Fundamental Review of Trading Book

Sensitivity Based Approach

Youngsuk Lee

Recap – Market Risk Capitalisation under FRTB

Question: Where do we need Standardised Approach under FRTB?

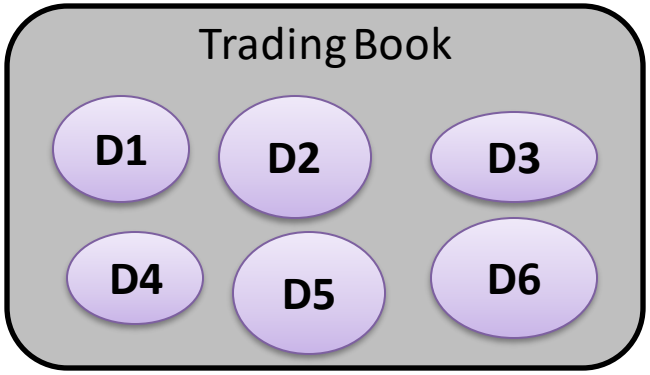
1. Market risk capitalisations:
   - organize trading book into desks
   - internal models waiver by desk
   - calculate capital

inside the waiver	outside the waiver
internal models approach i.e. ES, IDR, NMRF	**Standardised Approach** i.e. SBA

for capitals

2. Surcharge or Floor to IMA charges
   - *CP2: "...including to potentially be used as a surcharge or floor to an internal models based charge."*
   - Disclose Standard Approach charge calculated *across all positions* in the trading book *regardless* of waiver.

for disclosure



All positions under SA

Design Principles and Re-designing History

- Design principles for standardised approach (according to CP2)
  1. Simplicity, transparency and consistency
  2. Improved risk sensitivity
  3. Credible calibration
  4. Limited model reliance
  5. A credible fall back to internal models

  Inherent contradictions between some of these objectives; inevitable trade-offs

- Evolution of standardised approach over time (non-default risk)
  - CP1 (05/2012): partial risk factor approach and fuller risk factor approach
  - CP2 (10/2013): notional position decomposition approach
  - QIS2 (07/2014): sensitivity based approach (**SBA**) with disallowance factor
  - CP3 (12/2014): **SBA** with correlation scaling
  - ISDA/TBG on-going conversations: some key changes under **SBA**

Sensitivity Based Approach

As of CP3, Standardised approach (SA) consists of

- non-default risk charges:
  - calculated through **S**ensitivity **B**ased **A**pproach (SBA)
  - sum across
    - Delta, Curvature and Vega charges
    - risk factor classes:
      GIRR, CSR (non-sec), CSR (sec), equity, commodity, FX
- default charge: non-securitisations & securitisations

SA and SBA

- Sometimes, the term 'SBA' is over-used to include the SA default charge calculations as well.
- Strictly speaking, curvature calculations require more than those sensitivities that banks usually calculate day-to-day.

SBA - How It Works

Focus on Delta Charges

- explain using GIRR example

PV01's

V(x + 0.5bp) - V(x-0.5bp)

e.g. 1bp increase in EUR 1Y

- Trade 1: 20 profile
- Trade 2: 15 loss

Inputs: Risk sensitivities by currency bucket

define a set of risk factors

Bucket	Mat
EUR	1Y
	5Y
GBP	1Y
	5Y

calculate sensitivities for each trade

T1	T2	T3
+20		-15
+15		-20
	-20	+30
	-30	+15

net sensitivities across trades

Net
+5
-5
+10
-15

Capital Calculation: Aggregate netted risk sensitivities across risk factors.
But **HOW?**

SBA Risk Aggregation - Risk Weight

Risk Weighted Sensitivities

- For each risk factor k, a risk weight RW_k is assigned.
- Represents the 97.5% stressed expected shortfalls

risk weights as of CP3
- subject to further calibration

Net Sensitivities across trades

Bucket	Mat	Net
£	1Y	+5
	5Y	-5
$	1Y	+10
	5Y	-15

k	1Y	5Y
RW_k	150	100

multiply

Weighted Sensitivities

WS_k
+750
-500
+1500
-1500

- The individual capital charge for each position would be the risk weighted sensitivity itself. (e.g. £ 1Y: 750, $ 5Y: 1500)
- How to aggregate across all risk weighted positions?

