Agenda

1. Market Risk Approaches in Basel I-III Framework
2. Why FRTB?
3. Standardised Approach
4. Internal Models Approach
5. FRTB Challenges

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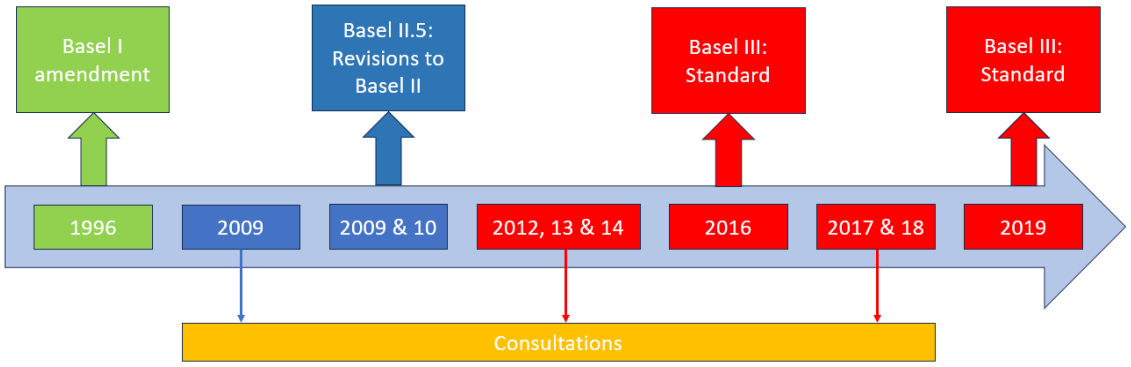
Minimum Total Capital Requirement Formula

- Minimum total capital requirement formula:

$$\frac{Capital}{RWA_{credit} + RWA_{market} + RWA_{operational} + RWA_{CVA}} \geq 8\,\%$$

Market Risk – Timeline to FRTB



Capital Requirement in Basel I-II

- Capital requirement to market risk can be calculated using:
  - Standardised measurement method (SMM),
  - Internal models approach (IMA).
- SMM:
  - Based on notional amount methods or sensitivity methods (duration, option Greeks)
- IMA:
  - Based on Value at Risk (VaR) model, 99% confidence level, 10-days horizon
  - Capital requirement $= max\left[VaR_{t-1}; (3 + add\_on) \cdot VaR_{avg}\right]$
    - Maximum of VaR of previous trading day and $VaR_{60\ day\ average} \cdot (3 + add\_on)$.
    - The add-on depends on backtesting results for the last 250 days, add_on falls into the interval $\langle 0,1 \rangle$.

Capital requirement in Basel II.5

- Aggregated capital requirement:

$$ACR_{Total} = max\left[VaR_{t-1}; (3 + add\_on) \cdot VaR_{avg}\right] + max\left[sVaR_t; (3 + add\_on) \cdot sVaR_{avg}\right] + IRC + CRM$$

  - *sVaR* = value at risk calculated on historical time series from stressed period
  - *IRC* (Incremental Risk Charge) = incremental default and migration risk of trading book positions
  - *CRM* (Comprehensive Risk Measure) = an estimate of risk in the correlation trading portfolio, taking into account credit spread, correlation, basis, recovery and default risks.

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FRTB - Objectives

- To develop an effective trading/banking book boundary condition.
- To achieve a regulatory framework that captures and capitalizes all market risks in the trading book.
- To achieve comparable levels of capital across internal risk models and standardised approach.

FRTB – Key Changes

Issues	Remediation
◆ Banks “intent to trade“ an instrument is the sole basis for the classification into banking and trading book	◆ Prescriptive rules for allocation ◆ Enhanced supervisory oversight ◆ Restrictions on the ability to arbitrage the boundary
◆ Model approval is at the Bank’s level	◆ Trade desk level approval and enhanced validation tests of models
◆ Internal models approach (VaR) was not sufficiently comprehensive	◆ Expected shortfall method ◆ Non-modellable risk factors ◆ Revised treatment of default risk

FRTB – key changes (2)

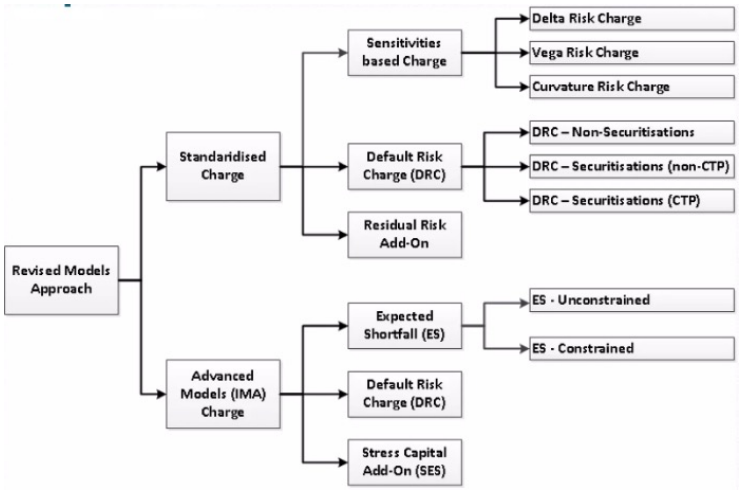
Issues	Remediation
◆ The standardised approach lacked risk sensitivity and therefore was not a credible alternative and complement to the internal models approach	◆ Sensitivity based capital (SBM) ◆ Default risk charge (DRC) ◆ Residual risk add-on (RRAO) ◆ Simplified sensitivity based approach for small/medium sized banks

