

FIXED INCOME RISK ENGINE

Module 0: Model parameters

Methodological notes

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1 Sovereign Risk Framework

In this paragraph a comparison between the currently applied Sovereign Risk Framework and the *reviewed* Sovereign Risk Framework to be applied with the *Expected Shortfall* methodology under development is provided.

1.1 Currently applied Sovereign Risk Framework

Along with the margining methodology a process of review has also been undertaken concerning the Sovereign Risk Framework.

The Sovereign Risk Framework (SRF) is the tool that is applied in order to retrieve the combination of parameters to be used in the margining process. In particular, each issuer country is assigned to a specific matrix of combinations (*holding period*, *lookback period* and *confidence level*) on the basis of its score in terms of rating and credit quality market indicators. The score of each country is reviewed periodically in order to verify whether the assignment still holds or if it is necessary to assign the country to a new matrix of combinations.

The criteria driving the definition of the score for each country are defined as follows:

- a) average rating from the three agencies (Moody's, S&P, Fitch);
- b) 5 years CDS quote retrieved from the market;
- c) 1 year probability of default;

The currently applied SRF has 8 score bands defined on the basis of a parameter B (ranging from 1 to 5 and linked to the rating as per point a) above) and a parameter L (ranging from 1 to 5 and linked to credit market indicators as per points b) and c) above). In particular, the following definitions of B and L apply:

Table 1: sovereign Risk Framework B and L criteria

B	B score criteria	L	L score criteria
B1	AAA	L1	5Y CDS, 1 year DP and Markit Data
B2	AA+ to AA-	L2	
B3	A+ to A-	L3	
B4	BBB+ to BBB-	L4	
B5	Below BBB-	L5	

where for the L parameter the 5Y CDS, the 1 year default probability and Markit iTraxx credit indices are checked against specific thresholds which are defined for each score band B (so that each band B has its own criteria for defining which countries within that B band are respectively L1, L2 etc...).

The possible set of combinations obtained by putting together B and L parameters is as follows:

Table 2: B and L combinations

B1	L1
B1	L2
B1	L3
B1	L4
B1	L5
B2	L1
B2	L2
B2	L3
B2	L4
B2	L5
B3	L1
B3	L2
B3	L3
B3	L4
B3	L5
B4	L1
B4	L2
B4	L3
B4	L4
B4	L5
B5	L1
B5	L2
B5	L3
B5	L4
B5	L5

In the currently applied Sovereign Risk Framework 8 score bands are currently defined. To each score band a matrix of combinations between *holding periods*, *lookback periods* and *confidence level* is assigned. The 8 score bands are as follows:

Table 3: SRF – score bands

B1	L1
B1	L2
B1	L3
B1	L4
B1	L5
B2	L1
B2	L2

B2	L3
B2	L4
B2	L5
B3	L1
B3	L2
B3	L3
B3	L4
B3	L5
B4	L1
B4	L2
B4	L3
B4	L4
B4	L5
B5	L1
B5	L2
B5	L3
B5	L4
B5	L5

- *Score Band 1: from B1L1 to B3L2;*
- *Score Band 2: B3L3;*
- *Score Band 3: B3L4;*
- *Score Band 4: from B3L5 to B4L2;*
- *Score Band 5: B4L3;*
- *Score Band 6: B4L4;*
- *Score Band 7: B4L5;*
- *Score Band 8: from B5L1 to B5L5¹.*

In the following table are reported the specific combinations assigned to each of the Score Band defined above:

¹ Score Band 8 refers to non investment grade issuers.

