

11th Capacity Building Seminar on General Insurance 20th December, 2024

RBC – Risk Calibration Techniques (Part 2)



Prasun Sarkar
Appointed Actuary and Chief Actuarial Officer, ICICI Lombard

Manoj Gatram, Ritu Kotnala and Harsh Shah
Actuarial Team, ICICI Lombard

Equity Risk - Calibration Techniques

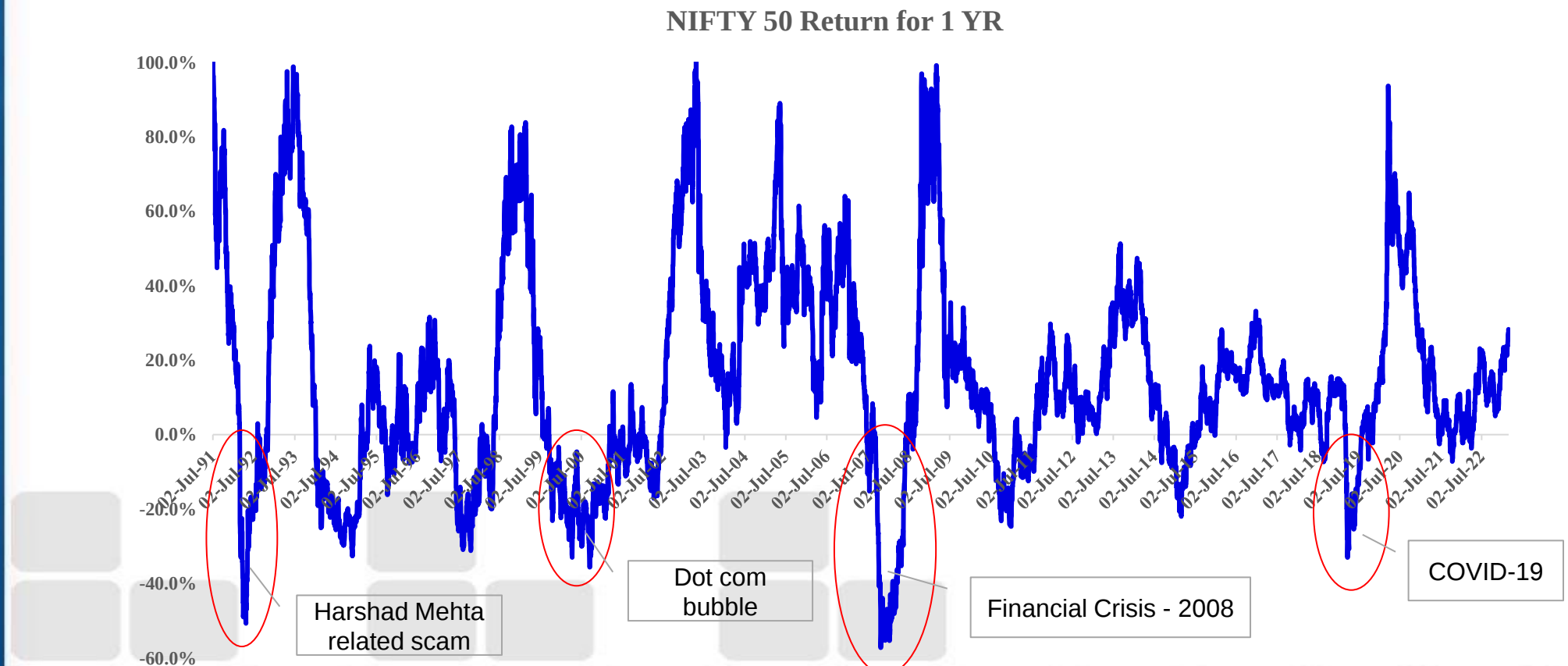


Market Risk – Equity

Introduction

Background

- Under IRBCF principles, Equity Risk Charges refers to potential for financial loss that arises from fluctuations in the value of equity investments in next 1 year at 99.5th VaR.



