Fundamental Review of the Trading Book

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London

Sensitivity Based Approach - Basis Risk

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Recap – Standardised Approach under FRTB

Why is Standardised Approach important under FRTB?

1. Market risk capitalisations for positions outside the waiver
2. Potential Surcharge or Floor to IMA charges
    - Disclose Standard Approach charge calculated *across all positions* in the trading book *regardless* of waiver

Key Design Principles

1. Simplicity, transparency and consistency
2. Improved risk sensitivity
3. Credible calibration
4. Limited model reliance
5. A credible fall back to internal models

Challenging…
Inherent contradictions
inevitable trade-offs

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Re-designing History

Evolution of Standardised Approach

- Consultation Paper 1 (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

Structure of Standardised Approach

- Non-default risk charges
  - Calculated through **S**ensitivity **B**ased **A**pproach (SBA)
  - Sum over Delta, Curvature and Vega charges

    Risk factor classes: GIRR, CSR (non-sec), CSR (sec), equity, commodity, FX
- Default charge: non-securitisations and securitisations

- ISDA/TBG on-going conversations: some key changes are expected

By the way…

- Sometimes, the term 'SBA' is over-used to include the SA default charge calculations as well
- Curvature requires more than those sensitivities that banks usually calculate day-to-day

SBA – How It Works

PV01's

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

e.g. 1*bp* increase in GBP 1Y

- Trade 1: 20 profit
- Trade 3: 15 loss

Focus on Delta Charges

- Explain using GIRR example

Inputs: Risk sensitivities by currency <u>bucket</u>

Define
a set of risk factors

Bucket	Mat
£	1Y
	5Y
$	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

In practice,
over 10 maturities

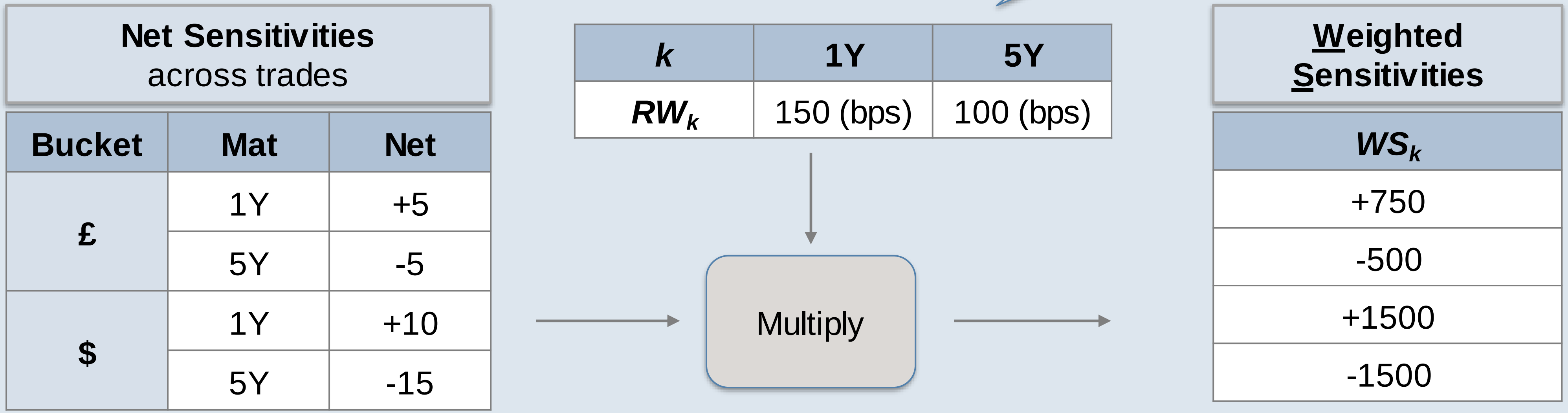
Capital calculation: <u>Aggregate</u> netted risk sensitivities across risk factors. But **HOW?**

SBA Risk Aggregation – Risk Weight

Risk Weighted Sensitivities

- For each risk factor k, a risk weight RW_k is assigned
- Represents the 97.5% expected shortfall over a stressed period

- 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 (bps)	100 (bps)

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 positions for the portfolio-level capital?

