

1. **Input excel file: “frtb_vega_sensitivities and delta correlations”**
 - a) Sheet: “Individual_Bond_Vegas”. Columns below:
 - i. Security = Security name of portfolio holding
 - ii. CSR Bucket = Bucket. This bucket contains sensitivity to below 5 expiry tenors
 - iii. Expiry_0.5Y-Vega sensitivity to 0.5Y tenor
 - iv. Expiry_1Y- Vega sensitivity to 1Y tenor
 - v. Expiry_3Y- Vega sensitivity to 3Y tenor
 - vi. Expiry_5Y- Vega sensitivity to 5Y tenor
 - vii. Expiry_10Y- Vega sensitivity to 10Y tenor
 - b) Sheet: “Delta correlations”-Contains correlations ($\rho_{kl}^{(DELTA)}$) between GIRR Delta tenors. For example correlation between 0.5Y and 1Y is 97%. These correlations will be used when calculating final correlations between Vega tenors in CSR buckets.
2. File: **“bond_sensitivities_detailed_for CSR Delta” file sheet “CSR non securitiz sectoral corr”**
 This sheet contains intra bucket correlations. This will be used in aggregating bucket capital charge into CSR non securitization Few example below:
 - a) Correlation between bucket 1/9 and 2/10 is 75%. Don’t get confused by “/” in column and row headers this just means 1 or 9 and 2 or 10. So correlation of 75% applies between buckets 9 and 2, buckets 9 and 10, buckets 1 and 2 and buckets 1 and 10. When “/” is missing that means only 1 bucket on that side.
 - b) Correlation between buckets 8 and 2/10. Correlation between buckets 8 and 2, and 8 and 10 is 10%.

3. CSR tenors: Just FYI

Tenor
0.5Y
1.0Y
3.0Y
5.0Y
10.0Y

4. **Aggregate expiry sensitivities inside tenors.** For example for CSR Bucket 1 , tenor 0.5Y expiry sensitivity would be 0-7-2+0 = -9. Same has to be done for every bucket and every tenor.
5. **Now we will have 1 row for each bucket and in that row we would have 5 expiry tenors, so 5 expiry columns for each bucket.**
6. **Risk weight** for Vega sensitivities: It is 1 or 100% for all tenors. Please create constant. Create a weighted sensitivity columns for each expiry. So we will create 5 new columns. They will be just copy of preexisting columns since

multiplying by 100% does not change tenor vega sensitivity. But even multiplying by constant 1 shows that we knew that Risk weight was 100%.

7. Correlations between CSR non securitization Vega tenors:

Calculate Correlations between CSR non securitization Vega tenors for the grid in below table

	Option expiry tenor correlation between tenors k and l				
	0.5Y	1Y	3Y	5Y	10Y
0.5Y	Fill me	Fill me	Fill me	Fill me	Fill me
1Y	Fill me	Fill me	Fill me	Fill me	Fill me
3Y	Fill me	Fill me	Fill me	Fill me	Fill me
5Y	Fill me	Fill me	Fill me	Fill me	Fill me
10Y	Fill me	Fill me	Fill me	Fill me	Fill me

$$\rho_{kl}^{(option\ expiry)} = e^{-\alpha \cdot \frac{|T_k - T_l|}{\min\{T_k, T_l\}}}$$

Where α is 1%

T_k is option expiry Vega tenor above

8. Calculate medium Correlation between Vega tenors: Vega tenors are 0.5Y, 1Y, 3Y, 5Y and 10Y.

$$\rho_{kl} = \rho_{kl}^{(DELTA)} \times \rho_{kl}^{(option\ expiry)}$$

k and l are Vega tenors

a) **High tenor correlation:** Based on collected medium correlations, calculate correlations of high correlation scenario. For this just multiply all medium correlations ρ_{kl} by 1.25. Correlations should be capped at 100%.

b) **Low tenor Correlations:**

Adjust each correlation in Medium correlation ρ_{kl} with below formula

$$\rho_{kl}^{low} = \max(2 \times \rho_{kl} - 100\%; 75\% \times \rho_{kl})$$

9. Calculate bucket capital charge for each bucket. You will use 3 sets of correlations so 3 bucket level capital charges will be there: High Correlation bucket charge, Low correlation bucket charge and medium correlation bucket charge . We have only one set of weighted sensitivities for each bucket, no high, medium or low.

$$K_b = \sqrt{\max(0, \sum_k WS_k^2 + \sum_k \sum_{k \neq l} \rho_{kl} \times WS_k \times WS_l)}$$

Where WS_k and WS_l = Weighted sensitivity
 ρ_{kl} is Low, Medium or High correlation matrix.

Now we have 3 bucket capital charges for each bucket
 10.

11. Calculate medium Correlation between buckets γ_{bc} for aggregating regulatory capital across buckets

- a) $\gamma_{bc}^{(rating)} = 1$. Type is IG for all holdings. There is no HY or NR. Where b and c are buckets
- b) $\gamma_{bc}^{(sector)} = 1$ if 2 buckets belong to same sector. Sector is a column in sheet Bond_Sensitivities. Each bucket belongs to a sector. If Sector is different of 2 buckets then please refer sheet “CSR non securitiz sectoral corr” for interbucket correlation.

$$\gamma_{bc} = \gamma_{bc}^{rating} \times \gamma_{bc}^{sector}$$

- c) **High inter-bucket correlation:** Multiply interbucket medium correlation γ_{bc} by 1.25. γ_{bc}^{high} Correlation should be capped at 100%
- d) **Low inter-bucket Correlations:**

Use below formula based on interbucket low correlation

$$\gamma_{bc}^{low} = \max(2 \times \gamma_{bc} - 100\%; 75\% \times \gamma_{bc})$$

12. Across bucket aggregation: Now all CSR buckets needs to be aggregated.

We will do this step 3 times.

Low correlation iteration: Use Low correlation bucket capital charge and low interbucket correlation

Medium correlation iteration: Use Medium correlation bucket capital charge and low interbucket correlation

High correlation iteration: Use High correlation bucket capital charge and low interbucket correlation.

In all these 3 iterations Bucket aggregate sensitivity step will be same so feel free to perform only once. Next 2 steps of CSR Non securitization Vega capital charge will be done 3 times(low, medium, high) and Recalculation of S_b will also be done thrice(low, medium, high). Weighted sensitivities remain same.

- a) **Bucket aggregate sensitivity** within each bucket by simple summation, i.e. by below formula

$$S_b = \sum WS_k$$

$$S_c = \sum WS_k$$

- b) **CSR Non securitization Vega capital charge** as below formula.

$$\sum_b K_b^2 + \sum_b \sum_{c \neq b} \gamma_{bc} S_b S_c$$

Apply sqrt to above calculated number.

If Vega capital charge is -(ve) then go to below extra step. Capital cannot be – (ve)

- c) If the sum in step (b) above gives -ve number use alternative approach as below.

I. ReCalculate S_b (Bucket aggregate sensitivity) for bucket “b”

$$S_b = \max[\min(\sum_k WS_k, K_b), -K_b]$$

For bucket c

$$S_c = \max[\min(\sum_k WS_k, K_c), -K_c]$$

II. And recalculate CSR Non securitization Vega capital charge:

$$\sum_b K_b^2 + \sum_b \sum_{c \neq b} \gamma_{bc} S_b S_c$$

13. All the metrics calculated above must be transported in excel document. We will need 3 metrics:

- a) Low correlation CSR Non securitization Vega capital charge
- b) Medium correlation CSR Non securitization Vega capital charge
- c) High correlation CSR Non securitization Vega capital charge