FRTB Approaches

- FRTB allows to use:
  - Simplified standardised approach (SSA),
  - Standardised approach (SA-TB),
  - Internal models approach (IMA).
- Contrary to the Basel II.5 framework, the SA-TB method is very important even if banks calculate the capital charge with the IMA method. Indeed, the bank must implement SA-TB in order to meet the output (or capital) floor requirement, which is set at 72.5% in January 2028:

$$\kappa_{market} = \max(\kappa^{IMA}, 72.5\% \cdot \kappa^{SA-TB})$$

FRTB – Approaches and Components



Adoption of FRTB Standard as of 31/10/2025

	Credit risk SA	Credit risk IRB	Market risk	CVA	Operational risk	Output floor
AR	31 December 2024				01 March 2025	
AU	01 January 2023	01 January 2023			01 January 2023	01 January 2023
BR	01 July 2023	01 July 2023	01 January 2027		01 January 2025	
CA	30 April 2023	30 April 2023	31 January 2024	31 January 2024	30 April 2023	30 April 2023
CN	01 January 2024	01 January 2024	01 January 2024	01 January 2024	01 January 2024	01 January 2024
HK	01 January 2025	01 January 2025	01 January 2025	01 January 2025	01 January 2025	01 January 2025
IN	01 April 2027		01 April 2027		01 April 2027	
ID	01 January 2023		01 January 2024	01 January 2024	01 January 2023	
JP	31 March 2024	31 March 2024	31 March 2024	31 March 2024	31 March 2024	31 March 2024
KR	01 January 2023	01 January 2023	01 January 2023	01 January 2023	01 January 2023	01 January 2023
MX	01 September 2021				01 January 2023	
SA	01 January 2023	01 January 2023	01 January 2023	01 January 2023	01 January 2023	01 January 2023
SG	01 July 2024	01 July 2024	01 January 2025	01 January 2025	01 July 2024	01 July 2024
ZA	01 July 2025	01 July 2025	01 July 2025	01 July 2025	01 July 2025	01 July 2025
CH	01 January 2025	01 January 2025	01 January 2025	01 January 2025	01 January 2025	01 January 2025
TR						
GB	01 January 2027	01 January 2027	01 January 2027	01 January 2027	01 January 2027	01 January 2027
US						
EU	01 January 2025	01 January 2025	01 January 2027	01 January 2025	01 January 2025	01 January 2025

Status
draft regulation published | draft regulation not published | final regulation published (not yet implemented by banks) | final regulation in force (implemented by banks) | not applicable

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Simplified Standardised Approach (SSA)

- Following the release of the BCBS (2016), the BCBS concluded that the sophistication of the proposed approach may pose a difficult challenge for some banks and therefore SSA was proposed.
- Based on scaled Basel II.5
- The capital requirement arising from the SSA is the simple sum of the recalibrated capital requirements arising from each of the four risk classes – interest rate risk (both general and specific), equity risk (both general and specific), FX risk and commodity risk:

$$\kappa^{SSA} = 1.3 \cdot \kappa_{IRR} + 3.5 \cdot \kappa_{EQ} + 1.2 \cdot \kappa_{FX} + 1.9 \cdot \kappa_{COM}$$

- SSA is designed for banks with relatively small or simple trading portfolio.
- The use of SSA must be approved by supervisor and following criteria should be considered:
  - the bank is not G-SIB,
  - IMA should not be used for any trading desk,
  - no CTP's (correlation trading portfolio) held by the bank.

Standardised Approach (SA-TB)

- The standardised approach capital requirement is the simple sum of three components:

$$\kappa^{SA-TB} = \kappa^{SBM} + \kappa^{DRC} + \kappa^{RRAO}$$

  - κ^{SBM} - capital requirement under the sensitivities-based method (SBM),
    - This component must be viewed as the pure market risk and is the equivalent of the capital charge for the general market risk.
  - κ^{DRC} - default risk capital (DRC) requirement,
    - The component that captures the jump-to-default risk (JTD) and replaces the specific risk.
  - κ^{RRAO} - residual risk add-on (RRAO),
    - The component that captures specific risks that are difficult to measure in practice.

Sensitivities-based Method (SBM)

- The capital requirement under the SBM must be calculated by aggregating three risk measures:

$$\kappa^{SBM} = \kappa^{Delta} + \kappa^{Vega} + \kappa^{Curvature}$$

- The capital requirement to κ^{SBM} is calculated in following steps:
  1. Calculation of κ^{Delta} and κ^{Vega}
  2. Calculation of $\kappa^{Curvature}$
  3. Adding-up of κ^{Delta}, κ^{Vega}, $\kappa^{Curvature}$ - „medium correlations“ scenario
  4. Repeat steps 1-3 for two scenarios „low correlations“ and „high correlations“
  5. Take the maximum capital requirement from 3 scenarios

FRTB – Definitions

- **Risk class:**
  - the seven risk classes defined for the SBM.
- **Risk factor:**
  - variables (e.g. a given vertex of a given interest rate curve or an equity price) within a pricing function decomposed from trading book instruments and which fall within scope of the risk factor definitions,
  - risk factors are mapped to a risk class.
- **Risk position:**
  - the main input that enters the risk charge computation,
  - for delta and vega risks, it is a sensitivity to a risk factor,
  - for curvature risk, it is the worst loss of two stress scenarios.
- **Bucket:**
  - a set of risk positions which are grouped together by common characteristics.
- **Risk charge:**
  - the amount of capital that a bank should hold as a consequence of the risks it takes,
  - it is computed as an aggregation of risk positions first at the bucket level, and then across buckets within a risk class defined for the SBM.

SBM - Risk Classes And Buckets

Risk class	Criteria	Number of buckets
GIRR	Currency	The number of currencies
CSR non-securitisations	Investment versus speculative grade and sector	18
CSR securitisations - CTP	Investment versus speculative grade and sector	16
CSR securitisations - non-CTP	Investment versus speculative grade and sector	25
FX risk	Currency pairs	The number of currency pairs
Equity risk	Market cap, economy and sector	13
Commodity risk	Commodity type	11

SBM – Definition of Sensitivities

- For each risk factor sensitivities are calculated as the change in the market value of the instrument as a result of applying a specified shift to each risk factor, assuming all the other relevant risk factors are held at the current level.
- **GIRR:**
  - The sensitivity of the instrument *i* to risk factor $\mathcal{F}_k$ is defined as the PV01 (present value basis point)
  - PV01 is measured by changing the interest rate *IR* at tenor *k* (IR_k) of the risk-free yield curve in a given currency by 1 basis point (i.e. 0.0001 in absolute terms) and dividing the resulting change in the market value of the instrument (V_i) by 0.0001:

$$s_{i,k} = \frac{V_i(\mathcal{F}_k + 0.0001) - V_i(\mathcal{F}_k)}{\mathcal{F}_k + 0.0001 - \mathcal{F}_k} = \frac{V_i(IR_k + 0.0001) - V_i(IR_k)}{0.0001}$$