Table 4: SRF – combinations²

Confidence Levels from B3L1 To B3L2		Lookback Period											
Holding period		>10 Years	10 Years	9 Years	8 Years	7 Years	6 Years	5 Years	4 Years	3 Years	2 Years	1 Year	6 Months
1 Day	99,50%	99,55%	99,60%	99,65%	99,70%	99,75%	99,80%	99,80%	99,80%	99,80%	99,80%	99,80%	99,80%
2 Days	99,40%	99,40%	99,45%	99,50%	99,55%	99,60%	99,65%	99,70%	99,70%	99,70%	99,70%	99,70%	99,70%
3 Days	99,00%	99,00%	99,00%	99,05%	99,10%	99,15%	99,20%	99,25%	99,30%	99,35%	99,40%	99,50%	
Confidence Levels B3L3		Lookback Period											
Holding period		>10 Years	10 Years	9 Years	8 Years	7 Years	6 Years	5 Years	4 Years	3 Years	2 Years	1 Year	6 Months
1 Day	99,50%	99,55%	99,60%	99,65%	99,70%	99,75%	99,80%	99,80%	99,80%	99,80%	99,80%	99,80%	99,99%
2 Days	99,40%	99,40%	99,45%	99,50%	99,55%	99,60%	99,65%	99,70%	99,70%	99,70%	99,70%	99,70%	99,70%
3 Days	99,00%	99,00%	99,00%	99,05%	99,10%	99,15%	99,20%	99,25%	99,30%	99,35%	99,40%	99,50%	
Confidence Levels B3L4		Lookback Period											
Holding period		>10 Years	10 Years	9 Years	8 Years	7 Years	6 Years	5 Years	4 Years	3 Years	2 Years	1 Year	6 Months
1 Day	99,50%	99,55%	99,60%	99,65%	99,70%	99,75%	99,80%	99,80%	99,80%	99,80%	99,80%	99,80%	99,99%
2 Days	99,40%	99,40%	99,45%	99,50%	99,55%	99,60%	99,65%	99,70%	99,70%	99,70%	99,70%	99,70%	99,99%
3 Days	99,00%	99,00%	99,00%	99,05%	99,10%	99,15%	99,20%	99,25%	99,30%	99,35%	99,40%	99,50%	
Confidence Levels from B3L5 To B4L2		Lookback Period											
Holding period		>10 Years	10 Years	9 Years	8 Years	7 Years	6 Years	5 Years	4 Years	3 Years	2 Years	1 Year	6 Months
1 Day	99,50%	99,55%	99,60%	99,65%	99,70%	99,75%	99,80%	99,80%	99,80%	99,80%	99,80%	99,80%	99,99%
2 Days	99,40%	99,40%	99,45%	99,50%	99,55%	99,60%	99,65%	99,70%	99,70%	99,70%	99,70%	99,70%	99,99%
3 Days	99,00%	99,00%	99,00%	99,05%	99,10%	99,15%	99,20%	99,25%	99,30%	99,35%	99,40%	99,50%	
Confidence Levels B4L3		Lookback Period											
Holding period		>10 Years	10 Years	9 Years	8 Years	7 Years	6 Years	5 Years	4 Years	3 Years	2 Years	1 Year	6 Months
1 Day	99,50%	99,55%	99,60%	99,65%	99,70%	99,75%	99,80%	99,80%	99,80%	99,80%	99,80%	99,80%	99,99%