Risk Aggregation – Correlations

Correlation Specification

- Specify a correlation for each pair of risk factors
  - ρ_{jk}: **intra-bucket** correlations
  - $\gamma_{£\$}$: **inter-bucket** correlations

			£		**$**	
			1Y	**5Y**	**1Y**	**5Y**
		WS_k	+750	-500	+1500	-1500
£	**1Y**	+750	**1**	**0.75**	**0.5**	
	5Y	-500	**0.75**	**1**		
$	**1Y**	+1500	**0.5**		1	**0.75**
	5Y	-1500			**0.75**	1

Correlations as of CP3 subject to further calibration

Charge Calculation

- Variance Calculation

$$\text{Delta Charge} = \sqrt{\sum_{k,l} \text{Corr}_{k,l} \cdot WS_k \cdot WS_l}$$

$$= \sqrt{\sum_{k} WS_k^2 + \sum_{k \neq l} \sum_{l} \text{Corr}_{k,l} \cdot WS_k \cdot WS_l}$$

- Nothing but.. Classic parametric VaR model
  - $k \sim N(0, RW_k^2)$
  - $corr(k, l) = \text{Corr}_{kl}$

Risk Aggregation via 2-Tier Cascade

Equivalent Variance Calculation via 2-Tiers Cascading

- Modularised into simpler calculations
- Drilling down into buckets
- Single correlation specification between buckets

			£		$	
			1Y	5Y	1Y	5Y
		WS_k	+750	-500	+1500	-1500
£	1Y	+750	1	0.75	0.5	
	5Y	-500	0.75	1		
$	1Y	+1500	0.5		1	0.75
	5Y	-1500			0.75	1

Step 1: Aggregate **within** each currency **bucket**

Bucket Charges	Net Positions
$K_{\pounds} = \sqrt{\sum_k WS_{\pounds,k}^2 + \sum_{k \neq l} \boxed{\rho_{kl}} \cdot WS_{\pounds,k} \cdot WS_{\pounds,l}}$	$S_{\pounds} = \sum_k WS_{\pounds,k}$
$K_{\$} = \sqrt{\sum_k WS_{\$,k}^2 + \sum_{k \neq l} \boxed{\rho_{kl}} \cdot WS_{\$,k} \cdot WS_{\$,l}}$	$S_{\$} = \sum_k WS_{\$,k}$

Step 2: Aggregate **across** buckets

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

$$= \sqrt{\sum_b K_b^2 + \sum_{b \neq c} \sum_c \gamma_{bc} \cdot S_b \cdot S_c} \qquad b, c = \pounds, \$$$

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SBA Framework

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

$$WS_k = RW_k \cdot s_k$$

  3. Bucket-level charge: Calculate charges K_b and net positions S_b

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

  4. Asset-level charge: Aggregate across buckets

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

- Two aspects not covered in our example.. But regulators are concerned..
  – Capturing basis risk: e.g. no distinction between OIS vs Libor curves
  – Correlation uncertainty: is it reasonable to consider a single correlation value?

Basis Risk

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

- Examples:
  - Instrument differences
  - Rate spreads
  - Underlying references
  - Legal differences

- Episode & Lesson
  - Unprecedented widening in rate spreads during 2008-2009 crisis
  - Importance of incorporating basis risks even though not material today

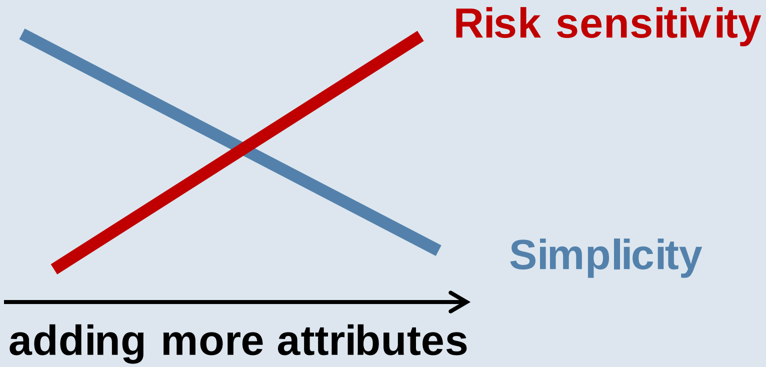
Capturing Basis Risk

Challenge of capturing basis risk under SBA

- Many sources of basis risk.. Difficult problem…
- Attempt in CP2: disallowance factor at the instrument level. Results more driven by the trade volume than the actual risk of the portfolio… So, not good..