- **CSR:**
  - The sensitivity of the instrument *i* to risk factor $\mathcal{F}_k$ is defined as the CS01

$$s_{i,k} = \frac{V_i(\mathcal{F}_k + 0.0001) - V_i(\mathcal{F}_k)}{\mathcal{F}_k + 0.0001 - \mathcal{F}_k} = \frac{V_i(CS_k + 0.0001) - V_i(CS_k)}{0.0001}$$

- **FX, EQ, COM:**
  - The equity delta sensitivity of the instrument *i* with respect to the equity risk factor $\mathcal{F}_k$ is given by

$$s_{i,k} = \Delta_i(\mathcal{F}_k) \cdot \mathcal{F}_k$$

where $\Delta_i(\mathcal{F}_k)$ measures the (discrete) delta of the instrument *i* by shocking the equity risk factor $\mathcal{F}_k$ by 1%:

$$s_{i,k} = \frac{V_i(1.01 \cdot \mathcal{F}_k) - V_i(\mathcal{F}_k)}{1.01 \cdot \mathcal{F}_k - \mathcal{F}_k} \cdot \mathcal{F}_k = \frac{V_i(1.01 \cdot \mathcal{F}_k) - V_i(\mathcal{F}_k)}{0.01}$$

SBM – Definition of Sensitivities (1)

- Vega risk sensitivity:

$$s_{i,k} = \frac{V_i(1.01 \cdot \mathcal{F}_k) - V_i(\mathcal{F}_k)}{1.01 \cdot \mathcal{F}_k - \mathcal{F}_k} \cdot \mathcal{F}_k = \frac{V_i(1.01 \cdot vol_k) - V_i(vol_k)}{0.01}$$

SBM – Risk Weights And Weighted Sensitivity

- Risk Weights:
  - **GIRR:**
    - The risk weights for each tenor in risk-free yield curves are set in the table.
    - The risk weight (RW) for the inflation risk factor and the cross-currency basis risk factors is set at 1.6%.
  - **FX:**
    - A risk weight of 30% applies to all the FX sensitivities.
    - For the specified currency pairs by the Basel Committee the above risk weight may at the discretion of the bank be divided by the square root of 2.
  - **Other classes:**
    - The risk weights are defined in tables for each class and corresponding bucket, see appendix.

Tenor (years)	RW
0,25	1,70%
0,5	1,70%
1	1,60%
2	1,30%
3	1,20%
5	1,10%
10	1,10%
15	1,10%
20	1,10%
30	1,10%

- Weighted sensitivity:
  - The weighted sensitivity is the product of the net sensitivity and the corresponding risk-weight of each risk factor $\mathcal{F}_k$

$$WS_k = s_k \cdot RW_k$$

where the net sensitivity is the sensitivity across instruments to each risk factor $\mathcal{F}_k$

$$s_k = \sum_i s_{i,k}$$

SBM – Risk Weights And Weighted Sensitivity (1)

- **Vega Risk:**
  - Risk weights for a given vega risk are defined in terms of liquidity horizons:

$$RW_k = min\left(RW_{vol} \cdot \sqrt{\frac{LH}{10}}; 100\%\right)$$

where $RW_{vol} = 55\%$.

Risk class	$LH_{risk\ class}$	Risk weights
GIRR	60	100%
CSR non-securitisations	120	100%
CSR securitisations (CTP)	120	100%
CSR securitisations (non-CTP)	120	100%
Equity (large cap and indices)	20	77.78%
Equity (small cap and other sector)	60	100%
Commodity	120	100%
FX	40	100%

SBM – Delta & Vega Capital Charge

- Capital requirement for the risk bucket:
  - The risk position for Delta bucket *b* must be determined by aggregating the weighted sensitivities to risk factors $\mathcal{F}_k$ within the same bucket using the corresponding prescribed correlation ρ_{kl}:

$$\kappa_b = \sqrt{\max\left(\sum_k WS_k^2 + \sum_k \sum_{k \neq l} \rho_{kl} \cdot WS_k \cdot WS_l\,, 0\right)}$$

- Capital requirement for the risk class:
  - The Delta risk charge is determined from risk positions aggregated between the Delta buckets within each risk class using the corresponding prescribed correlations γ_{bc}:

$$\kappa_{risk\ class}^{Delta} = \sqrt{\sum_b \kappa_b^2 + \sum_b \sum_{c \neq b} \gamma_{bc} \cdot S_b \cdot S_c}$$

  where $S_b = \sum_k WS_k$ for all risk factors in bucket *b* and $S_c = \sum_k WS_k$ in bucket *c*.
  - GIRR: parameter $\gamma_{bc} = 50\%$ must be used for aggregating between different currencies.
  - FX: uniform correlation parameter $\gamma_{bc} = 60\%$ applies to FX sensitivity or risk exposure pairs.

