EURONEXT CLEARING

COMMODITY DERIVATIVES RISK ENGINE

Initial Margins

Methodological notes

EURONEXT CLEARING

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Introduction

The purpose of this document is to describe the steps for computing the *Initial Margins* (i.e. 'what-if margins') for the Clearing Member's portfolio subject to margining.

Segregation of positions/contracts

The positions/contracts which form a Clearing Member's portfolio must be segregated based on their type, and in some cases also expiry date. Every 'cluster' of so-identified positions/contract will form a given sub-portfolio.

For further details on such 'clustering' please refer to the Section on labelling of positions in *Mark-to-market/Variation Margins* document.

General framework

1 Risk factors impacting financial products

The driving risk factors for *Initial Margins* calculation purposes are:

- *nearby* (expiry1, expiry2, …, expiry*n*) *futures* prices;
- (implied) volatility surfaces of *nearby futures* underlying *option* contracts – pivot *moneyness* coordinates;
- risk-free interest rate curves for relevant product currencies – tenors;
- exchange rates for relevant product currency-allowed clearing currency pairs.

For a given variable the status of 'risk factor' implies that its current value undergoes revaluation under a given set of scenarios.

For variables which are not considered 'risk factor' current values are instead assumed to stay constant under the same given set of scenarios.

2 Scenario (re)valuation of financial products (per product type)

Product scenario prices are calculated by applying *holding period*-returns to its risk factors and revaluating the product.

The revaluation mechanism per product type is described below.

- Positions in *futures*:
  Current, neutral scenario price is the current price employed for *Variation Margins* calculation purposes.
  Revaluation scenario prices are obtained applying price returns of the proper *nearby* to this price, according to what outlined in Subsection 3.2.
  The profit/loss recorded in that revaluation scenario will be equal to the difference between revaluation scenario price and current, neutral scenario price.

- Positions in *options*:
  Current, neutral scenario price is the theoretical (fair, model) price computed employing current risk factor values.
  Revaluation scenario prices are the theoretical (fair, model) prices computed employing risk factor scenario values, in turn computed according to what outlined in Subsections 3.2, 3.3, 3.4. Please refer to Section 5 for pricing formulas.
  The profit/loss recorded in that revaluation scenario will be equal to the difference between revaluation scenario price and current, neutral scenario price.

3 Building of risk factor returns

3.1 Input parameters

In order to compute returns the input risk factor time series must have length at least equal to the chosen *lookback period* plus the chosen *holding period* (for the relevant *Initial Margins*).

Since a scaling procedure is applied to risk factor returns for *Ordinary Initial Margins* calculation purposes, in that case the input risk factor time series must have length equal to the chosen *lookback period* plus the chosen *holding period* and the chosen *scaling window* (employed for EWMA volatility calculation purposes).

As for *Stressed Initial Margins*, *lookback period* and *holding period* will be sufficient.

* * *

Another parametric choice is needed in order to compute *futures* price returns: for every (underlying) product (i.e. *futures*) category (and currency) it must be specified whether these returns have to be computed in relative or absolute terms. This allows the CCP to properly treat products characterized by negative prices (such as spread *futures*). It also safeguards the CCP in other cases, i.e. in case of prices suddenly approaching 0 and/or turning negative: having built both computation frameworks, a simple parameter switch (from relative to absolute) would allow to properly handle the different pricing framework. Here below is an example of parametric table illustrating the framework:

Table 1: ***Futures*** price return computation framework

Product category code	**Underlying product category code**	**Underlying product currency**	***Futures* price return computation framework**
EBM	EBM	EUR	Relative
OBM			
ECO	ECO	EUR	Relative
OCO			
EMA	EMA	EUR	Relative
OMA			
EDW		EUR	Relative
TBD1		EUR	Relative
TBD2		EUR	Absolute
TBD3		EUR	Absolute
TBD4		EUR	Absolute
TBD5		EUR	Absolute
TBD6		EUR	Absolute

TBD7	EUR	Absolute
TBD8	EUR	Absolute
TBD9	EUR	Absolute
TBD10	EUR	Absolute
TBD11	EUR	Absolute
TBD12	EUR	Absolute

3.2 *Futures* prices

As mentioned above, *nearby* (expiry1, expiry2, …, expiry*n*) *futures* prices are the elective risk factors for *futures* prices. This implies that *futures* must be day-by-day tracked as *nearbys*. An example of *nearby* is the expiry1 *nearby,* which corresponds to the front month *futures*.

This approach fully relies on market data and is preferred to two available alternatives:

- an approach which doesn't fully rely on market data, i.e. computing *futures* prices as theoretical prices employing a pricing formula with an underlying price (e.g. an underlying asset spot price or a front month *futures* price) and the risk-free interest rate curve as inputs;
  this approach would imply either the need of a reliable, robust and deep time series of values of the underlying asset spot price (which is not the case of commodities, e.g. as opposed to equities, which are traded themselves on the market) or, in case of use of front month *futures* prices, that for maturities longer than that of the front month the only risk factors would be the risk-free interest rates, which doesn't seem to be properly the case of the commodity world;
- another approach fully relying on market data, i.e. tracking and employing *constant-maturity* (ttm1, ttm2, …, ttm*n*) *futures* prices;
  this approach would be similar to the *nearby* one, but a set of reference time-to-maturities would have to be chosen in advance (e.g. 3M, 6M, 1Y, …) and almost always interpolation/extrapolation procedures would be needed to compute their daily value, as market-traded maturities would rarely coincide with reference time-to-maturities (moreover, the reference to the front month, which is the most traded and liquid maturity, would be lost).

On a given (margin) date a given *futures* must then be first traced back to a given *nearby* in order to compute price returns.

3.2.1 Relative returns

For a given day *t* in the *lookback period* and *nearby*, *futures* price returns are computed according to the following formula:

(1) $$\Delta S_{t,nearby} = \ln\left(\frac{S_{t,nearby}}{S_{t-HP,nearby}}\right),$$

where:

- $S_{t,nearby}$ is the price at time *t*;
- *HP* is the chosen *holding period*.

