RepoClear SA

User's Specification

The Markets' Partner

Margining Methodology
on Bonds Cash and Repo Transactions
cleared by LCH.SA

Summary:

I. Foreword

This document is a guide to the development of a procedure for the calculation of margins on cash and repo (both «Classic», and «Buy-Sell-Back»1) bond transactions cleared by LCH. SA.
The calculation method is applicable for all bonds cleared by LCH.SA.
The margining methodology foresees the following types of margins:

- **Mark-To-Market Margins (Contingent Variation Margin)**, which re-evaluate on a daily basis the portfolio to the market
- **Initial Margins**, which evaluate the largest possible loss under the hypothesis of portfolio liquidation in the most unfavorable price/yield scenario reasonably possible

II. Calculation of Contingent Variation Margins

An example is provided in Annex 2.
The calculation is done trade by trade on the following steps:

1) Retrieval of market prices

In order to re-evaluate positions at their current market value, “mark-to-market” prices are used; such prices are representative of market conditions at the end of the trading day.

For Italian Government bonds and Spanish Government bond, prices are provided by MTS Italy and MTS Spain.
For others debts, prices are provided by a data provider.

2) Selection of transactions to be included

The following positions are included in calculation of Variation Margins:
- For cash transactions, all unsettled transactions as of margin calculation date
- For repo transactions, all transactions whose first “cash” leg has already been settled and its “forward” leg is still unsettled as of margin calculation date

[1] The main difference between «Classic» and «Buy-Sell-Back» Repos is in the management of coupons paid during the transaction. In «Classics», coupons paid on the bond during the term of the transaction are required to be paid on to the original seller upon receipt. Whereas in « Buy-Sell-Back » coupons are deemed to be paid to the buyer and reinvested at the repo rate until the termination of the transaction. The coupon amount plus the interest accrued from coupon payment date to transaction settlement date is then deducted from the cash to be received at the termination date.

3) Calculation of the accrued coupon

The time interval to be considered in coupon accrual calculation changes according to the type of contract:

a) For cash transactions, the accrued coupon is calculated starting from the maturity date of the previous coupon until the settlement date; it is not necessary to update such calculation during the two days between the trade date and the settlement date given that the accrual can be considered irrelevant for margining purposes
b) For repo transactions, the accrued coupon is calculated starting from the maturity date of the previous coupon until the first working day after margin calculation; in this case the accrual is considered relevant for margining purposes

The accrued coupon will be calculated according to the "Euroland" market convention: act/act.

4) Determination of Return Amount of the Initial Transaction

For Cash trades, The Return Amount of the Initial Transaction (RAIT) is equal to Traded Amount (TA):

RAIT = TA

For Repo, the Return Amount of the Initial Transaction (RAIT) is equal to the Traded Amount (TA) plus the Repo Interest (RI) minus the potential Coupon (C) during repo for Buy-Sell Back including interest on the coupon

RAIT = TA + RI – C

With $$RI = \frac{t \times TA \times RR}{36.000}$$

where *t* is number of days of the initial Repo and *RR* is the initial repo rate.
For Repo indexed on EONIA, RR is estimated with a weighted average between past known EONIA and OIS curve for future EONIA rate.

5) Determination of the Transaction Revaluated Amount

The Transaction Revaluated Amount (*TRA*) is equal to the nominal value (*NV*) of the traded security, revaluated at the current market price (*P*) as per 1) above, plus the accrued coupon (*AC*) calculated as per step 3) above. Therefore:

TRA = (NV/100) × (P + AC)

In case of bond indexed on inflation rate, the Transaction Revaluated Amount (*TRA*) is equal to the nominal value (*NV*) of the traded security, revaluated at the current market price (*P*) as per 1) above, plus the accrued coupon (*AC*) calculated as per step 3) above. This amount is multiply by the inflation index (Iidx) available for the intended settlement date. Therefore:

TRA = (NV/100) × (P + AC) × Iidx

6) Determination of Return Amount of the Replacement Transaction

For Cash trades, The Return Amount of the Replacement Transaction (RART) is equal to Traded Revaluated Amount (TRA):

RART = TRA

For Repo, the Return Amount of the Replacement Transaction (RART) is equal to the Traded Revaluated Amount (TRA) plus the Repo Interest (RI) minus the potential Coupon (C) during repo for Buy-Sell Back including interest on the coupon:

RART = TRA + RI – C

With $RI = \frac{t \times TA \times RR}{36.000}$

Where:

- TA = TRA
- *t* is number of days of the Replacement Repo from the calculation date plus one open day to the return date of the initial repo
- *RR* is the repo rate from Euro Repo Rate

7) Calculation of Mark-To-Market Margin per transaction

The Mark-To-Market Margin is equal to the difference between the **Return Amount of the Replacement Transaction** as per 5) above and the **Return Amount of the Initial Transaction** as per 5) above, discounted with Euribor.