Risk Factor Refinement (introduced in CP3)

- Add new attributes in the risk factor definition to further distinguish the source of risk sensitivities

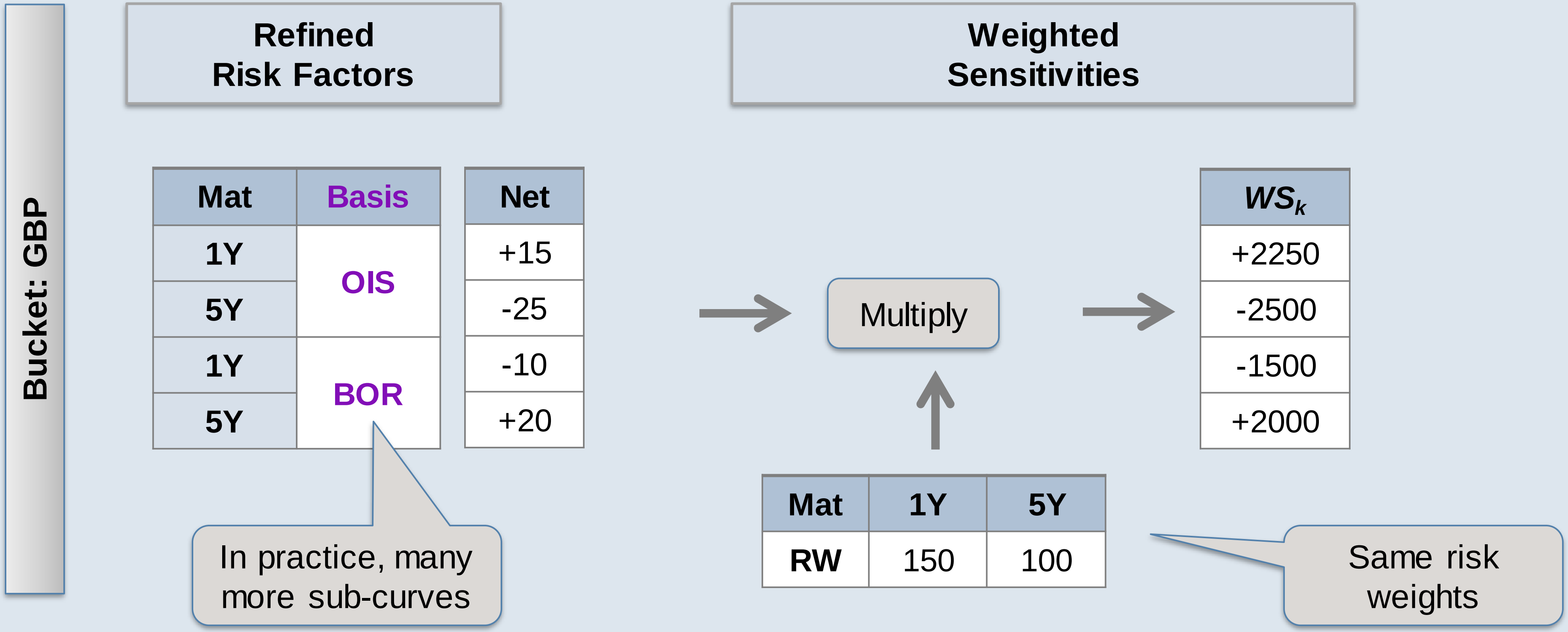


- Striking the right balance is the key challenge!

Example: GIRR

Asset class	**Main attributes** (prior to CP3)	**Basis attributes** (from CP3)
GIRR	Currency, maturity, inflation	Sub-curves (OIS, 1M, 3M, etc)

Basis Risk and Correlation Scaling Method



Bucket: GBP

Refined Risk Factors

Mat	Basis	Net
1Y	OIS	+15
5Y		-25
1Y	BOR	-10
5Y		+20

In practice, many more sub-curves

Multiply

Mat	1Y	5Y
RW	150	100

Same risk weights

Weighted Sensitivities

WS_k
+2250
-2500
-1500
+2000

Procedure

- Start with refined risk factors
- Calculate weighted sensitivities at each refined risk factor

