



GreenPoint>
Financial

FORDHAM UNIVERSITY

FRTB CAPSTONE COURSE 2019

Lecture 1

FRTB Overview



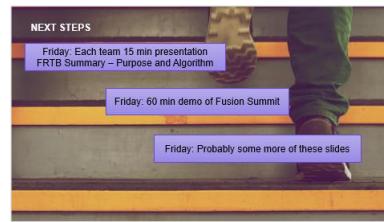
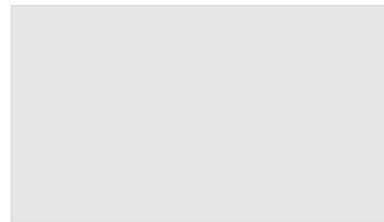
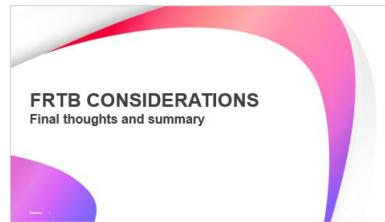
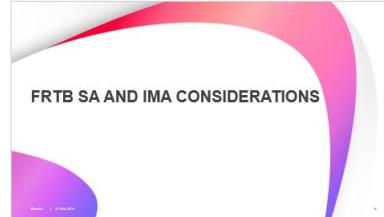
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ADMIN

- Did you sign up for Slack?
- Please add picture to Slack.
- Turn on Notifications on mobile devices so you can respond quickly
- Respond to Poll now.
- Who is not yet signed up officially?
- Access to system requires your IP address. Please send it to us via Slack. Please do not change frequently.

➤ Tomorrow first presentation about FRTB. We will have our own 4 teams based on (top test takers). We may change next week

Group	Group 1	Group 2	Group 3	Group 4
Test Takers	John Doe	Jane Smith	Bob Johnson	Alice Williams



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Groups			
Group1	Group2	Group3	Group4
Yu Dai	Jiayue Xing	Kai Lyu	Jinzhou Yao

ABOUT FINASTRA AND GREENPOINT

FINASTRA FACTS

FOOTPRINT ¹



~10,700+ employees

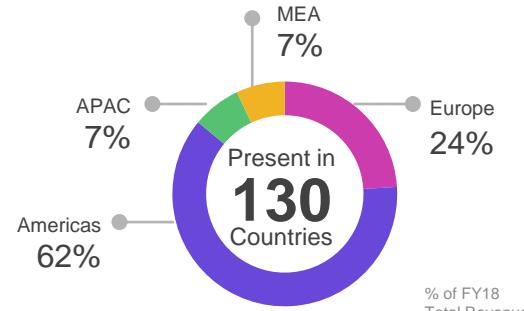


~70 offices

PRODUCT AND SERVICE OFFERINGS

- US Retail Banking
- International Retail Banking
- Corporate Banking
- Payments
- Treasury and Capital Markets
- Technology Enhanced Managed Services

INTERNATIONAL REACH ²



UNMATCHED SCALE AND PROFITABILITY ³

~\$1.9bn+ revenue

95% operating cash flow conversion⁴

DIVERSE, LOYAL CUSTOMER BASE



~9,000 clients



90

of the world's top 100
banks by asset size⁵



~94% retention rate⁶

OUR SOLUTIONS

THE BROADEST AND DEEPEST RANGE IN THE INDUSTRY

>>>>>>>>>>>>>>>>>> Risk Management <<<<<<<<<<<<<<<<

US Community Markets	International Retail Banking	Corporate Banking	Payments	Treasury & Capital Markets
<ul style="list-style-type: none"> > Omni-Channel Banking > Origination > Customer Relationship & Analytics > Business Lending > Consumer and Mortgage Lending 	<ul style="list-style-type: none"> > Omni-Channel Banking > Origination > Customer Relationship & Analytics > Personal Banking Products 	<ul style="list-style-type: none"> > Structured Lending > Commercial Lending > Trade Finance > Supply Chain Finance > Cash Management 	<ul style="list-style-type: none"> > Payment acquisition > Normalisation > Orchestration > Clearing > Payment Services > Processing 	<ul style="list-style-type: none"> > Treasury Management > Multi-asset Trading > Post-trade Processing > Prime Brokerage > Investment Management

LARGE AND DIVERSE CLIENT BASE WITH GLOBAL FOOTPRINT

Representative Client Base

Americas

~250



Europe

~1,000



Middle East and Africa

~300



Asia Pacific

~450



Across Tiers 1 – 4



125

Tier 1



200

Tier 2



450

Tier 3



1,225

Tier 4+

FINASTRA-GREENPOINT INTEGRATED FRTB CAPABILITIES

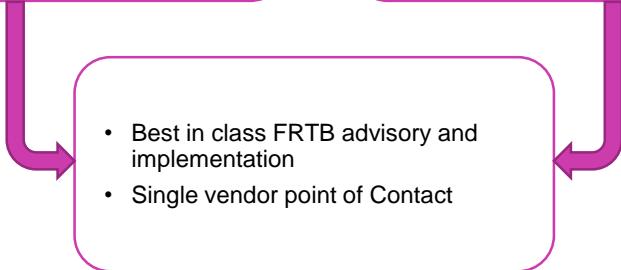
Best in class FRTB platform and industry-leading SMEs

Finastra

- Powerful, scalable best-of-breed FRTB platform.
- Componentized architecture.
- Robust data connectivity.
- Fast, massive and scalable compute capacity.

GreenPoint

- Advisory and project management directly overseen by experienced former risk managers and bankers.
- SME supported by published academic work in FRTB implementation and optimization.
- Experience with the FusionFabric platform.
- Company founded in 2002, owned by founders, employs 380+ FTE globally and is ISO certified.

- 
- ```
graph TD; A["Finastra"] --> C["Best in class FRTB advisory and implementation
Single vendor point of Contact"]; B["GreenPoint"] --> C
```
- Best in class FRTB advisory and implementation  
• Single vendor point of Contact

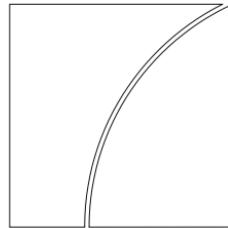
# FRTB SA AND IMA CONSIDERATIONS

# FRTB – FUNDAMENTAL REVIEW OF TRADING BOOK



Basel Committee  
on Banking Supervision

Consultative Document



Fundamental review of  
the trading book: A  
revised market risk  
framework

Issued for comment by 31 January 2014

October 2013

<https://www.bis.org/bcbs/publ/d457.htm>



# DRAWBACKS OF CURRENT STANDARD APPROACH



## NOT RISK SENSITIVE

Products with different risk characteristics often had the same risk weight and thus capital charge

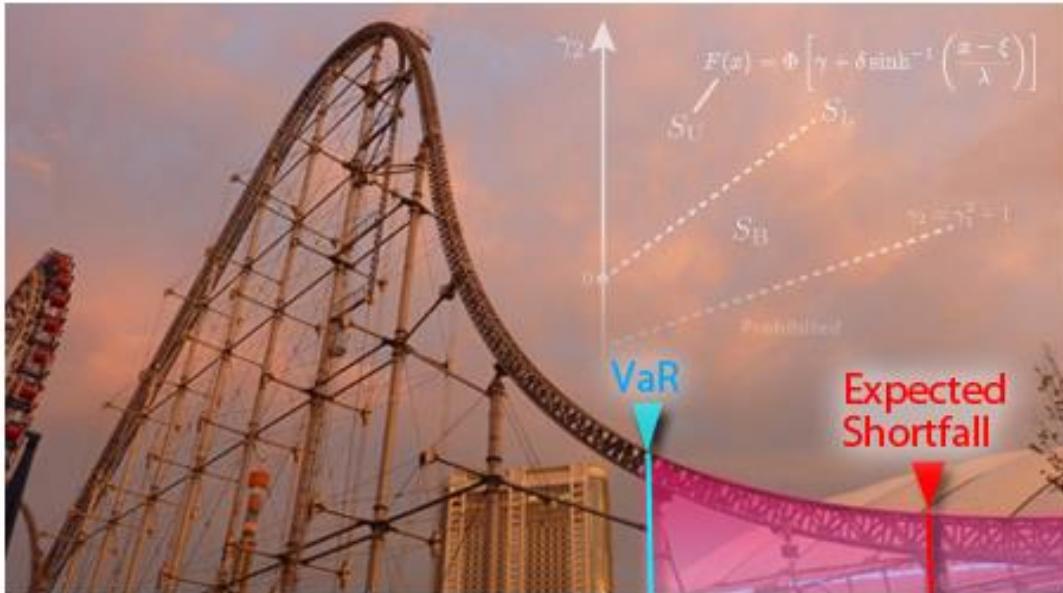
## LACK OF HEDGING & DIVERSIFICATION

Positions within a given asset class could not benefit from diversification when calculating capital charge

## EXTERNAL RATINGS

Misleading ratings negatively affects the assigned risk weight and therefore the capital charge

# VAR VS EXPECTED SHORTFALL



ES CAN SPOT THE BLACK SWANS THAT ARE MISSED BY VaR!



- ✓ ES more sensitive to tail behaviour and extremes of stress
- ✓ ES more sensitive to portfolio non-linearities and harder to “game”

## REASON FOR BASEL 2.5 -> FRTB?

Standardized  
Approach

FRTB capital charge based on **risks in trading book**

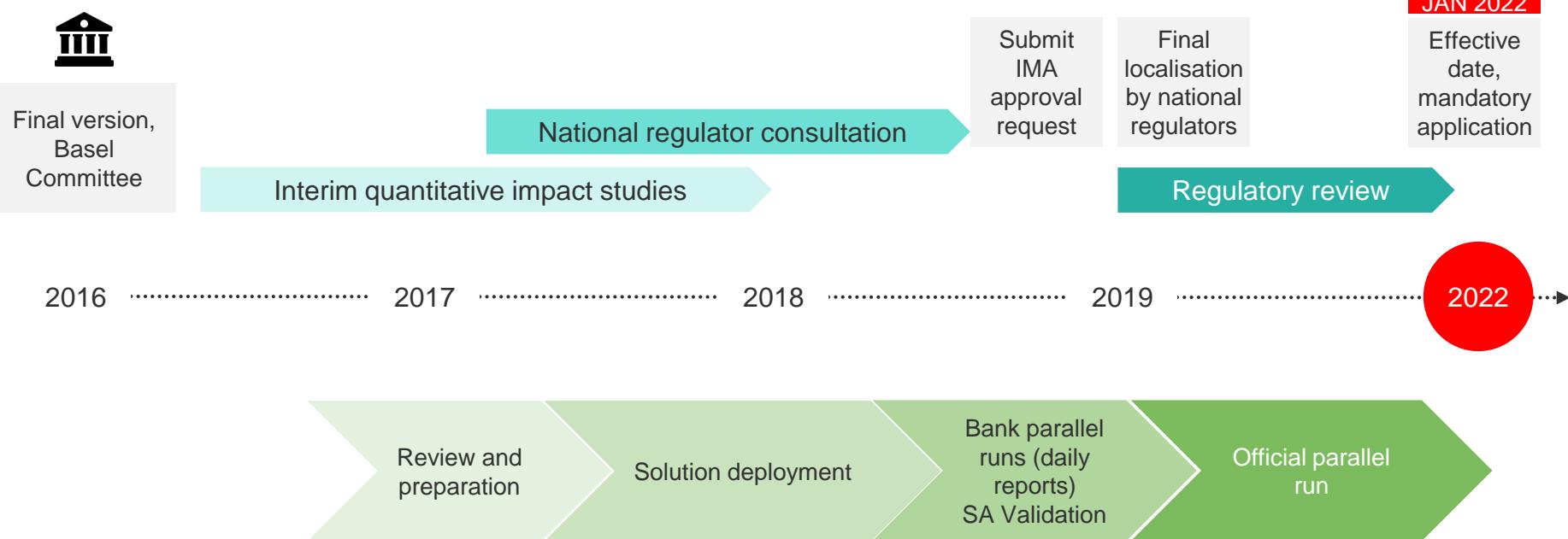
Internal Model  
Approach

Basel 2.5 uses **99% VaR**: Loss with 1% probability of losing more  
FRTB uses **97.5% ES**: Expected loss if loss exceeds 97.5% VaR

# COMPARISON OF BASEL 2.5 VS FRTB

|                         | Basel 2.5                                     | FRTB                                                      |
|-------------------------|-----------------------------------------------|-----------------------------------------------------------|
| Standardized Approach   | Standardized Charge                           | Sensitivity Based Approach<br>Default Risk Charge         |
| Internal Model Approach | VaR + Stressed VaR<br>Incremental Risk Charge | Expected Shortfall, Liquidity Adj.<br>Default Risk Charge |

# Tight path to FRTB compliance



# FRTB - which road to take?

## Standard Approach (SA)

- Who:** All internationally active banks
- What:** All Trading Book + FX/CMDTY from Banking Book
- When:** Monthly/on demand externally, daily internally
- Difficulty:** medium/high
- Charge:** high, higher than current SA

## Internal Model Approach (IMA)

- Who:** Conditional upon rigorous approval
- What:** Per Desk
- When:** Weekly externally, daily internally
- Difficulty:** high/extremely high
- Charge:** much lower, compelling for an active business or for specific cases

Beyond compliance  
and beyond 2020

SA

!!

!!!

IMA

!!!

!

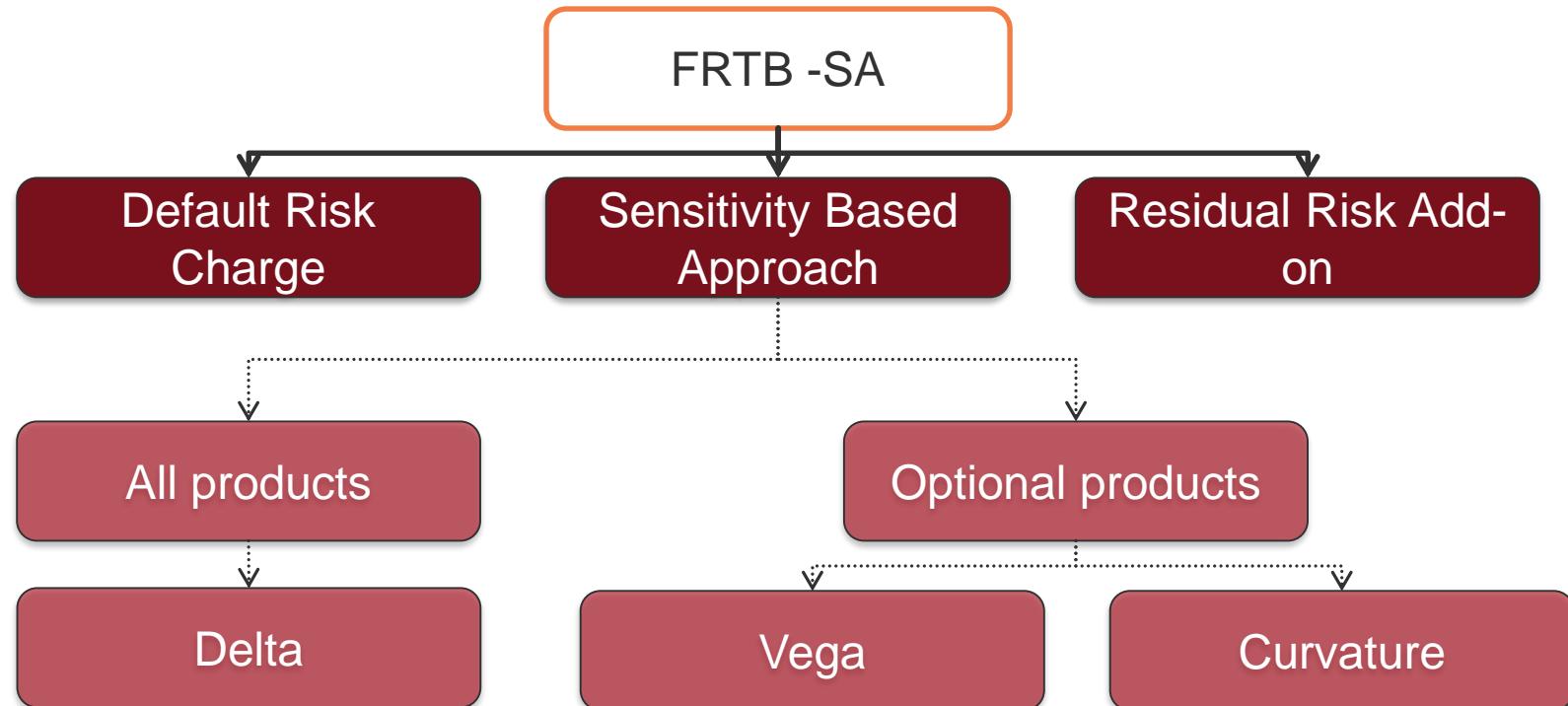
Technology/Operations Cost

Capital Charge

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# FRTB – SA (Standardized Approach)