Mark-To-Market Margin = (RART–RAIT)×position sign[2] / (1+r*(T-t-1)/360)

With:

- R= Euribor Rate
- T = Return date of the initial repo
- t = Calculation date

8) Calculation of the Overall Mark-To-Market Margin

The Overall Mark-To-Market Margin is equal to the sum of all the Mark-To-Market Margins calculated for each transaction.

Overall Mark-To-Market Margins = Σ Mark-To-Market Margins per each transaction.

A negative Mark-To-Market Margin is a debit for the member towards the CCP; a positive Mark-To-Market Margin is a theoretical credit for the member.

[2] **The buyer of a cash bond has a long position (+1), and the seller a short position (-1). The holder of a repo has a long position (+1), the holder of a reverse repo has a short position (-1).**

III. Calculation of Initial Margins

The methodology is based on the following steps:

1) Selection, evaluation and classification of transactions to be included

a) Selection of transactions

The following positions are evaluated (as in the case of the calculation of Variation Margins):

- For cash transactions, all unsettled transactions at margin calculation date
- For repo transactions, all transactions whose first "cash" leg has already been settled and its "forward" leg is still unsettled

b) Transaction evaluation

In order to obtain a single net balance for each security (identified by its ISIN code), long and short positions are algebraically summed (at their re-evaluated countervalue), independently of the transaction type (cash or repo) from which they have arisen.

c) Classification of portfolio securities

Net positions calculated at sub-step b) above are then divided in Classes by country, according to their sensitivity to interest rates fluctuations. Macaulay Duration is used as an indicator of such sensitivity (see VI Annex 1Annex1 - Duration Calculation).
Since duration changes every day it is necessary to reallocate daily securities in Classes.
Duration Classes are provided in a Risk Notice:

https://www.lch.com/risk-collateral-management/group-risk-management/risk-management-sa/sa-risk-notices-0

2) Determination of marginable positions

In order to take into consideration the opposite sensitivity to interest rate variations of positions of different signs, positions are reduced by a procedure that – keeping into consideration correlations between securities sorted by Duration Classes – determines the "Marginable Positions" that is the unbalanced positions on which margins must be calculated.

In order to achieve such aim, a sequence of offsetting priorities is determined according to a specific list (see **Erreur ! Source du renvoi introuvable.**); positions are offset within the same Duration Class (*Intra* Class Priority) and subsequently among different contiguous Duration Classes (*Inter* Class Priority). A Cross-Position Offsetting Factor is associated to each Priority.

Therefore, according to the established priority sequence, long and short positions within the same class are decremented by an amount equal to the Cross-Position Offsetting Factor applied to the smaller of he two positions.

Decremented Long Position Class n = Long Position Class n – [priority n Cross-Position Offsetting Factor × min (Long Position Class n; Short Position Class n)]

Decremented Short Position Class n = Short Position Class n – [priority n Cross-Position Offsetting Factor × min (Long Position Class n; Short Position Class n)]

When Inter Class Priorities are considered, both the long and the short position of one Class will be decremented of an amount equal to pertinent *Inter* Class Cross-Position Offsetting Factor applied to he smaller between the position itself and the position of opposite sign of the other Class.

Decremented Long Position Class n = Long Position Class n – [priority nm Cross-Position Offsetting Factor × min (Long Position Class n; Short Position Class m)]

Decremented Short Position Class n = Short Position Class n – [priority nm Cross-Position Offsetting Factor × min (Long Position Class m; Short Position Class n)]

Decremented Long Position Class m = Long Position Class m – [priority nm Cross-Position Offsetting Factor × min (Long Position Class m; Short Position Class n)]

Decremented Short Position Class m = Short Position Class m – [priority nm Cross-Position Offsetting Factor × min (Long Position Class n; Short Position Class m)]

For each Class the results obtained by the application of Priority *n* Cross-Position Offsetting Factor is the starting point for the application of Priority *n+1* Cross-Position Offsetting Factor.

Countervalues are rounded to the nearest integer euro before and after each calculation.

Priority and Offsets Classes are provided in a Risk Notice.

3) Calculation of Initial Margin

For each Class, long and short "Marginable Positions" – which have been obtained through the above described procedure – are compared and the largest (in absolute value) among them is multiplied by a coefficient (*Deposit Factor*) specifically established for that Duration Class.

Initial Margin per Class = Class Deposit Factor × Max (Long Marginable Position; Short Marginable Position)

The result is rounded to the nearest integer euro.