When it comes to applying the computed price returns (each of them representing a given scenario) to the current *futures* price to obtain scenario prices, the relevant formula is the following:

(2) $\widetilde{S_t} = S_{current} * e^{\Delta S_{t,nearby}}$,

where $S_{current}$ is the current price.

3.2.1.1 Missing historical risk factor data

One willing to build his/her model leveraging on a (potentially long) set of common, historical dates has to deal with missing data. Therefore, a method for filling data gaps is needed and this method has to be as reliable and flexible as possible.

The chosen method is employing benchmark data as fallbacks. In particular, the relative price returns computed for these benchmarks are applied to the *nearby futures* which require the filling and are paired to these benchmarks.

The pairing is reviewed at discrete time intervals or in any case needed.

Here below is an example of parametric table illustrating the pairing:

Table 2: Benchmark pairing – *Futures* price returns

Product category code	Underlying product category code	Underlying product currency	Benchmark	Benchmark product currency
EBM	EBM	EUR	EBM expiry1 *nearby* (i.e. front month)	EUR
OBM				
ECO	ECO	EUR	ECO expiry1 *nearby* (i.e. front month)	EUR
OCO				
EMA	EMA	EUR	EMA expiry1 *nearby* (i.e. front month)	EUR
OMA				
EDW		EUR	EDW expiry1 *nearby* (i.e. front month)	EUR
TBD1		EUR	TBD1 expiry1 *nearby* (i.e. front month)	EUR
TBD2		EUR	TBD2 expiry1 *nearby* (i.e. front month)	EUR

TBD3	EUR	TBD3 expiry1 *nearby* (i.e. front month)	EUR
TBD4	EUR	TBD4 expiry1 *nearby* (i.e. front month)	EUR
TBD5	EUR	TBD5 expiry1 *nearby* (i.e. front month)	EUR
TBD6	EUR	TBD6 expiry1 *nearby* (i.e. front month)	EUR
TBD7	EUR	TBD7 expiry1 *nearby* (i.e. front month)	EUR
TBD8	EUR	TBD8 expiry1 *nearby* (i.e. front month)	EUR
TBD9	EUR	TBD9 expiry1 *nearby* (i.e. front month)	EUR
TBD10	EUR	TBD10 expiry1 *nearby* (i.e. front month)	EUR
TBD11	EUR	TBD11 expiry1 *nearby* (i.e. front month)	EUR
TBD12	EUR	TBD12 expiry1 *nearby* (i.e. front month)	EUR

3.2.2 Absolute returns

For a given day *t* in the *lookback period* and *nearby*, *futures* price returns are computed according to the following formula:

(3) $\Delta S_{t,nearby} = S_{t,nearby} - S_{t-HP,nearby}$,

where:

- $S_{t,nearby}$ is the price at time *t*;
- *HP* is the chosen *holding period*.

When it comes to applying the computed price returns (each of them representing a given scenario) to the current *futures* price to obtain scenario prices, the relevant formula is the following:

(4) $\widetilde{S_t} = S_{current} + \Delta S_{t,nearby}$,

where $S_{current}$ is the current price.

3.2.2.1 Missing historical risk factor data

What illustrated for the relative return framework also applies to the absolute return one (pairing parameter table included).

However, the filling of the missing values with absolute price returns of a benchmark would potentially suffer from a scaling problem (i.e. the order of magnitude of the benchmark may be different from that of the paired *nearby futures*). Therefore, a rescaling procedure is needed: the absolute variations of the benchmark which have to be applied are rescaled up/down based on the $\frac{nearby}{benchmark}$ ratio computed employing the values at the common last available date (the variations of the benchmark are multiplied by this quantity).

3.2.3 Impact of the *futures* rolling dates (with treatment)

The use of *nearby futures* time series mandates to be careful around rolling dates (i.e. dates at which the reference *futures* for a given *nearby* changes due to the expiry of the front month *futures*). Indeed, one may happen to compute a price return based on two different instruments, which have a potentially very different time to expiry.

Indeed, for every expiry date in the past one has the following situation (assuming: *nearby* of interest: front month; *HP* = 3; expiry date of *futures xx/zzzz*: *t*):

Date (a)	Reference *futures* at (a)	Date *HP* business days before 'Date' (b)	Reference *futures* at (b)	Return
…	…	…	…	…
t+5	*yy/zzzz*	*t+2*	*yy/zzzz*	*yy/zzzz* vs *yy/zzzz*
t+4	*yy/zzzz*	*t+1*	*yy/zzzz*	*yy/zzzz* vs *yy/zzzz*
t+3	*yy/zzzz*	*t*	*xx/zzzz*	*yy/zzzz* vs *xx/zzzz*
t+2	*yy/zzzz*	*t-1*	*xx/zzzz*	*yy/zzzz* vs *xx/zzzz*
t+1	*yy/zzzz*	*t-2*	*xx/zzzz*	*yy/zzzz* vs *xx/zzzz*

t	*xx/zzzz*	*t-3*	*xx/zzzz*	*xx/zzzz* vs *xx/zzzz*
t-1	*xx/zzzz*	*t-4*	*xx/zzzz*	*xx/zzzz* vs *xx/zzzz*
…	…	…	…	…

In order to avoid this situation, a little correction must be introduced: for every commodity, one must identify all past *futures* expiry dates. Then, price returns with reference date between (expiry date + 1 business day) and (expiry date + *HP* business days) (both included) must be computed employing the next *nearby futures* price for the date *HP* business days before the reference date. This introduces consistency in the calculation of all returns, as shown in the table below:

Date (a)	Reference *futures* at (a)	Date *HP* business days before 'Date' (b)	Reference *futures* at (b)	Return
…	…	…	…	…
t+5	*yy/zzzz*	*t+2*	*yy/zzzz*	*yy/zzzz* vs *yy/zzzz*
t+4	*yy/zzzz*	*t+1*	*yy/zzzz*	*yy/zzzz* vs *yy/zzzz*
t+3	*yy/zzzz*	*t*	~~*xx/zzzz*~~ *yy/zzzz*	*yy/zzzz* vs ~~*xx/zzzz*~~ *yy/zzzz*
t+2	*yy/zzzz*	*t-1*	~~*xx/zzzz*~~ *yy/zzzz*	*yy/zzzz* vs ~~*xx/zzzz*~~ *yy/zzzz*
t+1	*yy/zzzz*	*t-2*	~~*xx/zzzz*~~ *yy/zzzz*	*yy/zzzz* vs ~~*xx/zzzz*~~ *yy/zzzz*
t	*xx/zzzz*	*t-3*	*xx/zzzz*	*xx/zzzz* vs *xx/zzzz*

t-1	*xx/xxxx*	*t-4*	*xx/xxxx*	*xx/xxxx* vs *xx/xxxx*
…	…	…	…	…

This applies waterfall-wise to all *nearbys*. By construction, the last *nearby* won't have a 'next *nearby futures*' to reference when needed. As a proxy, returns of the first *nearby* (which instead can be computed following the above process) will be applied.

3.3 *Options' underlyings' implied volatilities*

As mentioned above, for each asset (commodity) underlying *option* contracts a fixed set of pivot *nearby-moneyness* coordinates on the implied volatility surface represents the set of risk factors. A set of just one pair of pivot coordinates (e.g. *moneyness*: 1 (at-the-money) of front month *futures*) would imply that resulting volatility surface scenarios would be parallel, following the movements of that pair of pivot coordinates. On the other hand, numerous pairs would capture different aspects of volatility surface movements (slope, curvature) but be computationally unfeasible. A right balance is therefore needed.

For a given day *t* in the *lookback period*, if implied volatility data are stored as *option*-implied volatility pairs the first step is tracing back all available *options* to a given underlying *nearby*, then computing their *moneyness* ($\frac{F_t}{K}$, with F_t: underlying *futures* price and *K*: strike price) (hereinafter, the coordinates). Then, for every *nearby* every pivot *moneyness* coordinate will be matched to the implied volatility of the *option* which minimizes the distance between pivot coordinate and *option* coordinate. The chosen pivot *moneyness* coordinates will be the same for all *nearbys*. The distance equation is the following:

(5) $distance = |M_{option} - M_{pivot}|$,

where:

- M_{option}: *moneyness* of the *option*;
- M_{pivot}: pivot *moneyness*.

Having all pivot *nearby-moneyness* coordinate implied volatility data and reference *options*, for a given day *t* in the *lookback period* and pivot *nearby-moneyness* coordinate (*nearby*,*M*), underlying asset implied volatility returns are calculated according to the following formula:

(6) $\Delta\sigma_{t,nearby,M} = \ln\left(\frac{\sigma_{t,min_distance_option_t-HP}}{\sigma_{(t-HP),nearby,M}}\right)$,

where:

- σ_t is the implied volatility at time *t*;

- $\sigma_{min_distance_option_t-HP}$ is the implied volatility at time *t* of the *option* with minimum distance to the pivot coordinate at time *t-HP* (i.e. whose implied volatility is $\sigma_{(t-HP),nearby,M}$);
- *HP* is the chosen *holding period*.

For example, suppose for the front month *nearby* we track *moneyness*: 1 (at-the-money) as pivot coordinate (among others). Suppose also we are interested in the historical returns in implied volatility for the underlying *futures* ISIN IT0000000001, and one of the historical dates is the 06/01/2022. If we assume a *holding period* equal to *3 business days* the return will be between 03/01/2022 and 06/01/2022. The first input we need is the *nearby* that underlying *futures* ISIN is associated to (e.g. front month *nearby*, as the example suggests). Then, we need the reference *option* for the date 03/01/2022, that *nearby* and that pivot *moneyness* coordinate, together with its implied volatility: suppose those are *option* ISIN IT0000000002 and implied volatility 20%. We then need the implied volatility of the same *option* ISIN IT0000000002 on the 06/01/2022: suppose that it is 30%. The return associated to the 06/01/2022-pair of implied volatility pivot coordinates [front month *nearby-moneyness*: 1] combination can finally be computed as $ln\left(\frac{30\%}{20\%}\right)$, i.e. the ratio between the implied volatility on the *t* date of the *option* which is referenced for the given pair of pivot coordinates at *t-HP* and its (pivot) value on the *t-HP* date itself.

When it comes to applying the computed implied volatility returns (each of them representing a given scenario) to the current implied volatility of an *option* to obtain scenario implied volatilities for that *option*, it is important to stress that a given *option* must be first traced back to a given *nearby* and that the implied volatility returns to select for that *nearby* will be those among all pivot *moneyness* coordinates minimizing the distance between the *option* current coordinate and the pivot coordinate (see formula (5) above). The relevant formula will then be:

(7) $\tilde{\sigma}_{t,option} = \sigma_{current,option} * e^{\Delta\sigma_{t,nearby,M}}$,

where $\sigma_{current}$ is the current implied volatility.

3.3.1 Impact of the *options* expiring before underlying *futures* (with treatment)

Options on *futures* expire some days before their underlyings. This leads to the situation where there are time windows in which the front month *nearby futures* do not have *options* written on them, more precisely between the expiry date of these *options* and the introduction of a new *futures* expiry (after front month *futures* expiry date), the latter triggering the rolling process. Time windows may last roughly half a month up to an entire month.

This leads to the situation where an *option* in portfolio on a given margin date which references the front month *futures* may have gaps in the time series of pivot *moneyness* implied

volatility returns for that *nearby*, while this is not the case for underlying *futures* price returns (for which the only *caveat* is that illustrated in Subsection 3.2.3).

In order to cope with this issue, another little correction must be introduced: for every commodity, one must identify all past *option* expiry dates and underlying *futures* expiry dates. Then, in the abovementioned time window options on *futures nearby* 2 will be referenced for front month *futures nearby*.

