

## 'Finalized,' but Far from the Finish Line – Preparing for the Next Evolution of FRTB

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*The final text of the Fundamental Review of the Trading Book (FRTB) framework was published on January 14, 2016 by the Basel Committee on Banking Supervision (BCBS). Meeting the anticipation of banks around the world—after a long wait that included three years and four Quantitative Impact Studies (QIS) to create the 'final' version—what does this new evolution of FRTB mean for derivative market participants? From increasing capital requirements to P&L Attribution to IT review—what can banks do to adequately prepare?*

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### AN OVERVIEW

While the final FRTB text has some important changes from the fourth QIS of July 2015, including an extra year for implementation (with a new deadline of January 1st, 2019 for local translation and Dec 31st for latest date for 1st report submission by the financial institutions) and a reduced Residual Risk Add-on—many of the key rules in the framework remain unchanged from prior versions. Derivate market participants are finding the scope and complexity of the framework quite daunting.

Even with an “extra” year, implementing FRTB by the deadline will be a herculean task for many banks, and the capital impact of the regulation could be substantial – to the tune of up to a 40% market risk capital increase compared to the current framework, as estimated by the BCBS. With the anticipated changes, it's imperative that banks fully understand all of the rules and their ramifications, to ensure that capital impact and computational challenges are minimized as much as possible. Faced with the challenges of tons of additional calculations, huge amounts of data to be managed, and the need for better data quality—the prevalent trend emerging amongst financial institutions has been, not surprisingly, IT infrastructure planning in preparation for the imminent FRTB guidelines.

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## WHAT WILL IT TAKE TO CROSS THE FINISH LINE?

What can be done to adequately prepare for FRTB implementation? Clearly, this is a highly complex question without simple answers. For simplification purposes, this paper breaks down the key implications, requirements and methodologies related to the FRTB 'final' text and implementation. First, the paper starts by addressing the increasing capital risk charges of considerable concern to today's derivative market participants—as they continue to rethink derivative business strategy and impact on overall profitability. Next, our study explores the computational implications of FRTB and provides a comparison of the current framework vs. the FRTB framework for the Standardized Approach and Internal Model Approach. As the paper unfolds, it provides a comprehensive breakdown of the Standardized Approach and Internal Model Approach, including detailed methodologies and prescribed formulas—highlighting overall computational and data challenges and the need for organizations to review, and potentially revamp, IT infrastructure in preparation.

The chart below highlights the overall global level change in market risk capital requirements for both approaches, according to the BCBS.

### Increasing Market Risk Capital Requirements - An Overall Look

Global level change in market risk charges in the trading book by components (breakdown by risk measure)

In per cent Table 2

	Internally-modelled				Standardised	Grand Total
	ES	DRC	NMRF	Total	Delta, Vega, Curvature, and Default (Total)	
Simple Mean	-39	92	83	54	128	41
Median	-43	64	39	13	51	18
25th Percentile	-62	7	-19	-32	-62	-36
75th Percentile	-18	192	72	76	195	70

Note: A small number of banks were excluded from the simple mean results for ES, IDR, NMRF, Total (internally-modelled), Standardised and Grand Total for having an absolute percentage change of 1000% or higher. The simple (ie unweighted) mean figures for each of these columns were calculated separately.

Multiplier for ES in this analysis is assumed to be 1.

Source: Basel Committee on Banking Supervision

When looking at overall capital requirements, we see an approximate Grand Total increase of 41%, regardless of the method choice used. When we review the capital increase with FRTB for the Standardized Approach we see 128%, versus a total of 54% for the Internally-modelled Approach. Given the difference, it is no surprise that banks are looking at ways to revise their desks and businesses in a focused effort to have their internal models approved.

*“Overall we are concerned that despite the BCBS’s reiteration not to significantly increase overall capital requirements, trading book capital will increase by 40% under the new rules based on the BCBS’s impact assessment. We worry that the rules may have a negative effect on banks’ capital markets activities and reduce market liquidity.” - GFMA, IIF & ISDA’s Statement on January 14, 2016 highlighting market liquidity concerns.*

### FRTB PRIORITIES IN FOCUS

#### Changes to Market Risk Capital Charges

- Potential changes are anticipated to be significant<sup>1</sup>
- How could this impact your derivative business strategy going forward?