# Standard Approach in FRTB



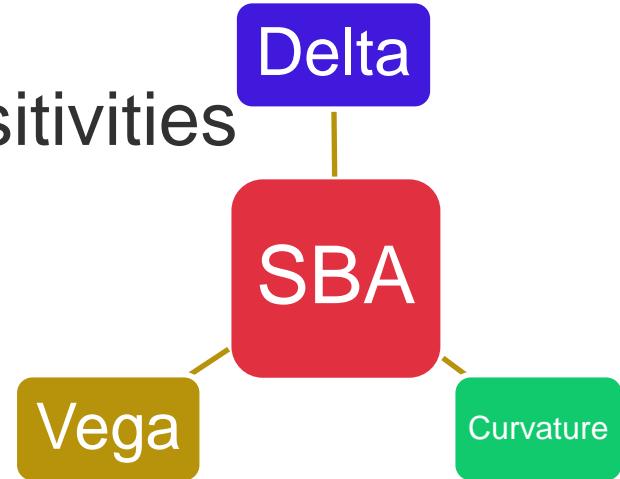
# Sensitivity Based Approach

Capital charges based on portfolio sensitivities using **front office model**

7 risk  
classes

- General Interest Rate Risk
- Credit Spread Risk : non-securitisation (ex: Bonds, Agencies, CDS)
- CSR: securitisation (ex: RMBS, CMBS...)
- CSR: securitisation correlation trading portfolio (ex :Synthetic CDO)
- Foreign Exchange Risk
- Equity Risk
- Commodity Risk

3  
Sensitivities



One reporting currency per bank for sensitivities denomination

# SENSITIVITY CALCULATION



## Prescriptive formulas for sensitivity calculation

| Risk                                   | Delta                                                                                                                                                                                          | Vega                                                                                                                                                                                                                                 | Curvature |
|----------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
| Interest Rate<br>Credit Spread<br>Repo | <ul style="list-style-type: none"> <li>1) Bump zero rates on regulatory time buckets</li> <li>2) Absolute Shifts</li> <li>3) Sticky delta</li> </ul> $\frac{NPV(ZR_t + 1bp) - NPV(ZR_t)}{1bp}$ | <ul style="list-style-type: none"> <li>1) Bump vols on regulatory pillars</li> <li>2) Rescale by vol</li> <li>3) Normal or log-normal volatility</li> </ul> $\sigma(t_i, T_j,) \times \frac{\partial V}{\partial \sigma(t_i, T_j,)}$ |           |
| FX<br>Commodity<br>Equity              | <ul style="list-style-type: none"> <li>1) Bump Spot/Forward</li> <li>2) Relative Shifts</li> <li>3) Sticky delta</li> </ul> $\frac{NPV(1.01 \times FX) - NPV(FX)}{1\%}$                        |                                                                                                                                                                                                                                      |           |

✓ Differ from usual sensitivities: can create gaps in FO systems

# FRTB COMPLEXITIES FOR FX PORTFOLIOS

FX P&L commonly done with FX Spot/Forwards and USD Discounting Only

FRTB SA requires Interest Rate Sensivities for all Currencies

FRTB IMA requires consistent P&L between Risk and Front-Office

Requires therefore to build Foreign Curves with FX Forwards. Like Xccy basis swap curves

Big Challenge for Enterprise Risk systems but Bread and Butter for Rates Trading Systems

We see Shift of Trading Systems into Enterprise Risk Due to FRTB

# Calculation cost

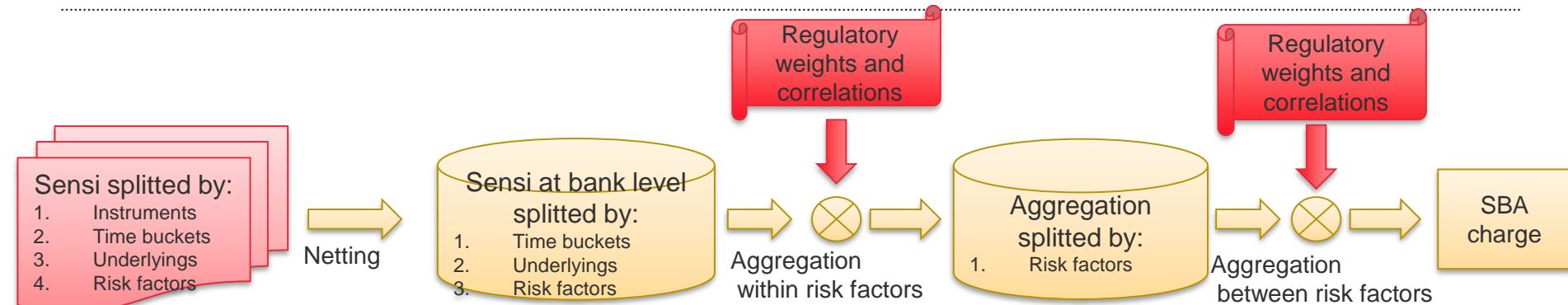
Summary for GBP ATM European swaption with bank reporting in EUR

|                           |      | Risk     | Delta | Curvature                | Vega | Total                            |
|---------------------------|------|----------|-------|--------------------------|------|----------------------------------|
| Application used (Summit) |      |          | MRA   | Shift Market Data<br>MRA | MRA  | Shift Market Data<br>MRA         |
| Number of<br>pricing      | GIRR | Discount | 20    | 2                        | 4    | 26                               |
|                           |      | Forward  |       |                          |      |                                  |
|                           | FX   | EUR/GBP  | 1     | 0                        | 0    | 1                                |
|                           |      | Total    | 21    | 2                        | 4    | 27 pricings (+1<br>base pricing) |

Estimation for simple products

| Trade type | Approximate number of pricings |
|------------|--------------------------------|
| IR swap    | 22 pricings                    |
| CCY swap   | 50 pricings                    |
| Swaption   | 27 pricings                    |
| FX option  | 60 pricings                    |

# Aggregation



Regulatory aggregation requires additional data collection

| Credit           | Equity                    | Commodity |
|------------------|---------------------------|-----------|
| Rating<br>Sector | Capitalization<br>Country | Type      |

# Residual Risk add-on

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Added to ensure sufficient coverage for uncaptured market risk

1% of notional for exotic underlying products

- Underlyings not included in the 7 risk classes
- **Bermudan Swaps fall in this category**

0.1% for exotic products

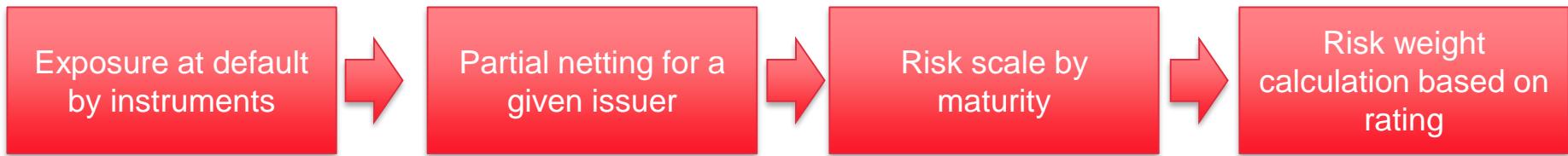
- Products that cannot be expressed as linear function of vanilla products
- Gap risks
- Prepayment risks
- Correlation risks

Back-to-back and centrally cleared deals are out of scope

# Default Risk Charge

Capture the jump-to-default risk of underlying for credit and equity instruments

- In line with banking book methodology: reduce arbitrage



Special treatments is done for securitization instruments:

- ✓ No netting between different underlying asset pools
- ✓ Partial netting between tranches for the same underlying

# Challenges for banks

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## New sensitivities definition

- Potential performance issues
- New methodologies
- New systems set-up

## New product classification

- Residual risk add-on: exotic underlyings/options
- SBA classification: optional/non optional
- Aggregation parameters for commodities/equity/credit

## Changing regulation requires flexibility

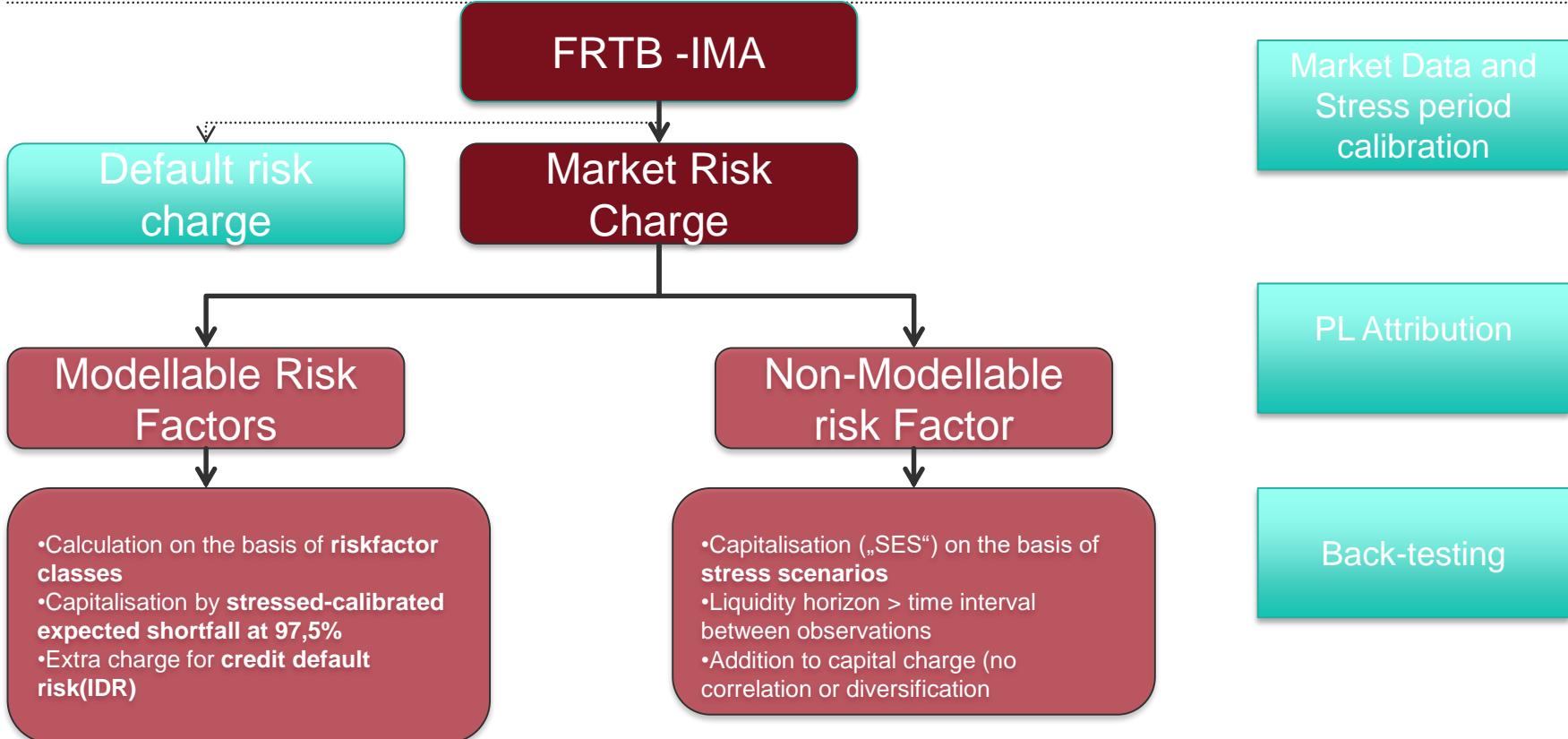
- Aggregation logic
- Sensitivity calculation

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# FRTB – IMA (Internal Model Approach)

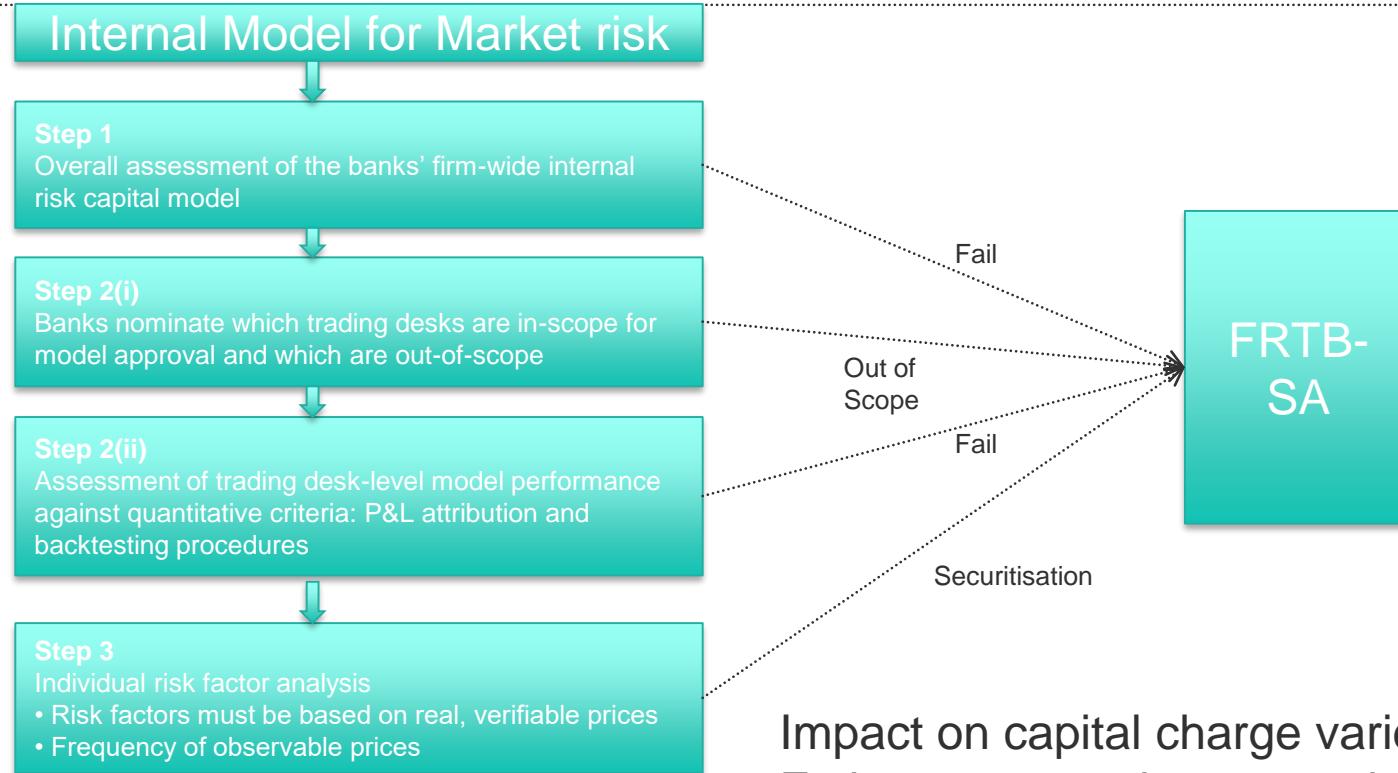
# Summary

## Internal model Approach (IMA) in FRTB



# Summary

## FRTB: From SA to IMA



Impact on capital charge varies from dek  
Estimates are going everywhere from 3 to  
even 20 times

# Summary

## Market Risk Charge

The IMA method require a shift from Var-Stressed Var to the stressed ES

- There is no requirement on the pricing models to be used but there are strict tests for FO/risk coherency and model adequacy.
- 10Y period of Market data(back to 2005) are needed for modelable risk factors
- The stress period is calibrated at least once a month
- Capital charge is computed Daily and reported weekly.