3.3.2 Missing historical risk factor data

What illustrated for the relative *futures* price return framework also applies to the *option* underlyings' implied volatility relative returns, with due differences.

Consistently with the pivotal role of the options on *futures nearby 2* described in the paragraph above, such *futures nearby* plays the role of benchmark in case of implied volatility returns:

Table 3 - Benchmark pairing – *Option* implied volatility returns

Product category code	Underlying product category code	Underlying product currency	Benchmark	Benchmark underlying product currency
OBM	EBM	EUR	OBM expiry2 *nearby*	EUR
OCO	ECO	EUR	OCO expiry2 *nearby*	EUR
OMA	EMA	EUR	OMA expiry2 *nearby*	EUR

3.4 *Risk-free interest rates*

Risk-free interest rates are risk factors which affect the valuation of *option* contracts.

For a given day *t* in the *lookback period*, product currency (*n*) and tenor (*y*), risk-free interest rate returns are computed according to the following formula:

(8) $\Delta r_{t,n,y} = r_{t,n,y} - r_{t-HP,n,y}$,

where:

- $r_{t,n,y}$ is the rate at time *t*;
- *HP* is the chosen *holding period*.

When it comes to applying the computed rate returns (each of them representing a given scenario) to the current rate to obtain scenario rates, the relevant formula is the following:

(9) $\tilde{r}_{t,n,y} = r_{current,n,y} + \Delta r_{t,n,y}$,

where $r_{current}$ is the current rate.

3.5 *Foreign exchange rates*

Foreign exchange rates are employed to convert product currencies to clearing currency(ies) for margining purposes.

For a given day *t* in the *lookback period*, foreign exchange rate returns are computed according to the following formula:

(10) $\Delta FX_t = \ln\left(\frac{FX_t}{FX_{t-HP}}\right)$,

where:

- FX_t is the rate at time *t*;
- *HP* is the chosen *holding period*.

When it comes to applying the computed rate returns (each of them representing a given scenario) to the current rate to obtain scenario rates, the relevant formula is the following:

(11) $\widetilde{FX}_t = FX_{current} * e^{\Delta FX_t}$,

where $FX_{current}$ is the current rate.

4 Scaling of risk factors returns

Scaling of risk factor returns will be applied only for *Ordinary Initial Margins* calculation purposes.

4.1 Inputs: Parameters and risk factor values

The scaling procedure is applied to the risk factor returns computed according to the methodologies described in Section 3. As mentioned above, for scaling purposes the input risk factor time series must have length equal to the chosen *lookback period* (*LP*) plus the chosen *holding period* (*HP*) and the chosen *scaling window* (*SW,* employed for EWMA volatility calculation purposes).

In addition to these, another parameter will be employed in the procedure: the smoothing factor λ, which can take value in the interval $(0,1)$.

The time series of a given input risk factor values can be generalized as follows (sorting: by 'Date', descending):

Table 4: Risk factor value time series

Date	Risk factor value
1	v1
2	v2
…	…
…	…
LP + SW + HP - 1	$v_{LP + SW + HP - 1}$
LP + SW + HP	$v_{LP + SW + HP}$

4.2 Inputs: (Unscaled) Risk factor returns

The above time series of values can be turned into a time series of (unscaled) returns employing formula (1), (3), (6), (8) or (10) (depending on the risk factor class). This new time series of returns has now length equal to the chosen *lookback period* plus the chosen *scaling window*.

Table 5: Risk factor return time series (1)

Date	Risk factor return
1	r1
2	r2
…	…
…	…
LP + SW - 1	$r_{LP + SW - 1}$

LP + SW	r_{LP+SW}

4.3 EWMA volatility

Given the above time series of returns, for each date *t* in the *lookback period* it is then necessary to compute a EWMA volatility value. To this aim, a seed volatility value is needed as the EWMA volatility formula is a recursive formula. This seed volatility is computed as the sample standard deviation of the returns in the *scaling window*:

$$(12)\ \sigma_{seed} = \sqrt{\sum_{t=LP+1}^{LP+SW} \frac{(r_t - \bar{r})^2}{SW-1}},$$

where:

- $r_{t=LP+1,LP+2,\ldots,LP+SW}$ are the returns in the *scaling window*;
- $\bar{r}$ is the average of these returns.

The time series of returns can now be reduced to the *lookback period* time series:

Table 6: Risk factor return time series (2)

Date	Risk factor return
1	r1
2	r2
…	…
…	…
LP - 1	r_{LP-1}
LP	r_{LP}

Each return in the *lookback period* is then paired to a EWMA volatility value. The EWMA volatility formula is the following:

$$(13)\ \sigma_{EWMA,t} = \sqrt{\lambda * \sigma^2_{EWMA,t+1} + (1-\lambda) * r_t^2}.$$

Since dates in this Section's tables are ordered in descending way (from most recent to oldest), above and following formulas indicate the date preceding a given date *t* as *t+1*.

The recursiveness of the formula is evident, as $\sigma_{EWMA,t}$ depends on the value of $\sigma_{EWMA,t+1}$. The first $\sigma_{EWMA,t}$ to compute is that associated to the farthest return of the *lookback period* (the 'LP' 'Date' one in the table above). Only in this case a $\sigma_{EWMA,t+1}$ value is not available, and here is why σ_{seed} is needed. Indeed, formula (13) for $t = LP$ becomes:

(14) $\sigma_{EWMA,LP} = \sqrt{\lambda * \sigma_{seed}^2 + (1-\lambda) * r_t^2}$.

Formula (13), which is a variant of the formula $\sigma_{EWMA,t} = \sqrt{\lambda * \sigma_{EWMA,t+1}^2 + (1-\lambda) * r_{t+1}^2}$, allows to weigh differently the returns based on the current volatility regime.