Basis Risk and Correlation Scaling Method (cont'd)

Aggregation through Correlation Scaling

			1Y	5Y	1Y	5Y
			OIS		BOR	
		WS_k	+2250	-2500	-1500	+2000
1Y	OIS	+2250	C		ϕ C	
5Y		-2500				
1Y	BOR	-1500	ϕ C		C	
5Y		+2000				

C =

	1Y	5Y
1Y	1	0.75
5Y	0.75	1

Procedure (cont'd)

- Aggregation via Variance
  - Specify correlations using main attributes
  - Correlation between basis risk factors: scaled down by ϕ

$$\begin{aligned}
& (K_{\pounds})^2 = \sum_k WS_k^2 + \sum_{k\neq l} \rho_{kl}\cdot WS_k\cdot WS_l \\
\text{OIS}\quad & = \sum_m WS^2_{OIS,m} + \sum_{m\neq n} c_{mn}\cdot WS_{OIS,m}\cdot WS_{OIS,n} \\
\text{BOR}\quad & + \sum_m WS^2_{BOR,m} + \sum_{m\neq n} c_{mn}\cdot WS_{BOR,m}\cdot WS_{6M,n} \\
\text{OIS v BOR}\quad & + 2\cdot\boxed{\phi}\cdot\left[\sum_m WS_{BOR,m}\cdot WS_{OIS,m} + \sum_{m\neq n} c_{mn}\cdot WS_{BOR,m}\cdot WS_{OIS,n}\right]
\end{aligned}$$

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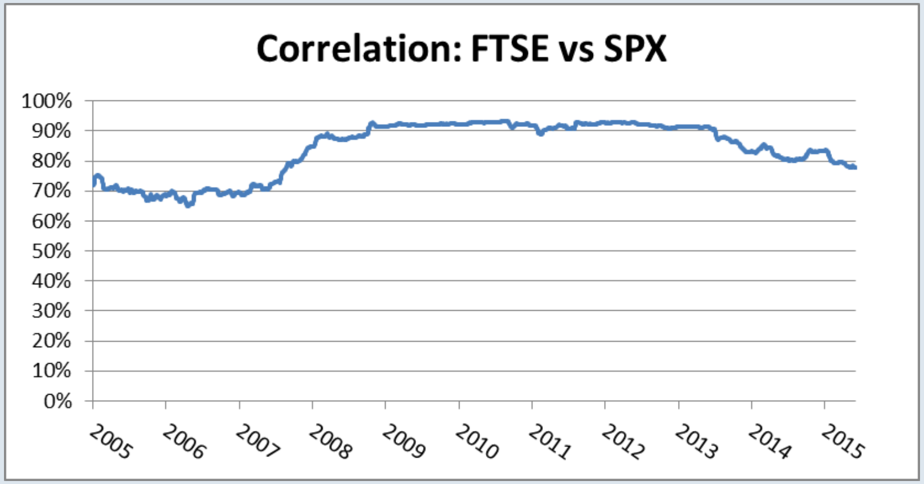
Capturing Correlation Uncertainty



On SBA Correlations (taken 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.* "