#### Methodology

- Trading/Banking book boundary changes—presumptive lists and qualification criterion (“intended purpose”) for being in Trading Book

#### Support for Standardized Approach

- SA is mandatory and must be used as fallback/benchmark

#### Expected Shortfall vs. VaR

- VaR becomes Expected Shortfall (ES) for Modellable Risk Factors
- Move from Stressed VaR to Stressed ES for Non-Modellable Risk Factors
- Additional scenarios potentially required

#### Changes to Liquidity Horizons (As Set by the Regulator)

- Integration of Market Liquidity Risk
- Incorporate Liquidity horizons from 10d to 250d

#### Support for Residual Risk Add-On<sup>2</sup>

- Required for Standardized Approach
- Defined as simple sum of gross notional amounts of instruments bearing residual risks multiplied by 0.1% as of today and 1% for “exotic” instruments

#### Model Validation

- P&L Attribution
- Backtesting
- Validation of Internal Model Method (IMM) at desk level

#### Default Risk Charge

- Measures capital requirements for default
- To be calculated in Standardized Approach (SA) and Internal Model Approach (IMA)

#### CVA Framework: Industry Recommendations Still Under Consideration<sup>3</sup>

#### Can your organization’s IT Infrastructure support these changes?

<sup>1</sup> <http://www.bis.org/bcbs/publ/d346.pdf>, Section 2.1

<sup>2</sup> Basel’s FRTB QIS: Why the Difference? <http://isda.derivatviews.org/2015/11/>

<sup>3</sup> Industry response to BCBS Consultative Paper on the Review of the CVA Risk Framework from ISDA, GFMA and IIF recommends at least one more Quantitative Impact Study (QIS) is carried out prior to finalization. <http://www.bis.org/bcbs/publ/d325.pdf>

## THE BOTTOM LINE: IT WILL BECOME OVERLOADED

In light of the new FRTB revisions, derivative practitioners will continue to face the challenges of many additional calculations and colossal amounts of data to be managed. To gain a better understanding of what has been prescribed, we will break-down here some of the newly prescribed FRTB calculation requirements in greater detail. Below are two examples:

### Standardized Approach requires the same calculations to be run 3 times with:

- High correlations
- Medium correlations on
- Low correlations
- Correlation between risk factors within a bucket
- Correlation across buckets within a bucket

### Internal Model approach requires up to 120 Expected Shortfall calculations for every qualified desk:

- 5 Liquidity Horizons
  - 7+1 (All = Bank) Asset Classes
  - 3 Calibration methods
- } 5 x 8 x 3 = 120 Expected Shortfall!

## METHODOLOGY OVERVIEW: THE FRTB EVOLUTION

For comparative purposes, let's now take an overall look at the methodologies for the Current Framework vs. those prescribed for the FRTB Framework—for both the Standardized Approach and the Internal Model Approach.

### Overview: Standardized Approach Evolution

	Current Framework	FRTB Framework
Metric	Risk weighted exposures	Sensitivity Based Approach (delta, vega, curvature)  Default Risk Charge on default (credit and equity)  Residual Risk Add-On as: - 1% notional on "exotic" instruments - 0.1% for instruments "bearing residual risk"
Calculation	Linear sum per asset class	Risk weighted sensitivities summed up by asset class
Perimeter	Trading Book not under Internal Model Approach	Trading Book not under Internal Modal Approach Trading Book under Internal Modal Approach for fallback/ benchmark

Overview: Internal Model Approach Evolution

	Current Framework	FRTB Framework
Metric	VaR@99% Stressed VaR@99%  $P[X > VaR_{\alpha}(X)] \leq \alpha$  Incremental Default Risk (bonds, CDS, equities) and Comprehensive Risk Measure (CTP) to manage migration and default risk based on VaR measure	(Stressed) Expected Shortfall@97.5%  $ES_{\alpha}(X) = E[X   X \geq VaR_{\alpha}(X)]$  Default Risk Charge on default (credit and equity) at 1Y based on prescribed 2F model for correlations
Liquidity	Daily shocks x $\sqrt{10}$	Specific liquidity horizon to risk factors and attached volatility Segregation between Modelling Risk Factors and Non Modelling Risk factors based on liquidity
Perimeter	Trading Book that qualifies to Internal Model Approach	Eligible Trading Desks into the Trading Book

**PART I: BREAKING THE METHODOLOGY DOWN – THE STANDARDIZED APPROACH**

Next, to gain a better understanding of what is involved, below in Part I of our methodology breakdown we look at the BCBS formula for the Standardized Approach Capital Charge, and examine each of its components individually—as prescribed by the regulators.