Market Risk – Equity

Introduction

Volatility of NIFTY 50 in historical years

Event	Peak to Bottom %fall	Time from Peak to bottom	Time from bottom to previous peak
Harshad Metha related Scam (1992)	54%	369 days	473 days
Dot com bubble (2000)	56%	588 days	833 days
Global Financial Crisis (2008)	61%	426 days	606 days
Covid (2020)	38%	69 days	231 days

Annualized Return for different duration of holding				
Time →	1	3	5	10
Min Return	-57.3%	-16.4%	-7.0%	-1.5%
Max Return	239.8%	58.9%	44.5%	20.6%
Average Return	16.9%	11.4%	11.4%	11.5%
Average Return (Recent 10 Yrs)	13.8%	12.4%	10.9%	11.1%
Average Return (Recent 5 Yrs)	14.2%	13.2%	10.9%	10.9%
Standard Deviation	32.3%	12.2%	9.0%	4.6%

- The volatility of returns decreases as the holding period of an investment increases.
- However, the IRBCF calibration, in accordance with the established principles, focuses on observing volatility over a one-year holding period for the calibration of the risk charge.

Market Risk – Equity

Approach in various jurisdictions



Approach in various jurisdictions

In most jurisdictions, the equity risk charge is calculated by applying the equity risk charge factor to the market/fair value of the equity investment.

Jurisdictions	Risk Charges														
IRBCF (QIS-1)	- Listed Equities – 45% - Unlisted Equities – 55%														
Economic Capital (India)	- If the proportion of equity investment is less than 10%, the risk charge is 0. - If the proportion of equity investment is 10% or more, the risk charge is calculated as: 45% × (Proportion of Equity Investment - 10%).														
Solvency II	- Listed Equities – 39% (Base Charge) + symmetric Adjustment - Unlisted Equities - 49% (Base Charge) + symmetric adjustment - In addition to above, separate provision for long term equities, infrastructure corporate/project equities etc,														
Singapore	- Developed Market Equities – 40% - Other than developed Market Equities – 50%														
AM Best (Credit Rating Agency)	AM Best consider MSCI global equity index to generate baseline risk factors at different VaR <table><tr><td>VaR Confidence level (%)</td><td>95.0</td><td>99.0</td><td>99.5</td><td>99.6</td></tr><tr><td>Baseline Capital Factor (%)</td><td>25</td><td>39</td><td>45</td><td>46</td></tr></table>					VaR Confidence level (%)	95.0	99.0	99.5	99.6	Baseline Capital Factor (%)	25	39	45	46
VaR Confidence level (%)	95.0	99.0	99.5	99.6											
Baseline Capital Factor (%)	25	39	45	46											

Market Risk – Equity

Approach in Indian Banking Sector



Comparison of BASEL – III (RBI) with IRBCF

Jurisdictions	Risk Charges
BASEL – III (RBI)	• 45 days (Short Horizon) The short time horizon under BASEL III is mainly driven by the emphasis on liquidity management, which takes precedence over other business considerations in the banking sector. • 1 in 100 years (99th percentile) • Risk charges are classified basis investment in other banks, financial entities and non-financial entities.
NAIC	• Risk Charge of 30% is applied to investments in common shares and joint ventures in which a company holds less than or equal to 10% ownership interest

Market Risk – Equity

Risk Charge Calibration Approach



Approach

- **Objective:** Determine the worst possible 1-year equity return at the 99.5th percentile level of VaR based on historical data from a representative index
- **Data Series (Rolling Annual Return basis vs Annualized Daily Return basis):**
 - (i) **Rolling Annual Return Basis:**
 - Calculate change in representative index over 1 year period (i.e. annual return) for each day
 - It is aligned with principles for IRBCF considering change in 1 year
 - (ii) **Annualized Daily Return Basis:**
 - Daily return is calculated as the change in the representative index for each day, with the assumption that daily returns are independent.
 - Annual VaR is derived by multiplying the daily return VaR by $\sqrt{252}$, where 252 is the number of trading days in a year.
 - Annualizing daily returns to calculate VaR overstates variability by assuming constant daily volatility throughout the entire year.