Initial Margins for each Duration Class are then summed up in order to obtain the total Initial Margins:

Total Initial Margins = Σ Initial Margin per each Duration Class

IV. Calculation of Total Margins

Total Margins are equal to the sum of Contingent Variation Margins, Initial Margins and potential Additional Margin. Should the amount Contingent Variation Margins credit be larger than the amount of Margin debits, the difference is not paid out to the member, being just a theoretical credit.

The Additional Margins are not described in this document.

Total Margins = Max (Initial Margins + Additional Margins - Mark-To-Market Margins; 0)

If Total Margins are a debit for the member, calculation of Total Margin can provide the following results:

a) If Total Margins are larger than the Total Margins collected the previous day, members are compelled to deposit the difference
b) If Total Margins are smaller than the Total Margins collected the previous day, the excess may be withdrawn by the member

An Excel replication tool of Initial Margins calculation is available upon request to LCH.SA Account manager.

V. Determination of parameters

The parameters used by the Margins Calculation Procedure for will be periodically revised and, if the case, updated in order to keep into account market conditions, volatility trends and the evolution of financial instruments.

It will be then possible to modify:

- ⇒ Number of Classes
- ⇒ Cross-Position Offsetting Factor;
- ⇒ Deposit Factor;
- ⇒ Duration Class “Borders”;
- ⇒ Priority List.

VI. Annex1 - Duration Calculation

a) Zero Coupon Bonds

The duration is, by definition, equal to the maturity of the bond.

b) Fixed Coupon Bonds

The duration or Macaulay's Duration (*D*) of a fixed coupon bond producing *n* cash flows $f_1, f_2, \ldots f_5, \ldots f_n$ at the maturities $t_1, t_2, \ldots t_5, \ldots t_n$ which may be reinvested at rate *i*, is represented by the following analytic expression:

$$D = \frac{\sum_{s=1}^{n} t_s f_s (1+i)^{-t_s}}{\sum_{s=1}^{n} f_s (1+i)^{-t_s}} \times \frac{1}{v}$$

Description of variable:

- ⇒ ***n*** is the number of the future cash flows (coupons and principal);
- ⇒ ***v*** is the annual frequency of coupons payments (i.e. 2 if semiannual);
- ⇒ t_s is the number of periods (or fraction) between the calculation date and the maturity day of f_s;
- ⇒ f_s is the amount of the periodical cash flow; it is equal to the coupon times the nominal value of the security, the last cash flow includes the principal, which is equal to the nominal value of the bond itself;
- ⇒ ***i*** is the internal rate of return (IRR); the IRR is the discount rate that when applied to futures cash flows produces the current market value of the bond. It is obtained by solving iteratively the following equation:

⇒ $$\sum_{s=1}^{n} f_s (1+i)^{-t_s} = P$$

where ***P*** is the current market value of the bond (dirty price).

All figures are rounded to the fourth decimal.

Below is an example of the duration at June 11, 2016 (settlement date June 13, 2019) of the OAT FR0011337880, final maturity 25th October 2022, annual coupon 2.25%, annual payout.
The Internal Rate Return is equal to -0.563%, corresponding to a Clean Price at 109.592 with an accrued coupon at 1.42397.

	Date	t (in years)	Cash Flows f	Discounted Cash Flows f * (1+i) ^-t	t * Discounted Cash Flows
Calculation Date	13/06/2019				
First Coupon	25/10/2019	0,3671	2,25	2,2547	0,8277
Second Coupon	25/10/2020	1,3699	2,25	2,2675	3,1061
Third Coupon	25/10/2021	2,3699	2,25	2,2803	5,4040
Forsth coupon + Principal	25/10/2022	3,3699	102,25	104,2140	351,1870
			Sum	111,0165	360,5249
			Duration	**3,2475**	

The duration is equal to 3.2475 years.

c) Floating Rate Bonds

Macaulay's duration is not applicable to floating rate bonds. The price volatility of these bonds is very low; in fact – since future coupons are adjusted to market rates – in case of a drop (raise) of interest rates, gains (losses) on the capital account are offset by losses (gains) on the interest receivable account.

However such realignment of the bond price to market rates conditions is not perfect valid for CCTs, since the accruing coupon is predetermined and its non-variability has necessarily an impact on the price of the bond (so-called "rigidity effect"), that will therefore show small variations in case of variations of interest rates[3].

The duration model for floating rate bonds are often too complex to be a viable solution for operational applications. The duration of floating rate bonds can be reasonably assumed equal to the time to maturity of the accruing coupon (t_1)[4].

d) Bonds indexed on inflation rate

BTPi : All the Italian inflation indexed bonds will be considered into the class 12 whatever their duration.
French, Spanish and German bonds indexed on inflation are assigned to duration classes upon their real duration.

3 The coupon is equal to 6 months gross RendiBot determined at the last auction before the beginning of the coupon accrual period plus a spread (s, equal to 0.30 or 0.15).