**Capital Charge/Formula:**

- Capital Charge<sub>Standardized Approach</sub> = Delta Risk Capital Charge  
 + Vega Risk Capital Charge  
 + Curvature Risk Capital Charge  
 + Default Risk Charge  
 + Residual Risk Add-On

**A. Delta and Vega Risk Capital Charge**

- 1) Calculate the next sensitivity  $S_k$  across instruments to each risk factor k
- 2) Calculate the risk weighted sensitivity thanks to the regulatory prescribed risk weights  $WS_k = RW_k S_k$
- 3) Aggregate across risk factors within the same bucket using  $\rho_{kl}$  the regulatory prescribed correlation

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

- 4) Aggregate across bucket using  $\gamma_{bc}$  the regulatory prescribed correlation

$$\text{Linear risk} = \sqrt{\sum_b K_b^2 + \sum_b \sum_{c \neq b} \gamma_{bc} S_b S_c}$$

Where  $S_b = \sum_k WS_k$  for all risk factors in bucket b

$$S_c = \sum_k WS_k \text{ for all risk in bucket c}$$

Knowing that if  $\sum_b K_b^2 + \sum_b \sum_{c \neq b} \gamma_{bc} S_b S_c < 0$

Then  $S_b = \max[\min(\sum_k WS_k, K_b), -K_b]$  for all risk factors in bucket b

$$S_c = \max[\min(\sum_k WS_k, K_c), -K_c] \text{ for all risk in bucket c}$$

Source: Basel Committee on Banking Supervision

## B. Curvature Risk Capital Charge

Below are the Principles as defined by BCBS:

- Calculate 2 stress scenarios per risk factor (upward/downward shock)
- Take worst loss in absolute value of the 2 stress scenarios
- After removing the Delta effect

1) Calculate the Curvature Risk position

$i$  is an instrument subject to optional or non-linear risk associated with delta risk factor  $k$

$x_k$  is the current level of risk factor  $k$

$V_i(x_k)$  the price of instrument  $i$  that depends on the current level of risk factor

$V_i(x_k^{(RW^{(curvature)+})})$  and  $V_i(x_k^{(RW^{(curvature)-})})$  are the prices of instrument  $i$  after a shock on  $x_k$  upward or downward

$$CVR_k = -\min \left[ \sum_i \left\{ V_i(x_k^{(RW^{(curvature)+})}) - V_i(x_k) - RW_k^{(curvature)} \cdot S_{ik} \right\}, \sum_i \left\{ V_i(x_k^{(RW^{(curvature)-})}) - V_i(x_k) - RW_k^{(curvature)} \cdot S_{ik} \right\} \right]$$

Source: Basel Committee on Banking Supervision

2) Aggregate within each bucket with the prescribed correlation  $\rho_{kl}$

$$K_b = \sqrt{\max \left( 0, \sum_k \max(CVR_k, 0)^2 + \sum_k \sum_{l \neq k} \rho_{kl} CVR_k CVR_l \psi(CVR_k, CVR_l) \right)}$$

Where  $\psi(CVR_k, CVR_l)$  equals 0 if  $CVR_k$  and  $CVR_l$  have both negative sign else 1

3) Aggregate across bucket within each risk class using the prescribed correlation  $\gamma_{bc}$

$$\text{Curvature risk} = \sqrt{\sum_b K_b^2 + \sum_b \sum_{c \neq b} \gamma_{bc} S_b S_c \psi(S_b, S_c)}$$

Where  $\psi(S_b, S_c)$  equals 1 if  $S_b$  and  $S_c$  have both negative sign else 0

•  $S_b = \sum_k WS_k$  for all risk factors in bucket  $b$

•  $S_c = \sum_k WS_k$  for all risk factors in bucket  $c$

Knowing that if  $\sum_b K_b^2 + \sum_b \sum_{c \neq b} \gamma_{bc} S_b S_c < 0$

Then  $S_b = \max[\min(\sum_k WS_k, K_b), -K_b]$  for all risk factors in bucket  $b$