Market Risk – Equity

Risk Charge Calibration Approach



Approach

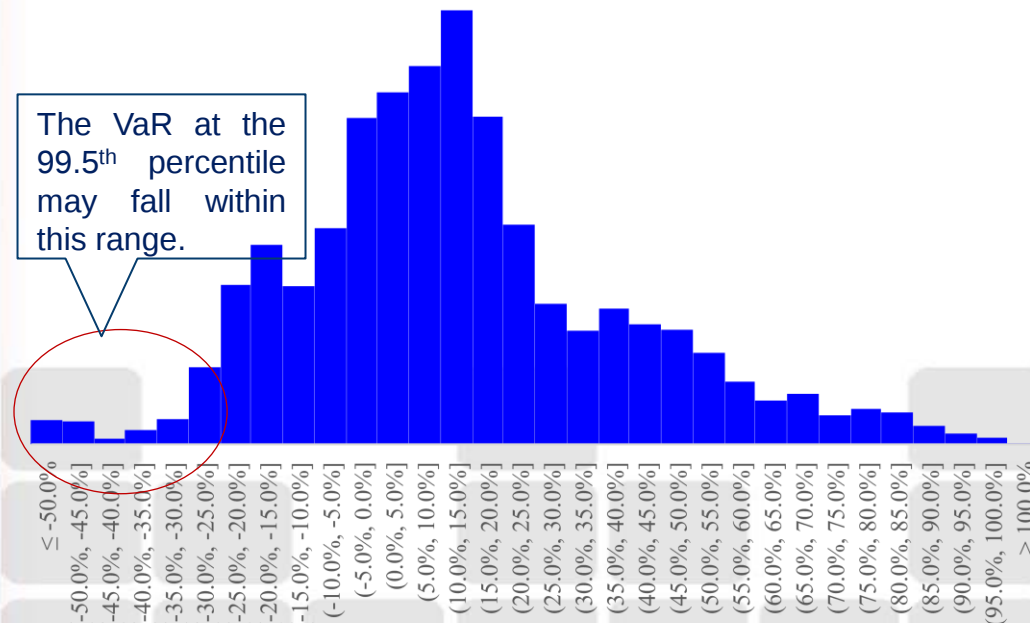
- **Objective:** Determine the worst possible 1-year equity return at the 99.5th percentile level of VaR based on historical data from a representative index (Say – NIFTY 50, NIFTY 500 or Sensex)
- **Parametric vs Non-parametric approach:**
 - (i) **Parametric approach:**
 - Assumes appropriate distributions such as Normal, Lognormal distributions etc
 - Selection of distributions based on Probability-Probability (PP) plots, Q-Q plots, and other goodness-of-fit tests to evaluate and compare the fit of different distributions to the data
 - Select best-fit distribution and calculate the Value-at-Risk (VaR) at the 99.5th percentile using the fitted distribution.
 - (ii) **Non-parametric approach:**
 - Doesn't rely on any assumptions about the underlying distribution of the data.
 - VaR can be directly derived by calculating 99.5th percentile based on empirical data over time.
 - It is sensitive to data size and tends to be less smooth compared to parametric models.

Market Risk – Equity Risk Charge Calibration Result

Result for calibration – Equity Risk Charge Factor at 99.5th VaR (NIFTY 50 Index)

- The results show a significant difference between the recent 5-10 years and the recent 15-30 years, as the recent 10-year period does not capture extreme events.
- For accurate calibration, it is essential to use a dataset covering a longer time frame, which includes all historical events.
- Below analysis is performed on data from 1995 to 2024.