2 Days	99,40%	99,40%	99,45%	99,50%	99,55%	99,60%	99,65%	99,70%	99,70%	99,70%	99,70%	99,70%	99,99%
3 Days	99,00%	99,00%	99,00%	99,05%	99,10%	99,15%	99,20%	99,25%	99,30%	99,35%	99,40%	99,50%	
4 Days	99,00%	99,00%	99,00%	99,05%	99,10%	99,15%	99,20%	99,25%	99,30%	99,35%	99,40%	99,50%	
Confidence Levels B4L4		Lookback Period											
Holding period		>10 Years	10 Years	9 Years	8 Years	7 Years	6 Years	5 Years	4 Years	3 Years	2 Years	1 Year	6 Months
1 Day	99,50%	99,55%	99,60%	99,65%	99,70%	99,75%	99,80%	99,80%	99,80%	99,80%	99,80%	99,80%	99,99%
2 Days	99,40%	99,40%	99,45%	99,50%	99,55%	99,60%	99,65%	99,70%	99,70%	99,70%	99,70%	99,70%	99,99%
3 Days	99,00%	99,00%	99,00%	99,05%	99,10%	99,15%	99,20%	99,25%	99,30%	99,35%	99,40%	99,50%	
4 Days	99,00%	99,00%	99,00%	99,05%	99,10%	99,15%	99,20%	99,25%	99,30%	99,35%	99,40%	99,50%	
5Days	99,00%	99,00%	99,00%	99,05%	99,10%	99,15%	99,20%	99,25%	99,30%	99,35%	99,40%	99,50%	
Confidence Levels B4L5		Lookback Period											
Holding period		>10 Years	10 Years	9 Years	8 Years	7 Years	6 Years	5 Years	4 Years	3 Years	2 Years	1 Year	6 Months
1 Day	99,50%	99,55%	99,60%	99,65%	99,70%	99,75%	99,80%	99,80%	99,80%	99,80%	99,80%	99,80%	99,99%
2 Days	99,40%	99,40%	99,45%	99,50%	99,55%	99,60%	99,65%	99,70%	99,70%	99,70%	99,70%	99,70%	99,99%
3 Days	99,00%	99,00%	99,00%	99,05%	99,10%	99,15%	99,20%	99,25%	99,30%	99,35%	99,40%	99,50%	
4 Days	99,00%	99,00%	99,00%	99,05%	99,10%	99,15%	99,20%	99,25%	99,30%	99,35%	99,40%	99,50%	
5Days	99,00%	99,00%	99,00%	99,05%	99,10%	99,15%	99,20%	99,25%	99,30%	99,35%	99,40%	99,50%	
Confidence Levels From B5L1 To B5L5		Lookback Period											
Holding period		>10 Years	10 Years	9 Years	8 Years	7 Years	6 Years	5 Years	4 Years	3 Years	2 Years	1 Year	6 Months
1 Day	99,50%	99,55%	99,60%	99,65%	99,70%	99,75%	99,80%	99,80%	99,80%	99,80%	99,80%	99,80%	99,99%
2 Days	99,40%	99,40%	99,45%	99,50%	99,55%	99,60%	99,65%	99,70%	99,70%	99,70%	99,70%	99,70%	99,99%
3 Days	99,00%	99,00%	99,00%	99,05%	99,10%	99,15%	99,20%	99,25%	99,30%	99,35%	99,40%	99,50%	
4 Days	99,00%	99,00%	99,00%	99,05%	99,10%	99,15%	99,20%	99,25%	99,30%	99,35%	99,40%	99,50%	
5Days	99,00%	99,00%	99,00%	99,05%	99,10%	99,15%	99,20%	99,25%	99,30%	99,35%	99,40%	99,50%	