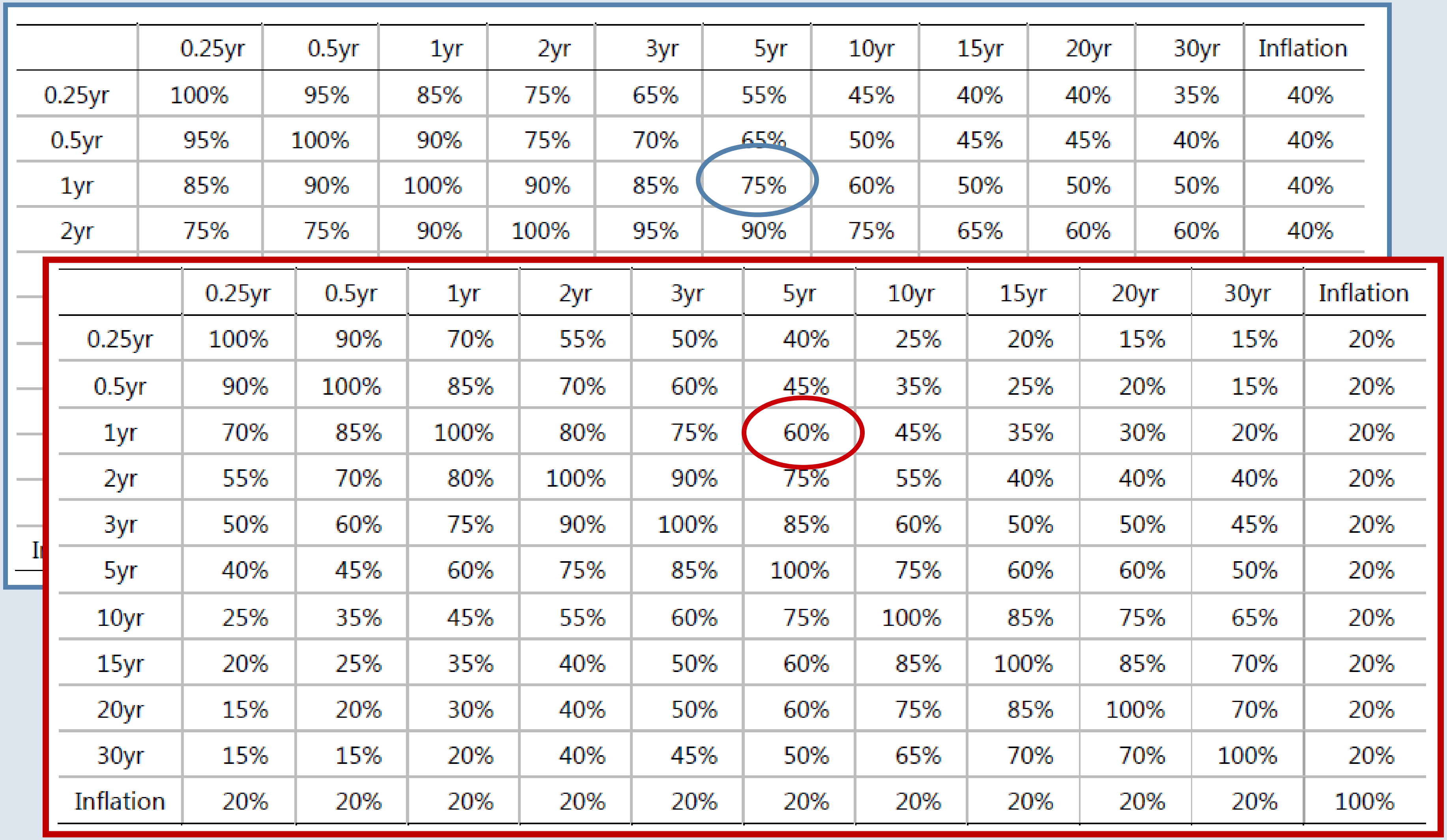
- Aggregation with **Asymmetric Correlations**: "*a higher correlation to be used when the risk positions have the same sign (to capture diversification benefits) and a lower correlation to be used when their signs differ (to reduce hedging benefits)*."

This is the current aggregation approach (CP3)

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

$$= \sqrt{\sum_k WS_k^2 + \sum_{\substack{k\neq l\\ \boxed{WS_k WS_l > 0}}} \boxed{\rho_{kl}^{+}}\, WS_k WS_l + \sum_{\substack{k\neq l\\ \boxed{WS_k WS_l < 0}}} \boxed{\rho_{kl}^{-}}\, WS_k WS_l} \qquad \rho_{kl}^{-} < \rho_{kl}^{+}$$

GIRR Correlation Sets



	0.25yr	0.5yr	1yr	2yr	3yr	5yr	10yr	15yr	20yr	30yr	Inflation
0.25yr	100%	95%	85%	75%	65%	55%	45%	40%	40%	35%	40%
0.5yr	95%	100%	90%	75%	70%	65%	50%	45%	45%	40%	40%
1yr	85%	90%	100%	90%	85%	75%	60%	50%	50%	50%	40%
2yr	75%	75%	90%	100%	95%	90%	75%	65%	60%	60%	40%