Correlations Between Risk Factors Within a Bucket – GIRR

- The delta risk correlation ρ_{kl} between weighted sensitivities WS_k and WS_l within the same bucket with different tenor and **same curve** is set in the correlation matrix below
- Each element of the correlation matrix is calculated using the following formula:

$$\rho_{kl} = \max\left[e^{-3\% \cdot \frac{|T_k - T_l|}{\min(T_k, T_l)}}; 40\%\right]$$

- The delta risk correlation between weighted sensitivities WS_k and WS_l within the same bucket with different tenor and **different curves** is equal to $99.9\% \cdot \rho_{kl}$

ρ_{kl}	0,25	0,5	1	2	3	5	10	15	20	30
0,25	100%	97%	91%	81%	72%	57%	40%	40%	40%	40%
0,5	97%	100%	97%	91%	86%	76%	57%	42%	40%	40%
1	91%	97%	100%	97%	94%	89%	76%	66%	57%	42%
2	81%	91%	97%	100%	99%	96%	89%	82%	76%	66%
3	72%	86%	94%	99%	100%	98%	93%	89%	84%	76%
5	57%	76%	89%	96%	98%	100%	97%	94%	91%	86%
10	40%	57%	76%	89%	93%	97%	100%	99%	97%	94%
15	40%	42%	66%	82%	89%	94%	99%	100%	99%	97%
20	40%	40%	57%	76%	84%	91%	97%	99%	100%	99%
30	40%	40%	42%	66%	76%	86%	94%	97%	99%	100%

SBM – Curvature Risk Charge

- The curvature risk uses a similar methodology, but it is based on two adverse scenarios:
  - the risk factor is shocked upward, and
  - the risk factor is shocked downward.
- The curvature risk is close to the gamma risk that we encounter in the theory of options.

SBM - Correlation Scenarios

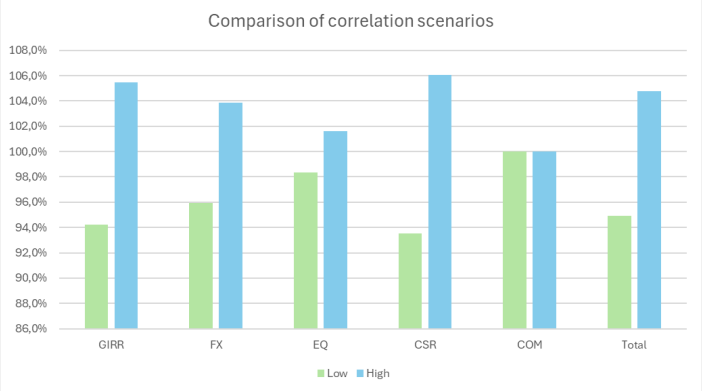
- In order to address the risk that correlations increase or decrease in periods of financial stress, three risk charge figures are to be calculated for each risk class, corresponding to three different scenarios on the specified values for the correlation parameter:
  - ρ_{kl} (correlation between risk factors within a bucket), and
  - γ_{kl} (correlation across buckets within a risk class).
- 3 correlation scenarios are considered:
  - high correlations
    - $\rho_{kl}^{high} = min(1.25 \cdot \rho_{kl}; 100\%),\ \gamma_{kl}^{high} = min(1.25 \cdot \gamma_{kl}; 100\%)$
  - medium correlations
    - $\rho_{kl}^{medium} = \rho_{kl}, \gamma_{kl}^{medium} = \gamma_{kl}$
  - low correlations
    - $\rho_{kl}^{low} = max(2 \cdot \rho_{kl} - 100\%; 0.75 \cdot \rho_{kl})\ , \gamma_{kl}^{low} = max(2 \cdot \gamma_{kl} - 100\%; 0.75 \cdot \gamma_{kl})$

Residual Risk Add-on (RRAO)

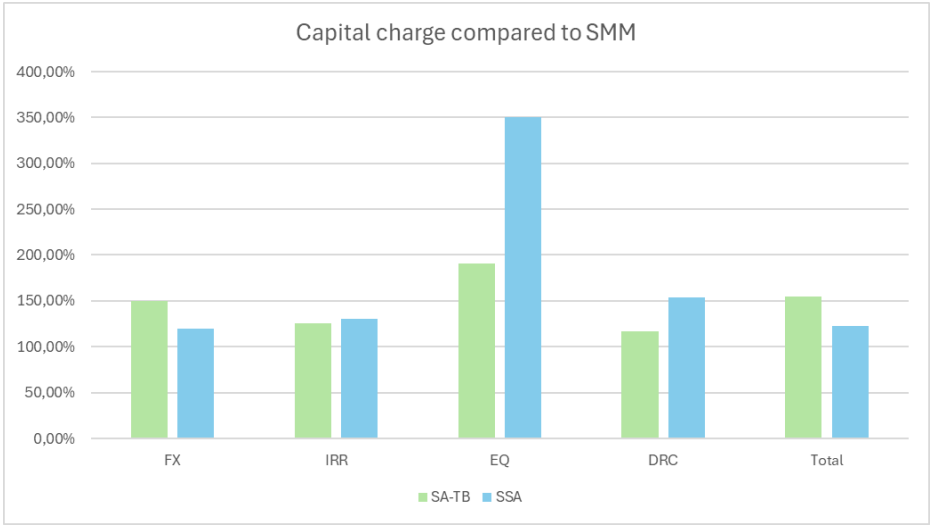
- Calculated for all instruments bearing residual risk separately in addition to other components of the capital requirement under the SA-TB.
- What instruments are subject to RRAO?
  - Instruments with Exotic Underlyings: Weather derivatives, natural disasters (catastrophe bonds) or longevity risks.
  - Instruments with Other Residual Risks:
    - Gap risk: Sudden large price changes (e.g. path-dependent options like Asian or Barrier options).
    - Correlation risk: Dependence on the correlation between multiple assets (e.g. Best-of/Worst-of options, Himalayan options).
    - Behavioral risk: Risks tied to prepayment or cancellation (e.g. certain mortgage-backed products).
- The RRAO is the simple sum of gross notional amounts of the instruments bearing residual risks multiplied by a risk weight.
  - The risk weight for instruments with an exotic underlying is 1.0%.
  - The risk weight for instruments bearing other residual risks is 0.1%.

SBM – Capital Charge

- For each scenario, the bank must determine a scenario-related risk charge at the portfolio level as the simple sum of the risk charges at risk class level for that scenario.
- The ultimate portfolio level risk capital charge is the largest of the three scenario-related portfolio level risk capital charges.