In the current MVP margining methodology each country is assigned to one of the score bands above. The deposit factor for each node of that country's curve is obtained as the worst result (most conservative result) between the VaRs computed on the time series for each combination of *lookback period* / *holding period* / *confidence level* of that specific score band.

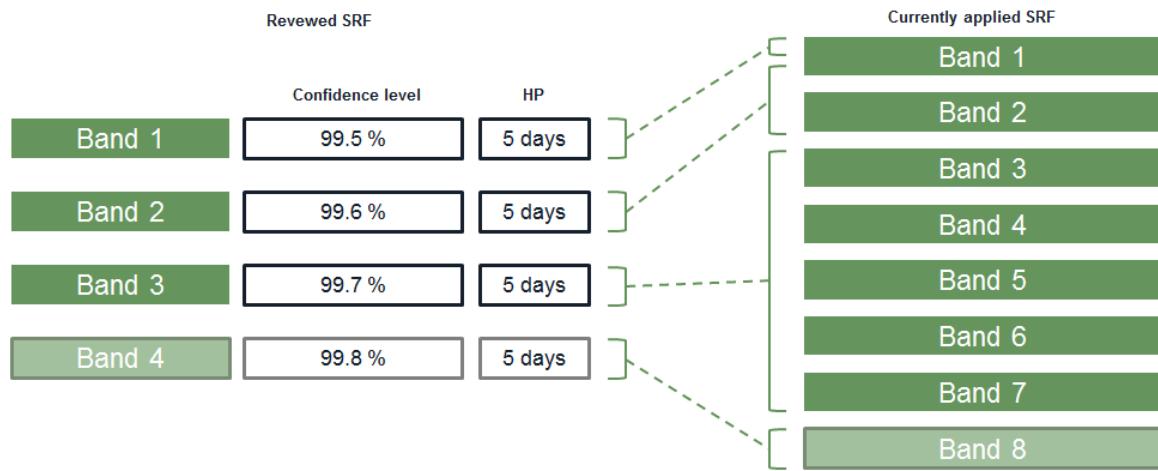
² The 6 months lookback period is currently disabled.

1.2 *Reviewed* Sovereign Risk Framework

The *Expected Shortfall* margining methodology will benefit from the use of a single *lookback period*. Furthermore, the *holding period* used will also have a lesser degree of granularity (meaning that if a *holding period* of 3 days is used, only the 3-days variations are considered and not the maximum between the 1-day, 2-day and 3-day variations). The different granularity of the *reviewed* Sovereign Risk Framework will allow for an aggregation of the pre-existing score bands (given the lower number of possible combinations) thus resulting in a more intelligible and less burdensome framework.

The *reviewed* Sovereign Risk Framework has been designed as follows:

Figure 1: *reviewed* Sovereign Risk Framework



the score bands on the right side of Figure 1 refer to the currently applied SRF, while the score bands on the left are related to the *reviewed* SRF. The number of score bands has been reduced from 8 to 4 (with the last score band still representing non investment grade countries). The first 3 *reviewed* score bands are the result of the aggregation of the first 7 score bands of the SRF currently applied. In particular, *reviewed* score band 1 is reserved to highly rated countries (typically countries with a rating ranging from AAA to AA+) and with a quoted 5Y CDS rate that witnesses the high credit standing of those countries. *Reviewed* score band 2 is for countries typically ranging from AA to A and still with a 5Y CDS representing a mid to low probability of triggering the default event. *Reviewed* score band 3 is reserved to countries typically ranging from A- to BBB-.

The rating ranges given above are not an absolute reference as the 5Y CDS and the 1 year default probability are also driving criteria (and the *reviewed* score bands are not defined only on the basis of parameter B, i.e. average rating, but also on the basis of parameter L, i.e. credit quality indicators):

- *Reviewed Score Band 1: from B1L1 to B2L2;*
- *Reviewed Score Band 2: from B2L3 to B3L3;*
- *Reviewed Score Band 3: from B3L4 to B4L5;*
- *Reviewed Score Band 4: from B5L1 to B5L5.*

To each *reviewed* score band is assigned a different *confidence level* ranging from the 99.5% of the higher band up to 99.8% of the non investment grade band (i.e. *reviewed* score band 4). A 5 days *holding period* is used for all *reviewed* score bands with the result that a higher *holding period* would therefore be applied to countries ranked in all the original score bands. Only the hp-days variations are considered (not the maximum between all the possible sub-*holding periods*). The whole time series are taken into consideration for the *lookback period*.

Please note that the SRF framework will only be applied to the scaled margining methodology, since the unscaled floor will benefit from the application of a single set of parameters (in particular, the only difference between the two is that for the floor a constant 99.5% confidence level is applied across all countries regardless of their ranking).