$S_c = \max[\min(\sum_k WS_k, K_c), -K_c]$  for all risk factors in bucket  $c$

Source: Basel Committee on Banking Supervision

## C. High/Medium/Low Correlations on Delta, Vega and Curvature Charge

1) Linear (Delta + Vega) and Non-Linear (Curvature) charge must be calculated as the worst capital charge that depends on level of:

- $\rho_{kl}$  Correlation between risk factors within a bucket
- $\gamma_{bc}$  Correlation across buckets within risk class

2) The level of  $\rho_{kl}$  and  $\gamma_{bc}$  to be used are:

- High correlation
    - $\rho_{kl} \times 1.25$
    - $\gamma_{bc} \times 1.25$
  - Medium correlations
    - $\rho_{kl}$
    - $\gamma_{bc}$
  - Low correlations
    - $\rho_{kl} \times 0.75$
    - $\gamma_{bc} \times 0.75$
- } Worst loss!

Source: Basel Committee on Banking Supervision

#### D. Default Risk Charge

The Principles defined by BCBS are outlined below:

- **Three Credit sub-books will need to be created and used to capture Jump-To-Default (JTD) risk:**

I. Non-Securitization

II. Securitization-Non-CTP, including its hedges

III. Securitization – CTP, including its hedges

- **Correlation Trading Portfolio definition, as defined in FRTB:**

- Not re-securitization positions, nor derivatives of securitization exposures
- All reference entities are:
  - Single name products, including single name credit derivatives
  - For which a liquid two-way market exists
  - Including traded indices on these reference entities
- The instrument does not reference an underlying that would be treated as:
  - A retail exposure
  - A residual mortgage exposure
  - Or a commercial mortgage exposure

##### I. Default Risk Charge – Non-Securitization

###### METHODOLOGY:

1. Calculate Gross Jump-To-Default risk as a function of:

- Notional amount or face value
- Market value
- Prescribed Loss Given Default (LGD)

$$\text{JTD (long)} = \max [\text{LGD} \times \text{notional} + \text{P\&L } 0]$$

$$\text{JTD (short)} = \min [\text{LGD} \times \text{notional} + \text{P\&L}]$$

- 100% for equity and non-senior debt instrument
- 75% for senior debt

2. Apply offsetting rules to calculate Net JTD risk positions
3. Calculate the hedge ratio benefit to be applied on short positions to discount the hedge benefits

$$WtS = \frac{\sum net JTD_{long}}{\sum net JTD_{long} + \sum |net JTD_{short}|}$$

4. Calculate the DRC which is the sum of bucketed DRC<sub>b</sub>. Across credit quality DRC<sub>b</sub> calculated as follows:

$$DRC_b = \max \left[ \left( \sum_{i \in Long} RW_i \cdot net JTD_i \right) - WtS \cdot \left( \sum_{i \in Short} RW_i \cdot |net JTD_i| \right); 0 \right]$$

Source: Basel Committee on Banking Supervision

## **II. Default Risk Charge – Securitization Non-CTP**

1. Calculate Gross Jump-To-Default risk—which is the exposure market value because the LGD is already included in the default risk weights (i.e. to avoid double counting)
2. Offsetting – same as per Non-Securitization except that:
  - a. Risk weights are coming from the Banking Book/ SEC - IRBA  
(*Securitization Internal Rating Based Approach <http://www.bis.org/bcbs/publ/d303.pdf>*)
  - b. No offsetting is allowed
    - Across securitization of different underlying asset pools even if the tranche is the same
    - And across tranches of the same asset pool
3. Hedge ratio benefit – same as per Non Securitization
4. Calculate the DRC which is the sum of bucketed DRC<sub>b</sub> across credit quality

## **III. Default Risk Charge – Securitization CTP**

It should be noted that in the regulation, Nth-to-Default products are to be treated as tranching products with steps prescribed below:

1. Calculate Gross Jump-To-Default risk (exposure market value because the LGD is already included in the default risk weights (i.e. to avoid double counting))
2. Offsetting – same as per Securitization Non-CTP:
  - a. Across maturities allowed for index products having the same index family, series and tranche
  - b. For long/ short exposures that are perfect replication through decomposition
  - c. For long/ short position that are otherwise equivalent except for a residual component, the net amount is the residual exposure
  - d. No offsetting is allowed across different tranches of:
    - The same index
    - The same series
    - Different series of the same index
    - Different index families
3. Hedge ratio benefit
  - Buckets are each index
  - WtS is applied to net short position in the CTP not in the bucket by itself

