FRTB Summary for GIRR

APPLICATIONS TO RISK MANAGEMENT AND FRTB

PLATSON CONSULTING

Contents

Overview

1. The new (and recently updated) proposals have a focus on **quantifying the risks** under stressed scenarios, hence the move away from VAR (which indicates the loss at a certain threshold but doesn't indicate the size of the potential loss) to Expected Shortfall (ES) which attempts to estimate what that loss might be

2. There are clear guidelines on the delineation between the Trading Book and Banking Book and trading desks are more distinctly defined

3. 2 main models for banks to choose between
   a) Standardised Approach (SA) – Sensitivities Based - simpler to apply but more conservative
   b) Internal Model Approach (IMA) – more realistic - to qualify for this, the model must pass **backtesting** and correctly **attribute PL** within defined tolerances. Risk factors within the model are also assessed to ascertain how observable they are

4. The incorporation of market illiquidity (was 10days for all - now up to 120 days) is an improvement designed to distinguish between deep and liquid markets vs those which are less so

1. FRTB - Banking book vs Trading book – definitions / restrictions and Trading book rules
2. Standardised Approach - Sensitivities Based method
3. Internal Models Approach
4. PL Attribution Test

Banking Book vs Trading Book

1. Banking book should include FX risk and commodities risk only
2. Trading desk:
   a. Each individual trader or trading account must be assigned to only one trading desk.
   b. Clear reporting line to senior management and must have a clear and formal compensation policy linked to its pre-established objectives.
3. Transferring risk between desks not allowed for capital purposes – if a risk transfer occurs capital must be accounted for by taking the maximum capital allocation before or after the switch
4. Transfers are allowed if:
   a. The transfer is documented with respect to the banking book interest rate risk being hedged and the sources of such risk
   b. The internal risk transfer must be subject to trading book capital requirements under the market risk framework on a stand-alone basis for the dedicated internal risk transfer desk, separate from any other GIRR or other market risks generated by activities in the trading book
5. Credit risk – Banks must be consistent and use either
   a. the *Standardised approach* risk weights in both the banking book and the trading book or
   b. the *Internal Ratings-Based (IRB)* risk weights in both books

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Standardised Approach - Sensitivities Based Method

The Standardised Approach is the sum of SBM+DRC+RRAO as described below. The focus of this section is the SBM

1. <u>Sensitivities Based Method (SBM)</u>
   Delta, Vega, Curvature are measured within each **Risk Class (7)**
   GIRR
   FX
   Equities
   Commodities
   Credit Spread Risk (CSR) - three types: Non-securitisation, Securitisation, Securitisation correlation

2. <u>Default Risk Charge (DRC)</u>
   Three types - Non-securitisation, Securitisation, Securitisation correlation

3. <u>RRAO (non-linear)</u>
   i. Sum of gross notional amounts of the instruments bearing residual risks, multiplied by a risk weight of 1.0% for instruments with an exotic underlying and a risk weight of 0.1% for instruments bearing other residual risks
   ii. Trades which are listed and/or eligible for central clearing must be excluded from the residual risk add-on
   iii. Must include Gap risk, correlation risk, behavioural(prepayment)
   iv. CTD, smile, correlation, dividend do not necessarily require inclusion to RRAO

Sensitivities Based Method for GIRR

BIS definitions:
Risk Class = GIRR
Risk Bucket = Currency (somewhat confusingly)
Risk Factor = Variables (eg a given vertex of a given interest rate curve) - mapped to risk class
Risk Charge = Aggregation of risk positions first at the bucket (currency) level, and then across buckets (currencies)

i. Each instrument with optionality is subject to vega risk and curvature risk - Instruments without optionality are not subject to vega risk and curvature risk.

ii. Delta and Vega risks must be calculated separately, with no diversification benefit recognised between delta and vega risk factors

iii. Curvature - risk is based on two stress scenarios involving an upward shock and a downward shock