	0.25yr	0.5yr	1yr	2yr	3yr	5yr	10yr	15yr	20yr	30yr	Inflation
0.25yr	100%	90%	70%	55%	50%	40%	25%	20%	15%	15%	20%
0.5yr	90%	100%	85%	70%	60%	45%	35%	25%	20%	15%	20%
1yr	70%	85%	100%	80%	75%	60%	45%	35%	30%	20%	20%
2yr	55%	70%	80%	100%	90%	75%	55%	40%	40%	40%	20%
3yr	50%	60%	75%	90%	100%	85%	60%	50%	50%	45%	20%
5yr	40%	45%	60%	75%	85%	100%	75%	60%	60%	50%	20%
10yr	25%	35%	45%	55%	60%	75%	100%	85%	75%	65%	20%
15yr	20%	25%	35%	40%	50%	60%	85%	100%	85%	70%	20%
20yr	15%	20%	30%	40%	50%	60%	75%	85%	100%	70%	20%
30yr	15%	15%	20%	40%	45%	50%	65%	70%	70%	100%	20%
Inflation	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	100%

Asymmetric Correlation (1/2)

Sample Portfolio 1

- OIS, well-hedged by BOR (e.g. Libor 6M)

Mat	Basis	WS_k
1Y	**OIS**	+5
1Y	**BOR**	-5

1Y	**1Y**
OIS	**BOR**
+5	**-5**
1	$\phi \cdot 1$
$\phi \cdot 1$	1

- $K_b^2 = (+5)^2 + (-5)^2 + 2\,\phi\,(+5)(-5)$

$$= 50\,(1 - \phi)$$

- with $\phi = 1$, i.e. no basis assumption

$$K_b = 0!$$

Sample Portfolio 2

- OIS, well-hedged by BOR (e.g. Libor 6M)

  At 5Y maturity. Identical otherwise.

Mat	Basis	WS_k
5Y	**OIS**	+5
5Y	**BOR**	-5

- with $\phi = 1$, i.e. no basis assumption

$$K_b = 0$$

Asymmetric Correlation (2/2)

Sample Portfolio 3

- Combine two portfolios

Mat	**Basis**	***RW**$_k$*
1Y	**OIS**	+5
5Y		+5
1Y	**BOR**	-5
5Y		-5

1Y	**5Y**	**1Y**	**5Y**
OIS		**BOR**	
+5	+5	-5	-5

$$\begin{array}{cc} \begin{pmatrix}1 & 0.75\\ 0.75 & 1\end{pmatrix} & \phi\begin{pmatrix}1 & 0.60\\ 0.60 & 1\end{pmatrix}\\ \phi\begin{pmatrix}1 & 0.60\\ 0.60 & 1\end{pmatrix} & \begin{pmatrix}1 & 0.75\\ 0.75 & 1\end{pmatrix}\end{array}$$

Corr: 1y vs 5y	
same sign	diff sign
0.75	0.60

- $$\begin{aligned} K_b^2 = &\ (+5)^2 + (+5)^2 + 2(0.75)(+5)(-5)\\ + &\ (-5)^2 + (-5)^2 + 2(0.75)(-5)(-5)\\ + &\ 2\,\phi\,[\,(+5)(-5) + (+5)(-5) + 2(0.60)(+5)(-5)\,] \end{aligned}$$

$$K_b^2 = 50\cdot(1 - \phi) + 100\cdot(\,0.75 - 0.60\,\phi\,)$$

- So, even with $\phi = 1$,

  $K_b = 3.9!$

What's wrong?

- Not only conservative for this well-hedged portfolio
- Triangle law is broken

$$K_b(1Y \,\&\, 5Y) > K_b(1y) + K_b(5Y)$$

wrong diversification effect

Alternative Approach – Correlation Scenarios

What's Next?

- The regulators has recognised this flaw with the asymmetric correlation approach
- Most likely, the alternative method will be 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
- Incorporate both basis risk & correlation uncertainty in SBA framework

- Back to our example:
  - Correlation scaling with $\phi = 1$
  - Correlation scenario method

$K_b = 0!$

Risk Factor Refinement in Other Asset Classes

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 (*)

(*) They were main attributes in CP2

- Introduction of index basis: single name vs index
  - Delta risk on an index position (e.g. S&P500, iTraxx) shall be decomposed into constituents
  - Sensitivities between single name and index position: subject to a correlation scaling

- Too complicated? Sufficient enough? Any missing risks?

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
- 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 ϕ, are subject to re-calibration
- Risk factor refinement (P&L attributions)

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Questions?