5 classes of risk need to be considered:

1. Interest Rate
2. Credit
3. FX
4. Equity
5. Commodity

| Risk Class    | Risk Factor Category                                                              | 10 | 20 | 40 | 60 | 120 |
|---------------|-----------------------------------------------------------------------------------|----|----|----|----|-----|
| Interest Rate | Interest rate -domestic currency of a bank: EUR, USD, GBP, AUD, JPY, SEK, and CAD | x  |    |    |    |     |
|               | Interest rate other currencies                                                    |    | x  |    |    |     |
|               | Interest rate ATM volatility                                                      |    |    | x  |    |     |
|               | Interest rate (other than yields and ATM volatility)                              |    |    | x  |    |     |
| Credit Risk   | Credit spread -sovereign (IG)                                                     |    | x  |    |    |     |
|               | Credit spread -sovereign (HY)                                                     |    |    | x  |    |     |
|               | Credit spread -corporate(IG)                                                      |    |    | x  |    |     |
|               | Credit spread -corporate(HY)                                                      |    |    | x  |    |     |
|               | Credit spread -structured (cash and CDS)                                          |    |    |    | x  |     |
|               | Credit (other)                                                                    |    |    |    | x  |     |
| FX            | FX rate-liquid currency pairs                                                     | x  |    |    |    |     |
|               | FX rate (other currency pairs)                                                    |    | x  |    |    |     |
|               | FX volatility                                                                     |    |    | x  |    |     |
|               | FX (other)                                                                        |    |    | x  |    |     |
| Equity        | Equity price (large cap)                                                          |    | x  |    |    |     |
|               | Equity price (small cap)                                                          |    | x  |    |    |     |
|               | Equity price (large cap) volatility                                               |    | x  |    |    |     |
|               | Equity price (small cap) volatility                                               |    |    | x  |    |     |
|               | Equity (other)                                                                    |    |    | x  |    |     |
| Commodity     | Energy price                                                                      |    | x  |    |    |     |
|               | Precious price                                                                    |    | x  |    |    |     |
|               | Other commodities price                                                           |    |    | x  |    |     |
|               | Energy price volatility                                                           |    |    | x  |    |     |
|               | Precious metal price volatility                                                   |    |    | x  |    |     |
|               | Other commodities price volatility                                                |    |    | x  |    |     |
|               | Commodity (other)                                                                 |    |    | x  |    |     |

# Internal Model Capital Charge calculation

## Modellable risk factors

---

- Modellable and minimum 10 Y history /back to 2005
- Allowed ES to be ran on a reduced set of risk factor
- Condition: Limited set should Explain 75% variation of full ES (average over 12 week period)
- Proxies are possible (e.g Equity mapping from index through beta)

### Stress period calibration

- Monthly update process
- Calibrate the most severe 12 month-period (largest loss of ES on the reduced set)

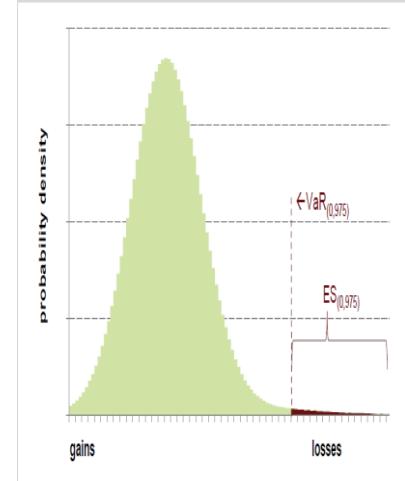
# Internal Model Capital Charge calculation

## Expected Shortfall(1/5)

- Perimeter: Trading Desk and Bank-wide
- VAR and Stressed VAR have been replaced by Expected Shortfall (97.5%)
- Expected Shortfall(ES) equals the expected value of losses in excess of the VaR at a given confidence level:

$$ES_{\alpha} = E[L / L \geq Var_{\alpha}]$$

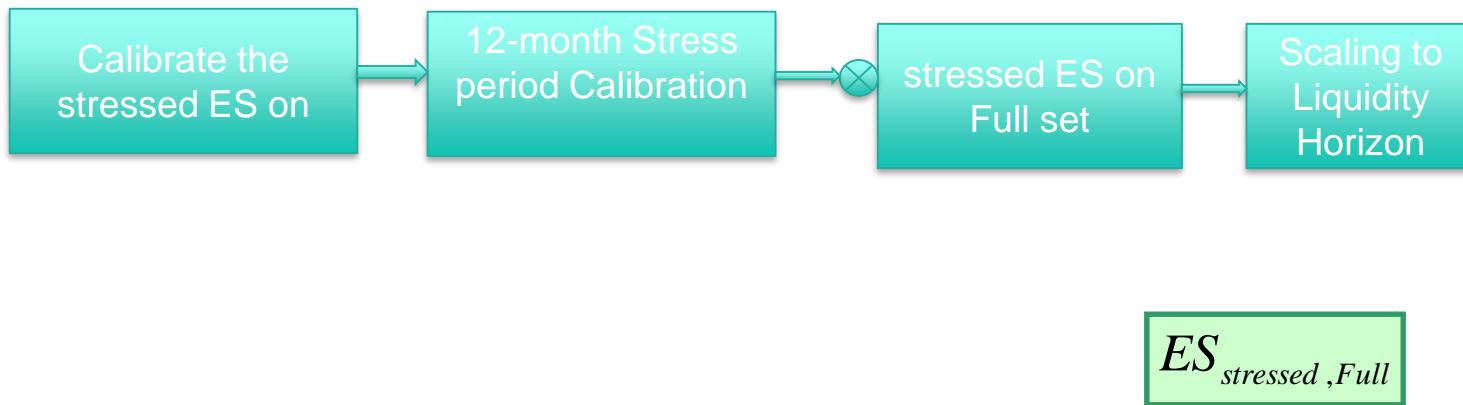
- Historical ,Monte-carlo simulation and even analytical Based models are allowed (as long as it passed the tests).
- There is no requirement of full revaluation
- Based on a 10-Days Holding period
- The ES is scaled based on a liquidity horizon depending on the risk factor (from 10d to 1Y)



# Summary

## Expected Shortfall(2/5)

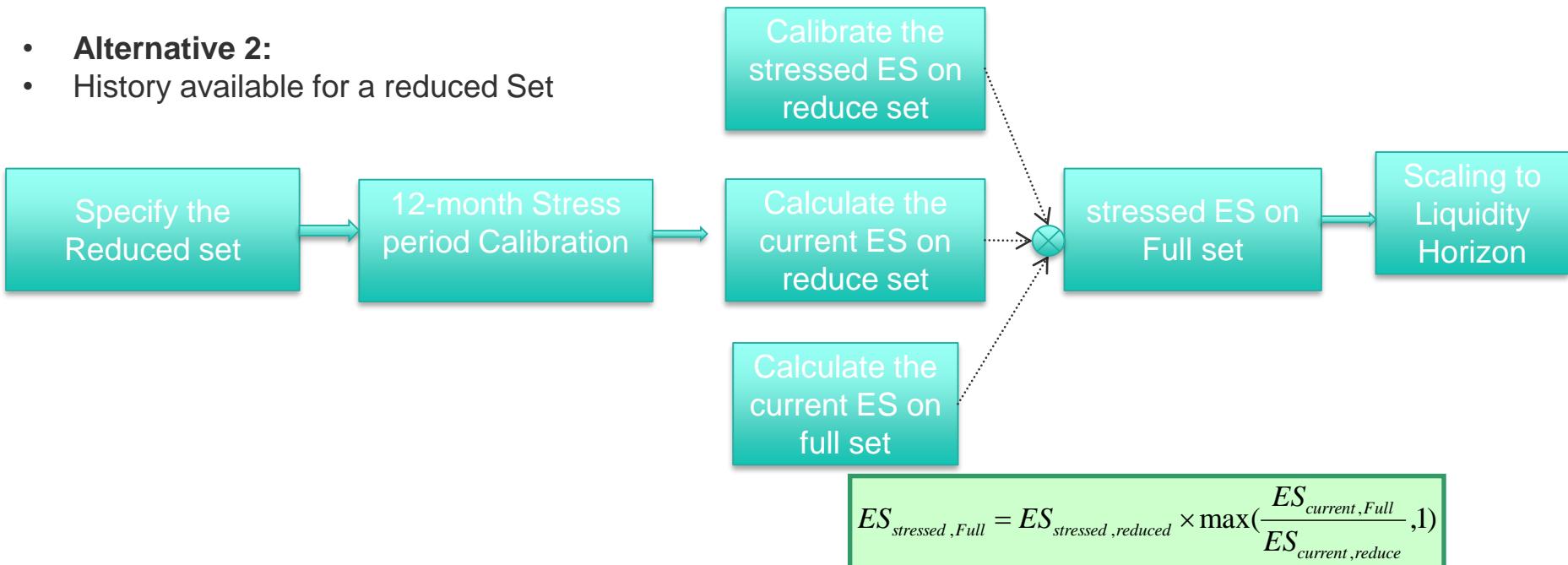
- Perimeters: Trading Desk and Bank-wide
- **Alternative 1:** Full set of market data available for the full History



# Summary

## Expected Shortfall(3/5)

- Perimeters: Trading Desk and Bank-wide
- **Alternative 2:**
- History available for a reduced Set



# Internal Model Capital Charge calculation

## Expected Shortfall(4/5)

- Liquidity Horizon per Risk Factor

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

- 5 possible Horizons, 5 possible risk class

$$ES_{stressed, Full} = ES_{stressed, reduced} \times \max\left(\frac{ES_{current, Full}}{ES_{current, reduced}}, 1\right)$$

| Risk Class    | Risk Factor Category                                                              | 10 | 20 | 40 | 60 | 120 |
|---------------|-----------------------------------------------------------------------------------|----|----|----|----|-----|
| Interest Rate | Interest rate –domestic currency of a bank: EUR, USD, GBP, AUD, JPY, SEK, and CAD | x  |    |    |    |     |
|               | Interest rate other currencies                                                    |    | x  |    |    |     |
|               | Interest rate ATM volatility                                                      |    |    | x  |    |     |
|               | Interest rate (other than yields and ATM volatility)                              |    |    | x  |    |     |
| Credit Risk   | Credit spread –sovereign (IG)                                                     |    | x  |    |    |     |
|               | Credit spread –sovereign (HY)                                                     |    |    | x  |    |     |
|               | Credit spread –corporate(IG)                                                      |    | x  |    |    |     |
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|               | Credit spread –structured (cash and CDS)                                          |    |    |    | x  |     |
|               | Credit (other)                                                                    |    |    |    | x  |     |
| FX            | FX rate–liquid currency pairs                                                     | x  |    |    |    |     |
|               | FX rate (other currency pairs)                                                    |    | x  |    |    |     |
|               | FX volatility                                                                     |    |    | x  |    |     |
|               | FX (other)                                                                        |    |    | x  |    |     |
| Equity        | Equity price (large cap)                                                          | x  |    |    |    |     |
|               | Equity price (small cap)                                                          |    | x  |    |    |     |
|               | Equity price (large cap) volatility                                               |    | x  |    |    |     |
|               | Equity price (small cap) volatility                                               |    |    | x  |    |     |
|               | Equity (other)                                                                    |    |    | x  |    |     |
| Commodity     | Energy price                                                                      |    | x  |    |    |     |
|               | Precious price                                                                    |    | x  |    |    |     |
|               | Other commodities price                                                           |    |    | x  |    |     |
|               | Energy price volatility                                                           |    |    | x  |    |     |
|               | Precious metal price volatility                                                   |    |    | x  |    |     |
|               | Other commodities price volatility                                                |    |    |    | x  |     |
|               | Commodity (other)                                                                 |    |    |    | x  |     |

Overall Calculation can add up to 6\*3 different ES calculations at minimum (21\*3 at worst)

# Internal Model Capital Charge calculation

## Expected Shortfall(5/5)

- Aggregation of capital charge

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

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

- $\rho=0.5$
- 5 risk factor groups

| Risk Class    | Risk Factor Category                                                              | 10 | 20 | 40 | 60 | 120 |
|---------------|-----------------------------------------------------------------------------------|----|----|----|----|-----|
| Interest Rate | Interest rate –domestic currency of a bank: EUR, USD, GBP, AUD, JPY, SEK, and CAD | x  |    |    |    |     |
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|               | Credit spread –corporate(IG)                                                      |    | x  |    |    |     |
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|               | FX volatility                                                                     |    |    | x  |    |     |
|               | FX (other)                                                                        |    |    | x  |    |     |
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| Commodity     | Energy price                                                                      |    | x  |    |    |     |
|               | Precious price                                                                    |    | x  |    |    |     |
|               | Other commodities price                                                           |    |    | x  |    |     |
|               | Energy price volatility                                                           |    |    | x  |    |     |
|               | Precious metal price volatility                                                   |    |    | x  |    |     |
|               | Other commodities price volatility                                                |    |    |    | x  |     |
|               | Commodity (other)                                                                 |    |    |    | x  |     |

# Internal Model Capital Charge calculation

## NMRF – Stress (1/1)

- **Stressed capital add-on (SES): Aggregate regulatory capital measure for non-modellable risk factors in model-eligible desks.**
- Each non-modellable risk factor is to be capitalised using a stress scenario (SES)
- For non-modellable risk factors arising from idiosyncratic credit spread risk, banks may apply the same stress scenario (ISES)

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

# IMA-Market risk charge

---

$$C_A = \max\{IMCC_{t-1} + SES_{t-1}; m_c \cdot IMCC_{avg} + SES_{avg}\}$$

$m_c \geq 1.5$  (depends on the results of backtesting)

Average over previous 60 days

# Internal Model

## DRC – Var Based

- Specific desk approval for the DRC model
- Var Based DRC: 1-year Var at 99% percentage level (weekly calculation, 1y horizon)
- Internal model not possible on the securitization products (includes Equity, sovereign and default debt)
- DRC with 1-year Var at 99% percentage level (weekly calculation, 1y horizon)
- PD,LGD and correlation calibration are following IRB (internal rating based approach)

| Internal Model     |              |              |
|--------------------|--------------|--------------|
|                    | Spread Risk  | Default Risk |
| Securitization     | Not eligible |              |
| Non-securitization | Included     | <b>DRC</b>   |

$$DRC_t = \max(DRC_{t-1}, \overline{DRC}_{[t,t-12w]})$$

# Internal Model

## Model Validation(1/2) – PL Attribution

- **Actual P&L**: P&L based on the marking to market of the books excluding fees and commissions
- **Hypothetical P&L**: P&L produced by revaluing the positions held at the end of previous day using current day market data
- **Risk-Theoretical P&L**: daily desk level P&L predicted by the risk management model including all risk factor used in ES (it may also include NMRF)

Has been modified. Address in your presentation

- Daily computation
- Reporting is done on a monthly basis
- At most **3 breaches in last 12 Months** admitted

Unexplained P & L = HypoP & L - RiskP & L

3  
exceptions

|                                                                |
|----------------------------------------------------------------|
| $\frac{\text{MeanUnexplainedP\&L}}{\text{stdevHypoPL}} < 10\%$ |
| $\frac{\text{VarUnexplainedP\&L}}{\text{VarHypoPL}} < 20\%$    |

# Internal Model

## Model Validation (2/2)– Backtesting

- Number of exception of 1day Var vs 1Day PL
- 1 day 99% var and 97.5 Var to be compared to the actual P&L and the hypothetical P&L
- At most 12 exceptions for the 99% and 30 exception for the 97.5% in past year.

$ActualPL < Var_{99\%}$   
 $HypoPL < Var_{99\%}$

$ActualPL < Var_{97.5\%}$   
 $HypoPL < Var_{97.5\%}$

12 exceptions  
30 exceptions

| Zone        | Number of exceptions | multiplier |
|-------------|----------------------|------------|
| Green zone  | 0                    | 1.50       |
|             | 1                    | 1.50       |
|             | 2                    | 1.50       |
|             | 3                    | 1.50       |
|             | 4                    | 1.50       |
|             | 5                    | 1.70       |
| Yellow zone | 6                    | 1.76       |
|             | 7                    | 1.83       |
|             | 8                    | 1.88       |
|             | 9                    | 1.92       |
| Red zone    | 10 or more           | 2.00       |

# Internal Model

## Stress Period Calibration

---

- Determine the reduce risk factor set
- Compute the most 12-month stress period back to at least 2005
- Reduce set should explain at least 75% of ES 97.5%
  
- Monthly calibration at the minimum (on-demand calibration should be possible).

# Internal Model

## FRTB IMA– A computation Game?

---

- X ES computation (from 3 to 63)
- Y stress scenarios for NMRF
- 2 Vars for backtesting
- 3 PLs : Actual PL, Hypo PL and risk PL
- 1DRC Var

# Internal Model

## Implementation Challenges

---

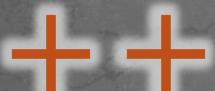
- ✓ Be proactive, not reactive -requirements will change, new regulations will be added.
- ✓ Look at enterprise-wide risk
  - Siloed solutions no longer work
- ✓ Design to reuse infrastructure for Standardised and Internal Models approaches
- ✓ Aim for consistent interfaces to disparate systems
  - Front Office position feeds
  - Pricing analytics
  - Historical market data
- ✓ Automate data gathering and cleaning
  - Improve data quality
  - Free up risk managers from manual work
- ✓ Use a single pricing engine across front office and risk management to avoid extra model validation
- ✓ Improve reporting to help Risk Management.
  - Trace sources of risk from capital charge back to positions and market data
  - Drill down to desk level and to individual positions, across all business lines