1.3 Core model parameters / assumptions

The following table summarizes the parameters / assumptions that will be used in the margining model under development:

Table 5: parameters / assumptions

Typology	<i>Expected Shortfall</i>
Tail / s approach	<i>Single tail</i>
Cross margining	<i>Applied</i>
Scaling window	<i>60 days</i>
λ	<i>99.9%</i>
Holding period	<i>5 days (see Figure 1)</i>
Confidence level	<i>With cross-margining, the most conservative level (highest among all countries) is now applied for the scaled ES, ranging from 99.5% to 99.8% (see Figure 1); 99.7% for the unscaled floor</i>
Lookback period	<i>Anchored to 2004 for the scaled ES; 10-year rolling window for unscaled ES</i>
Weighting	<i>Equally weighted Expected Shortfall</i>

a description of the table above is provided in the following paragraphs.

1) TYPOLOGY

The *Expected Shortfall* is the chosen risk measure. Given the distribution of gains/losses of the variations computed over a specific time series, it represents the weighted average of the observations that lie on the tail/s. By definition, it represents a more conservative risk measure with respect to VaRs methodologies.

2) TAIL/S APPROACH

The single tail approach has been chosen. It means that only the distribution tail of the losses is taken into consideration (see more in module 4). This choice is coherent with the sign of the marginable position.

3) CROSS MARGINING

Cross margining between different issuers is applied. Positions on securities issued by different countries are jointly considered, allowing for offsetting effects across issuers when computing margin requirements. As a result, a unified portfolio is used for margin calculation rather than separate sub-portfolios by issuer country.

4) SCALING WINDOW, λ

In order to compute the *Scaled Expected Shortfall* (see modules 3 and 4) a seeding volatility must be defined at first. The seeding volatility window (also scaling window) is defined in 60 business days. The λ parameter of 99.9% is calibrated in order to balance the model reactivity to market volatility and the satisfaction of the anti pro-cyclicality concern.

5) HOLDING PERIOD

Holding period is 5 days for all countries of the *reviewed* score bands. Given a *holding period* n , only the n -days variation is considered in the computation of the *Expected Shortfall*.

6) CONFIDENCE LEVEL

With the introduction of cross-margining, the *confidence level* for the scaled approach is now set to the most conservative value, i.e., the highest among all countries, rather than depending on the issuer country and its position in the *reviewed* SRF matrix for the scaled approach. A constant *confidence level* of 99.7% is applied for the unscaled floor across all countries regardless of their ranking in the *reviewed* SRF.

7) LOOKBACK PERIOD, WEIGHTING

The *lookback period* used for margining purposes is anchored to 2004 for the scaled ES, while a standard 10-year rolling window is used for the unscaled ES. The Expected Shortfall is computed using equal weights, applied uniformly along the tail of the loss distribution.

1.4 Add-on model parameters / assumptions

A description of the parameters used for the computation of the add-ons follows (for how each single add-on participates in the definition of the final margin requirements please refer to the specific modules):

1) DE-CORRELATION

The 80% rule is applied.

2) CONCENTRATION / IDIOSYNCRATIC

Country	Lookback period	Confidence level	ES/Var	Unscaled/ Scaled	Single tail/ Double tail	Isin add-on multiplier
IT	1Y	0.997	ES	UNSCALED	DOUBLE TAIL	0.25
ES	1Y	0.997	ES	UNSCALED	DOUBLE TAIL	0.25
IE	1Y	0.996	ES	UNSCALED	DOUBLE TAIL	0.25
PT	1Y	0.997	ES	UNSCALED	DOUBLE TAIL	0.25
AT	1Y	0.996	ES	UNSCALED	DOUBLE TAIL	0.25
FI	1Y	0.996	ES	UNSCALED	DOUBLE TAIL	0.25
NL	1Y	0.995	ES	UNSCALED	DOUBLE TAIL	0.25
FR	1Y	0.996	ES	UNSCALED	DOUBLE TAIL	0.25
DE	1Y	0.995	ES	UNSCALED	DOUBLE TAIL	0.25
BE	1Y	0.996	ES	UNSCALED	DOUBLE TAIL	0.25
SN	1Y	0.995	ES	UNSCALED	DOUBLE TAIL	0.25