SBA Risk Aggregation - Correlation

Variance-Covariance (VCV)

- aggregation across all positions.
- incorporate hedging and diversification effects by specifying
  - ρ_{jk}: **intra-bucket** correlations
  - $\gamma_{£\$}$: **inter-bucket** correlations

WS_k
+750
-500
+1500
-1500

		£		$	
		1Y	5Y	1Y	5Y
£	1Y	1	0.75	0.5	
	5Y	0.75	1		
$	1Y	0.5		1	0.75
	5Y			0.75	1

correlations as of CP3
subject to further calibration

aggregate **within** each currency **bucket**

charges	net positions
$K_{£} = \sqrt{\sum_k WS_{£,k}^2 + \sum_{k \neq l} \rho_{kl} \cdot WS_{£,k} \cdot WS_{£,l}}$	$S_{£} = \sum_k WS_{£,k}$
$K_{\$} = \sqrt{\sum_k WS_{\$,k}^2 + \sum_{k \neq l} \rho_{kl} \cdot WS_{\$,k} \cdot WS_{\$,l}}$	$S_{\$} = \sum_k WS_{\$,k}$

aggregate **across buckets**

$$\text{Delta Charge} = \sqrt{K_{£}^2 + K_{\$}^2 + 2 \cdot \gamma_{£\$} \cdot S_{£} \cdot S_{\$}}$$

SBA Framework - Summary and Missing Bits

- Organize all risk factors into the bucketing structure for each asset class
  1. For each risk factor k, calculate the net sensitivity s_k across all trades
  2. Weight the net sensitivity by the risk weight RW_k

$$WS_k = RW_k \cdot s_k$$

  3. For each bucket, calculate charges K_b & net positions S_b

$$K_b = \sqrt{\sum_k WS_k^2 + \sum_{k \neq l} \rho_{kl} WS_k WS_l} \quad \& \quad S_b = \sum_k WS_k$$

  4. Asset-level charge across buckets

$$\text{Charge} = \sqrt{\sum_b K_b^2 + \sum_{b \neq c} \gamma_{kl} S_k S_l}$$

- Key Missing Elements
  - capturing basis risk
  - correlation uncertainty

SBA

Classic Parametric VaR Model

- $k \sim N(0, RW_k^2)$
- $corr(k, l) = \rho_{kl}$

Basis Risk

- What is a basis risk?
  risk that two *highly correlated* risk factors do not move in line
- Examples:

source of basis risk	**examples**
instrument differences	Future vs FRA CDS vs Bond equity price with or without dividend
rate spreads	OIS/Libor 3M/Libor 6M JPY Libor vs JPY Tibor cross-currency basis swap
underlying references	Senior vs Sub-ordinated Brent vs WTI
legal differences	deliverable vs non-deliverable CDS doc clauses

- Unprecedented widening in rate spreads during 2008-2009 crisis.
- Importance of incorporating basis risks even thought not material today.

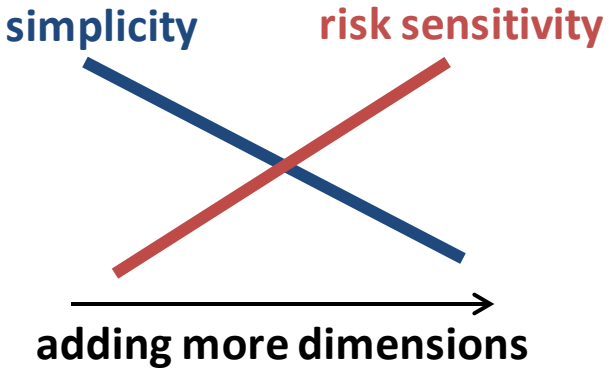
Capturing Basis Risk

Challenge of capturing basis risk under SBA

- ideal situation: incorporate all (most) basis risk without altering the SBA framework. But, difficult.
- Attempt in CP2: capturing basis risk by applying the disallowance factor at the instrument level. Results driven by the trade volume then the actual risk of the portfolio.

Risk Factor Refinement. since CP3

- Add *new dimensions* in the risk factor definition.



- Striking the right balance is the key challenge!

Risk Factor Refinement in CP3

Additional basis risk factor attributes

asset class	**main attributes** (prior to CP3)	**basis attributes** (from CP3)
GIRR	currency, maturity, inflation	sub-curves (OIS, 1M, 3M, etc)
Credit (NonSec)	underlying obligor, maturity	bond vs CDS
Equity	underlying obligor	dividend forecast repo risk
FX	exchange rate	maturity
Commodities	commodity type	basis, location, maturity (*)

- Introduction of index basis: single name vs index
- Questions
  - Sufficient enough? any missing risks? too complicated?
  - How to aggregate risk sensitivities?
    - risk weights and correlations are specified over main attributes
    - how about basis risk?

(*) they were main attributes in CP2

Basis Risk and Correlation Scaling Method

Refined Risk Factors | Weighted Sensitivities | **Aggregation through Correlation Scaling**

Bucket: GBP

Mat	Basis	Net	WS_k
1Y	OIS	+15	+2250
5Y	OIS	-25	-2500
1Y	6M	-10	-1500
5Y	6M	+20	+2000

multiply

same risk weights

Mat	1Y	5Y
RW	150	100

		1Y	5Y	1Y	5Y
		OIS		6M	
1Y	OIS	C		(1-x) C	
5Y	OIS				
1Y	6M	(1-x) C		C	
5Y	6M				

C =

1	0.75
0.75	1

Procedure

- start with refined risk factors
- calculate weighted sensitivities at refined risk factors
- VCV aggregate: correlation between basis risk factors: scaled down by **(1 - x)**

$$(K_{£})^2 = \sum_k WS_k^2 + \sum_{k \neq l} \rho_{kl} \cdot WS_k \cdot WS_l$$

OIS:
$$= \sum_m WS_{OIS,m}^2 + \sum_{m \neq n} c_{mn} \cdot WS_{OIS,m} \cdot WS_{OIS,n}$$