# **FRTB CONSIDERATIONS**

## **Final thoughts and summary**

# No easy choices

SA



IMA

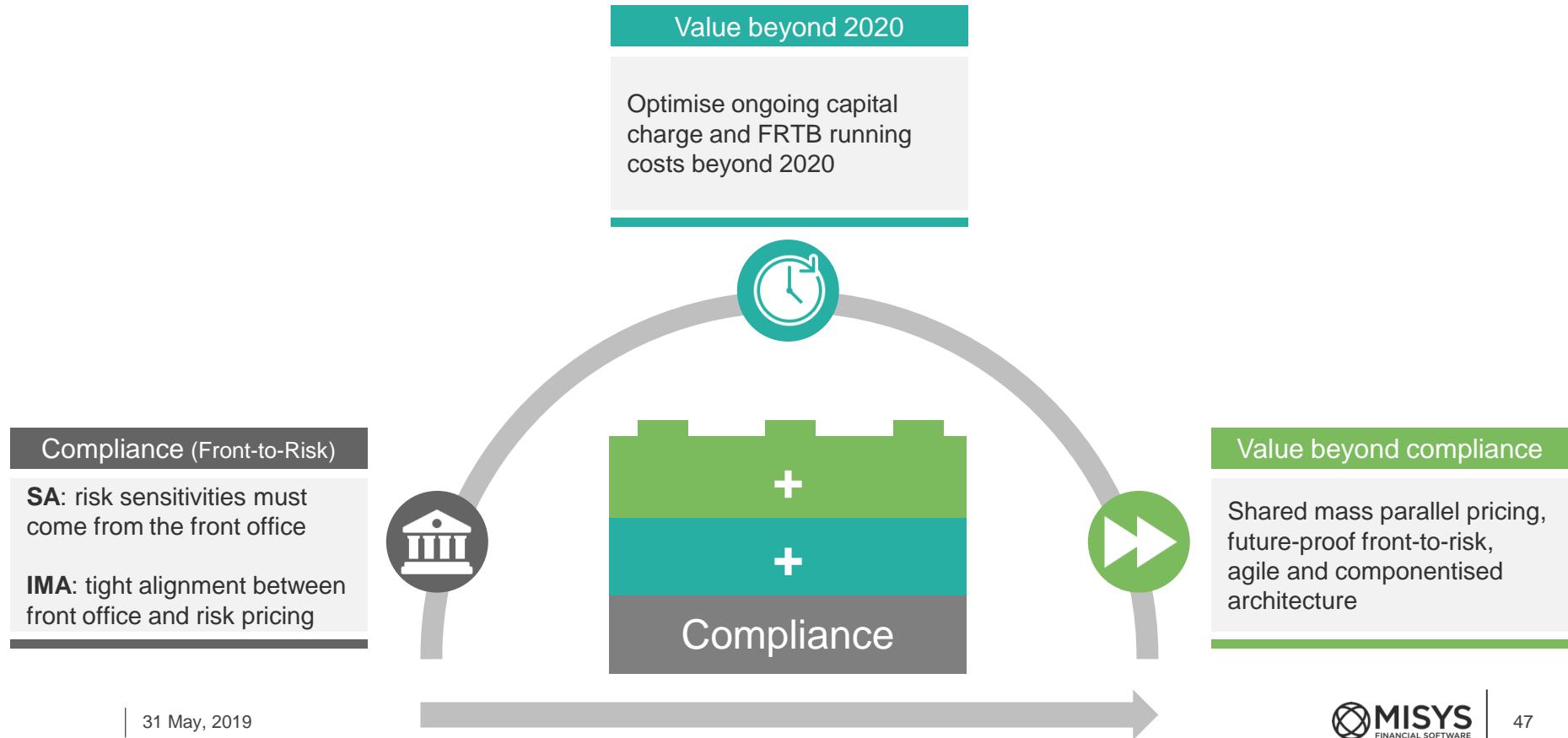


Front-to-risk  
compliance

Capital charge impact

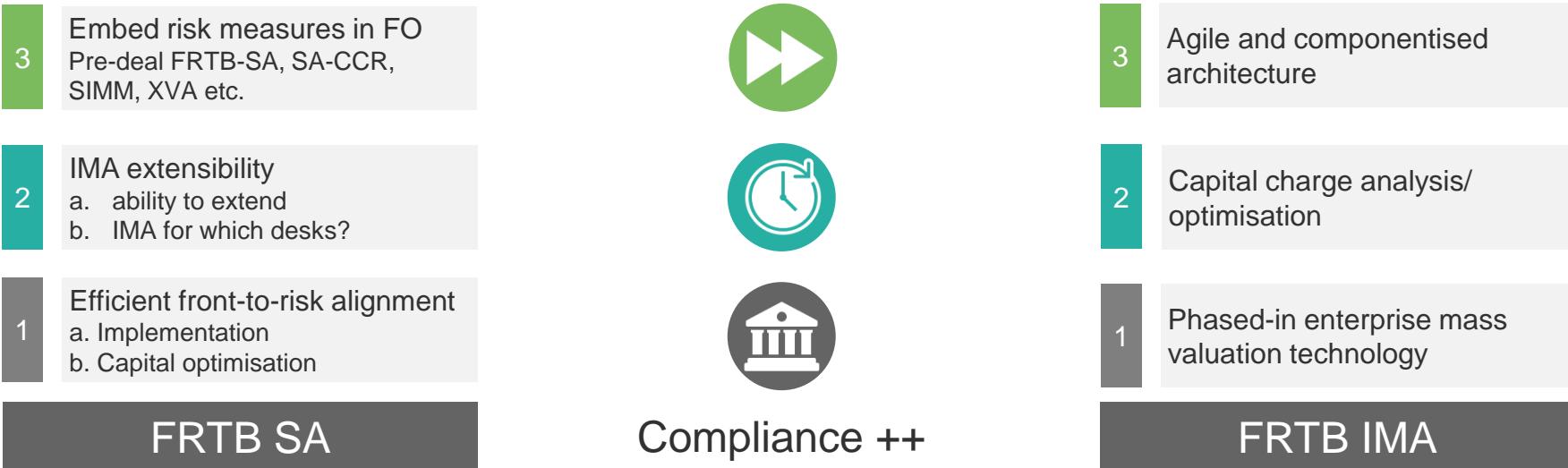
Computation load and  
operational complexity

# The ideal FRTB solution: future-proof, efficient compliance



# Compliance ++ applied to FRTB

---



# Optimize and Analysis Your Capital Charge

## Standard Approach

- Post trade investigation, with all underpinning results (risk class, vertex, correlation scenario, etc)
- Aggregation at desk level, asset level and Bank Level
- Drill Down Capabilities
- Pre trade check, post trade “what if”



## Internal Model Approach

- Front office to risk consistent valuation framework
- Granular levels of information (e.g., decomposition by first/second order sensitivities, curve/surface data points, by time effects)
- Market standard pricing models out-of-the-box
- Out of the Box Dashboards for IMA approach





**GIRR charges**

| Risk measure ↑                 | CorrelationScenario | Exposure |
|--------------------------------|---------------------|----------|
| Desk                           | High                | 7,823K   |
| <b>Risk measure: Curvature</b> |                     |          |
| IRExo                          | High                | 2,820K   |
| IRExo                          | Low                 | 2,189K   |
| IRExo                          | Medium              | 2,558K   |
| LONDON_DTREAS                  | High                | 7K       |
| LONDON DTREAS                  | Low                 | 6K       |
|                                |                     | 216,040K |

**GIRR charges desk br...**

| Dimension | Value       |
|-----------|-------------|
| Curvature | 100,000,000 |
| Delta     | 10,000,000  |
| Gamma     | 1,000,000   |

**GIRR charges bkt brkdwn**

| Bucket ↑           | Measure | CorrelationScenario | Exposure |
|--------------------|---------|---------------------|----------|
| Desk               |         |                     | 649K     |
| <b>Bucket: CAD</b> |         |                     |          |
| TORONTO_EXOTIC     | Delta   | Medium              | 218K     |
| TORONTO_EXOTIC     | Delta   | High                | 229K     |
| TORONTO_EXOTIC     | Delta   | Low                 | 202K     |
| <b>Bucket: EUR</b> |         |                     | 9,746K   |
| LONDON_DOLLAR      | Delta   | Medium              | 127K     |
| LONDON_DOLLAR      | Delta   | High                | 133K     |
| LONDON_DOLLAR      | Delta   | Low                 | 112K     |
| <b>Bucket: GBP</b> |         |                     | 1,085K   |
| LONDON_DER1        | Delta   | Medium              | 1,139K   |
| LONDON_DER1        | Delta   | High                | 1,003K   |
|                    |         |                     | 247,753K |

**GIRR curvature bkt brkdwn**

**Drag a column**

| Desk          | CorrelationScenario | Ccy | ↑ | Curvature |
|---------------|---------------------|-----|---|-----------|
| NY_IRD        | Low                 | EUR |   | 1K        |
| NY_IRD        | Medium              | EUR |   | 1K        |
| NY_IRD        | High                | EUR |   | 2K        |
| NY_EXOTIC     | Low                 | GBP |   | 5K        |
| NY_EXOTIC     | Medium              | GBP |   | 6K        |
| NY_EXOTIC     | High                | GBP |   | 6K        |
| LONDON_DTREAS | Low                 | EUR |   | 6K        |
| LONDON DTREAS | Medium              | EUR |   | 7K        |
| LONDON DTREAS | High                | EUR |   | 7K        |
|               |                     |     |   | 7,953K    |

**GIRR Vega vertices pivot**

|        | 5.000  | 3.000   | 10.000 | 1.000 | 6.000 | Grand Total |
|--------|--------|---------|--------|-------|-------|-------------|
| 10.000 | -1,020 | -1,806  | -174   | 0     | 0     | -19,982     |
| 3.000  | -315   | 0       | -417   | 0     | 0     | -3,752      |
| 5.000  | -2,895 | -1,080  | -381   | 0     | 0     | -4,355      |
| 6.000  | -37    | 0       | 0      | 0     | 0     | -37         |
| 1.000  | 34,254 | 162,231 | 0      | 0     | 0     | 196,486     |

**GIRR Trade Expo...**

| Measure ↑             | Ccy ↑ | Curve ↑ | PrimaryVertex ↑ | Exposure |
|-----------------------|-------|---------|-----------------|----------|
| Tradeld               |       |         |                 | 518,240K |
| <b>Measure: Delta</b> |       |         |                 |          |
| Ccy: CAD              |       |         |                 | -4,704K  |
| Curve: CDOR           |       |         |                 | 24,824K  |
| PrimaryVertex: 0.25   |       |         |                 | 500K     |
| TNT0000003150         |       |         |                 | 500K     |
| PrimaryVertex: 0.5    |       |         |                 | 914K     |
| TNT0000002161         |       |         |                 | 4K       |
| TNT0000003150         |       |         |                 | 810K     |
| TNT0000002163         |       |         |                 | 4K       |
| TNT0000002149         |       |         |                 | -4K      |
| PrimaryVertex: 1      |       |         |                 | 762K     |
| TNT0000002153         |       |         |                 | 12K      |
| TNT0000002149         |       |         |                 | -12K     |
| TNT0000002161         |       |         |                 | 12K      |
| TNT0000003150         |       |         |                 | 750K     |
| PrimaryVertex: 10     |       |         |                 | 312K     |
| TNT0000003150         |       |         |                 | 312K     |

**GIRR Curvature trade exposures**

| Desk                 | Ccy        | Tradeld         | CurvatureUp | CurvatureDown |
|----------------------|------------|-----------------|-------------|---------------|
| NY_IRD               | EUR        | CAP_LN          | 1K          | -2K           |
| NY_EXOTIC            | USD        | SUMMIT_01       | 9K          | -64K          |
| NY_EXOTIC            | GBP        | SUMMIT_01       | 6K          | -4K           |
| <b>LONDON_DTREAS</b> | <b>EUR</b> | <b>CRANFRTB</b> | <b>9K</b>   | <b>-9K</b>    |
| LONDON_DTREAS        | EUR        | 17047S          | -3K         | -11K          |
| LONDON_EURO          | EUR        | FLOOR0          | 1K          | 0             |
| LONDON_EURO          | USD        | 17320S          | -14K        | 13K           |
| LONDON_EURO          | EUR        | 17320S          | 12K         | -13K          |
| LONDON_EURO          | EUR        | 17039S          | 0           | -2K           |
| LONDON_EURO          | EUR        | 17043S          | 7K          | -4K           |

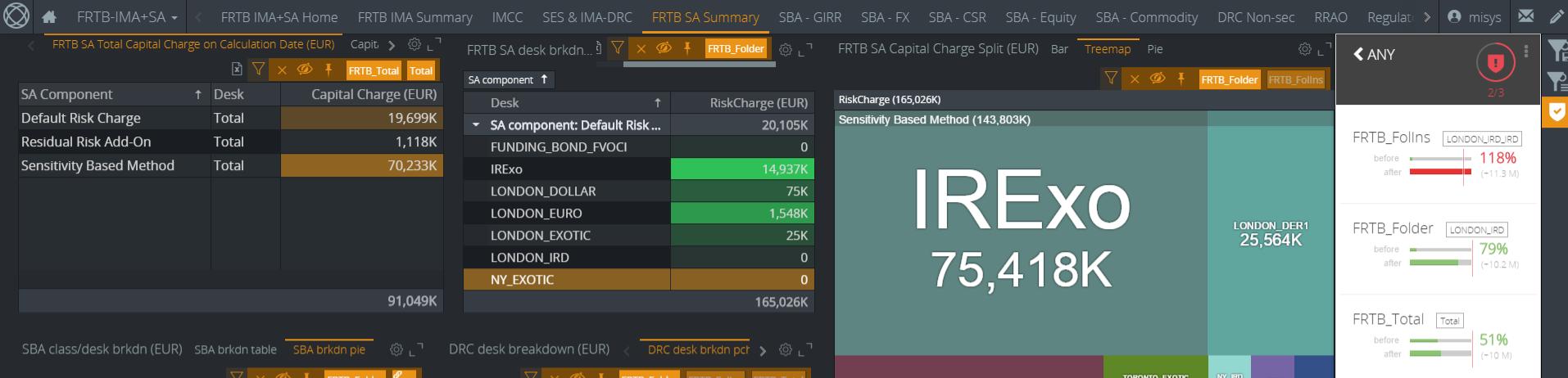
**Front-to-risk alignment**

GIRR delta vertices | GIRR Delta vertices chart | GIRR Delta vertices table

RiskWeightedExposure

Ccy

RiskWeightedExposure Exposure



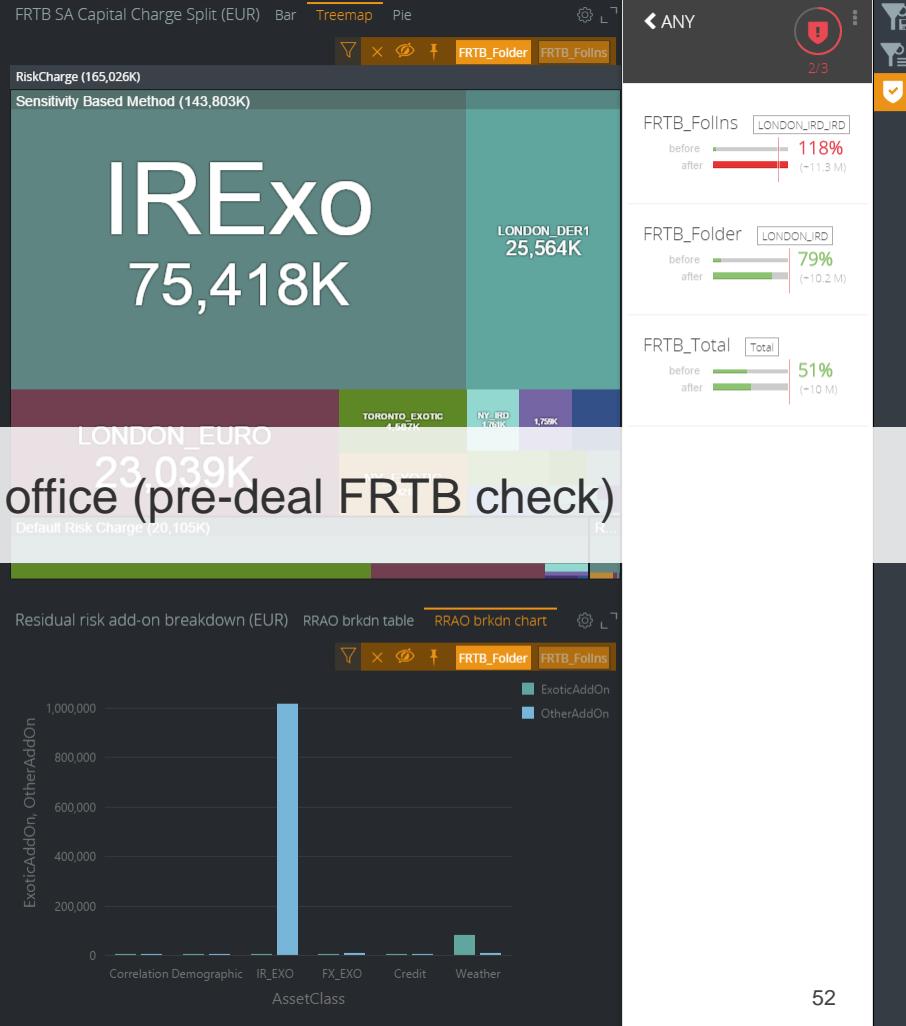
SBA class/desk brkdn (EUR) SBA brkdn table SBA brkdn pie

DRC desk breakdown (EUR) DRC desk brkdn pcr

## Embed risk measures in the front office (pre-deal FRTB check)



Desk



# Build your Own Dashboards: Simple and Fully configurable

The screenshot displays a dashboard builder application with the following components:

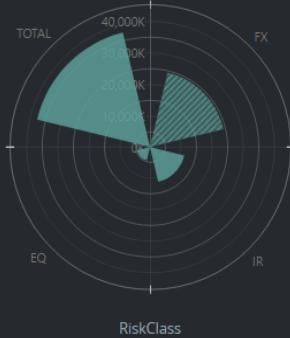
- Top Navigation:** FRTB-SA, FRTB SA Summary, SBA - GIRR, SBA - FX, SBA - CSR, SBA - Equity, SBA - Commodity, DRC Non-sec, RRAO, Regulatory Parameters.
- Left Panel:** A large circular donut chart labeled "SBA brkdn pie". Below it are buttons for "Default types" (Default types) and "Use custom" (Use custom). A legend indicates categories: FX (teal), Commodity (blue), Equity (dark blue), GIRR (grey), and CSR (yellow).
- Middle Left:** Two stacked bar charts: "FRTB SA Total Capital Charges (EUR)" and "FRTB SA Capital Charge Split (EUR)".
- Middle Right:** A treemap visualization titled "FRTB SA Capital Charge Split (EUR)" showing segments like "RiskCharge (73,133K)" and "Sensitivity Based Method (67,847K)".
- Bottom Right:** A chart titled "RRAO brkdn chart" showing "OtherAddOn" values around 80,000.
- Right Side:** A sidebar for managing boards:
  - New board: FRTB SA Summary (selected)
  - Name: FRTB SA Summary
  - Hidden: Hidden
  - Comment: Comment
  - Other sections: SBA - GIRR, SBA - FX, SBA - CSR, SBA - Equity, SBA - Commodity, DRC Non-sec, RRAO, Regulatory Parameters.
- Bottom Bar:** A toolbar with icons for various chart types: Bar Chart, Button, Calendar, Card, Column Chart, Compliance, Drill Down T..., DX Bubble C..., DX Bullet Ch..., DX Chart, DX Map, DX Pie Chart, DX Pivot, DX Polar Ch..., DX Range, and a plus sign (+).