4. Calculate the bucketed charge  $DRC_b$  without any floor (ie. this DRC by bucket can be negative):

$$DRC_b = \left( \sum_{i \in Long} RW_i \cdot net JTD_i \right) - Wt_{S_{CTP}} \cdot \left( \sum_{i \in Short} RW_i \cdot net JTD_i \right)$$

5. Calculate the DRC based on the bucketed  $DRC_b$  across credit quality with the following rules:

- Positive bucket level default risk
- 50 % of negative bucket level default risk

$$DRC_{CTP} = \max_b \left[ \sum_b (\max[DRC_b, 0] + 0.5 \times \min[DRC_b, 0]), 0 \right]$$

Source: Basel Committee on Banking Supervision

## RESIDUAL RISK ADD-ON: REVISED IN THE 'FINAL' FRTB TEXT

The Residual Risk Add-on was for the first time introduced with the July 2015 QIS. In summary, the Residual Risk Add-On intends to cover “exotic instruments”—meaning instruments in the Trading Book having an underlying exposure that is not in the scope of Delta, Vega and Curvature risk in any risk class of the SBA or DRC in the Standardized Approach.

New to the Final FRTB text as of January 2016, is a revision to the Residual Risk Add-on for the Standardized Approach. The final text revises the residual risk add-on for “other residual risks.” Specifically, 0.1% gross notional for instruments bearing “other residual risks” which are prescribed by BCBS as follows:

- Subject to delta, vega and curvature risk capital charges
- With payoffs that cannot be written or perfectly replicated, as a finite linear combination of vanilla options
- With a single underlying
- Instruments under CTP

In the final text, the residual risk add-on is prescribed as 1% gross notional for “exotic” instruments—such as longevity, weather, natural disasters and future realized volatility, as an underlying exposure for a swap. This does not apply to back-to-back trades or trades going to CCPs.

**In summary, as defined by BCBS, the Residual Risk Add-On is the simple sum of:**

- Gross notional amounts of instruments “bearing residual risks” multiplied by 0.1%
- Gross notional amounts of “exotic” instruments multiplied by 1%
- For instruments without any notional amount, the maximum potential loss is used

Overall, the bottom-line of the Residual Risk Add-On will likely result in an expensive new charge, with no offsetting allowed.

## PART II: BREAKING DOWN THE METHODOLOGY – THE INTERNAL MODEL APPROACH

Part II of our methodology breakdown explores in detail the individual components prescribed by BCBS for the Internal Model Approach. First, since market participants are particularly concerned with new potential capital charges, we'll have a look at the BCBS formula derivation for the Internal Model Approach Capital Charge.

### INTERNAL MODEL APPROACH – Capital Charge

Capital Charge<sub>Internal Model</sub> = C<sub>ApprovedDesks</sub> + DRC + C<sub>Unapproved Desks</sub>

- Where: C<sub>ApprovedDesks</sub> = max [IMCC<sub>t-1</sub> + SES<sub>t-1, m<sub>c</sub></sub> (IMCC<sub>avg</sub> + SES<sub>avg</sub>)]
- max [IMCC<sub>t-1</sub> + SES<sub>t-1, m<sub>c</sub></sub> (IMCC<sub>avg</sub> + SES<sub>avg</sub>)]
- IMCC<sub>t-1</sub> is the most recent Internal Model Capital Charge (ie. Expected)

Shortfall based on Modellable Risk Factors

$$IMCC = \rho(IMCC(C)) + (1-\rho) \sum_{i=1}^R IMCC(C_i)$$

$$IMCC(C) = ES_{R,S} \times \frac{ES_{F,C}}{ES_{R,C}}$$

$$IMCC(C_i) = ES_{R,S,i} \times \frac{ES_{F,C,i}}{ES_{R,C,i}}$$

- SES<sub>t-1</sub> is the most recent change based on Non-Modellable Risk Factors
- m<sub>c</sub> is a multiplier
  - Floored at 1.5 or set by individual Supervisors
  - And increased by overshooting during the bank level backtesting