Table 7: Risk factor return time series with EWMA volatility

Date	Risk factor return	EWMA volatility
1	r1	$\sigma_{EWMA,1} = f(\sigma_{EWMA,2}, r1, \lambda)$
2	r2	$\sigma_{EWMA,2} = f(\sigma_{EWMA,3}, r2, \lambda)$
…	…	…
…	…	…
LP – 1	r_{LP-1}	$\sigma_{EWMA,LP-1} = f(\sigma_{EWMA,LP}, r_{LP-1}, \lambda)$
LP	r_{LP}	$\sigma_{EWMA,LP} = f(\sigma_{seed}, r_{LP}, \lambda)$

4.4 Scaling factors

EWMA volatilities are employed to compute the scaling factors which will finally be applied to the returns in order to obtain scaled returns. The scaling factor applied to a given return *t* is computed employing the following formula (mid-volatility approach):

(15) $scaling_factor_t = \frac{\sigma_{EWMA,1} + \sigma_{EWMA,t}}{2 * \sigma_{EWMA,t}}$

where $\sigma_{EWMA,1}$ is the EWMA volatility associated to the most recent return.

Formula (15) is a variant of the full-volatility approach formula $scaling_factor_t = \frac{\sigma_{EWMA,1}}{\sigma_{EWMA,t}}$.

Table 8: Risk factor return time series with EWMA volatility and scaling factor

Date	Risk factor return	EWMA volatility	Scaling factor
1	r1	$\sigma_{EWMA,1} = f(\sigma_{EWMA,2}, r1, \lambda)$	$sf1 = f(\sigma_{EWMA,1}) = 1$
2	r2	$\sigma_{EWMA,2} = f(\sigma_{EWMA,3}, r2, \lambda)$	$sf2 = f(\sigma_{EWMA,1}, \sigma_{EWMA,2})$
…	…	…	…
…	…	…	…
LP - 1	r_{LP-1}	$\sigma_{EWMA,LP-1} = f(\sigma_{EWMA,LP}, r_{LP-1}, \lambda)$	$sf_{LP-1} = f(\sigma_{EWMA,1}, \sigma_{EWMA,LP-1})$
LP	r_{LP}	$\sigma_{EWMA,LP} = f(\sigma_{seed}, r_{LP}, \lambda)$	$sf_{LP} = f(\sigma_{EWMA,1}, \sigma_{EWMA,LP})$

4.5 Scaled risk factor returns

Scaling factors are applied to returns and scaled returns are retrieved:

(16) $scaled_risk_factor_return_t = unscaled_risk_factor_return_t * scaling_factor_t$.

Table 9: Risk factor scaled return time series

Date	Risk factor return	EWMA volatility	Scaling factor	Scaled risk factor return
1	r1	$\sigma_{EWMA,1} = f(\sigma_{EWMA,2}, r1, \lambda)$	$sf1 = f(\sigma_{EWMA,1}) = 1$	$sr1 = f(r1, sf1)$
2	r2	$\sigma_{EWMA,2} = f(\sigma_{EWMA,3}, r2, \lambda)$	$sf2 = f(\sigma_{EWMA,1}, \sigma_{EWMA,2})$	$sr2 = f(r2, sf2)$
…	…	…	…	…
…	…	…	…	…
LP - 1	r_{LP-1}	$\sigma_{EWMA,LP-1} = f(\sigma_{EWMA,LP}, r_{LP-1}, \lambda)$	$sf_{LP-1} = f(\sigma_{EWMA,1}, \sigma_{EWMA,LP-1})$	$sr_{LP-1} = f(r_{LP-1}, sf_{LP-1})$
LP	r_{LP}	$\sigma_{EWMA,LP} = f(\sigma_{seed}, r_{LP}, \lambda)$	$sf_{LP} = f(\sigma_{EWMA,1}, \sigma_{EWMA,LP})$	$sr_{LP} = f(r_{LP}, sf_{LP})$

4.6 Scaled risk factor scenario values

Scaled risk factor scenario values are obtained employing the same formulas as unscaled ones (formulas (2), (4), (7), (9) and (11)). The only difference is that scaled risk factor returns are applied to risk factor current values rather than (unscaled) risk factor returns.

5 Derivatives pricing formulas

5.1 *Options*

All cleared *options* are American-style *options* on *futures*.

Pricing is a function of (ignoring *option* expiry T and strike price K):

$$P_s = f(F_s, rfr_s, \sigma_s),$$

where:

- P_s: scenario price (including current, neutral scenario);
- F_s: scenario underlying *futures* price (including current, neutral scenario);
- rfr_s: scenario currency-relevant risk-free curve (including current, neutral scenario);
- σ_s: scenario *option* implied volatility (including current, neutral scenario).

If the *option* expiry date doesn't match a tracked tenor of the currency-relevant risk-free interest rate curve, linear interpolation (between two tenors)/flat extrapolation (before first tenor and after last tenor) techniques must be applied to tracked tenors in order to obtain current rates and scenario rates corresponding to the abovementioned date.

As stressed above, a given *option* will be revalued applying to its current implied volatility the implied volatility returns of the pivot *nearby-moneyness* coordinate minimizing the distance between the *option* current coordinate and the pivot coordinate.

5.1.1 Input parameters

A parametric choice is needed in order to compute *option* prices: for every (underlying) product (i.e. *futures*) category (and currency) it must be specified whether options have to be priced employing a model that allows negative underlying prices and/or strike prices or not. This safeguards the CCP in case of underlying prices suddenly approaching 0 and/or turning negative: having built both computation frameworks, a simple parameter switch (from regular to negative prices) would allow to properly handle the different pricing framework. Here below is an example of parametric table:

Table 10: *Option* pricing framework

Product category code	Underlying product category code	Underlying product currency	Pricing framework
OBM	EBM	EUR	Regular prices
OMA	EMA	EUR	Regular prices
OCO	ECO	EUR	Regular prices

5.1.2 Regular pricing framework

The adopted model is the Barone Adesi-Whaley model (1987).[1] Every case of failed convergence to a price (as the model includes an iterative root finding algorithm) is treated employing the Black model (1976) as fallback. Finally, the price cannot fall in negative territory and/or below the intrinsic value of the *option* ($\max(F-K,0)$ for a *call option* and $\max(K-F,0)$ for a *put option*).