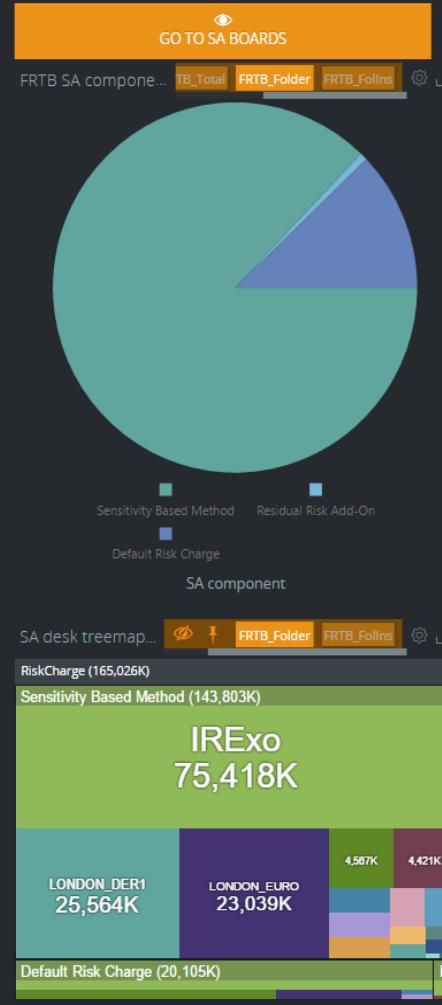
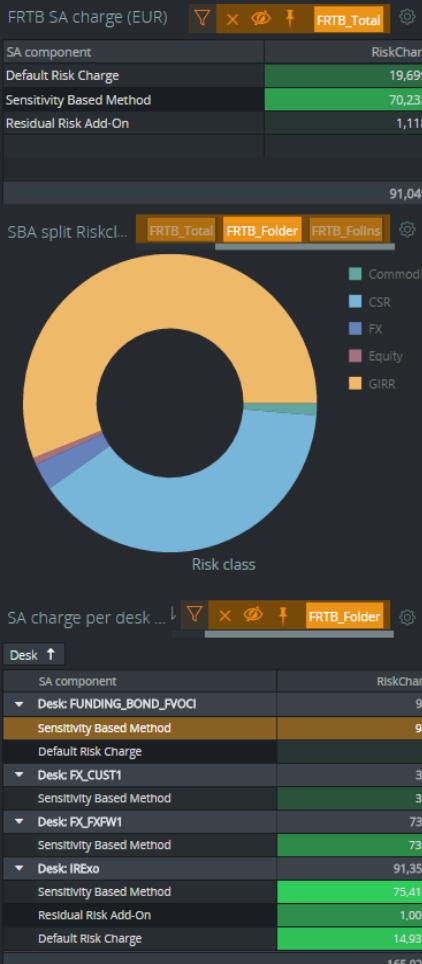
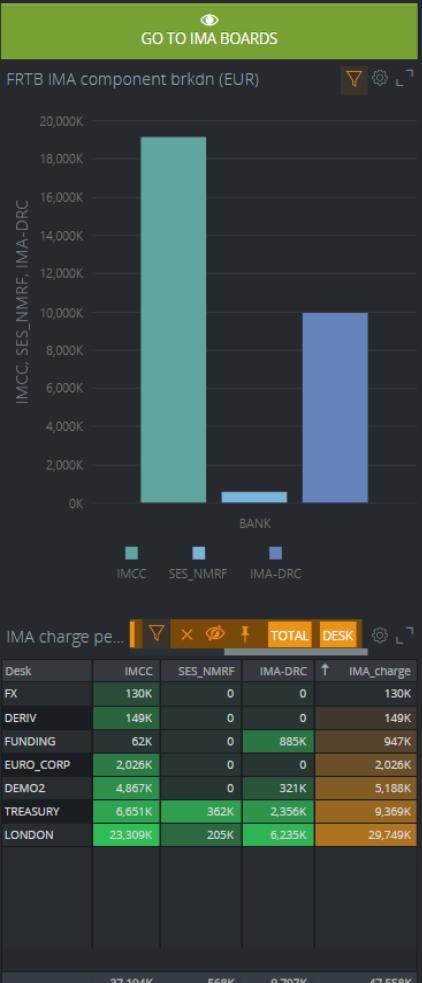


| FRTB IMA charge (EUR) |          |         |            | BANK | TOTAL |
|-----------------------|----------|---------|------------|------|-------|
| IMCC                  | SES_NMRF | IMA-DRC | IMA_charge |      |       |
| 19,131K               | 568K     | 9,900K  | 29,599K    |      |       |

| IMCC split RiskClass/Desk (EUR) |          |         |            | BANK | DESK |
|---------------------------------|----------|---------|------------|------|------|
| IMCC                            | SES_NMRF | IMA-DRC | IMA_charge |      |      |
|                                 |          |         |            |      |      |



| IMA desk treemap (EUR) |                |  |  | BANK | DESK |
|------------------------|----------------|--|--|------|------|
| IMA_charge (47,558K)   |                |  |  |      |      |
| LONDON                 | (29,749K)      |  |  |      |      |
| <b>LONDON</b>          | <b>29,749K</b> |  |  |      |      |
| TREASURY               | (9,369K)       |  |  |      |      |
| <b>TREASURY</b>        | <b>9,369K</b>  |  |  |      |      |
| DEMO2                  | (5,188K)       |  |  |      |      |
| <b>DEMO2</b>           | <b>5,188K</b>  |  |  |      |      |
| EURO..                 |                |  |  |      |      |
| FU...                  |                |  |  |      |      |



## FRTB SA Total Capital Charge on Calculation Date (EUR) Capit ▶

FRTB Total Total

| SA Component             | ↑ Desk | Capital Charge (EUR) |
|--------------------------|--------|----------------------|
| Default Risk Charge      | Total  | 4,764K               |
| Residual Risk Add-On     | Total  | 118K                 |
| Sensitivity Based Method | Total  | 29,447K              |
|                          |        | 34,329K              |

## FRTB SA desk brkdn... ▾ × ⚡ ↑ FRTB\_Folder

## FRTB SA Capital Charge Split (EUR) Bar Treemap Pie

FRTB\_Folder FRTB\_Follns

SA component ↑

| Desk                           | ↑ | RiskCharge (EUR) |
|--------------------------------|---|------------------|
| SA component: Default Risk ... |   | 5,168K           |
| FUNDING_BOND_FVOCI             |   | 0                |
| LONDON_DOLLAR                  |   | 75K              |
| LONDON_EURO                    |   | 1,548K           |
| LONDON_EXOTIC                  |   | 25K              |
| LONDON_IRD                     |   | 0                |
|                                |   | 73,899K          |

RiskCharge (73,899K)

Sensitivity Based Method (68,613K)

LONDON\_DER1  
25,564KLONDON\_EURO  
23,199K

SBA class/desk brkdn (EUR)

SBA brkdn table

SBA brkdn pie

CSR

FX

Equity

GIRR

Commodity

DRC desk breakdown (EUR)

DRC desk brkdn pct

FRTB\_Folder Low
FRTB\_Folder FRTB\_Follns FRTB\_Total

CSR

FX

Equity

GIRR

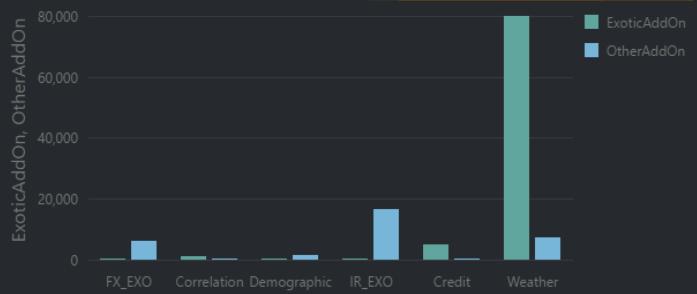
Commodity



Residual risk add-on breakdown (EUR)

RAO brkdn table

RAO brkdn chart

FRTB\_Folder FRTB\_Follns


Risk class

Desk

AssetClass

### GIRR charges

Risk measure ↑

| Desk          | CorrelationScenario | Exposure |
|---------------|---------------------|----------|
| LONDON_DTREAS | High                | 7K       |
| LONDON_DTREAS | Low                 | 6K       |
| LONDON_DTREAS | Medium              | 7K       |
|               |                     | 162,173K |

### GIRR charges desk...

FRTB\_Total FRTB\_Folder FRTB\_Follns Low

Delta  
Vega  
Curvature  
Risk measure

### GIRR Vega vertices p...

X ⚡ ↕ GIRR Vega EUR GBP USD

|             | 5.000  | 3.000   | Grand Total |
|-------------|--------|---------|-------------|
| 1.000       | 34,257 | 162,231 | 196,489     |
| Grand Total | 34,257 | 162,231 | 196,489     |

### GIRR charges bkt brkdn

Bucket ↑

| Desk           | Measure | CorrelationScenario | Exposure |
|----------------|---------|---------------------|----------|
| TORONTO_EXOTIC | Delta   | High                | 229K     |
| TORONTO_EXOTIC | Delta   | Medium              | 218K     |
| TORONTO_EXOTIC | Delta   | Low                 | 202K     |
|                |         |                     | 649K     |
| FX_FXFWI       | Delta   | High                | 77K      |
| FX_FXFWI       | Delta   | Low                 | 67K      |
| FX_FXFWI       | Delta   | Medium              | 73K      |
| NY_FLOW        | Delta   | Medium              | 93K      |
|                |         |                     | 200,476K |

### GIRR delta vertices

GIRR Delta vertices chart GIRR ↗

Measure ↑ Ccy ↑ Curve ↑ PrimaryVertex ↑

RiskWeightedExposure

Exposure

Ccy

### GIRR Curvature trade expo...

X ⚡ ↕ GIRR FRTB\_Folder

| Tradeld    | Exposure |
|------------|----------|
| 1,517,346K | -4,704K  |
| 24,824K    | 500K     |
| 814K       | 4K       |
| 4K         | 810K     |
| -4K        | 12K      |
| 762K       | 12K      |
| 12K        | 750K     |

### GIRR curvature bkt brkdn

Drag a column

| Desk          | CorrelationScenario | Ccy | ↑ | Curvature |
|---------------|---------------------|-----|---|-----------|
| LONDON_EURO   | Low                 | EUR |   | 0         |
| LONDON_EURO   | Medium              | EUR |   | 0         |
| LONDON_EURO   | High                | EUR |   | 0         |
| NY_EXOTIC     | Low                 | GBP |   | 5K        |
| NY_EXOTIC     | Medium              | GBP |   | 6K        |
| NY_EXOTIC     | High                | GBP |   | 6K        |
| LONDON_DTREAS | Low                 | EUR |   | 6K        |
|               |                     |     |   | 981K      |

### GIRR Curvature trade expo...

Drag a column

| Tradeld   | CurvatureUp | CurvatureDown |
|-----------|-------------|---------------|
| 1,517,345 | -17K        | 17K           |
| 173195    | 28K         | -26K          |
| FLOOR0    | 1K          | 0             |
| 173205    | 12K         | -13K          |
| 173205    | -14K        | 13K           |
| 170395    | 0           | -2K           |
| CRANFRTB  | 9K          | -9K           |
| 170475    | -3K         | -11K          |

FX charges

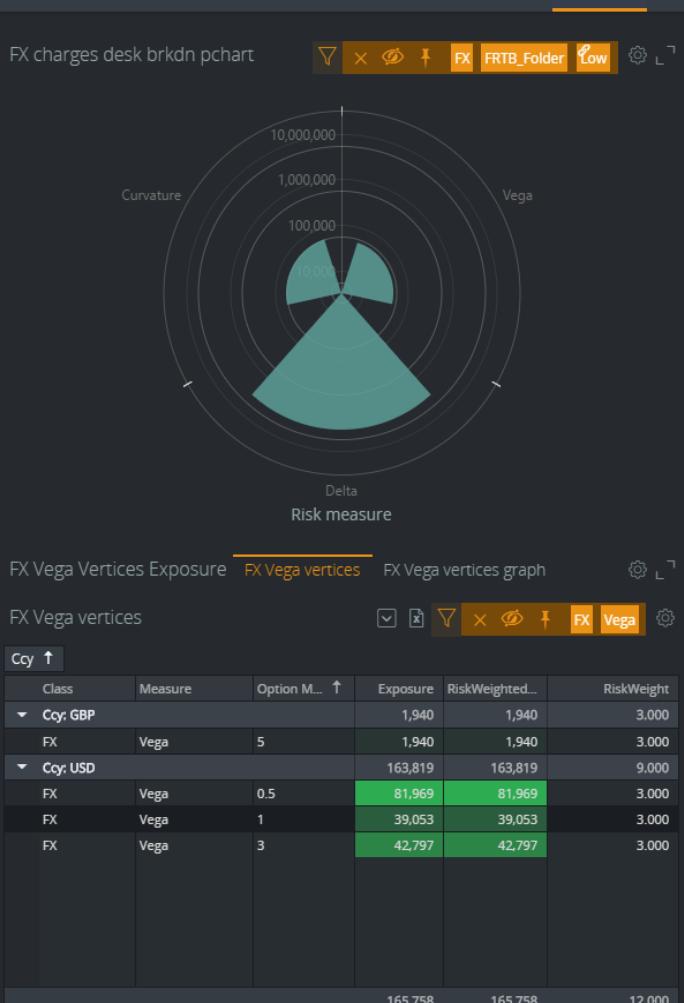
| Desk  | Risk measure | Exposure | CorrelationScenario |
|-------|--------------|----------|---------------------|
| Total | Vega         | 47K      | Low                 |
| Total | Curvature    | 52K      | Low                 |
| Total | Delta        | 2,970K   | Low                 |
|       |              | 3,068K   |                     |

FX charges bkt brkd...

| Bucket ↑       | Measure ↑ |                     |
|----------------|-----------|---------------------|
| Desk           | Exposure  | CorrelationScenario |
| Bucket: CAD    | 3,203K    |                     |
| Measure: Delta | 3,203K    |                     |
| Total          | 3,203K    | Low                 |
| Bucket: GBP    | 7K        |                     |
| Measure: Delta | 7K        |                     |
| Total          | 7K        | Low                 |
| Measure: Vega  | 1K        |                     |
| Total          | 1K        | Low                 |
| Bucket: SEK    | 3K        |                     |
| Measure: Delta | 3K        |                     |
| Total          | 3K        | Low                 |
| Bucket: USD    | 265K      |                     |

FX curvature bkt brkd...

| Ccy ↑    |           |                     |
|----------|-----------|---------------------|
| Desk     | Curvature | CorrelationScenario |
| Ccy: GBP | 5K        |                     |
| Total    | 5K        | Low                 |
| Ccy: USD | 85K       |                     |
| Total    | 85K       | Low                 |



FX Trade Exposu...

| Measure ↑                | Ccy ↑          |               |            |             |               |
|--------------------------|----------------|---------------|------------|-------------|---------------|
| Tradeld                  | Desk           | PrimaryVertex | Exposure   |             |               |
| Measure: Delta           |                |               | 12,682,961 |             |               |
| Ccy: CAD                 |                |               | 11,544,060 |             |               |
| TNT0000002169            | TORONTO_EXOTIC | 0             | 77,720     |             |               |
| TNT0000002170            | TORONTO_EXOTIC | 0             | 9,521,120  |             |               |
| TNT0000002149            | TORONTO_EXOTIC | 0             | 94,320     |             |               |
| TNT0000003150            | TORONTO_EXOTIC | 0             | 500,020    |             |               |
| TNT0000002161            | TORONTO_EXOTIC | 0             | 778,290    |             |               |
| TNT0000002160            | TORONTO_EXOTIC | 0             | 134,320    |             |               |
| TNT0000002163            | TORONTO_EXOTIC | 0             | 438,270    |             |               |
| Ccy: GBP                 |                |               | 34,810     |             |               |
| 16371S                   | LONDON_DER1    | 0             | 5,020      |             |               |
| 16342S                   | LONDON_DER1    | 0             | 5,020      |             |               |
| 16383S                   | LONDON_DER1    | 0             | 5,020      |             |               |
| 16305S                   | LONDON_DER1    | 0             | 5,020      |             |               |
|                          |                |               | 12,738,214 |             |               |
| FX Trade Curvature Ex... | FRTB_Folder    | FX            |            |             |               |
| Ccy ↑                    | Class          | Tradeld       | TimeBand   | CurvatureUp | CurvatureDown |
| Ccy: GBP                 |                |               |            | 5K          | -4K           |
| FX                       | SUMMIT_01      | NY_EXOTIC     |            | 5K          | -4K           |
| Ccy: USD                 |                |               |            | -90K        | 92K           |
| FX                       | SUMMIT_01      | NY_EXOTIC     |            | 1K          | 0             |
| FX                       | 17320S         | LONDON_EURO   |            | 0           | 0             |
| FX                       | 15379S         | LONDON_EURO   |            | -1K         | 1K            |
| FX                       | 17319S         | LONDON_EURO   |            | -93K        | 93K           |
| FX                       | 15736S         | LONDON_EURO   |            | 2K          | -2K           |
|                          |                |               |            | -85K        | 88K           |