Capital Charge Example



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IMA – Models and Parameters

- What is new?
  - **Risk measure:** Value-at-Risk (VaR) and stressed VaR replaced with one single measure Expected Shortfall (ES),
    - ES better captures "tail risk" by accounting for the magnitude of losses beyond the VaR threshold.
  - **Confidence level:** 97.5%
  - **Calculation period:** ES calculation based on 12-month stressed period in which the portfolio experiences the largest loss.
  - **Horizon:** 5 sets of liquidity horizons – 10 (base horizon), 20, 40, 60, 120 (days)
  - **Implementation level:** Trading desk
    - A trading desk is “an unambiguously defined group of traders or trading accounts that implements a well-defined business strategy operating within a clear risk management structure”.
    - Some trading desks are approved for the use of internal models, while other trading desks must use the SA-TB approach.
- No particular type of ES model is prescribed, the model can be based on either historical simulation, Monte Carlo simulation, or appropriate analytical methods.
- ES model used must capture all the material risks run by the bank, must be confirmed through
  - profit and loss (P&L) attribution (PLA) tests, and
  - backtesting.

Capital Charge

- Aggregate capital requirement (ACR_{Total}) for market risk is equal to the aggregate capital requirement for
  - approved and eligible trading desks,
  - the standardised approach capital requirement for trading desks that are either out-of-scope for model approval or that have been deemed ineligible to use the internal models approach.

$$ACR_{Total} = C_A + DRC_A + C_U + DRC_U$$

where

C_A = Capital charge for internal model approved trading desks,

DRC_A = Default risk charge for internal model approved trading desks,

C_U = Aggregate standardised capital charge for unapproved trading desks,

DRC_U = Standardised default risk charge for unapproved trading desks.

- If at least one eligible trading desk is in the PLA test amber zone, a capital surcharge is added.

Capital Charge for Internal Model Approved Trading Desks

- The aggregate (non-DRC) capital requirement for those trading desks approved and eligible for the IMA is equal to the maximum of the most recent observation and a weighted average of the previous 60 days scaled by a multiplier

$$C_A = max\left(IMCC_{t-1} + SES_{t-1}; m_C \cdot IMCC_{avg} + SES_{avg}\right)$$

where

$IMCC$ = Aggregate capital requirement for modellable risk factors of IM approved trading desks,

SES = Capital requirement for non-modellable risk factors of IM approved trading desks,

m_C = multiplication factor that is fixed at 1.5 unless it is set at a higher level by the supervisory authority (on the basis of their assessment of the quality of the bank's risk management system).

Capital Charge for Modellable Risk Factors (IMCC)

- The aggregate capital requirement for modellable risk factors is based on the weighted average of the constrained and unconstrained ES capital requirements

$$IMCC = \rho \cdot ES_{unconstrained} + (1-\rho) \cdot ES_{constrained}$$

where

$ES_{unconstrained}$ = ES for all risk factors (honoring diversification),

$ES_{constrained} = ES_{GIR} + ES_{CS} + ES_{EQ} + ES_{FX} + ES_{COM}$, i.e. the sum of individual ES for all risk classes,

ρ = relative weight assigned to the bank's internal model, the value set to 0.5.

- Model approval on trading desk level, but capitalisation on risk class level (for securitizations SA-TB used).

$$ES_{unconstrained} = ES_{R,S} \frac{ES_{F,C}}{ES_{R,C}} \qquad ES_{constrained} = ES_{R,S,j} \frac{ES_{F,C,j}}{ES_{R,C,j}}$$

where

$ES_{R,S}$ = ES measure based on the most severe 12-month stress period with a reduced set of risk factors,

$ES_{R,C}$ = ES measure based on the current (most recent) 12-month period with a reduced set of risk factors,

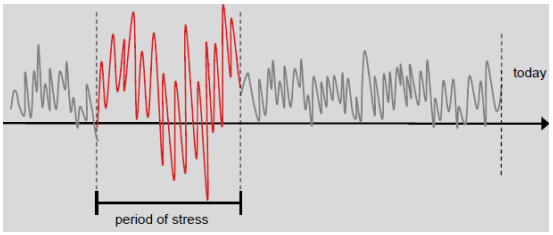
$ES_{F,C}$ = ES measure based on the current (most recent) 12-month period with a full set of risk factors.

Period of Stress Calibration

- ES measure must replicate an ES outcome that would be generated on the bank's current portfolio if the relevant risk factors were experiencing a period of stress.
- Banks must specify a reduced set of risk factors that are relevant for their portfolio and for which there is a sufficiently long history of observations
- **Risk factors:**
  - Data inputs calibrated to historical data from 12-month stress period,
  - If a reduced set is used, it has to explain 75% of variation in full ES model (on average over preceding 12 week period)

$$\frac{1}{60} \cdot \sum_{k=0}^{59} \frac{ES_{R,C}^{t-k}}{ES_{F,C}^{t-k}} \geq 75\%$$

  - This reduced set of risk factors is subject to supervisory approval
- **Stressed period:**
  - Observation period starting at least from 1. January 2007
  - Update stressed period and market data for current period at least once a month



Expected Shortfall

- ES versus VaR:
  - VaR asks the question *"How bad can things get"*
  - ES asks the question "*If things do get bad, how much can the bank expect to lose*"
- Expected shortfall formula:

$$ES_{t+K}^{p} = E\left(L \middle| L \geq VaR_{t+K}^{p}\right)$$

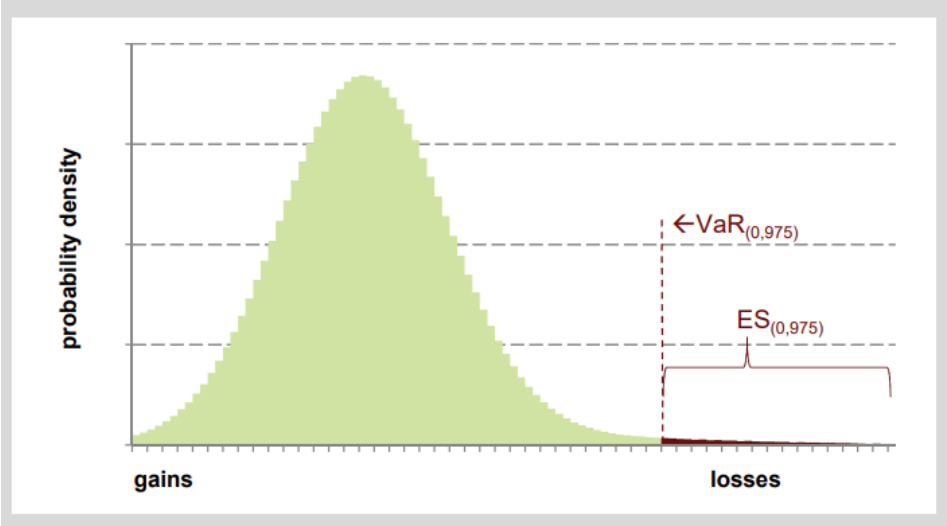
where L = portfolio loss

p = confidence level

K = time horizon

- When profits and losses are normally distributed, ES at 97.5% corresponds to a VaR at 99%.
- The ES has to be calculated on a daily basis bank-wide and at least on trading desk level.

