EURONEXT CLEARING

FIXED INCOME RISK ENGINE

Repo-concentration risk add-on

Methodological notes

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1 Introduction

R*epo* (both *term* – i.e. whose spot leg has already settled – and *forward starting* – i.e. whose spot leg has yet to settle) trades require the CCP to perform at least one closing *repo* trade in case of default by one of the two couterparties, as illustrated in Mark-to-market Module. This closing *repo* trade, having opposite sign with respect to the original defaulter's one, is assumed to be performed at evaluation date *t* (when margins are calculated).

Its particular features are:

- *Duration*: depending on the duration (*forward starting*)/residual duration (*term*) of the original *repo* trade;
- *Collateral security price*: dirty nominal market price;
- *Repo rate*: paid by the *long* counterparty (spot: cash borrower/bond seller, term: viceversa) to the *short* counterparty (spot: cash lender/bond buyer, term: viceversa), can be broken down into a risk-free component and a component linked to the riskiness and the appetibility of the collateral security, as well as of the length and amount of the *repo* operation.

A *repo rate* can indeed take on positive or negative values depending on the liquidity of the money market (inverse function), the riskiness of the collateral security (direct function) and the appetibility of the collateral security (*special* rather than *general collateral* – inverse function), and on the combination of these factors. Also length and amount of the *repo* operation impact directly on its rate.

The risk-free component will be shocked for the purpose of the *add-on* computation, in order to account for potential significant changes to the relevant yield curve (what-if scenario), especially in relation to high-amount medium/long-term trades (for which the market liquidity is lower), without prejudice to what has already been calculated for *mark-to-market margins*.

For *mark-to-market margins* calculation purposes the rate of a *repo* trade is compared to the rate of the hypothetical closing *repo* operation, observed on the market (composed employing the current EUR OIS curve and keeping constant the original spread to the EUR OIS curve at trade date), and the difference (credit or debit, discounted) contributes to the calculation of the *margin* itself.

Shocks will be computed with a set of parameters (in particular, *holding periods*) which worsen as the *repo* length and amount are concentrated towards medium/long-term maturities, which are deemed to be far less liquid.

The input data needed for the calculation of the *add-on* are:

- *Evaluation date t*;

- *Original repo trade spot leg settlement date* T_1;
- *Original repo trade term leg settlement date* T_2;
- *Dirty nominal market price* P_{mkt} *of the original repo trade collateral security at evaluation date* t;
- *Original repo trade principal amount* N;
- *Original repo trade sign (long L: +, short S: -)*;
- *EUR OIS spot curve at evaluation date t*;
- *Complete time series of the various tenors of the aforementioned curve.*

The model parameters are instead:

- *Concentration thresholds;*
- *Holding period HP(s)* →

SAMPLE COUNTRY MATRIX		
REPO MATURITY BAND	**REPO AMOUNT BAND**	**HP**
(7-31]	(0-500,000,000]	5
(7-31]	(500,000,000-1,000,000,000]	5
…	…	…
(31-93]	(0-500,000,000]	5, 6
(31-93]	(500,000,000-1,000,000,000]	5, 6, 7
…	…	…
…	…	…

- *Lookback period LP(s);*
- *Confidence level(s)* α*;*
- *Single tail st/double tail dt approach;*
- *Value at Risk VaR/Expected Shortfall ES approach;*

Currently this concentration parametric stress doesn't apply to interoperable CCP nor to those Participants which are considered of strategic importance in sustaining the Italian public debt by mean of their "institutional" activity.

2 Methodology

In light of what illustrated in Mark-to-market Module, in case of default of the *long* counterparty the closing *repo* trade *interest* R_2 will be received by the CCP, which would thus benefit from a potential increase in the *repo rate*, all other factors being equal.

Instead, in case of default of the *short* counterparty R_2 will be paid by the CCP, which would thus benefit from a potential decrease in the *repo rate* of the closing *repo* trade, all other factors being equal.