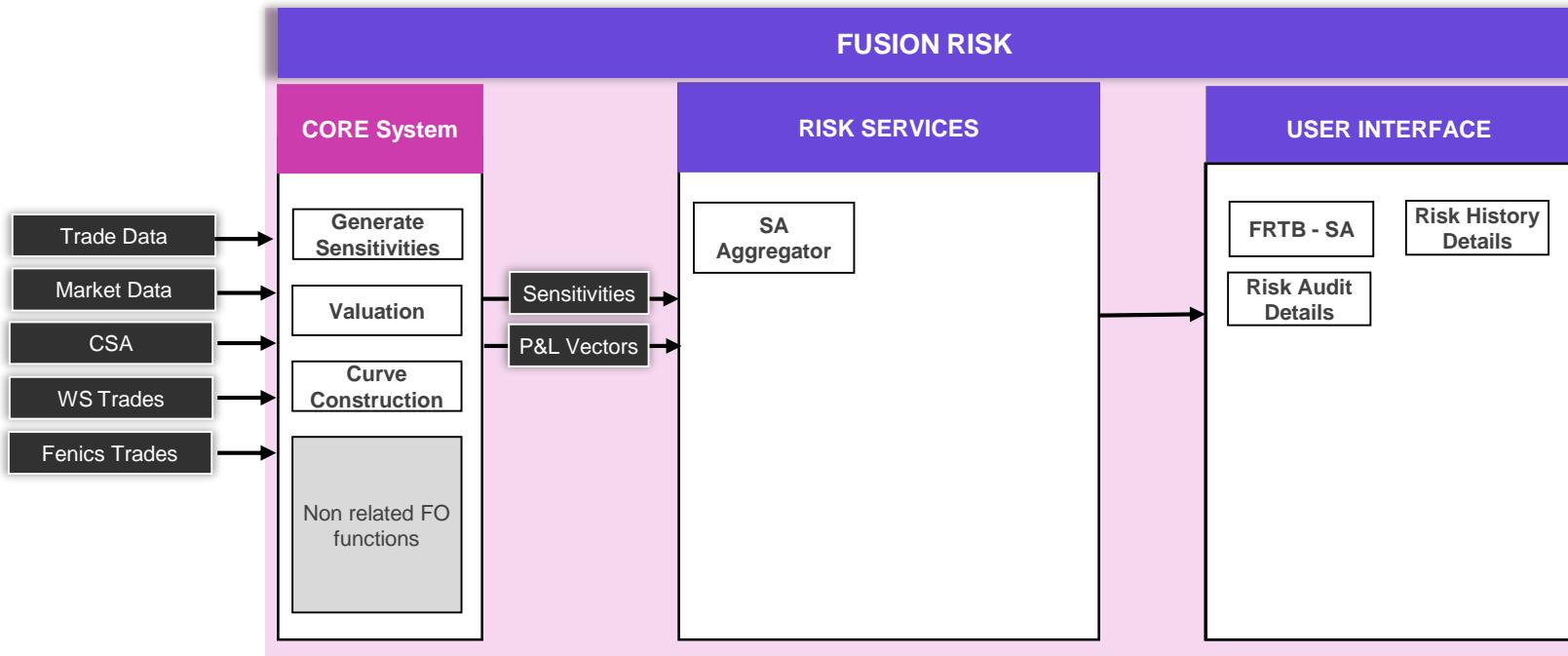
# FRTB-IMA : PnL Attribution review, One single Front to Risk Pricing



# SOLUTION ARCHITECTURE

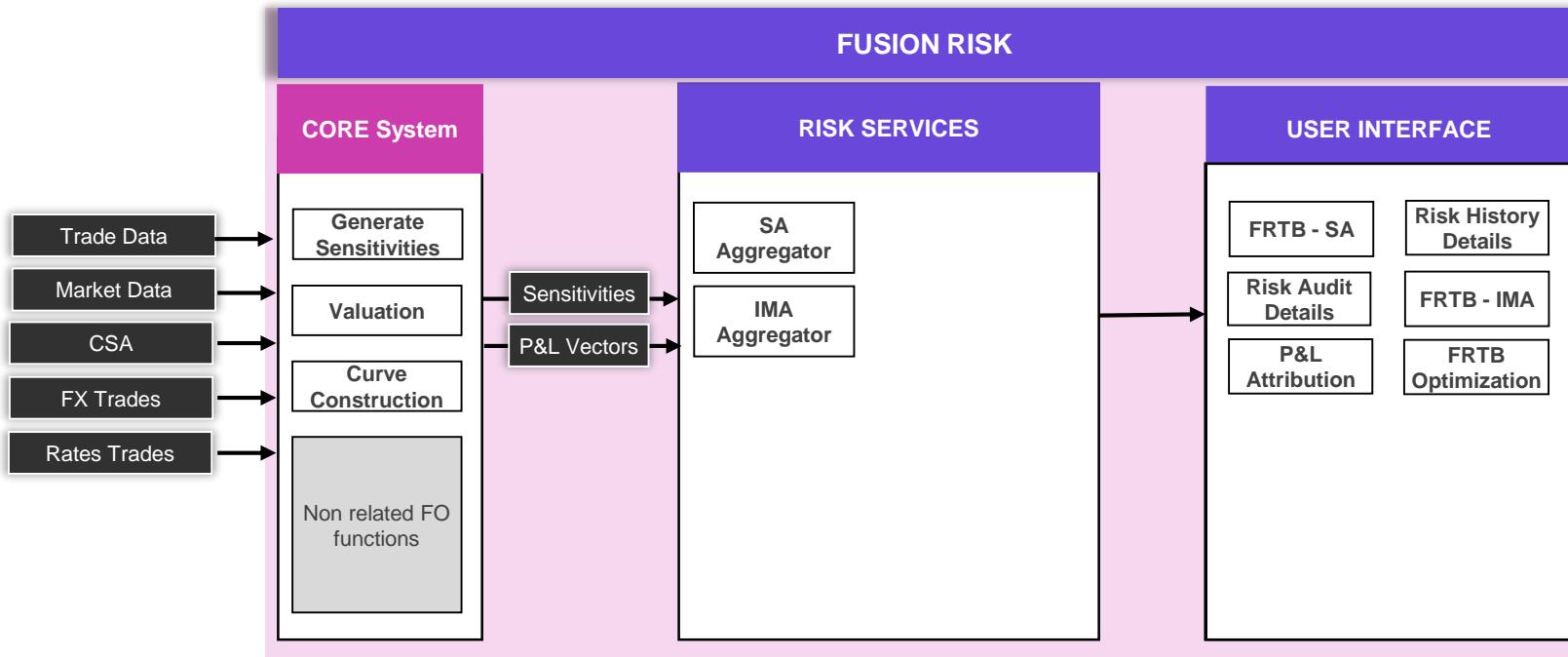
# SA ARCHITECTURE

Finastra takes trades from all core systems and calculates valuations and sensitivities



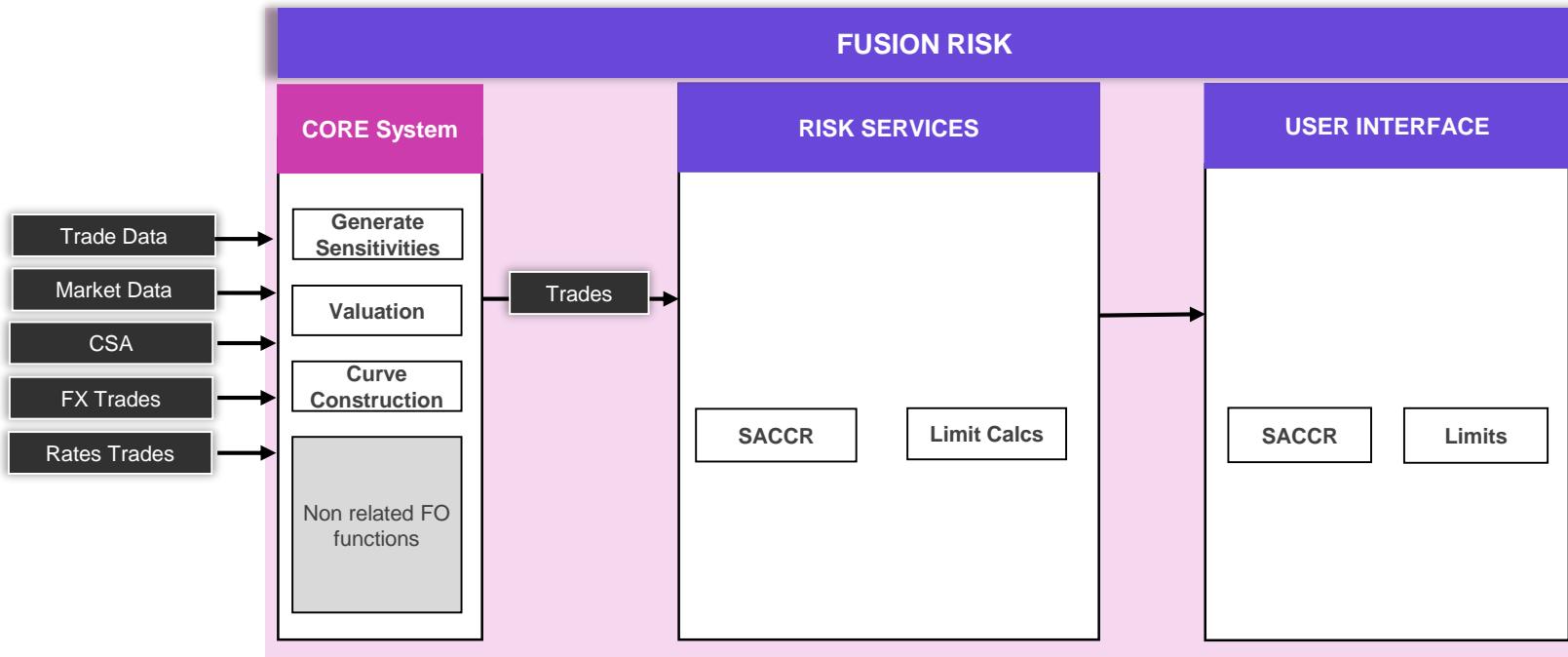
# IMA ARCHITECTURE

## Finastra calculates IMA numbers



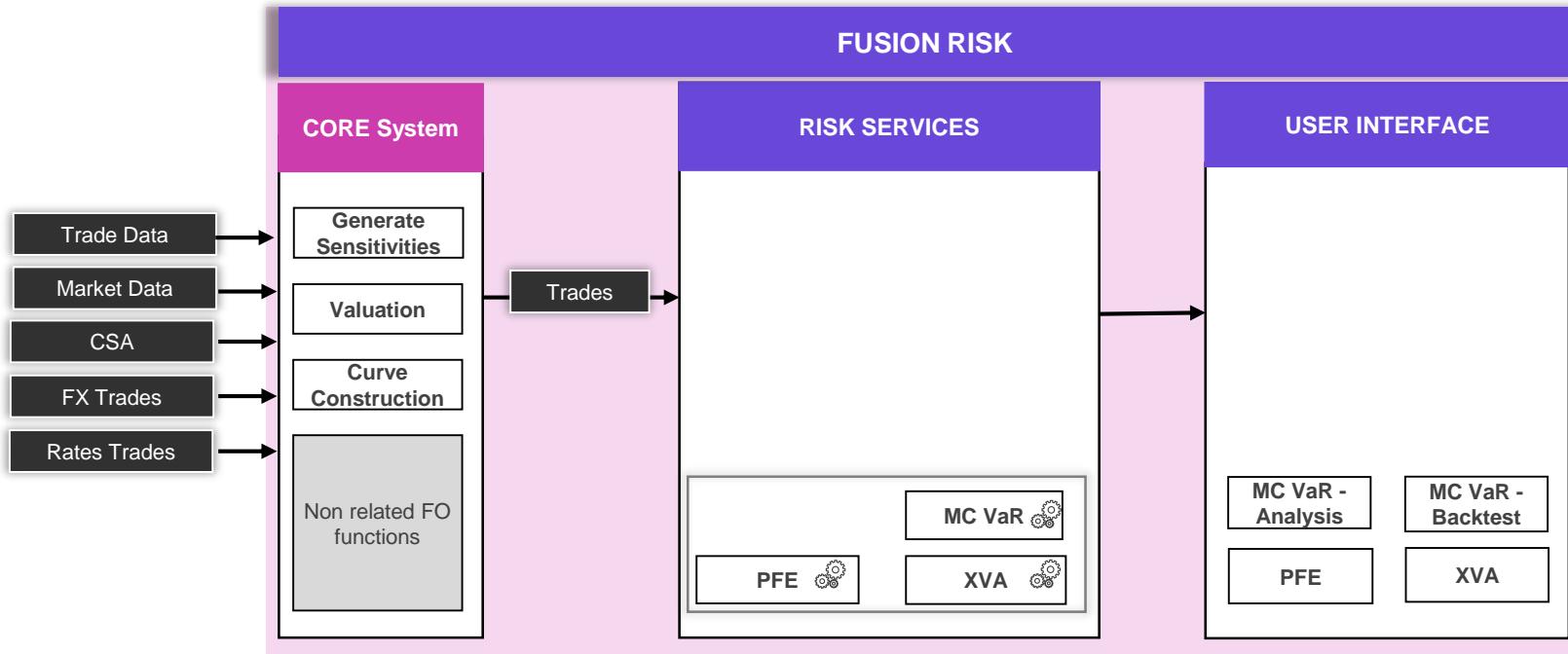
# SA-CCR ARCHITECTURE

Finastra calculates SA-CCR



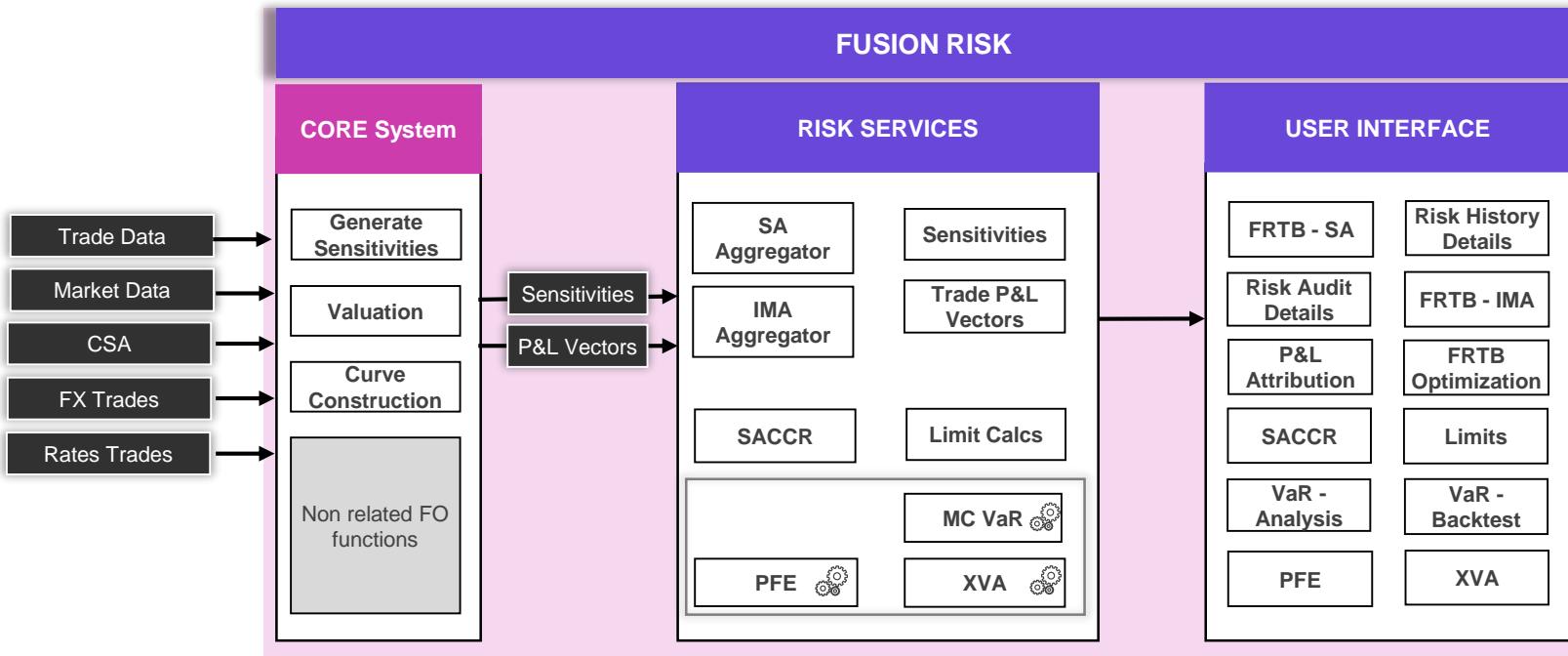
# ADVANCED RISK ARCHITECTURE

Finastra calculates all advanced risk measures including MC VaR, PFE and CVA



# END STATE FOR TREASURY AND GLOBAL MARKETS RISK

Finastra proposed end state solution enables the target integrated global markets risk platform