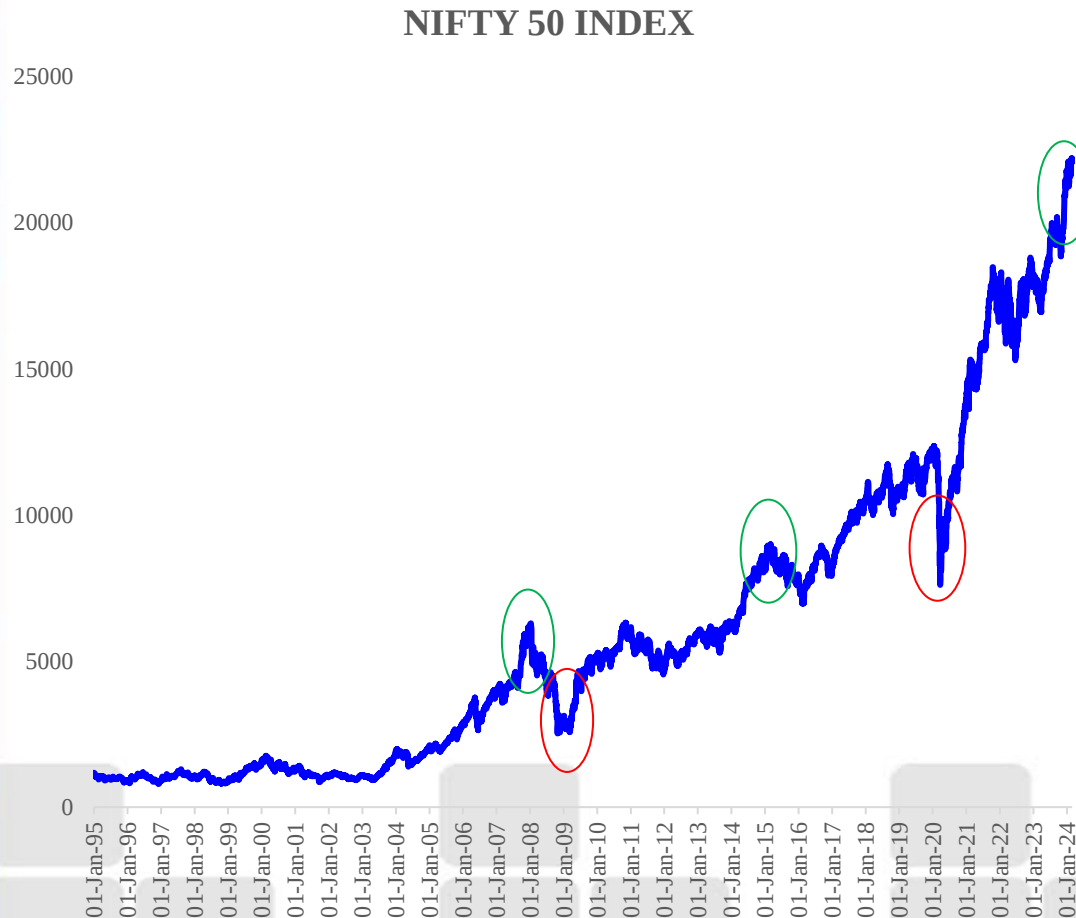
Distribution of NIFTY 50 Return - 1 YR (Rolling Annual Basis)



Time Horizon considered for the analysis (in yrs) →	Recent 5	Recent 10	Recent 15	Recent 20	Recent 25	Recent 30
Log-normal						
Annual Rolling Return (daily data)	-26%	-23%	-30%	-35%	-38%	-38%
Annualized Daily Returns	-30%	-25%	-28%	-35%	-36%	-38%
Normal						
Annual Rolling Return (daily data)	-36%	-30%	-41%	-46%	-52%	-52%
Annualized Daily Returns	-32%	-27%	-30%	-40%	-41%	-44%
Non-Parametric Approach: 99.5th Percentile (Annual Returns)	-27%	-24%	-44%	-52%	-51%	-51%

Market Risk – Equity Symmetric Adjustment (SA)

Need for Symmetric Adjustment



- Solvency II has proposed adjustment to a constant risk charge factor to reflect current market conditions which would adjust capital charge accordingly.
- These adjustments are pro-cyclical in nature meaning the risk charge factor increases during periods of bull market and decreases in bear market.
- SA helps in immunizing the solvency ratio against short-term fluctuations in equity value.