Sensitivities Based Method - Delta, Vega, Curvature

1. <u>Delta</u> = risk (USD) per bp *10,000
   i. Risk-free curve – use OIS, but if unavailable use the swaps curve, otherwise sovereign curve (but credit risk still needs to be accounted for)
   ii. OIS, 3m LIBOR, TIBOR, 6m, onshore and offshore etc all must be considered as separate curves
   iii. Linear interpolation is acceptable or any method used by risk control
   iv. Inflation – use a flat curve with no term structure – risks are aggregated by simple sum
   v. Xccy – always vs EUR or vs USD. No term structure - curves are considered flat and are in addition to GIRR and allocated in the term structure of the relevant risk-free yield curve

2. <u>Vega</u> = Vega sens*implied vol (ie the time value in the option) so can use normal or lognormal vols
   i. Structures with no maturity, strike, barrier (or multi strikes) are included in the RRAO
   ii. First order sensitivities - assume implied vol remains constant

3. <u>Curvature</u> – a parallel shift of the risk weight of 0.25yr (weighted by 1/sqrt2) for major currencies (120bps) and revalue, excluding the delta move
   i. All vertices of all curves (within a currency) must be shifted at the same time in order to compute the relevant risk-free yield curve curvature risk charge
   ii. The curvature risk is then the largest of the parallel up and down moves = -MIN(Value Up - Value flat - delta pnl , Value Up - Value flat - delta pnl)
   iii. Summing across currencies (buckets), using corresponding correlations
   iv. No curvature risk charge for inflation and cross currency basis risks

SBM – Risk Weights and Correlations

1. <u>Risk Weights</u>
   i. IR Delta weights in table to right - divide by SQRT(2) for selected currencies (EUR, USD, GBP, AUD, JPY, SEK, CAD and domestic)
   ii. Xccy and inflation = 2.25%
   iii. Vega Risk weight = min (55% *SQRT(LHiq Horizon)/sqrt(10); 100%) - for GIRR =min (55% * SQRT(60)/sqrt(10), 100%) = 100%
   iv. FX Risk Weight = 30% (divide by SQRT(2) as per above for major currencies)

2. <u>Correlation</u>
   i. 3 scenarios for correlation (both within and across buckets within a risk class (GIRR) Bucket (eg ccy).
   Generally only the lowest correlation scenario (75%) needs to be considered
   rho low = max (2*unstressed correlation-1, 75%*unstressed correlation. Effectively doubles the correlation gap if the unstressed correlation is greater than 87.5% and if below, just multiplies unstressed correlation by 75%
   ii. <u>Delta Correlation</u> (eg 2y vs 3y) = MAX(EXP(-3%*(3-2)/MIN(2,3)),40%) = 98.5% (3% is a constant)
   rho low = max (2*98.5%-1, 75%*98.5%) = 97.02
   Between curves of the same currency (between 6s3s etc) = 99.9%– reduces to 99.8% in the stressed scenario
   iii. <u>Vega correlation</u> – similar to delta but repeated for maturities and options
   Eg 1y3y vs 5y10y: =MIN{ EXP[-1%*ABS(5-1)/MIN(5, 1)] , EXP[-1%*ABS(10-3)/MIN(10, 3)] } =93.9%
   The 75% weighting is applied in a similar fashion to the delta to give 87.7% correlation between 1y3y and 5y10y in a stressed scenario.
   iv. <u>Across currencies</u>
   IR = 50%
   Vega = 50% (reduces to 25% in lower correlation scenario)
   Curvature = 25%
   v. Inflation = 40%, Xccy =0%

	Weights	SQRT(2)
0.25	1.70%	**1.20%**
0.5	1.70%	1.20%
1	1.60%	1.13%
2	1.30%	0.92%
3	1.20%	0.85%
5	1.05%	0.74%
10	1.05%	0.74%
15	1.05%	0.74%
20	1.05%	0.74%
30	1.05%	0.74%

SBM example: Short 1bn USD 2y2y A+50 P

Results (next few slides show how these are derived) show that:

SA (k USD)					
Delta	CRV	Vega	SA RWA	Equity	Return
3,874	4,980	5,286	14,140	1,414	**735**

1. Total RWA of almost 14m required.
2. 1.4m USD of Equity Required (assuming 10% CET1 Ratio)
3. Annual Return of 730k USD = 7**bps of notional** – assuming:
   RoE = 13%
   Cost/Income ratio = 75%
4. Initially this structure is worth **28bps** so over the lifetime of the unhedged trade, capital costs would around 50% of the initial premium using the SA method

SBM example: Short 1bn USD 2y2y A+50 P

Delta

1. Risk Weight the buckets by multiplying by the risk weights (the latest BIS - d436 has a range so the mid-point has been assumed)

2. Calculate the correlation matrix so that all risks can be aggregated into one delta number.

3. This leads to a delta RWA of **3.9m USD for 50k USD of risk = 75bps. Effective required return would be about 4bps on the delta.**

4. For an equivalent swap 950k DV01~ 250m USD implies about 1.5% of notional, cf 1.0% or 0.1% for the RRAO – however no netting allowed in RRAO

	k USD	Risk Weights	SQRT(2)	Risk Weighted
0.25y	0	1.70%	1.20%	0
0.5y	0	1.70%	1.20%	0
1y	0	1.60%	1.13%	0
2y	55	1.30%	0.92%	5,045,999
3y	-53	1.20%	0.85%	-4,515,463
5y	-53	1.05%	0.74%	-3,931,109
10y	0	1.05%	0.74%	0
15y	0	1.05%	0.74%	0
20y	0	1.05%	0.74%	0
30y	0	1.05%	0.74%	0
TOTAL	-51			

SBM example: Short 1bn USD 2y2y A+50 P

Vega

1. Risk weight vega numbers by multiplying by the respective volatility (as per below example, Normal vega by Normal Vols – this effectively gives the value of the optionality in the trades)
(For large cap equities there is a slight reduction of about 22% on this risk weight but not applicable to GIRR vega)

2. Again a correlation matrix is required to aggregate these to one number

3. Summing the above gives a Vega RWA of **5.3m for 87k per Normal risk for an effective required return of about 3 NVol**

Original Vega	0.5y	1y	3y	5y	10y	TOTAL
0.5y						
1y		(22)	(22)			(43)
3y		(22)	(22)			(43)
5y						
10y						
TOTAL		(43)	(43)			(87)

Norm Vol	0.5y	1y	3y	5y	10y
0.5y	40.2	40.2	54.6	58.1	59.5
1y	48.5	48.5	59.8	62.7	64.3
3y	70.3	70.3	70.6	71.0	68.7
5y	76.8	76.8	73.2	72.2	68.7
10y	70.0	70.0	69.5	66.7	63.1

Risk Weighted	0.5y	1y	3y	5y	10y	TOTAL
0.5y						
1y		(1,049,525)	(1,294,054)			(2,343,579)
3y		(1,521,271)	(1,527,763)			(3,049,034)
5y						
10y						
TOTAL		(2,570,796)	(2,821,817)			(5,392,613)

SBM example: Short 1bn USD 2y2y A+50 P

Curvature

1. We parallel shift the curve by the risk weight of the 0.25yr point (weighted by 1/sqrt2 for major currencies) – in this case up by 120bps

2. All curves (OIS, 3M 6M) must be shifted in parallel simultaneously

3. Revalue the currency's portfolio (only including trades with curvature, so exclude any swaps delta.
   After bumping up and down 120bps,extract the effect due to the initial delta and then take the maximum loss from the up / down scenarios. If long gamma, the CRV charge is set to zero

4. Curvature risk exposure aggregated within each bucket (currency) and then across currencies using 25% correlation

5. For the example a curvature of RWA of **5.0m – requiring a return of 260k USD per annum, around 10% of the option's initial premium**