Expected Shortfall (1)



Impact of the Liquidity

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

where

$ES(P)$ = expected shortfall of the portfolio at horizon 10 days considering all risk factors

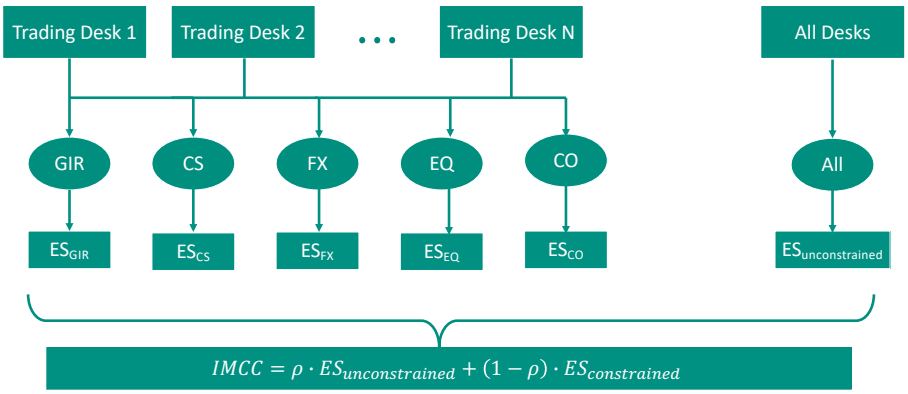
$ES_T(P,j)$ = expected shortfall of the portfolio at horizon relevant for category *j* considering the risk factors that belong to the liquidity category *j* of the risk class

- In each of the periods a potential loss occurs based on the change of active risk factors.
- For computational purpose, individual expected shortfalls are calculated based on 10-day shocks and scaled by the square root of time law.
- Assumptions:
  - Risk factors are hedged in their liquidity horizon. (e.g. Risk factors with a LH of 10 days are not relevant for the second time period).
  - Normally distributed and uncorrelated losses.

Impact of the Liquidity (1)

		Liquidity Horizon				
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	✔				
	Interest rate other currencies		✔			
	Interest rate ATM volatility				✔	
	Interest rate (other than yields and ATM volatility)				✔	
Credit Risk	Central Government, incl. central banks of Member States of the Union		✔			
	Covered bonds issued by credit institutions established in Member States of the Union (IG)		✔			
	Credit spread – sovereign (IG)		✔			
	Credit spread – sovereign (HY)			✔		
	Credit spread – corporate(IG)			✔		
	Credit spread – corporate(HY)				✔	
	Credit spread – volatility					✔
	Credit (other)					✔
FX	FX rate-liquid currency pairs	✔				
	FX rate (other currency pairs)		✔			
	FX volatility			✔		
	FX (other)			✔		
Equity	Equity price (large cap)	✔				
	Equity price (small cap)		✔			
	Equity price (large cap) volatility		✔			
	Equity price (small cap) volatility				✔	
	Equity (other)				✔	
Commodity	Energy price		✔			
	Precious price		✔			
	Other commodities price				✔	
	Energy price volatility				✔	
	Precious metal price volatility				✔	
	Other commodities price volatility					✔
	Commodity (other)					✔

Aggregation Between Risk Classes for Approved Trading Desks



Model Eligibility of Risk Factors

- A bank must determine which risk factors within its trading desks that have received approval to use the IMA are eligible to be included in the bank's internal expected shortfall (ES) model for regulatory capital requirements
- Risk Factor Eligibility Test (RFET) - test requires identification of a sufficient number of real prices that are representative of the risk factor. To be modellable, a risk factor must meet one of the following two numerical criteria over the previous 12 months:
  - The 24/90 Rule:
    - at least 24 real price observations per year (measured over the period used to calibrate the current ES model), and
    - over the previous 12 months there must be no 90-day period in which fewer than four real price observations are identified for the risk factor.
  - The 100-Price Rule:
    - at least 100 real price observations over the previous 12 months
- ES model should include all risk factors corresponding to the regulatory risk factors specified under the SA-TB unless they are not material for the bank's trading positions.
- The modellability is linked to an ability to observe price data of sufficient quality and frequency, as well as to the liquidity of instruments linked to the specific risk factors

Capital Charge for Non-modellable Risk Factors (SES)

- All risk factors identified as non-modellable must be capitalised individually, on a bank level and based on stress scenarios for each NMRF, taking into account the liquidity horizons.
- Capital requirements for each non-modellable risk factor (NMRF) are to be determined using a stress scenario that is calibrated to be at least as prudent as the ES calibration used for modelled risks, i.e. a loss calibrated to a 97.5% confidence threshold over a period of stress.
  - In determining that period of stress, a bank must determine a common 12-month period of stress across all NMRFs in the same risk class.
  - For each NMRF, the liquidity horizon of the stress scenario must be the greater of the liquidity horizon assigned to the risk factor and 20 days.
  - For NMRFs arising from idiosyncratic credit spread risk and idiosyncratic equity risk banks may apply a common 12-month stress period.

$$SES = \sqrt{\sum_{i=1}^{I} ISES_{NM,i}^2} + \sqrt{\sum_{j=1}^{J} ISES_{NM,j}^2} + \sqrt{\left(\rho \cdot \sum_{k=1}^{K} SES_{NM,k}\right)^2 + (1-\rho^2) \cdot \sum_{k=1}^{K} SES_{NM,k}^2}$$

where

$ISES_{NM,i}$ = stress scenario capital requirement for idiosyncratic credit spread non-modellable risk *i* from the *I* risk factors aggregated with zero correlation,

$ISES_{NM,j}$ = stress scenario capital requirement for idiosyncratic equity non-modellable risk *j* from the *J* risk factors aggregated with zero correlation,

$SES_{NM,k}$ = stress scenario capital requirement for non-modellable risk *k* from *K* risk factors,

$\rho = 0.6$.