5.1.2.1 Barone Adesi-Whaley model (and Black model)

$$C = (C_{BLACK} + A_2 * \left(\frac{F}{F^*}\right)^{q_2}) * I_{F<F^*} + (F-K) * I_{F\geq F^*},$$

$$P = (P_{BLACK} + A_1 * \left(\frac{F}{F^{**}}\right)^{q_1}) * I_{F>F^{**}} + (K-F) * I_{F\leq F^{**}},$$

with:

- *C*: *call option* price;
- *P*: *put option* price;
- *K*: *option* strike price;
- *F*: underlying *futures* price;
- *T*: *option* time to maturity (difference between *option* expiry date and margin date, in year fractions);
- rfr_T: currency-relevant risk-free rate corresponding to *option* time to maturity;
- σ: *option* implied volatility;
- $\Phi()$: standard Normal cumulative distribution function;
- I_x: indicator function, equal to 1 if x is true and 0 if false;
- $C_{BLACK} = e^{-rfr_T*T} * (F * \Phi(d_1) - K * \Phi(d_2))$: *call* price according to Black model;
- $P_{BLACK} = e^{-rfr_T*T} * (K * \Phi(-d_2) - F * \Phi(-d_1))$: *put* price according to Black model, with
- $d_1 = \frac{ln\left(\frac{F}{K}\right)+0.5*\sigma^2*T}{\sigma*\sqrt{T}}$ and
- $d_2 = d_1 - \sigma * \sqrt{T}$;
- $q_2 = \frac{1+\sqrt{1+8*\frac{rfr_T}{\left(1-e^{-rfr_T*T}\right)*\sigma^2}}}{2}$;
- $q_1 = \frac{1-\sqrt{1+8*\frac{rfr_T}{\left(1-e^{-rfr_T*T}\right)*\sigma^2}}}{2}$;

[1] An alternative would have been the Binomial model.

- F^*: zero value of F in the equation:
  $(F^* - K) - \left(C_{BLACK}(F^*) + \left(1 - e^{-rfr_{T^*}T} * \Phi\left(d_1(F^*)\right)\right) * \frac{F^*}{q_2}\right) = 0;$
- F^{**}: zero value of F in the equation:
  $(K - F^{**}) - \left(P_{BLACK}(F^{**}) - \left(1 - e^{-rfr_{T^*}T} * \Phi\left(-d_1(F^{**})\right)\right) * \frac{F^{**}}{q_1}\right) = 0;$
- $A_2 = \frac{F^*}{q_2} * (1 - e^{-rfr_{T^*}T} * \Phi\left(d_1(F^*)\right));$
- $A_1 = -\frac{F^{**}}{q_1} * (1 - e^{-rfr_{T^*}T} * \Phi\left(-d_1(F^{**})\right)).$

Once computed Black model prices, q_2 and q_1 quantities, it is then needed to iteratively find the value of F^*/F^{**} via root finding algorithm (please find more details in model parameters module). A_2 and A_1 quantities can then be computed and finally Barone Adesi-Whaley model prices can be retrieved.

The above formulas are retrieved from Barone Adesi-Whaley 1987 paper "Efficient analytic approximation of American option values" (Journal of Finance vol. XLII no. 2), fixing the *futures*' cost of carry $b = 0$ and substituting S with F.

5.1.3 Negative pricing framework

The adopted model is the Bachelier model.[2]

5.1.3.1 Bachelier model

$$C = e^{-rfr_{T^*}T} * ((F - K) * \Phi(d_1) + \sigma * \sqrt{T} * \varphi(d_1)),$$

$$P = e^{-rfr_{T^*}T} * ((K - F) * \Phi(-d_1) + \sigma * \sqrt{T} * \varphi(d_1)),$$

with:

- C: *call option* price;
- P: *put option* price;
- K: *option* strike price;
- F: underlying *futures* price;
- T: *option* time to maturity (difference between *option* expiry date and margin date, in year fractions);
- rfr_T: currency-relevant risk-free rate corresponding to *option* time to maturity;
- σ: *option* implied volatility;
- $\Phi()$: standard Normal cumulative distribution function;
- $\varphi()$: standard Normal probability density function;

[2] An alternative would have been the displaced Black model.

- $d_1 = \frac{F-K}{\sigma * \sqrt{T}}$.

SUB1 sub-portfolio

All (net) positions in the various instruments in a Clearing Member's portfolio and in the same product group are margined together.

1 *Initial Margins* calculation

While the aim of the *Mark-to-market/Variation Margins* is a backward-looking, product-specific evaluation of a Clearing Member's portfolio of positions (assessing current conditions or comparing current conditions to trade/previous conditions), that of the *Initial Margins* is a forward-looking ('what-if') portfolio evaluation to cover potential future post-default losses.

For *Initial Margins* calculation purposes, the same (net) positions in instruments (with relative multipliers) which are part of a Clearing Member's portfolio and are marked-to-market are then revalued under a given set of (common, risk factor variation) scenarios.

Revaluation and margining at portfolio (product group) level allows to account for hedging, diversification and cross-correlation effects within the same portfolio (product group), thus introducing margin offsetting (netting) benefits.

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 11: 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 in case of *options*, while in case of *futures* both current and revalued product prices are converted employing revalued FX rates.

Table 12: (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 13: Clearing Member's portfolio's (re)valued products in clearing currency xxx

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

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

for *options*,

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

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

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*. This has implications in terms of close-out trades, which in turn result in the above difference in formulas.

Table 14: 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	$P/L_{1,\,LP,\,xxx}$ = ($P_{1,\,LP,\,xxx}$ - $P_{1,\,current,\,xxx}$) * $multiplier_1$	$P/L_{2,\,LP,\,xxx}$ = ($P_{2,\,LP,\,xxx}$ - $P_{2,\,current,\,xxx}$) * $multiplier_2$	…	$P/L_{n,\,LP,\,xxx}$ = ($P_{n,\,LP,\,xxx}$ - $P_{n,\,current,\,xxx}$) * $multiplier_n$

A product group P&L scenario distribution is instead obtained summing (converted) P/Ls of products belonging to that same product group, applied to position size, in every scenario.