### INTERNAL MODEL: EXPECTED SHORTFALL/MODELLABLE RISK FACTORS (MRF)

Next, we'll review how BCBS defines Modellable Risk Factors. According to FRTB guidelines, a Modellable Risk Factor must qualify with the below criteria:

#### I. Availability of "real" price:

- From own transaction
- From transaction between other arms-length parties
- If the price comes from a transaction for a 3rd party vendor

#### II. Continuously

- At least 24 observable "real" prices per year covering the period used to calibrate the current Expected Shortfall model
- With a maximum period of one month between two consecutive observations

#### III. Can be a derived risk factor from Modellable Risk Factors (since July 2015 QIS)

**INTERNAL MODEL: EXPECTED SHORTFALL/LIQUIDITY HORIZON**

The expected shortfall/liquidity horizon under the Internal Model Approach has been defined by BCBS as, “The time required to execute transactions that extinguish an exposure to a risk factor, without moving the price of the hedging instruments in stressed market conditions.” Below is an illustration:

Input of the scaled ES, risk factors shocks without scaling from shorter terms:

$$ES = \sqrt{(ES_{\tau}(P))^2 + \sum_{j \geq 2} \left( ES_{\tau}(P, j) \sqrt{\frac{(LH_j - LH_{j-1})^2}{T}} \right)^2}$$

j	LH
1	10
2	20
3	60
4	120
5	250

If it is assumed that all risk factors are from the same liquidity horizon category, then the ES scales from the 10-day ES as follows

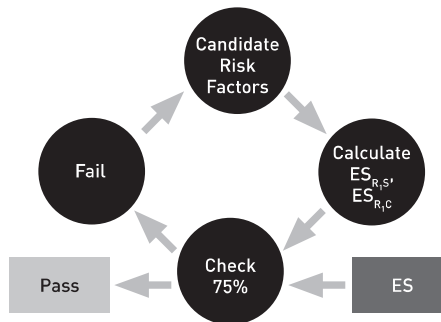
J	LH <sub>j</sub>	Scalar
1	10	1
2	20	√2
3	60	√6
4	120	2√3
5	250	5

**INTERNAL MODEL EXPECTED SHORTFALL/CALIBRATION**

According to the FRTB guidelines, practitioners are allowed to use any choice of risk factors provided that they can explain 75% of the variation of the Expected Shortfall, per the formula below:

$$ES = ES_{R,S} \times \frac{ES_{F,C}}{ES_{R,C}}$$

- Where
- R denotes Reduced number of MRF
  - F denotes Full number of MRF
  - C denotes Current MRF
  - S denotes worst Stressed period of MRF
  - $\frac{ES_{F,C}}{ES_{R,C}}$  is floored at 1



In addition, here it should also be noted that according to the guidance “Current” means:

- 12 months of observation from today
- At least an update once a month in the current environment
- And updates done as soon as there is a significant move in the market

When it comes to the above formula, “Stressed” period is defined as:

- 12 months period of stress over the observation horizon in which the portfolio experiences the largest loss
- Span at least back to 2007
- Observation equally weighted
- At least an update once a month
- Updates done as soon as there is a significant move in the market

**NEW - INTERNAL MODEL STRESSED EXPECTED SHORTFALL (SES): NON-MODELLABLE RISK FACTORS (NMRF)**

According to BCBS, Non-Modellable risk factors are defined as all the risk factors that can't qualify for Modellable Risk Factors. Specifically, there are two kinds of NMRF:

- NMRF arising from idiosyncratic credit spread risk
- Others

Let's now look at the prescribed formula, as stated by BCBS:

Formula =

- L Non-Modellable idiosyncratic credit spread factors to aggregate with 0 correlation
- K other NMRF
- $SES_{NM,j}$  is the stress scenario capital charge for Non-Modellable risk j