Bank-wide Backtesting

- Objective: To assess the overall accuracy of the IMA for market risk capital across the entire bank.
- Aggregated Level of Comparison:
  - Compares the aggregate 99th percentile of VaR (1-day horizon) for all desks with IMA approval.
  - The VaR is compared against both the aggregate Hypothetical P&L (HPL) and Actual P&L (APL) for the entire portfolio.
    - Hypothetical P&L (HPL) - the P&L produced by revaluing the positions held at the end of the previous day using the market data at the end of the current day
    - Actual P&L (APL) - the daily economic P&L based on the marking to market of the books and records of the bank (excl. fees and commissions)
    - Number of exceptions = $max\left(N_{Ex}^{APL}, N_{Ex}^{HPL}\right)$
- If the bank-wide test fails, the bank loses the right to use internal models globally, regardless of how well individual desks performed in their specific PLA tests.

Backtesting zone	Number of exceptions	Backtesting dependent multiplier (to be added to any qualitative add-on per [MAR33.44])
Green	0	1.50
	1	1.50
	2	1.50
	3	1.50
	4	1.50
Amber	5	1.70
	6	1.76
	7	1.83
	8	1.88
	9	1.92
Red	10 or more	2.00

Trading Desk Level Backtesting And P&L Attribution

Backtesting

- Focus on model coverage
- Compares the 1-day 99th percentile and 97.5th percentile VaR against both HPL and APL
- If any given trading desk experiences either more than 12 exceptions (against HPL or APL) at the 99th percentile or 30 exceptions at the 97.5th percentile in the most recent 12-month period, the capital requirement for all of the positions in the trading desk must be determined using the SA-TB.

P&L Attribution (PLA)

- Focus on model precision - verify that simplifications in the risk model do not lead to significant deviations from the actual pricing of instruments.
- Compares the HPL with the Risk Model P&L (RTPL)
  - Risk Model P&L (RTPL) - the daily desk-level P&L that is predicted by the risk management model conditional on a realization of all relevant risk factors that enter the model.
- Metrics & Zones:
  - Spearman Correlation: Measures the alignment of P&L ranks (Green if > 0.8, Red if < 0.7), i.e. measures if the model captures the direction and rank of market moves.
  - Kolmogorov-Smirnov: Measures the alignment of P&L distributions (Green if < 0.09, Red if > 0.12), i.e. measures if the model captures the volatility and shape of the P&L
- Consequences:
  - Green: Full IMA usage allowed.
  - Amber: IMA allowed, but with a capital surcharge.
  - Red: Failed, the desk must revert to the SA-TB.

Agenda

1. Market Risk Approaches in Basel I-III Framework
2. Why FRTB?
3. Standardised Approach
4. Internal Models Approach
5. FRTB Challenges

FRTB Challenges

- Data challenges
- Infrastucture challenges – in case of IMA the bank must calculate capital charge using 2 approaches (SA-TB, IMA)
- What if analysis – with so many charges difficult to estimate the impact, the bank needs suitable tools
- In IMA the Bank will compute multiple expected shortfalls or other calculations based on the following configurations:
  - 5 risk classes (IRR, CS, FX, EQ, COM)
  - 6 levels of aggregation (5 risk classes + 1 firm wide)
  - 5 liquidity horizons (10, 20, 40, 60, 120)
  - 3 configurations – reduced stressed, full current, reduced current
  - Full set of risk factors
  - Current scenario
  - Stressed scenario
  - Monthly recalibration of the stressed period per risk class
  - 1 day VaR calculation for backtesting purposes

Thank you

J&T BANKA, a.s.
Sokolovská 700/113a, 186 00 Praha 8, ČR
www.jtbanka.cz

Appendix

SBM - CSR Non-securitisations Buckets

Bucket number	Credit quality	Sector	Risk-weight
1	Investment grade (IG)	Sovereigns including central banks, multilateral development banks	0,5%
2		Local government, government-backed non-financials, education, public administration	1,0%
3		Financials including government-backed financials	5,0%
4		Basic materials, energy, industrials, agriculture, manufacturing, mining and quarrying	3,0%
5		Consumer goods and services, transportation and storage, administrative and support service activities	3,0%
6		Technology, telecommunications	2,0%
7		Health care, utilities, professional and technical activities	1,5%
8		Covered bonds	2,5%
9	High yield (HY) & non-rated (NR)	Sovereigns including central banks, multilateral development banks	2,0%
10		Local government, government-backed non-financials, education, public administration	4,0%
11		Financials including government-backed financials	12,0%
12		Basic materials, energy, industrials, agriculture, manufacturing, mining and quarrying	7,0%
13		Consumer goods and services, transportation and storage, administrative and support service activities	8,5%
14		Technology, telecommunications	5,5%
15		Health care, utilities, professional and technical activities	5,0%
16	Other sector		12,0%
17	IG indices		1,5%
18	HY indices		5,0%