(19) $\widetilde{P/L}_{product_group,scenario} = \sum_i \widetilde{P/L}_{product\ i,scenario} * n_contracts_i$

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 15: Clearing Member's product group's P&L in clearing currency xxx

Scenario	Product group P/L in clearing currency *xxx*
Revaluation 1	$P/L_{1,\,xxx}$ = $P/L_{1,\,1,\,xxx}$ * $n_contracts_1$ + $P/L_{2,\,1,\,xxx}$ * $n_contracts_2$ + … + $P/L_{n,\,1,\,xxx}$ * $n_contracts_n$
Revaluation 2	$P/L_{2,\,xxx}$ = $P/L_{1,\,2,\,xxx}$ * $n_contracts_1$ + $P/L_{2,\,2,\,xxx}$ * $n_contracts_2$ + … + $P/L_{n,\,2,\,xxx}$ * $n_contracts_n$
…	…
…	…
Revaluation LP - 1	$P/L_{LP-1,\,xxx}$ = $P/L_{1,\,LP-1,\,xxx}$ * $n_contracts_1$ + $P/L_{2,\,LP-1,\,xxx}$ * $n_contracts_2$ + … +

	$P/L_{n,\,LP-1,\,xxx} * n_contracts_n$
Revaluation LP	$P/L_{LP,\,xxx} =$ $P/L_{1,\,LP,\,xxx} * n_contracts_1 +$ $P/L_{2,\,LP,\,xxx} * n_contracts_2 +$ $\ldots +$ $P/L_{n,\,LP,\,xxx} * n_contracts_n$

The relevant risk measure is finally computed on the product group P&L scenario distribution and represents the Clearing Member's product group *Initial Margins*.

This risk measure can be:

- ES (average of tail observations)/VaR (first observation outside the tail);
- with single (only 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* – please refer to model parameters document:

(20) $n_tail_observations = LP * (1 - \alpha)$

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 it the average of just 1 number).

Table 16: Clearing Member's product group's risk measure in clearing currency xxx

Product group risk measure in clearing currency *xxx*
$P\&L_{xxx}$ risk measure

1.1 Ordinary and Stressed historical risk measures

The chosen risk measure is based on risk factor returns which are historically simulated. This historical risk measure (i.e. *Initial Margins*) is computed under two different configurations:

- *Ordinary*;
- *Stressed*.

These are two different quantities and are the output of distinct computations. These calculations are executed on the same Clearing Members' portfolios of positions and share the vast majority of methodological details. The fundamental discrepancies are:

- risk factor returns are scaled (filtered according to dynamic volatility) for *Ordinary Initial Margins* calculation purposes only;
- chosen *lookback periods* differ in terms of length and construction methodology;
- (other) input parameters may differ.

Stressed Initial Margins play an anti-procyclical (APC) role, improving stability in margin requirements during stress periods.

Please refer to *Total Margins* document for the aggregation of the various product group risk measures, leading to the SUB1 sub-portfolio *Initial Margins*.

SUB2 sub-portfolio

All (net) positions in the various instruments in a Clearing Member's portfolio are margined separately, thus each forming a single-instrument sub-sub-portfolio. The segregation of these positions from the positions in SUB1 sub-portfolio and the adjustment to the *Initial Margins* computed allows the CCP to approach the potential physical delivery phase with a more conservative margin buffer.

1 *Initial Margins* calculation

What illustrated above on SUB1 sub-portfolio applies, with the only difference that a full product group revaluation is replaced by the revaluation of a set of single-instrument sub-sub-portfolios.

For a given single-instrument sub-sub-portfolio, tables Table 11 to Table 14 simplify to a single-product case. Similarly, sub-sub-portfolio scenario P/L equation will involve no summations.

2 *Initial Margins* adjustment

Once computed the *Initial Margins*, their value is floored at a certain percentage of the expected *futures* position settlement value. Such percentage is obtained multiplying the *margin_percentage* parameter shared with SUB3 sub-portfolio by a daily increasing parametric fraction of it (*increasing_percentage*).

Hence, the final *Initial Margins* formula will be as follows ('usual' *Initial Margins* are named $IM_{risk_measure}$ rather than simply *IM*):

(21) $$IM = IM_{risk_measure} + \max\left(F * |n_{contracts}| * multiplier_{product} * margin_percentage * increasing_percentage - IM_{risk_measure}; 0\right),$$

where:

- F: current *futures* price;
- $n_{contracts}$: position size, with sign (+: long; -: short);
- $multiplier_{product}$: *futures* multiplier;
- $margin_percentage$: percentage of the expected *futures* position settlement value;
- $increasing_percentage$: daily increasing fraction of the above.

Here below is an example of parametric tables illustrating the possible *margin_percentage* and *increasing_percentage* values:

Table 17 - Margin percentage

Underlying product category code	Underlying product code	Position sign	*margin_percentage*
EBM	EUR	+ (i.e. long)	100%
ECO	EUR	+ (i.e. long)	0%
EMA	EUR	+ (i.e. long)	100%
EBM	EUR	- (i.e. short)	60%
ECO	EUR	- (i.e. short)	0%
EMA	EUR	- (i.e. short)	60%

Table 18 - Increasing percentage

increasing_percentage
$\frac{HP-(T-t)}{HP+1}$

Here *HP* is the model *holding period*, *T* is the expiry date of the *futures* and *t* is the margin date ((*T-t*) being their difference in business days).

Please refer to *Total Margins* document for the aggregation of the various sub-sub-portfolios risk measures, leading to the SUB2 sub-portfolio *Initial Margins*.

SUB3 sub-portfolio

All contracts in a Clearing Member's portfolio are prudentially margined separately, thus each constituting a single-contract sub-sub-portfolio.