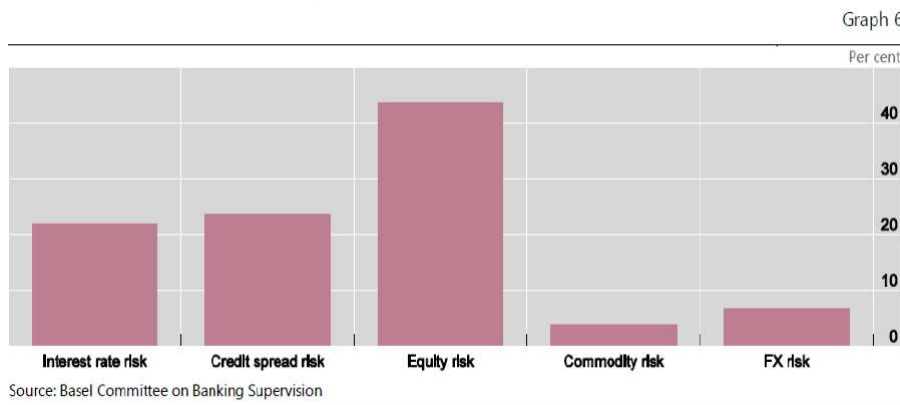
$$SES = \sqrt{\sum_{i=1}^L ISES_{NM,i}^2 + \sum_{j=1}^K SES_{NM,j}}$$

Source: Basel Committee on Banking Supervision

Clearly, it is not surprising that there is an appetite to reduce NMRF in order to reduce capital costs, however, this is likely to fail when running:

- P&L Attribution
- Backtesting

Proportion of total NMRF capital by asset class



**INTERNAL MODEL: DEFAULT RISK CHARGE (DRC)/OVERVIEW**

According to BCBS, Default Risk Charge means for each and every position, an incremental loss amount relative to the current valuation to avoid double counting.

The Default Risk Charge is calculated as follows:

- As a VaR (99.9%), not an Expected Shortfall
- Over a 1 year horizon

Using:

- A 2 factors simulation model based on listed equity prices and credit spreads
- Based on a 1Y period of stress taken from a 10Y historical data, using a 250 Liquidity Horizon
  - With default correlations based on credit spreads or on listed equity prices
  - Has a 3 bps floored default probability
  - Market implied default probabilities cannot be used

#### **NEW - INTERNAL MODEL: DEFAULT RISK CHARGE/DEFAULT PROBABILITIES**

Banks must establish a hierarchy of their PDs sources to avoid any 'cherry picking'.

The rules for PDs are:

- Use of approved IRB PD if the bank has such IRB approved process
- Risk neutral PDs are not appropriate for observed PDs
- PDs must be measured based on historical default data, such as a formal default event

#### **NEW - INTERNAL MODEL: DEFAULT RISK CHARGE/LOSS GIVEN DEFAULT**

According to BCBS:

- Loss given default (LGD) must be interpreted as 1-recovery rate
- Clear hierarchy of LGDs sources to avoid any 'cherry picking'

Also, as defined by the BCBS, the rules for LGDs are:

- Use of approved IRB PD, if the bank has such IRB approved process
- LGDs are calculated from a market perspective based on:
  - *Position's current market value - position's expected market value subsequent to default*
  - *Floored to 0*
- LGDs are based on a sufficient amount of historical data to derive robust and accurate estimates

#### **INTERNAL MODEL – APPROVAL/P&L ATTRIBUTION**

P&L Attribution (in terms of data gathering and obtaining approvals from regulators) is perceived to be one of the more challenging components to implement under FRTB, according to market participants. Here, we will break-down the requirements of P&L Attribution in order to gain a better understanding of all that is involved:

##### P&L ATTRIBUTION

- **Monthly basis** at desk level
- **Risk-Theoretical P&L:** P&L at Desk level that is predicted by Risk Management models conditional on realization of all relevant risk factors that enter the model
- **Hypothetical P&L:** P&L produced by revaluating the positions held at the end of the previous day using the market data at the end of the current day

Next, we'll take a look at the P&L Attribution methodology, as prescribed by BCBS:

#### METHODOLOGY

1. Calculate Risk - **Theoretical Daily P&L** produced by daily observed variations in the risk factors:
  - a. **Modellable Risk Factors** used for P&L and risk calculations
  - b. And **Non-Modellable Risk Factors** used for P&L and risk calculations
2. Compare this Risk - **Theoretical Daily P&L** to the **Hypothetical Daily P&L** based on mark-to-market:

Where  $A = \text{Unexplained } (PL_{\text{Risk-Theo}} - PL_{\text{Hypothetical}})$

$-10\% < \text{Mean } (A) / \text{Standard Deviation } (PL_{\text{Hypothetical}}) < 10\%$

$\text{Variance } A / \text{Variance } (PL_{\text{Hypothetical}}) < 20\%$

3. Report breaches
  - a. There is breach if one of the 2 above ratios exceed the range
  - b. If there are more than 4 breaches over the last 12 months, then the desk goes under Standard Approach

#### **INTERNAL MODEL: APPROVAL AND DESK BACKTESTING**

According to BCBS, below is a breakdown of the methodology involved with this process.