# **WORLDCLASS ANALYTICS**

To Achieve Front to Risk Analytics

# MODEL USERS AND FOCUS

| Model user                                             | Model usage                                                        | Model expectations                          |
|--------------------------------------------------------|--------------------------------------------------------------------|---------------------------------------------|
| <b>Traders and business decision-makers</b>            | Identification and assessment of trades and business opportunities | ✓ Fast implementation and changes           |
| <b>Risk managers</b>                                   | Quantification of risk measures and management of risk limits      | ✓ Consistency                               |
| <b>Senior management and executive decision-makers</b> | Profitability, performance and strategy assessment                 | ✓ Long-term reliability                     |
| <b>Financial control</b>                               | Valuation and quantification of P&L and attribution                | ✓ Explanatory power, accuracy, consistency, |
| <b>Financial accounting</b>                            | Risk asset quantification, capital and liquidity charge assessment | ✓ Enterprise-level precision                |
| <b>Regulators and policymakers</b>                     | Capital adequacy, institutional and systemic risk assessment       | ✓ Enterprise-level precision and stability  |

# FINASTRA ANALYTICS MISSION

**Transparency and consistency in valuation and risk within institutions**

➤ **Industry leading analytics and model synchronization**

- Versatile curve building and management capability, vast library of pricing models, comprehensive transparency, rich and open APIs

➤ **Deep risk and hedge functionalities**

➤ **Risk, regulatory and front office capabilities**

- Strong expertise in synchronization experience and process

➤ Foundation for **consistency** across functions and better analytics

# WORLD CLASS BUILDING AND MANAGEMENT CURVE CAPABILITY



**Consistency across businesses without compromise**

- **Used by over 100 Tier 1 – 3 financial institutions** for both buy / sell sides
  - Curve capture
  - Curve building
  - Risk management
  - Finance / Accounting
- **Arbitrage free** pricing and risk across:
  - FX, FI, OTC / listed derivatives
  - All market data: Ccy, Rates, vols, smiles...
- **Easy** to maintain, flexible
- **Seamless and low risk** implementation

# VERSATILE CURVE AND RISK CAPABILITY



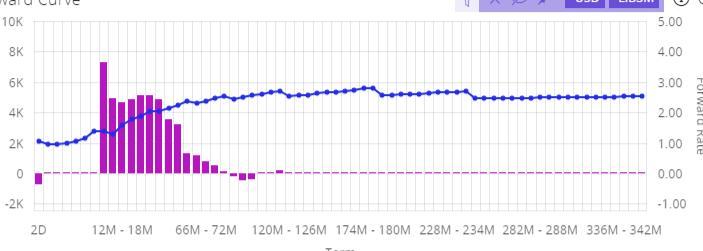
- **Sophisticated curve building**
  - Wide instrument coverage
  - Generic / business / calendar / actual dates
  - Imply off market / synthetic deals to add to curve
  - Unlimited curve dependencies
- **Deep hedge capability for IR curves hedges and sensitivities by:**
  - Market Rates
  - Generated zeros
  - Equivalent mkt rates: swaps, futures...
  - Perturbative, parallel, cumulative, scenarios


[Bucketed Delta](#) [Forward Domain](#) [Native Domain](#) [Zero Domain](#)
[Define Buckets](#)

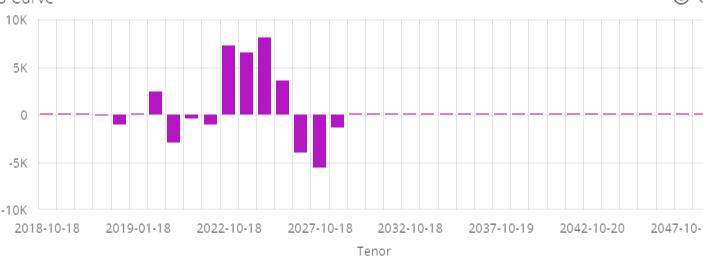
|             | ► USD  | ► AUD  | ► EUR   | ► JPY | ► CNY | ► GBP   | Delta (RepCcy) | ▼ ⓘ C 🔍 ⓘ |
|-------------|--------|--------|---------|-------|-------|---------|----------------|-----------|
| Grand Total | 71,837 | 29,772 | 42,330  | 6,717 | 153   | 132,088 |                |           |
| ON          | 7      |        |         |       |       |         |                |           |
| TN          | -16    | 1      | -121    | 7     | 0     | 7       |                |           |
| 1W          | -180   | 1      | -20     | 4     | 0     | -40     |                |           |
| 2W          | -417   | 1      | -105    | 0     | 0     | -95     |                |           |
| 3W          | -200   |        | -111    | 0     | 0     |         |                |           |
| 1M          | -579   | -106   | -307    | 0     | 0     | -472    |                |           |
| 2M          | -503   | -263   | -24     | -1    | -1    | -945    |                |           |
| 3M          | 1,455  | -433   | 1,973   | -19   | -3    | -4,289  |                |           |
| 6M          | 2,324  | -1,746 | -1,570  | -392  | 0     | -3,966  |                |           |
| 1Y          | 2,080  | -2,065 | 1,329   | -48   | 0     | 11,317  |                |           |
| 2Y          | 1,492  | 3,497  | 6,683   | -16   | 0     | 17,546  |                |           |
| 3Y          | 25,545 | 20,379 | -53,221 | -5    | 15    | -3,834  |                |           |
| 5Y          | 30,432 | -3,956 | 12,764  | 43    | 42    | 57,159  |                |           |
| 6Y          | 131    |        | 383     | 40    | 1     |         |                |           |
| 7Y          | 11,852 | 9,041  | 34,750  | 3,628 | 49    | 30,940  |                |           |
| 9Y          | -9     |        | 206     | 19    | 0     |         |                |           |
| 10Y         | -1,578 | 5,421  | 37,553  | 3,458 | 51    | -1,434  |                |           |
| 15Y         | 0      | 0      | 2,168   | 0     | 0     | 49,558  |                |           |
| 20Y         | 0      | 0      | 0       | 0     | 0     | -365    |                |           |
| 25Y         | 0      |        | 0       | 0     | 0     |         |                |           |
| 30Y         | 0      | 0      | 0       | 0     | 0     | -19,000 |                |           |

Delta projected against

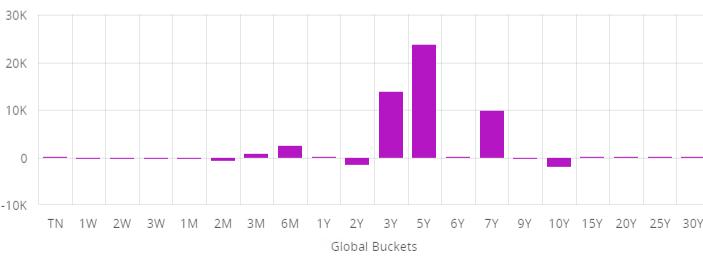
Forward Curve



Zero Curve



Bucketed Delta





Bucketed Delta

Forward Domain

Native Domain

Zero Domain

Define

Delta (RepCcy)

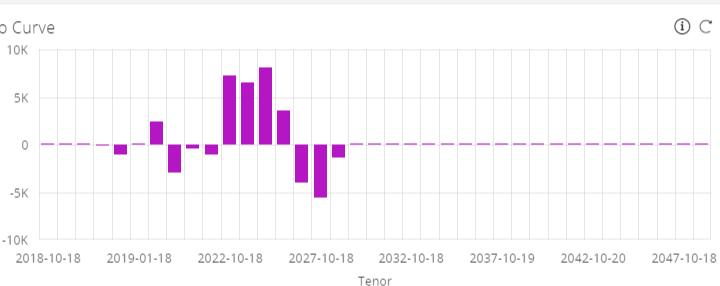
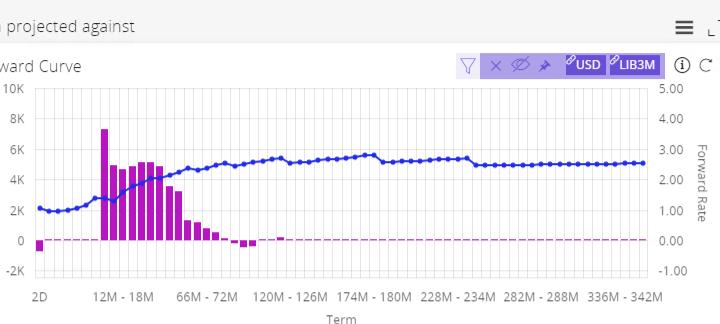
▼ ⓘ

|             | ► USD  | ► AUD  | ► EUR   | ► JPY | ► CNY | ► GBP |
|-------------|--------|--------|---------|-------|-------|-------|
| Grand Total | 71,837 | 29,772 | 42,330  | 6,717 | 153   |       |
| ON          | 7      |        |         |       |       |       |
| TN          | -16    | 1      | -121    | 7     | 0     |       |
| 1W          | -180   | 1      | -20     | 4     | 0     |       |
| 2W          | -417   | 1      | -105    | 0     | 0     |       |
| 3W          | -200   |        | -111    | 0     | 0     |       |
| 1M          | -579   | -106   | -307    | 0     | 0     |       |
| 2M          | -503   | -263   | -24     | -1    | -1    |       |
| 3M          | 1,455  | -433   | 1,973   | -19   | -3    |       |
| 6M          | 2,324  | -1,746 | -1,570  | -392  | 0     |       |
| 1Y          | 2,080  | -2,065 | 1,329   | -48   | 0     |       |
| 2Y          | 1,492  | 3,497  | 6,683   | -16   | 0     |       |
| 3Y          | 25,545 | 20,379 | -53,221 | -5    | 15    |       |
| 5Y          | 30,432 | -3,956 | 12,764  | 43    | 42    |       |
| 6Y          | 131    |        | 383     | 40    | 1     |       |
| 7Y          | 11,852 | 9,041  | 34,750  | 3,628 | 49    |       |
| 9Y          | -9     |        | 206     | 19    | 0     |       |

Bucketed Delta Forward Domain Native Domain Zero Domain Define Buckets

Delta (RepCcy) ▾ ⓘ C ⚡ ⚡

|             | ▼ USD |       |        |        |        | USD Total | ► AUD  | ► EUR   | ► JPY | ► CNY | ► GBP   |
|-------------|-------|-------|--------|--------|--------|-----------|--------|---------|-------|-------|---------|
|             | OIS   | FED   | LIB6M  | LIB1M  | LIB3M  |           |        |         |       |       |         |
| Grand Total | 3,766 | 0     | 20,818 | 1,700  | 45,553 | 71,837    | 29,772 | 42,330  | 6,717 | 153   | 132,088 |
| ON          | 7     |       |        |        |        | 7         |        |         |       |       |         |
| TN          | 3     | 0     | 3      | -22    | 1      | -16       | 1      | -121    | 7     | 0     | 7       |
| 1W          | -6    | 0     | -8     | -77    | -88    | -180      | 1      | -20     | 4     | 0     | -40     |
| 2W          | 12    | 0     | -21    | -193   | -215   | -417      | 1      | -105    | 0     | 0     | -95     |
| 3W          | 0     | 0     | -98    | 0      | -102   | -200      |        | -111    | 0     | 0     |         |
| 1M          | 1     | 0     | -249   | 0      | -330   | -579      | -106   | -307    | 0     | 0     | -472    |
| 2M          | 1     | 0     | 216    | 1      | -721   | -503      | -263   | -24     | -1    | -1    | -945    |
| 3M          | 16    | 0     | 632    | 33     | 774    | 1,455     | -433   | 1,973   | -19   | -3    | -4,289  |
| 6M          | -2    | 0     | -422   | 398    | 2,351  | 2,324     | -1,746 | -1,570  | -392  | 0     | -3,966  |
| 1Y          | 45    | 0     | 179    | 1,814  | 41     | 2,080     | -2,065 | 1,329   | -48   | 0     | 11,317  |
| 2Y          | 3,001 | 0     | -185   | 269    | -1,593 | 1,492     | 3,497  | 6,683   | -16   | 0     | 17,546  |
| 3Y          | 2     | 0     | 10,576 | 1,076  | 13,891 | 25,545    | 20,379 | -53,221 | -5    | 15    | -3,834  |
| 5Y          | 686   | 0     | 7,016  | -993   | 23,723 | 30,432    | -3,956 | 12,764  | 43    | 42    | 57,159  |
| 6Y          | 0     | 30    | -7     | 107    | 131    |           | 383    | 40      | 1     |       |         |
| 7Y          | 0     | 2,703 | -598   | 9,747  | 11,852 | 9,041     | 34,750 | 3,628   | 49    |       | 30,940  |
| 9Y          | 0     | 2     | 0      | -11    | -9     |           | 206    | 19      | 0     |       |         |
| 10Y         | 0     | 444   | 0      | -2,022 | -1,578 | 5,421     | 37,553 | 3,458   | 51    |       | -1,434  |
| 15Y         | 0     | 0     | 0      | 0      | 0      | 0         | 2,168  | 0       | 0     |       | 49,558  |
| 20Y         | 0     | 0     | 0      | 0      | 0      | 0         | 0      | 0       | 0     |       | -365    |
| 25Y         | 0     | 0     | 0      | 0      | 0      |           | 0      | 0       | 0     |       |         |
| 30Y         | 0     | 0     | 0      | 0      | 0      | 0         | 0      | 0       | 0     |       | -19,000 |



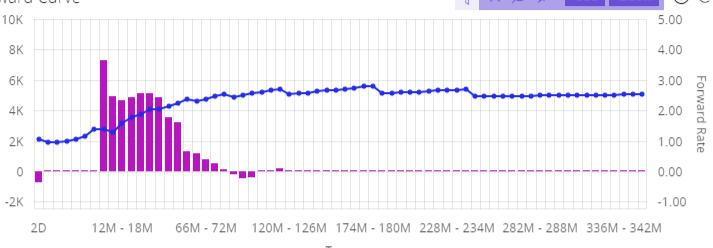

 Bucketed Delta Forward Domain Native Domain Zero Domain

Define Buckets

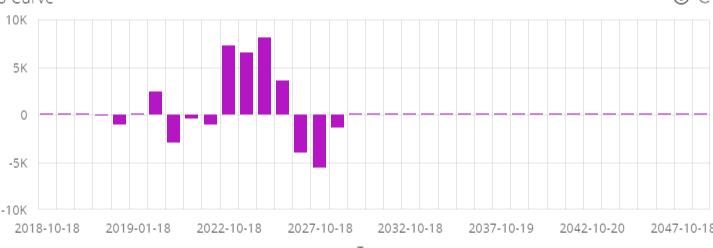
|             | ▼ USD Total | USD   |     |       |       |       | ► CNY | ► EUR  | ► JPY  | ► GBP  | ► AUD |
|-------------|-------------|-------|-----|-------|-------|-------|-------|--------|--------|--------|-------|
|             |             | OIS   | FED | LIB6M | LIB3M | LIB1M |       |        |        |        |       |
| 0M - 6M     | 11,945      | 702   | 0   | 2,552 | 7,331 | 1,360 | 29    | -1,357 | -1,112 | 8,803  | 1,918 |
| 6M - 12M    | 9,242       | 675   | 0   | 2,650 | 4,926 | 991   | 97    | -783   | 44,375 | 14,815 | 4,885 |
| 12M - 18M   | 8,675       | 1,172 | 0   | 2,657 | 4,674 | 171   | 95    | -282   | 47,089 | 9,538  | 5,381 |
| 18M - 24M   | 7,928       | 501   | 0   | 2,486 | 4,894 | 47    | 91    | -1,570 | 47,092 | 10,749 | 6,226 |
| 24M - 30M   | 7,956       | 242   | 0   | 2,546 | 5,133 | 34    | 89    | -2,797 | 47,092 | 6,949  | 6,050 |
| 30M - 36M   | 7,942       | 204   | 0   | 2,576 | 5,137 | 25    | 88    | -2,650 | 47,074 | 7,452  | 3,866 |
| 36M - 42M   | 7,025       | 236   | 0   | 1,922 | 4,852 | 15    | 84    | 2,304  | 47,049 | 7,216  | 3,590 |
| 42M - 48M   | 4,670       | 175   | 0   | 1,115 | 3,549 | -169  | 84    | 6,075  | 47,341 | 7,238  | -275  |
| 48M - 54M   | 4,327       | 195   | 0   | 1,088 | 3,210 | -167  | 80    | 5,863  | 47,130 | 7,282  | -271  |
| 54M - 60M   | 843         | -341  | 0   | 37    | 1,314 | -167  | 39    | 5,261  | 47,442 | 7,279  | 544   |
| 60M - 66M   | 1,240       | 0     | 161 | 1,162 | -83   | 37    | 5,705 | 47,420 | 5,481  | 531    |       |
| 66M - 72M   | 1,006       | 0     | 243 | 814   | -50   | 36    | 3,255 | 47,423 | 3,267  | 1,508  |       |
| 72M - 78M   | 719         | 0     | 239 | 529   | -49   | 35    | 3,321 | 47,119 | 2,185  | 1,464  |       |
| 78M - 84M   | 340         | 0     | 181 | 160   | 0     | 34    | 3,606 | 46,419 | 1,052  | 707    |       |
| 84M - 90M   | -50         | 0     | 171 | -221  | 0     | 33    | 4,453 | 45,688 | 977    | 709    |       |
| 90M - 96M   | -440        | 0     | 0   | -440  | 0     | 31    | 3,267 | 45,746 | 969    | 703    |       |
| 96M - 102M  | -424        | 0     | 0   | -424  | 0     | 29    | 1,296 | 44,467 | 1,031  | 673    |       |
| 102M - 108M | 52          | 0     | 0   | 52    | 0     | 0     | -135  | 154    | 952    | 2      |       |
| 108M - 114M | 55          | 0     | 0   | 55    | 0     | 0     | 0     | 1,177  | 76     | 888    | 2     |
| 114M - 120M | 200         | 0     | 0   | 200   | 0     | 0     | 0     | 1,044  | 29     | 928    | 0     |
| 120M - 126M | 0           | 0     | 0   | 0     | 0     | 0     | 0     | 272    | 0      | 972    | 0     |
| 126M - 132M | 0           | 0     | 0   | 0     | 0     | 0     | 0     | 270    | 0      | 954    | 0     |
| 132M - 138M | 0           | 0     | 0   | 0     | 0     | 0     | 0     | 257    | 0      | 1,022  | 0     |
| 138M - 144M | 0           | 0     | 0   | 0     | 0     | 0     | 0     | 0      | 0      | 1,060  | 0     |
| 144M - 150M | 0           | 0     | 0   | 0     | 0     | 0     | 0     | 0      | 0      | 988    | 0     |
| 150M - 156M | 0           | 0     | 0   | 0     | 0     | 0     | 0     | 0      | 0      | 994    | 0     |
| 156M - 162M | 0           | 0     | 0   | 0     | 0     | 0     | 0     | 0      | 0      | 1,011  | 0     |
| 162M - 168M | 0           | 0     | 0   | 0     | 0     | 0     | 0     | 0      | 0      | 1,006  | 0     |
| 168M - 174M | 0           | 0     | 0   | 0     | 0     | 0     | 0     | 0      | 0      | 994    | 0     |
| 174M - 180M | 0           | 0     | 0   | 0     | 0     | 0     | 0     | 0      | 0      | 945    | 0     |
| 180M - 186M | 0           | 0     | 0   | 0     | 0     | 0     | 0     | 0      | 0      | 997    | 0     |
| 186M - 192M | 0           | 0     | 0   | 0     | 0     | 0     | 0     | 0      | 0      | 996    | 0     |
| 192M - 198M | 0           | 0     | 0   | 0     | 0     | 0     | 0     | 0      | 0      | 996    | 0     |
| 198M - 204M | 0           | 0     | 0   | 0     | 0     | 0     | 0     | 0      | 0      | 853    | 0     |
| 204M - 210M | 0           | 0     | 0   | 0     | 0     | 0     | 0     | 0      | 0      | 637    | 0     |
| 210M - 216M | 0           | 0     | 0   | 0     | 0     | 0     | 0     | 0      | 0      | 582    | 0     |