6. As an aside, buying a payer and then fully hedging the delta and vega results in a curvature charge whereas buying the receiver doesn't. This is due to the Payer having discount curves move but the delta hedges don't, so a long payer swaption will have slgihtyl less positive convexity in the SA model and thus attract more curvature charges than the receiver.
   There is therefore an opportunity to buy receivers, sell payers and pay the underlying delta to add positive curvature to the portfolio and reduce capital charges

1.20%	k USD	bps
Initial Value	-2,823	-28.2
options delta	-51	-0.5
up npv	-13,971	-139.7
up delta effect	-6,168	-61.7
up curvature effect	-4,980	-49.8
down npv	-168	-1.7
down delta effect	6,168	61.7
down curvature effect	-3,513	-35.1
worst scenario	**4,980**	49.8

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IMA – Qualitative Standards

1. Bank risk Management System – conceptually sound and implemented with integrity
2. Regular back-testing and PL Attribution tests
3. Model must be qualitatively sound – starting point for both regulatory (SA) and IMA models must be same and IMA should at a minimum cover the risk factors as per SA
    a. Stress tests reviewed monthly by senior management
        i. Information on the largest loss during the period – eg no of days of peak day losses would have been covered by ES
        ii. 6 Simulations – 1987 Equity Crash, ERM 1992-93, 1994Q1 Interest rate rises, 1998 Russian financial crisis, 2000 tech bubble burst, 2007-08 Sub-Prime, 2011-12 Euro-Zone crisis
        iii. Correlations reaching extreme levels of -1 to +1
    b. Annual validation

IMA – Model Validation / Back-testing

1. Exclude fees, commissions, bid-ask, intraday trading
2. Additional tests may include: backtesting for longer than three years
3. For each desk for each business day over the previous three years,
   i. The daily profit or loss for the desk (assumes positions at end of previous business day are unchanged)
   ii. Testing of portfolios must be done at both the trading desk and bank-wide level
   iii. Two daily VaR's for the desk calibrated to a one-tail 99.0 and 97.5 percent confidence level , and a daily ES calibrated to 97.5
   iv. Compare each days' 1-day static VAR (most recent 12m) at 97.5% and 99% for **BOTH** the desk's one-day actual P&L (APL) and the one-day hypothetical P&L (HPL)
   v. Limit is 12 exceptions at the 99th percentile or 30 exceptions at the 97.5th percentile
   vi. The p-value of the profit or loss on each day for the desk (probability of observing a profit that is less than, or a loss that is greater than the amount reported according to the model used to calculate ES).

4. Hypothetical portfolios to ensure that the model is able to account for particular structural features
5. Ensure that the model captures concentration risk

IMA – Quantitative (97.5% ES)

1. Take the Full set of risk factors of Delta, Gamma and Vega for the portfolio

2. Compress this to the Reduced Risk Factors

3. For each day going back to 1-Jan-2007, calculate and sum the PL for each of these risk factors and thus find **the worst 12 month stress period**.
 (For the 1bn USD 2y2y A+50P, this is found to be 10-Oct-2007 to 09-Oct-2008 at -16.7m)

4. For each of the risk factors (**constrained**), and for all risk factors combined (**unconstrained**), calculate each of the **10-day PLs** within that 260 day period, giving 250 10-day PLs and calculate the average of the worst six (2.5% of 250 = 6) . Capital is the average of these 2
In our example, **3 combined risk factors = -7.5m**, Delta = -4.0m (80bp rally) Gamma =-1.8m and Vega = -2.1m (vol up 24Normals)

5. Bucket risks by Liquidity horizons - LH for G7 IR = 10days, LH for IR Vol = 60days (all capped at maturity of instrument)
10day bucket - All of the risk factors are included so square 7.5m
20day bucket - Only Vega is in the– square 2.1m and multiply by SQRT[(20-10)/10].
40day and 60 day buckets – Similarly only Vega and multiply by SQRT[(40-20)/10] and 60day SQRT[(60-40)/10] respectively
Sum these 4 and SQRT to get the **ESrs** = Expected Shortfall(Reduced factors, stressed period)= 8.9m for this portfolio

6. Scale ESrs up by the amount that the reduced factors underestimates the Full Risk Factors over the past calendar year (ES(full factors, current)
The ES (reduced factors, current) has to account for at least 75% of the ES(full factors, current)
Internal Model Capital Charge IMCC(C) = ESrs*(ESf,c/ESr,c).

