * multiplier_n$

2.2 Different approach for *decorrelation risk*

Instead of computing the whole portfolio P&L scenario distribution, *d* 'decorrelation sub-portfolio' P&L scenario distributions are calculated summing (converted) P/Ls of products belonging to the same underlying asset 'cluster', applied to position size, in every scenario. *d* is the number of underlying asset 'clusters' characterizing the Clearing Member's portfolio.

(3) $\widetilde{P/L}_{decorrelation\_sub-portfolio\ j,scenario} = \sum_{i\,|\,i \in j} \widetilde{P/L}_{product\ i,scenario} * n\_contracts_i$

If one wants to express losses as positive quantities and profits as negative quantities the number of contracts must be computed subtracting long positions from short positions (S – L).

Table 5: Clearing Member's 'decorrelation sub-portfolio' *j*'s P&L in clearing currency *xxx*

Scenario	'Decorrelation sub-portfolio' *j* P/L in clearing currency *xxx*
Revaluation 1	$P/L_{j,1,xxx} = P/L_{j,1,1,xxx} * n\_contracts_1 + P/L_{j,2,1,xxx} * n\_contracts_2 + \ldots +$

	$P/L_{j, n, 1, xxx}$ * $n\_contracts_n$
Revaluation 2	$P/L_{j, 2, xxx}$ = $P/L_{j, 1, 2, xxx}$ * $n\_contracts_1$ + $P/L_{j, 2, 2, xxx}$ * $n\_contracts_2$ + … + $P/L_{j, n, 2, xxx}$ * $n\_contracts_n$
…	…
…	…
Revaluation LP - 1	$P/L_{j, LP-1, xxx}$ = $P/L_{j, 1, LP-1, xxx}$ * $n\_contracts_1$ + $P/L_{j, 2, LP-1, xxx}$ * $n\_contracts_2$ + … + $P/L_{j, n, LP-1, xxx}$ * $n\_contracts_n$
Revaluation LP	$P/L_{j, LP, xxx}$ = $P/L_{j, 1, LP, xxx}$ * $n\_contracts_1$ + $P/L_{j, 2, LP, xxx}$ * $n\_contracts_2$ + … + $P/L_{j, n, LP, xxx}$ * $n\_contracts_n$

The relevant risk measure is finally computed on the 'decorrelation sub-portfolio' P&L scenario distribution and represents the Clearing Member's *Initial Margins* for that particular 'decorrelation sub-portfolio'. The risk measure can be:

- ES (average of tail observations)/VaR (first observation outside the tail of the distribution);
- with single (only actual values of losses are taken into account)/double (absolute values of both gains and losses are taken into account) tail approach;
- if ES, with equal/different weighting of tail events.

The number of tail observations is a function of the chosen *confidence level* α and *lookback period* LP:

$n_tail_observations = LP * (1 - \alpha)$The rounding of the above multiplication is at the nearest integer. If the decimal part of the result is exactly equal to 0.5 the rounding is prudentially down. If the rounding leads to a (rounded) result of 0, 1 value is forced. In that case, the ES will coincide with that tail observation (being the average of just 1 number).

Table 6: Clearing Member's 'decorrelation sub-portfolio''s risk measure in clearing currency *xxx*

Decorrelation sub-portfolio' risk measure in clearing currency *xxx*
$P\&L_{xxx}$ risk measure

3 *Decorrelation risk* add-on computation

The *decorrelation risk* add-on calculation formula takes as inputs both the Clearing Member's portfolio *Initial Margins* (please refer to the relevant module for further details) and the set of *d* Clearing Member's 'decorrelation sub-portfolio' *Initial Margins*. By definition, the sum of the latter are always greater than (or equal to) the former.

(4) $DECO_{ordinary} = (1 - decorrelation\_parameter) * (\sum_j^d IM_{ordinary,decorrelation\_sub-portfolio\,j} - IM_{ordinary,portfolio})$

(5) $DECO_{stressed} = (1 - decorrelation\_parameter) * (\sum_j^d IM_{stressed,decorrelation\_sub-portfolio\,j} - IM_{stressed,portfolio})$