Delta projected against

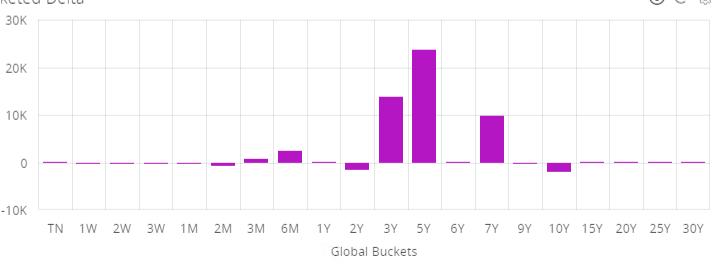
Forward Curve



Zero Curve



Bucketed Delta



☒ Delta ▾ ⓘ C

|             | ▼ USD Total | USD   |     |       |       |       | ▶ CNY | ▶ EUR  | ▶ JPY  | ▶ GBP  | ▶ AUD |
|-------------|-------------|-------|-----|-------|-------|-------|-------|--------|--------|--------|-------|
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| 18M - 24M   | 7,928       | 501   | 0   | 2,486 | 4,894 | 47    | 91    | -1,570 | 47,092 | 10,749 | 6,226 |
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| 30M - 36M   | 7,942       | 204   | 0   | 2,576 | 5,137 | 25    | 88    | -2,650 | 47,074 | 7,452  | 3,866 |
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| 42M - 48M   | 4,670       | 175   | 0   | 1,115 | 3,549 | -169  | 84    | 6,075  | 47,341 | 7,238  | -275  |
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| 60M - 66M   | 1,240       |       | 0   | 161   | 1,162 | -83   | 37    | 5,705  | 47,420 | 5,481  | 531   |
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| 72M - 78M   | 719         |       | 0   | 239   | 529   | -49   | 35    | 3,321  | 47,119 | 2,185  | 1,464 |
| 78M - 84M   | 340         |       | 0   | 181   | 160   | 0     | 34    | 3,606  | 46,419 | 1,052  | 707   |
| 84M - 90M   | -50         |       | 0   | 171   | -221  | 0     | 33    | 4,453  | 45,688 | 977    | 709   |
| 90M - 96M   | -440        |       | 0   | 0     | -440  | 0     | 31    | 3,267  | 45,746 | 969    | 703   |
| 96M - 102M  | -424        |       | 0   | 0     | -424  | 0     | 29    | 1,296  | 44,467 | 1,031  | 673   |
| 102M - 108M | 52          |       | 0   | 0     | 52    | 0     | 0     | -135   | 154    | 952    | 2     |

# MARKET LEADING ANALYTICS — SOFR ILLUSTRATION



## ➤ Ahead of the market

- SOFR (1M, 3M) Two futures segments intertwined bootstrap
- “Same underlying, same generation”
- Do not enforce any overlap priorities
- Different averaging payoff, compounding methods intertwine
- Fully equipped curve building with Fed meeting days methodology

Quant Reference: *“A simple multicurve model for pricing SOFR futures and other derivatives” by Fabio Mercurio*

# MODELS APPLICABLE TO FX AND RATES BOOK

## Synchronization and validation ready

- FX Options
  - Black-Scholes
  - Bachelier
  - Vanna Volga
  - Trinomial Tree
  - PDE solver
- Xccy Swaps
  - Discounted cash flow (Multicurve “XUSD” basis curve pricing supported)
- Caps/floor
  - Black-Scholes
  - Bachelier
- Listed Options
  - Black-Scholes
  - Binormal Tree

# MODEL VALIDATION AND CALIBRATION

Experience helping customer with Synchronization / Validation

➤ Our philosophy is **complete transparency**

- Full documentation, derivations
- Model components and calibration
- Adjustments, intermediate calculations
- On screen (e.g. Cash Flows + DF; product outputs)

# ON DEMAND SYNCHRONIZATION TOOLS

| EUR Pips        | EUR Amount     | USD %          | USD Pips        | USD Amount      |                    |                    |                |                |
|-----------------|----------------|----------------|-----------------|-----------------|--------------------|--------------------|----------------|----------------|
| 153.19          | 17,157.44      | 1.684          | 188.66          | 18,865.68       |                    |                    |                |                |
| 3,852.65        | 431,497.29     | 42.362         | 4,744.58        | 474,458.31      |                    |                    |                |                |
| BSGKvan         | adjSpot        | Vol            | rd: asOf to exp | rf: asOf to exp | rd: exp to expSpot | rf: exp to expSpot | rd: exp to del | Input Strike   |
| Call            | 1.099562668387 | 0.109096321728 | 0.02381552588   | -0.003309720357 | 0.024655975657     | -0.002531312676    | 0.024655975657 | 1.120000000000 |
| Date            | AsOfDate       | Exp            | Del             | ExpSpot         | Time to exp        |                    |                |                |
|                 | 04/18/19       | 07/24/19       | 07/24/19        | 07/24/19        | 0.260273972603     |                    |                |                |
| d1              | d2             |                |                 |                 |                    |                    |                |                |
| -0.173524059868 | -0.22918788458 |                |                 |                 |                    |                    |                |                |
| FXO Value       | Delta          | Gamma          | Vega            | Rho             | Phi                | Theta              | Lambda         | Alpha          |
| 0.018865675858  | 0.431497285570 | 6.426970505471 | 0.220641463265  | 0.121075301901  | -0.126088919869    | -0.058663095282    | 0.826269587572 | 0.080429769690 |

# COMPREHENSIVE DOCUMENTATION



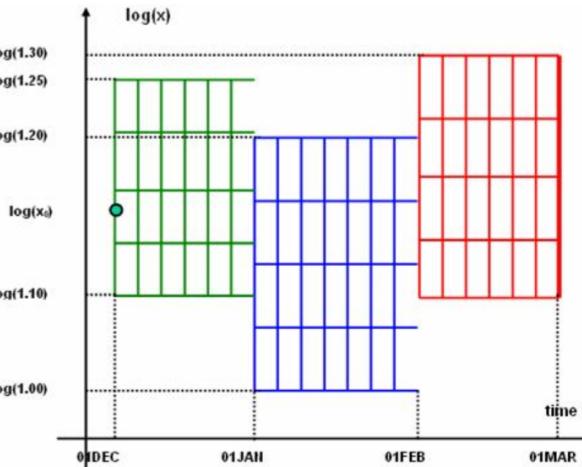
Contents Search Expand All/Collapse All

- FX Option Pricing
  - Basic Concepts
  - European (Vanilla) Options
    - American Options
    - American Option Quadratic Approximation Greeks
  - Asian Options
  - Barrier Options
    - Single Barrier Options
    - Digital Options
  - Complex Barrier Options
    - About Complex Barrier Options
    - Pricing Model
      - The General Pricing Model Theory
      - Boundary Conditions
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## Setting up the Grid for Multiple-Period PDE Solving

Multiple grids are set up according to the schedule to match up the barrier conditions:



The PDE is then solved one period at a time until it reaches the **As of date**:

# COMPREHENSIVE DOCUMENTATION (2)

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- European (Vanilla) Options
  - American Options
  - American Option Quadratic Approximation Greeks
- Asian Options
- Barrier Options
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## Model Dump Information for Complex Barrier Options

When the grid size is small (currently set at 100 by 100 matrix), user can examine the model to gain an understanding of the pricing as a model validation tool.

Here is an example of the model dump:

| Dump value of P |                    |                    |                 |         |          |          |          |          |          |          |          |          |          |
|-----------------|--------------------|--------------------|-----------------|---------|----------|----------|----------|----------|----------|----------|----------|----------|----------|
|                 |                    |                    | Log(underlying) | 4.70048 | 4.719042 | 4.737603 | 4.756165 | 4.774727 | 4.793288 | 4.81185  | 4.830411 | 4.848973 | 4.867534 |
| Time            | p <sub>0prev</sub> | p <sub>0next</sub> | Underlying      | 110     | 112.0608 | 114.1603 | 116.2991 | 118.4779 | 120.6976 | 122.9669 | 125.2625 | 127.6093 | 130      |
| 0.084932        | 0                  | 0                  | 0               | 0       | 0        | 0        | 0.447077 | 1.067065 | 1.608416 | 2.048019 | 2.242774 | 2.423538 | 0        |
| 0.063699        | 0                  | 0                  | 1               | 0       | 0.174079 | 0.479641 | 0.696077 | 0.943044 | 1.193467 | 1.267655 | 1.029919 | 0.219559 | 0        |
| 0.042466        | 0                  | 0                  | 2               | 0       | 0.240203 | 0.407604 | 0.623414 | 0.766519 | 0.787118 | 0.694069 | 0.493778 | 0.463678 | 0        |
| 0.021233        | 0                  | 0                  | 3               | 0       | 0.162356 | 0.35077  | 0.45822  | 0.525892 | 0.546695 | 0.503901 | 0.427181 | 0.124714 | 0        |
|                 | 0                  | 0                  | 4               | 0       | 0.135787 | 0.233596 | 0.334003 | 0.388723 | 0.394255 | 0.361471 | 0.230222 | 0.185963 | 0        |

The matrix above shows the value of the option on the grade for underlying FX between 110 and 130 where two knockout barriers are placed. This example is run with **Iterations** set to 10, resulting in a grid consisting of 10 columns. In this example,  $M_{per}$  is equal to 4.

The row with time = 0 is the row where the four-point interpolation is performed. The four point interpolation can also be found as part of the model dump:

| Model dump for 4 points interpolation |                |
|---------------------------------------|----------------|
| X                                     | P              |
| 1 116.299069738107                    | 0.334002889408 |
| 2 118.477921367576                    | 0.388723270192 |

# SYNCHRONIZATION PROCESS

1. Bank selects trade/profitable date
  - Indicative complete set of market data
2. Bank selects a simplified portfolio
  - Indicative measures to replicate
3. Finastra reproduces computation measures
  - Import/capture trades, market data
4. Review results for material differences
  - Drill down to investigate reasons
  - Review reasons: material in terms of modelling? Setting?
  - Consider enhancement / customization
5. Produces document and screenshots, commentary, spreadsheets with numerical effects

# FULLY OPEN

## Ultimate flexibility for Synchronization



### ➤ APIs

- Curve Generation API
- Interpolation API
- Forward rate API
- Hedge API
- Pricing API

The screenshot shows the FINASTRA API Online Help interface. The left pane is a navigation tree with various API categories. A pink rectangle highlights the "External Rate Interpolation Example" link under the "Curve Generation API" section. The right pane displays the content of this example, which includes a brief description and a code snippet.

**External Rate Interpolation Example**

Like External Curve Generation, Rate Interpolation's call to the external function is The sINTERP\_METHOD enumeration underlying the list is extendible so that the sINTERP\_METHOD, it appears in the Market Sheet window along with the core n When the client-defined interpolation method is selected, the sBuildZeroCurve pi sExtInterpRate to execute the client algorithm and exit upon its successful compl

```
#include "stk.h"

mDLLEXPORT int sExtInterpRate (sRATE * Rate, int * CurPntr,
sDATE Date, sCURVELIST * Curve,
sDATE AsOfDate, sUCHAR Mode)
{
int i, j, cur;

if (Curve->List.ItemsUsed == 0)
{
mLogMessage("Empty Curve");
return(sERROR);
}

if (CurPntr)
{
cur = *CurPntr;
}
else
{
cur = 0;
}

if (cur >= Curve->List.ItemsUsed || cur < 0 ||
Date < Curve->Data[cur].Date)
```

## SUMMARY

### Consistency in valuation and risk across institution

- Versatile Curve system, vast menu of pricing models with ultimate transparency with rich, open APIs
  - Market leading analytics, model synchronization
- Deep risk and hedge functionalities for all functional areas
  - Front, risk, regulatory

# P&L EXPLAIN

P/L attribution – Go through example of Light weight risk (near real time) and intraday p/l attribution (first order risk if no full revaluation is possible)  
– Use Fx options as the product to demo.

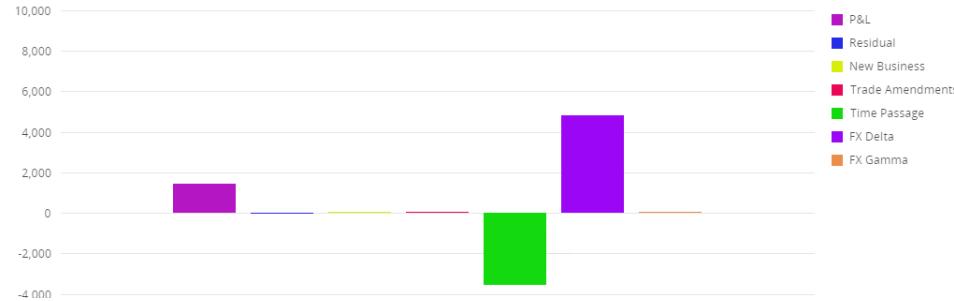
# OVERVIEW

## Real-time P&L Explanation for all asset classes, market data and pricing models

- Provides detailed explanation of the P&L between two dates
- Ensures in real-time that the bank is not exposed to unknown risks that drive the P&L
- Based on changes in the level of interest and fx rates, changes of volatilities, basis spreads, OAS, time effect, new business and other measures
- Taylor expansion with a full revaluation for sensitivities
- Should be used by anyone in the bank who needs to understand the P&L behavior of a portfolio
- Ultimate transparency by drilling down to trades and each market data point

“ This P&L Explain allows me to close my books with a single view by scanning the residuals ”

**Head trader Sell Side NY**



# EXPLANATORY POWER

For all market data points: 1<sup>st</sup> Order, 2<sup>nd</sup> Order, Cross Gammas

| Market Data Type | Metrics                                                                                                                               |
|------------------|---------------------------------------------------------------------------------------------------------------------------------------|
| Interest Rate    | <b>Delta</b><br><b>Gamma</b><br><b>Swap Spread &amp; Any Basis Spread</b><br><b>Vega</b><br><b>Smile</b><br>Seasonality for Inflation |
| FX               | <b>Delta</b><br><b>Gamma</b><br><b>Vega</b><br><b>Smile</b><br><b>BB/RR</b>                                                           |

| Market Data Type | Metrics                                                                                                 |
|------------------|---------------------------------------------------------------------------------------------------------|
| Equity           | <b>Delta</b><br><b>Gamma</b><br><b>Vega</b><br><b>Smile</b><br>Dividend                                 |
| Fixed Income     | <b>Price</b><br><b>OAS</b><br>Prepayment                                                                |
| Credit           | CDS Spread<br>Recovery                                                                                  |
| Other            | Any Correlation<br><b>Funding</b><br><b>Reset</b><br><b>Cashflows</b><br><b>Theta – Drift and Shift</b> |

- Bold is applicable to GM
- Italics is in addition for Treasury
- CCST scope requires all items

## NEXT STEPS

Friday: Each team 15 min presentation  
FRTB Summary – Purpose and Algorithm

Friday: 60 min demo of Fusion Summit

Friday: Probably some more of these slides