6M:
$$+ \sum_k WS_{6M,m}^2 + \sum_{m \neq n} c_{mn} \cdot WS_{6M,m} \cdot WS_{6M,n}$$

OIS v 6M:
$$+ 2 \sum_{m,n} (1-x) \cdot c_{mn} \cdot WS_{6M,m} \cdot WS_{OIS,n}$$

Capturing Correlation Uncertainty

On SBA Correlations (from CP2)

- **calibration period**: "*...calibrated based on a long time period – because stress period correlations will not always be prudent for certain portfolios.*"
- **two levels**: "*In order to capture the lack of stability in correlation parameters in some cases, two values have been specified for each pair of risk positions.*"
- aggregation with **asymmetric correlations**: "*a **higher correlation** to be used when the risk positions have the **same sign** (to capture diversification benefits) and a **lower correlation** to be used when their **signs differ** (to capture hedging benefits).*"

$$K_b = \sqrt{\sum_k WS_k^2 + \sum_{k \neq l} \rho_{kl} WS_k WS_l}$$

$$= \sqrt{\sum_k WS_k^2 + \sum_{k \neq l} \rho_{kl}^{+} WS_k WS_l + \sum_{k \neq l} \rho_{kl}^{-} WS_k WS_l} \qquad \rho_{kl}^{-} < \rho_{kl}^{+}$$

$WS_k WS_l > 0$ $\qquad$ $WS_k WS_l < 0$

Asymmetric Correlation & Flaw

- introduced in CP2
- conservative selection of correlation at each pair of risk factors

Too Conservative!

- Illustration with Credit (Non-Sec)
- Refined risk factors

attributes	
main	obligor name & maturity
basis	bond vs CDS

- correlation structure (CP3)

	same name diff maturity	diff name
same sign	90%	40%
diff sign	60%	10%

Example

- Tesco bond , well-hedged by CDS

Tesco	1Y	2Y
bond	+100	+100
CDS	-100	-100

- Correlation Scaling (with x = 0) & Asymmetric Correlation

  K_b = 109.5!

  no basis assumption

- Triangle law is broken!

  For each maturity, $K_b = 0$

	1Y
bond	+100
CDS	-100

	2Y
bond	+100
CDS	-100

K_b(1Y + 2Y) > K_b(1Y) + K_b(2Y) !!!

Alternative Approach - Correlation Scenarios

What's Next?

- The regulators has recognized this flaw with the asymmetric correlation approach.
- Most likely, the alternative method is based on correlation scenarios
  1. define two correlation scenarios:

     one with high correlations and the other with low correlations
  2. for each scenario, calculate the capital charge
  3. take the maximum or average of two

- Back to our bond/CDS example:
  - correlation scaling with x = 0
  - correlation scenario method

    $K_b = 0$!

Basis Risk: Further Considerations (1/2)

- So far, examples with GIRR and Credit (Non-Sec). Other asset classes?

  With risk factor refinement under CP3...

  - FX
    - new risk factor dimensions: trade maturity
    - somewhat distant from usual market practices (via XCCY basis swaps)
    - attention brought to the regulators

FX Maturity Buckets
less than 1yr
1yr to 3yr
more than 3yr

  - EQ
    - new risk factor dimensions: dividend forecast and repo levels
    - exact definitions and corresponding risk sensitivities yet to be fully described
  - Commodities
    - CP2 specification was refined enough
    - Room to improve the risk factor definition & bucket specifications
  - Credit (Sec) and CTP: approaches yet to be finalised

Basis Risk: Further Considerations (1/2)

- Index basis: Index vs Single Name
  - CP3: Delta risk on an index position (e.g. S&P500, iTraxx) shall be decomposed into constituents.
  - A pair of risk sensitivities, one from a single name position and the other from an index position, is subject to a correlation scaling.

- (More) difficulty of standardising basis risk

  e.g. GIRR sub-curve basis:
  - difficult to standardise a set of sub-curves
  - no universal market practice how sensitivity calculations on sub-curves are calculated and stored in their risk system
  - different banks, different results

In Closing: getting there but not yet final...

Framework Improvement

- Overall, the SBA framework is sound, in particular, for delta risk charge.
- Correlation scaling method is introduced as a mean to capture basis risk
- However, when coupled with asymmetric correlations, the method is flawed, leading to unrealistic capital levels.
- Working together with the industry, the regulators also recognize the issue and an alternative method is being considered.
- Likely the alternative is based on two correlation scenarios, taking the maximum charge from two separate calculations.
- For certain asset classes, there are still rooms to improve in the risk factor refinements (definition and sensitivities) for better capturing basis risk.

Parameter Re-Calibration:

- All SBA parameters, including correlation scaling factors (1-x), are subject to re-calibration.

Questions?