SBM - CSR Securitisations (CTP) Buckets

Bucket number	Credit quality	Sector	Risk-weight
1	Investment grade (IG)	Sovereigns including central banks, multilateral development banks	4,0%
2		Local government, government-backed non-financials, education, public administration	4,0%
3		Financials including government-backed financials	8,0%
4		Basic materials, energy, industrials, agriculture, manufacturing, mining and quarrying	5,0%
5		Consumer goods and services, transportation and storage, administrative and support service activities	4,0%
6		Technology, telecommunications	3,0%
7		Health care, utilities, professional and technical activities	2,0%
8		Covered bonds	6,0%
9	High yield (HY) & non-rated (NR)	Sovereigns including central banks, multilateral development banks	13,0%
10		Local government, government-backed non-financials, education, public administration	13,0%
11		Financials including government-backed financials	16,0%
12		Basic materials, energy, industrials, agriculture, manufacturing, mining and quarrying	10,0%
13		Consumer goods and services, transportation and storage, administrative and support service activities	12,0%
14		Technology, telecommunications	12,0%
15		Health care, utilities, professional and technical activities	12,0%
16	Other sector		13,0%

SBM - CSR Securitisations (non-CTP) Buckets

Bucket number	Credit quality	Sector	Risk-weight	Note
1	Senior investment grade (IG)	RMBS – Prime	0,9%	x
2		RMBS – Mid-prime	1,5%	
3		RMBS – Sub-prime	2,0%	
4		Commercial mortgage-backed securities (CMBS)	2,0%	
5		Asset-backed securities (ABS) – Student loans	0,8%	
6		ABS – Credit cards	1,2%	
7		ABS – Auto	1,2%	
8		Collateralised loan obligation (CLO) non-CTP	1,4%	
9	Non-senior IG	RMBS – Prime	1,1%	Scaled up by multiple of 1,25 of corresponding senior IG buckets
10		RMBS – Mid-prime	1,9%	
11		RMBS – Sub-prime	2,5%	
12		Commercial mortgage-backed securities (CMBS)	2,5%	
13		Asset-backed securities (ABS) – Student loans	1,0%	
14		ABS – Credit cards	1,5%	
15		ABS – Auto	1,5%	
16		Collateralised loan obligation (CLO) non-CTP	1,8%	
17	High yield & non-rated	RMBS – Prime	1,6%	Scaled up by multiple of 1,75 of corresponding senior IG buckets
18		RMBS – Mid-prime	2,6%	
19		RMBS – Sub-prime	3,5%	
20		Commercial mortgage-backed securities (CMBS)	3,5%	
21		Asset-backed securities (ABS) – Student loans	1,4%	
22		ABS – Credit cards	2,1%	
23		ABS – Auto	2,1%	
24		Collateralised loan obligation (CLO) non-CTP	2,5%	
25	Other sector		3,5%	x

SBM - Equity Risk Buckets

Bucket number	Market cap	Economy	Sector	Risk-weight	
				Equity spot price	Equity repo rate
1	Large	Emerging market economy	Consumer goods and services, transportation and storage, administrative and support service activities, healthcare, utilities	55%	0,55%
2			Telecommunications, industrials	60%	0,60%
3			Basic materials, energy, agriculture, manufacturing, mining and quarrying	45%	0,45%
4			Financials including government-backed financials, real estate activities, technology	55%	0,55%
5		Advanced economy	Consumer goods and services, transportation and storage, administrative and support service activities, healthcare, utilities	30%	0,30%
6			Telecommunications, industrials	35%	0,35%
7			Basic materials, energy, agriculture, manufacturing, mining and quarrying	40%	0,40%
8			Financials including government-backed financials, real estate activities, technology	50%	0,50%
9	Small	Emerging market economy	All sectors described under bucket numbers 1, 2, 3 and 4	70%	0,70%
10		Advanced economy	All sectors described under bucket numbers 5, 6, 7 and 8	50%	0,50%
11	Other sector			70%	0,70%
12	Large market cap, advanced economy equity indices (non-sector specific)			15%	0,15%
13	Other equity indices (non-sector specific)			25%	0,25%

SBM - Commodity Risk Buckets

Bucket number	Commodity bucket	Examples of commodities allocated to each commodity bucket (non-exhaustive)	Risk weight
1	Energy - solid combustibles	Coal, charcoal, wood pellets, uranium	30%
2	Energy - liquid combustibles	Light-sweet crude oil; heavy crude oil; West Texas Intermediate (WTI) crude; Brent crude; etc (ie various types of crude oil)	35%
		Bioethanol; biodiesel; etc (ie various biofuels)	
		Propane; ethane; gasoline; methanol; butane; etc (ie various petrochemicals)	
		Jet fuel; kerosene; gasoil; fuel oil; naphtha; heating oil; diesel etc (ie various refined fuels)	
3	Energy - electricity and carbon trading	Spot electricity; day-ahead electricity; peak electricity; off-peak electricity (ie various electricity types)	60%
		Certified emissions reductions; in-delivery month EU allowance; Regional Greenhouse Gas Initiative CO2 allowance; renewable energy certificates; etc (ie various carbon trading emissions)	
4	Freight	Capesize; Panamax; Handysize; Supramax (ie various types of dry-bulk route)	80%
		Suezmax; Aframax; very large crude carriers (ie various liquid-bulk/gas shipping route)	
5	Metals – non-precious	Aluminium; copper; lead; nickel; tin; zinc (ie various base metals)	40%
		Steel billet; steel wire; steel coil; steel scrap; steel rebar; iron ore; tungsten; vanadium; titanium; tantalum (ie steel raw materials)	
		Cobalt; manganese; molybdenum (ie various minor metals)	
6	Gaseous combustibles	Natural gas; liquefied natural gas	45%
7	Precious metals (including gold)	Gold; silver; platinum; palladium	20%
8	Grains and oilseed	Corn; wheat; soybean seed; soybean oil; soybean meal; oats; palm oil; canola; barley; rapeseed seed; rapeseed oil; rapeseed meal; red bean; sorghum; coconut oil; olive oil; peanut oil; sunflower oil; rice	35%
9	Livestock and dairy	Live cattle; feeder cattle; hog; poultry; lamb; fish; shrimp; milk; whey; eggs; butter; cheese	25%
10	Softs and other agriculturals	Cocoa; arabica coffee; robusta coffee; tea; citrus juice; orange juice; potatoes; sugar; cotton; wool; lumber; pulp; rubber	35%
11	Other commodity	Potash; fertilizer; phosphate rocks (ie various industrial materials)	50%
		Rare earths; terephthalic acid; flat glass	