Bond Type	Concentration Ratio Floor	Concentration Ratio Cap	HP
FLOATER	0.0	0.05	5
FLOATER	0.05	0.1	5,6
FLOATER	0.1	0.15	5,6,7
FLOATER	0.15	0.2	5,6,7,8
FLOATER	0.2	0.25	5,6,7,8,9
FLOATER	0.25	1.0	5,6,7,8,9,10
LINKER	0.0	0.05	5
LINKER	0.05	0.1	5,6
LINKER	0.1	0.15	5,6,7
LINKER	0.15	0.2	5,6,7,8
LINKER	0.2	0.25	5,6,7,8,9
LINKER	0.25	1.0	5,6,7,8,9,10
BULLET/ZCB	0.0	0.05	-
BULLET/ZCB	0.05	0.1	-
BULLET/ZCB	0.1	0.15	5, 6, 7
BULLET/ZCB	0.15	0.2	5,6,7,8
BULLET/ZCB	0.2	0.25	5,6,7,8,9
BULLET/ZCB	0.25	1.0	5,6,7,8,9,10

3) REPO CONCENTRATION

Country	Lookback period	Confidence level	ES/VaR	Unscaled/Scaled	Single tail/Double tail
IT	1Y	0.997	ES	UNSCALED	DOUBLE TAIL
ES	1Y	0.997	ES	UNSCALED	DOUBLE TAIL
IE	1Y	0.996	ES	UNSCALED	DOUBLE TAIL
PT	1Y	0.997	ES	UNSCALED	DOUBLE TAIL
AT	1Y	0.996	ES	UNSCALED	DOUBLE TAIL
FI	1Y	0.996	ES	UNSCALED	DOUBLE TAIL
NL	1Y	0.995	ES	UNSCALED	DOUBLE TAIL
FR	1Y	0.996	ES	UNSCALED	DOUBLE TAIL
DE	1Y	0.995	ES	UNSCALED	DOUBLE TAIL
BE	1Y	0.996	ES	UNSCALED	DOUBLE TAIL
SN	1Y	0.995	ES	UNSCALED	DOUBLE TAIL

Maturity Floor	Maturity Cap		Amount Floor	Amount Cap	HP
(days)	(days)				
0	7		0	500 000 000	-
0	7		500 000 000	1 000 000 000	-
0	7		1 000 000 000	5 000 000 000	-
0	7		5 000 000 000	10 000 000 000	-
7	31		0	500 000 000	5
7	31		500 000 000	1 000 000 000	5
7	31		1 000 000 000	5 000 000 000	5, 6
7	31		5 000 000 000	10 000 000 000	5, 6, 7
31	93		0	500 000 000	5, 6
31	93		500 000 000	1 000 000 000	5, 6
31	93		1 000 000 000	5 000 000 000	5, 6, 7
31	93		5 000 000 000	10 000 000 000	5, 6, 7, 8
93	366		0	500 000 000	5, 6, 7
93	366		500 000 000	1 000 000 000	5, 6, 7, 8
93	366		1 000 000 000	5 000 000 000	5, 6, 7, 8
93	366		5 000 000 000	10 000 000 000	5, 6, 7, 8, 9
366	10 000		0	500 000 000	5, 6, 7, 8
366	10 000		500 000 000	1 000 000 000	5, 6, 7, 8, 9
366	10 000		1 000 000 000	5 000 000 000	5, 6, 7, 8, 9
366	10 000		5 000 000 000	10 000 000 000	5, 6, 7, 8, 9, 10

Parametric stress on holding periods for concentration purposes are not applied on Italian debt for those Participants which are deemed of strategic importance for the stability of the financial system (e.g. Banca d'Italia, Ministero delle Economie e delle Finanze).