4 The complete modified duration formula (which takes into consideration also the spread *s*) for a floating rate bonds is the so-called Yawitz's Duration:

$$D_f = \frac{t_1}{(1+i)} + \frac{(s - fm)[1-(1+i)^{-n}]}{P \times i} \times \left[\frac{1+i}{i} - \frac{n}{(1+i)^n - 1} \right]$$

This formula takes into consideration both the already mentioned "rigidity effect" and the "rental effect" that is given by the difference between the spread (s) and the financial margin (fm), which represents the additional cost (compared to market yields) applied by the market to floating rates bonds.

VII. Annex 2 - Examples of Variation Margins

Disclaimer: This calculation tool has been created by LCH.SA to assist current and potential clearing members in order for them to estimate their Variation Margins on the RepoClear segment cleared by LCH.SA. LCH.SA does not warrant or represent that this calculation tool is comprehensive, complete, verified or accurate and accepts no responsibility or liability for any loss, damage, cost or expense of whatsoever kind arising directly or indirectly from or in connection with the use of this calculation and accepts no liability for decision taken, or systems work carried out by any party, based on this calculation tool. This calculation tool does not form part of the Clearing Rules or any contractual documentation between LCH.SA and its clearing members.

Calculation done the 10/06/2019 at the end of day on the following portfolio of 4 trades:

Input	Calculation date + 1 (CD)	11/06/2019			
	ISIN	FR0012517027	IT0005246134	DE0001102390	ES00000123C7
	Description	OAT 0.5% 25/05/2025	BTPI 15/05/2028 1.30%	BUND 0.5% 15/2/2026	BON 5.9% 30/07/2026
	Type	Classic Repo	Classic Repo	Cash trade	BuyAndSellBack
	Sens	Repo	Reverse Repo	Buyer	Repo
	Start date (SD)	01/04/2019	18/03/2019	11/06/2019	15/05/2019
	Return Date (RD)	01/07/2019	18/06/2019		20/09/2019
	Nominal	100 000 000	4 000 000	7 000 000	100 000 000
	Traded Amount (TA)	102 320 000,00	4 059 567,35	7 483 623,29	142 611 506,85
	Repo Rate (Percentage) (RR)	EONIA + Spread	- 0,37		-0,44
	Spread (Basis Point)	- 18,00			
	Coupon during repo				30/07/2019
	Coupon rate				5,9
Step 1	Settlement Price (P) on 10/06/2019 EndOfDay	105,015	97,55	106,855	140,181
Step 3	Accrued Coupon (AC) on 11/06/2019	0,023224	0,09538		5,107945
	Accrued Coupon (AC) on Settlement Date			0,158904	
	Inflation Coef (Iidx) on 11/06/2019		1,04004		
Step 4	Past number of day (PN) = (CD) - (SD)	71			
	Past EONIA from 18/03/2019 to 11/06/2019 (PE)	-0,36128169			
	Past Interest past PI = TA * (PE + S/100)*PN/36000	- 109 229,44			
	Remaining number of day (RN) = (RD) - (CD)	20			
	Futur EONIA estimated with OIS curve (FE)	-0,3594			
	Futur Interest FI = TA * (FE + S/100)*RN/36000	- 30 661,89			
	Repo Interest (RI)=PI+FI or TA * RR*(RD-SD)/36000	- 139 891,34	- 3 838,55	-	- 223 107,78
	Coupon (C)				5 900 000,00
	Interest on coupon (IC)				- 3 749,78
	Return Amount of the Initial Transaction RAIT = TA + RI - (C + IC)	102 180 108,66	4 055 728,80	7 483 623,29	136 492 148,85
Step 5	Transaction Revaluated Amount (TRA) = N * (P + AC)* Iidx	105 038 224,00	4 062 204,04	7 490 973,28	145 288 945,00
Step 6	MarkToMarket Repo Rate (Euro Repo curve) (RR')	-0,5794	-0,540814286		-0,714006667
	Interest of Replacement Repo (RI') = TRA * RR' * (RD-CD) / 3600	- 33 810,64	- 427,17		- 291 040,69
	Coupon (C')				5 900 000,00
	Interest on coupon (IC')				- 6 084,92
	Return Amount of the Replacement Transaction RART = TRA - RI' - (C' + IC')	105 004 413,36	4 061 776,87	7 490 973,28	139 103 989,23
Step 7	MarkToMarket Euribor Rate (Euribor curve) (ER)	-0,381666667	-0,390333333	-0,368	-0,31
	Position Sign (PS)	1	-1	1	1
	CVM = PS * (RART - RAIT) / (1+ER*(RD-CD)/36000)	2 824 903,68	- 6 048,52	7 349,99	2 614 113,94
Step 8	**Global CVM**	**5 440 319,09**			