1 *Initial Margins* calculation

The *Initial Margins* for this sub-portfolio type are quite different from those of the other two, as this only contains expired (*futures*) contracts triggering the physical delivery process. The main rationale behind these margins is that from the expiry date onwards in case of default the CCP can find itself in the position of (indirectly) going on the spot market to buy/sell the underlying asset (i.e. commodity), risking to 'suffer' a negative price difference between the underlying spot price and the *futures* delivery settlement price (hereinafter also *DSP*).

Therefore, the underlying commodity spot price is the relevant risk factor for contracts in this sub-portfolio. Since underlying commodity spot prices (current and historical values) retrievable from external data sources lack representativity (there are also availability and/or depth concerns), the (commodity-relevant) front month (i.e. expiry1 *nearby*) *futures* price historical returns are employed as a reasonable proxy of underlying riskiness, i.e. in order to simulate the evolution of the underlying sport price.

For every contract one has to start retrieving the *DSP* (determined at expiry date, and matching at that date the underlying spot price by market construction – convergence of the *futures* price to the spot price as time to expiry shortens).

This *DSP* is the price in current, neutral scenario.

In revaluation scenarios the proper front month *futures* price historical returns are applied to this value. These returns are computed employing a *holding period* equal to *HPpd*, hence different from the model *holding period*. This *physical delivery holding period* takes into account the number of business days available to the CCP for (indirectly) going on the spot market and the length of the delivery process, and allows to reflect the fact that the last available underlying spot price dates back to *futures* expiry date *T*.

Here below are examples of parametric *HPpd*:

Table 19 - *HPpd*

Underlying product category code	Underlying product currency	*HPpd*
EBM	EUR	*12*
ECO	EUR	*27*
EMA	EUR	*12*

Table 11 shown for SUB1 sub-portfolio purposes changes in light of the above:

Table 20: Clearing Member's sub-portfolio's (re)valued product

Scenario	Product value
Current, neutral	$P_{current} = DSP$
Revaluation 1	$P_1 = DSP_1$
Revaluation 2	$P_2 = DSP_2$
…	…
…	…
Revaluation LP – 1	$P_{LP-1} = DSP_{LP-1}$
Revaluation LP	$P_{LP} = DSP_{LP}$

with:

(22) $DSP_t = (DSP * e^{\Delta S_{t,front_month}})$ or
(23) $DSP_t = (DSP + \Delta S_{t,front_month})$,

depending on the adopted return framework. Please refer to Section 3.2 to better understand the computation of $\Delta S_{t,front_month}$, bearing in mind that the model *holding period HP* must be replaced by the *physical delivery holding period HPpd*.

The rest of the steps illustrated for SUB1 sub-portfolio purposes almost completely applies.

A full portfolio revaluation is replaced by the revaluation of a set of single-contract sub-sub-portfolios. For a given single-contract sub-sub-portfolio, tables Table 11 to Table 13 simplify to a single-product case.

The relevant product scenario P/L equation will follow *option* model rather than *futures* model.

Table 14 also simplifies to a single-product case.

Sub-sub-portfolio scenario P/L equation will involve no summations.

Ordinary-Stressed double tracks still apply.

2 *Initial Margins* adjustment

Once computed the *Initial Margins*, their value is multiplied by a parametric process-linked compensatory element (*extra_percentage*) and then floored at a certain percentage of the *futures* delivery settlement value. Such percentage is obtained adding the *margin_percentage* parameter shared with SUB2 sub-portfolio and a parametric process-linked fee percentage (*fee_percentage*).

In particular, focusing on the *margin_percentage*, the reason behind it is that the CCP must also protect itself from the risk that the buyer receives (part of) the goods before paying the settlement amount due to the seller (as no *delivery vs payment* – *dvp* – system applies) and defaulting. This is a possibility, despite theoretical, which if happened would leave the CCP without the possession of the goods to (indirectly) sell on the spot market to a third party. A similar protection layer is envisaged as capable of being triggered also for sellers' positions, for the sake of symmetry and conservativeness of the margins.

Hence, the final *Initial Margins* formula will be as follows ('usual' *Initial Margins* are named $IM_{risk_measure}$ rather than simply *IM*):

(24) $$IM = IM_{risk_measure} * (1 + extra_percentage) + \max\left(DSP * |n_{contracts}| * multiplier_{product} * (margin_percentage + fee_percentage) - IM_{risk_measure} * (1 + extra_percentage); 0\right),$$

where:

- $extra_percentage$: buffer percentage to the computed *Initial Margins*;
- *DSP*: *futures* delivery settlement price determined at its expiry;
- $n_contracts$: contract size, with sign (+: long; -: short);
- $multiplier_{product}$: *futures* multiplier;
- $margin_percentage$: percentage of the *futures* delivery settlement value;
- $fee_percentage$: percentage of the *futures* delivery settlement value used to cover fees.

Here below is an example of parametric tables illustrating the possible *extra_percentage*, *margin_percentage* (also illustrated for SUB2 sub-portfolio purposes) and *increasing_percentage* values:

Table 21 - Extra percentage

Underlying product category code	Underlying product currency	*extra_percentage*
EBM	EUR	10%
ECO	EUR	10%
EMA	EUR	10%

Table 22 - Margin percentage

Underlying product category code	Underlying product code	Position sign	*margin_percentage*
EBM	EUR	+ (i.e. long)	100%
ECO	EUR	+ (i.e. long)	50%
EMA	EUR	+ (i.e. long)	100%

EBM	EUR	- (i.e. short)	60%
ECO	EUR	- (i.e. short)	0%
EMA	EUR	- (i.e. short)	60%

Table 23 – Fee percentage

Underlying product category code	Underlying product currency	*fee_percentage*
EBM	EUR	3%
ECO	EUR	3%
EMA	EUR	3%

Please refer to *Total Margins* document for the aggregation of the various sub-sub-portfolios risk measures, leading to the SUB3 sub-portfolio *Initial Margins*.

Disclaimer

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