7. (Combine any other risk factors – FX, Equities etc using the appropriate correlations to get the IMCC of the portfolio)

8. **Capital Requirement = max(IMCCt-1 + SESt-1, m*IMCCavg60days + SES avg 60day)** where m is a factor based on back-testing results)M ranges from 1.5 to 2) and SES arises from Non-modellable risk factors (the PLATSON solution aims to minimise reliance on NMRF). We have assumed m=1.5 but reduced IMCC avg 60days by 1/3 so our overall **CA = 8.9m for the –1bn 2y2y A+50 Payer**

Risk Factor Selection (Modellable)

Modellable risk is included within a Global Expected Shortfall (ES) and a Default Risk Charge (DRC)
Non-modellable risk is subject to a Stressed capital add-on (SES) – the sum of these three will give the capital allocation

Modellable Risk Factors

Considerable effort must be made to determine the modellable risk factors as the cost of not doing so is a much higher capital charge. Too many risk factors can become unobservable – non-modellable, too few and a desk is more likely to fail the PLAT test. Swaption Volatilities for longer expiries and tenors may not be modellable as per below

1. Continuously available *real* prices for a sufficient set of representative transactions.
2. It is a price at which the institution has conducted a transaction;
3. It is a verifiable price for an actual transaction between other arms-length parties; or the price is obtained from a committed quote.
   If the price is obtained from a third-party vendor, where: (i) the transaction has been processed through the vendor; (ii) the vendor agrees to provide evidence of the transaction to supervisors upon request; and (iii) the price meets the three criteria immediately listed above, then it is considered to be real for the purposes of the modellable classification.
4. A modellable risk factor must have at least **24 observable real prices per year** with a **maximum period of one month** between two consecutive observations

Risk Factor Selection (Non-Modellable)

Non-modellable Risk Factors

NMRF are factors that affect pricing, but cannot be included in the ES calculation.

Capitalised using a stress scenario calibrated to be at least as prudent as ES at 97.5% calibrated over an extreme stress period.

The liquidity horizon of the stress scenario must be the greater of the largest time interval between two consecutive price observations over the prior year and the liquidity horizon assigned to the risk factor (10 days for swaps, 60 days for options)

No correlation or diversification effect between other non-modellable risk factors is permitted

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P&L Attribution Test
Spearman correlation and one of Chi-squared or K-S

In order to use IMA, PL Attribution testing needs to be passed
Amber doesn't necessarily require an immediate move to SA from IMA

HPL = Hypothetical PNL (Actual PNL based off MTM)
RTPL = Risk-Theoretical PNL (Predicted from Front Office or Risk)

1. Spearman – rank based correlation between the HPL and RTPL over 250 days.
2. One of the following 2 tests will be used
   a. Chi-squared – create 5 bins each containing 50 HPL and then count RTPL falling in each bin. Chi-squared is the Sum of the difference of the numbers of each bucket squared / 50. Reported quarterly
   b. Kolmogorov-Smirnov – Largest absolute difference between the empirical cumulative distribution functions of HPL and RTPL

Spearman		Chi		K-S	
82.5%	100.0%	0.0	14.0	0.000	0.083
75.0%	82.5%	14.0	18.0	0.083	0.095
0.0%	75.0%	18.0	1000.0	0.095	0.500

Summary

1. Banks can either use SA (SBM) or IMA – but need to pass PLAT (and back-testing) in order to qualify to use IMA
2. SBM charges separately for delta, vega and curvature and can be significantly more punitive in part due to prescribed correlations and a reduced correlation scenario
3. IMA allows for previous actual market correlations and should result in lower capital allocation. However this may require the use of non-standard risk factors and proving that these are modellable may prove involving

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Unauthorized Disclosure Notice

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