#### METHODOLOGY

1. Compare VaR (1 day, 97.5%) and VaR (1 day, 99%) to ES (97.5%):
  - The VaR calculations are based on 1 year of desk daily P&L  
*(XVA adjustment excluded)*
  - Calculations are done on EOD positions
  - Daily P&L to use are both:
    - Daily Hypothetical P&L
    - Daily Risk-Theoretical P&L
2. Report breaches and go on Standardized Approach, if a desk experiences over 12 months:
  - More than 12 exceptions for the VaR (99%) on Hypothetical P&L or Risk-Theoretical P&L
  - More than 30 exceptions for the VaR (97.5%) on Hypothetical P&L or Risk-Theoretical P&L

#### **INTERNAL MODEL: APPROVAL AND BANK BACKTESTING**

Next, we'll have a look at the methodology for approval for Bank Backtesting as provided by BCBS.

#### METHODOLOGY

1. Find outliers
  - VaR (1 day, 99%, YoY hist. data) > Actual Loss
  - VaR (1 day, 99%, YoY hist. data) > Hypothetical Loss
  - If calculation cannot be run

2. Recalculate  $m_c$  using the table provided by the Regulator:

Table 2

Zone	Number of exceptions	multiplier	Cumulative probability
Green zone	0	1.50	8.11%
	1	1.50	28.58%
	2	1.50	54.32%
	3	1.50	75.81%
	4	1.50	89.22%
Yellow zone	5	1.70	95.88%
	6	1.76	98.63%
	7	1.83	99.60%
	8	1.88	99.89%
	9	1.92	99.97%
Red zone	10 or more	2.00	99.99%

Source: Basel Committee on Banking Supervision

Based on the data and research to date, most banks will still experience challenges in meeting the requirements needed for implementing P&L Attribution testing and having their internal models approved, which could prove costly. Looking forward, there is also concern amongst market participants that varying jurisdictions may interpret requirements in different ways, leading to inconsistencies.

## CONCLUSION

In this paper, we've provided a detailed outline that breaks down the requirements, methodologies and formulas pertaining to the 'final' FRTB text in order to provide a more simplified understanding of the potential IT challenges and costs ahead. The analysis in this paper highlights how the Standardized Approach is expensive in terms of capital and IT resources. Market practitioners remain perplexed by big data challenges—including managing and manipulating the data in the way that they need it, and as prescribed by regulators.

For the Internal Model Approach, a workflow engine will be a necessity at inception and also ongoing to meet desk eligibility requirements and for Modelling Risk Factor v. Non-Modelling Risk Factor segregation. Clearly, there is an appetite to lower Non-Modelling Risk Factors due to increased expense. The Internal Model Approach overall will also be time consuming, with big data to manage and manipulate. Far from the finish line, Banks will need to be very creative when it comes down to trying to manage the future expense and evolution of their IT infrastructure and desk organization in light of the new FRTB requirements under both approaches—with particular concerns surrounding profitability and the mitigation of increased capital charges, P&L Attribution challenges and consistent interpretations of the FRTB final text in varying jurisdictions around the globe.

## AUTHOR BIOGRAPHY

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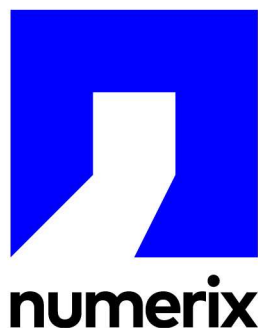
Franck Rossi is a Director of Product Management at Numerix, responsible for product strategy and thought leadership related to banking and derivatives regulations. He also works with clients to understand and document their requirements so Numerix can develop the required functionality into its software. Prior to joining Numerix, Mr. Rossi worked at Thomson Reuters in Product Management in Regulations, Analytics and Structured Products, and at HSBC in Interest Rate Structured Products. He holds an MSc in Finance and Mathematics from Paris-Dauphine University.

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