Here below a representation for an original *term repo* trade:

When	*Original term repo trade term leg settlement date* T_2
What	$\pm R_2 = f(r, (T_2\text{-}t), P_{mkt}, N, sign)$

with *r*: *repo rate* (%) of the closing *term repo* trade;

$$R_2 = r/100 * (T_2 - t)_{days}/360 * P_{mkt} * N/100 * sign$$

and for an original *forward starting repo* trade:

When	*Original forward starting repo trade term leg settlement date* T_2
What	$\pm R_2 = f(r, (T_2\text{-} T_1), P_{mkt}, N, sign)$

with *r*: *repo rate* (%) of the closing *forward starting repo* trade;

$$R_2 = r/100 * (T_2 - T_1)_{days}/360 * P_{mkt} * N/100 * sign$$

The effects of a potential significant variation in *r* can be captured by revaluing the relevant yield curve in *LP* historical scenarios and picking the worst variation in terms of *repo interest* for the Clearing Member, given the employed parameter set. This variation will contribute to the definition of the *add-on* at evaluation date *t*.

It should be borne in mind that a Clearing Member's portfolio is usually made up of multiple *repo* trades, often with opposite sign: the effect of the variation in *r* must therefore be assessed at entire portfolio level, and not at single trade level.

The calculation steps are the following:

For every portfolio:

1) Take *repo* and *forward starting repo* positions only;

For every Country in the portfolio:

a) Compute *repo* maturities in terms of calendar days, *i.e.* term leg settlement dates T_2 – evaluation date t;
b) Compute *repo* lengths in terms of calendar days, *i.e.* term leg settlement dates T_2 – spot leg settlement dates T_1 (then employed for *forward starting repos* only);
c) Compute closing *repo interest trade-dependent* components for every *repo* (act/360 day count convention):

$$R_{2,trade} = (T_2 - t)_{days}/360 * P_{mkt} * N/100 * sign$$ for *term repos,*

*i.e. repo maturity/360 * current market value * sign*,

$$R_{2,trade} = (T_2 - T_1)_{days}/360 * P_{mkt} * N/100 * sign$$ for *forward starting repos,*

*i.e. repo length/360 * current market value * sign*;

d) Sum *repo* principal amounts (taken with sign) and closing *repo interest trade-dependent* components (taken with sign) by *repo* maturity: a net principal amount-closing *repo interest trade-dependent* component pair per *repo* maturity will be obtained;
e) Drop *repo* maturities having net principal amount equal to 0;
f) Identify the *HP* set applied to the *repo* maturity looking at *repo* maturity-(absolute value of) principal amount pair and detecting the appropriate set in the *HP* parameter matrix;
g) Drop *repo* maturities having null *HP* set (coherent to current default procedure);
h) Linearly interpolate potentially missing tenors of EUR OIS curve corresponding to *repo* maturities, employing contiguous tenors;

For every *repo* maturity ←→ EUR OIS curve (potentially interpolated) tenor:

i) Turn the rate time series (x_t, x_{t-1}, ...) into n rate absolute variation time series ($x_t - x_{t-HP}$, $x_{t-1} - x_{t-HP-1}$, ...), one per *HP* identified at point f) above for the *repo* maturity;
ii) Multiply the *repo* maturity *repo interest trade-dependent* component (taken with sign) computed at point d) above times each variation of each *HP*: this way n shock time series are obtained, one per *HP*: these are shocks to the *repo interest* the CCP will have to face (receive/pay) in case of default of the counterparty whose portfolio is subject to margining (if the *repo interest trade-dependent* component is positive the CCP will be a net recipient for that *repo* maturity, and viceversa);
iii) Discount to evaluation date t (employing continuous compounding and *act/360* day count convention) above computed shocks, employing most recent EUR OIS tenor rate i in the following formula:
    - $shock\_present\_value\_{i,j} = shock\_{i,j} * 1/(1+i/100)^\wedge(tenor/360)$, with i: *HP* and j: scenario
iv) Compute the numbers of tail events for each discounted shock time series employing following formula:
    - $tail\_events\_number = round(len(time\ series) * (1- \alpha);0)$
v) For every discounted shock time series of all *HPs* a risk measure will be computed, according to the given parameter set:

		EXPECTED SHORTFALL	
		True	**False**
DOUBLE TAIL	**True**	Take absolute values of discounted shocks, then take *tail_events_number* biggest shocks and compute their average	Take absolute values of discounted shocks, then take *tail_events_number+1st* biggest shock
	False	Take *tail_events_number* most negative discounted shocks, take absolute values and compute their average	Take *tail_events_number+1st* most negative discounted shock and take absolute value

vi) The *repo* maturity risk measure will be the most conservative among all risk measures computed for all *HPs*

For every Country in the portfolio:

i) The sum of the risk measures for every *repo* maturity corresponds to the Country *add-on*

Per every portfolio:

2) The sum of the Country *add-ons* corresponds to the portfolio *add-on*