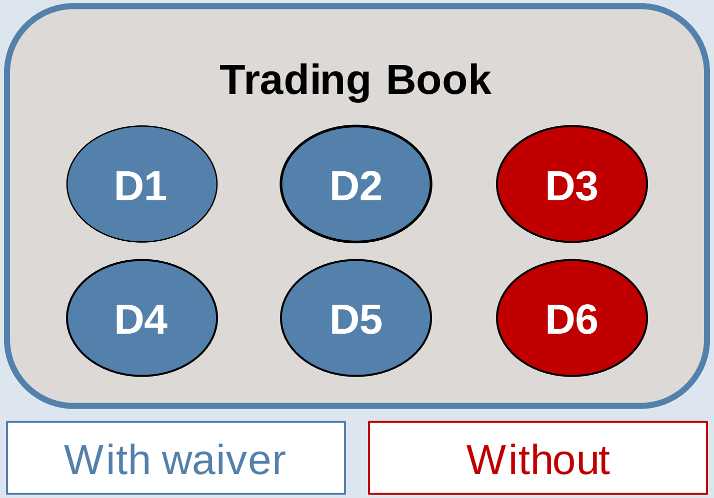
Appendix

Market Risk Capitalisation under FRTB

1. Market risk capitalisations
   - Organise 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** • non-default charge: SBA • default charge

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

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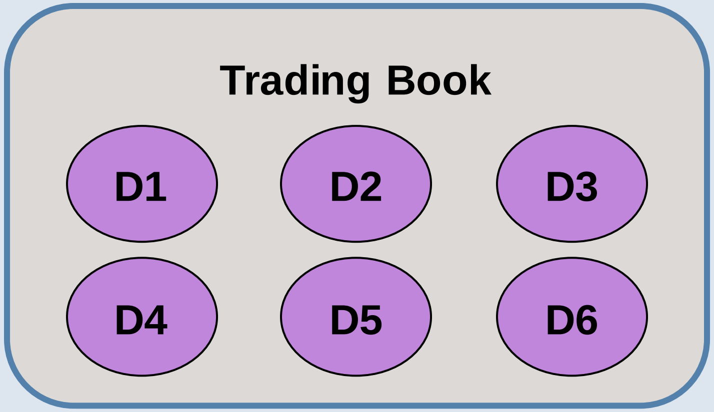

All positions under SA

Basis Risk 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

Asymmetric Correlation in Credit (Non-Sec)

Additional Example with Credit (Non-Sec)

- Refined risk factors

Attributes	
Main	Obligor name & maturity
Basis	Bond vs CDS

- Correlation structure (CP3)

	Same name		**Diff name**
	Same maturity	**Diff maturity**	
Same sign	1.0	0.9	0.4
Diff sign		0.6	0.1

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Asymmetric Correlation in Credit (Non-Sec)(cont'd)

Sample Portfolio 1

- Tesco bond, well-hedged by CDS

RW_k	**1Y**
Bond	+5
CDS	-5

- $K_b^2 = (+5)^2 + (-5)^2$
  $+ 2\phi(1.0)(+5)(-5)$
- with $\phi = 1$, i.e. no basis assumption
- $K_b = 0$!

Sample Portfolio 2

- Tesco bond, well-hedged by CDS

RW_k	**1Y**
Bond	+5
CDS	-5

- $K_b = 0$

Sample Portfolio 3

- Tesco bond , well-hedged by CDS

RW_k	**1Y**	**2Y**
Bond	+5	+5
CDS	-5	-5

$$\boxed{\begin{aligned}(K_b)^2 = {} & (+5)^2 + (+5)^2 + 2(0.9)(+5)(+5) \\ + {} & (-5)^2 + (-5)^2 + 2(0.9)(-5)(-5) \\ + 2\phi\big[& (+5)(-5) + (+5)(-5) \\ & + 2(0.6)(+5)(-5)\big]\end{aligned}}$$

$K_b = 5.5$!

Triangle law is broken!

$K_b(1Y \,\&\, 2Y) > K_b(1Y) + K_b(2Y)$!!!

Basis Risk – FX, EQ, Commodities and Credit (Sec)

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 and bucket specifications

- Credit (Sec) and CTP: approaches yet to be finalised

GIRR Basis Risk – Further Considerations

Difficulty of standardising basis risk

- 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