Market Risk – Equity

Symmetric Adjustment



Symmetric Adjustment (SA) in Solvency II

- In Solvency II, Below formula is proposed to calculate SA basis current market conditions.

$$\text{Symmetric Adjustment} = \left[\frac{1}{2} \left(\frac{CI - AI}{AI} - 8\% \right) \right]_{-10\%}^{+10\%}$$

(CI denotes current value of index, AI denotes average value of index for last 3 Yrs, 8% is benchmark return)

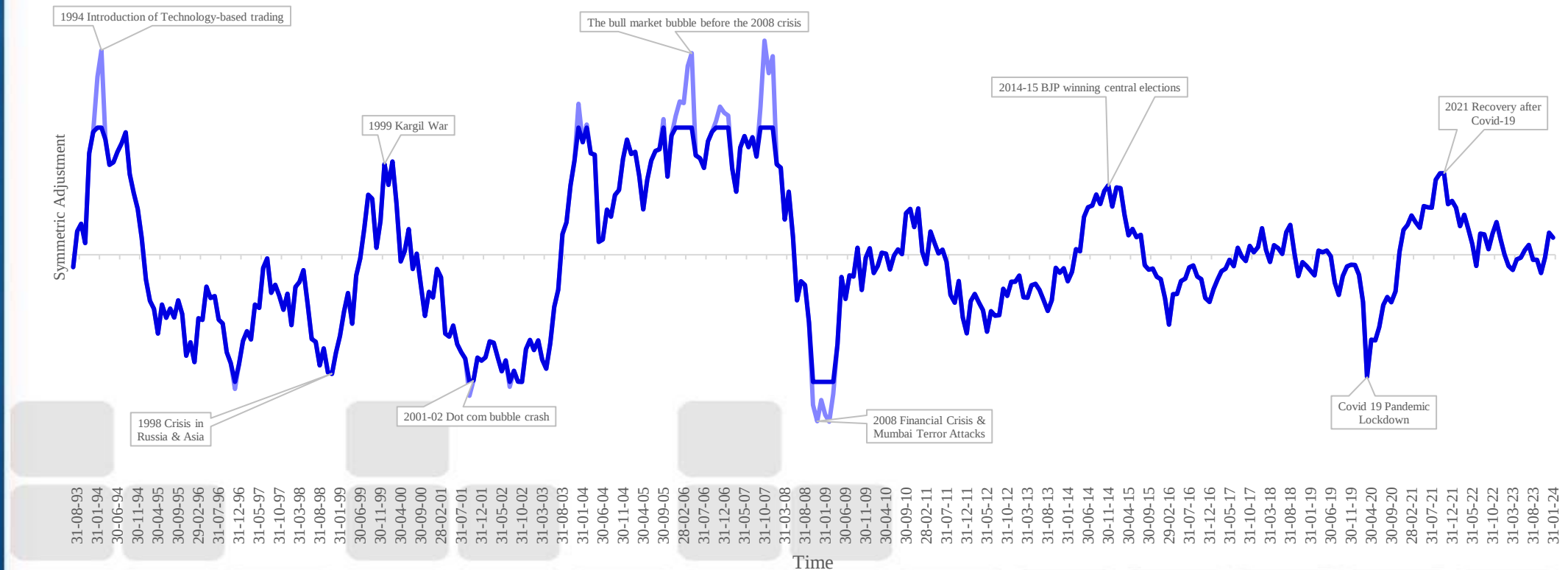
- The formula calculates **short term return** by comparing the current value to the average value and then compares this to the **benchmark expected return**. It attributes half of this market volatility to short-term fluctuations, which is considered as SA (symmetric adjustment) in the equity risk charge factor.
- The actual equity returns of the global equity index, as mentioned in EIOPA, are measured to be at 8% which can be interpreted as a benchmark expected return over 1.5 years (1.5 years being the average duration in the 3 years averaging period).
- Additionally, under Solvency II, SA is capped at +10% and -10%. However, this cap limits the effectiveness to induce any change in behavior among the market participants during the bear and the bull run.

Market Risk – Equity

Symmetric Adjustment

Symmetric Adjustment (SA) – Based on NIFTY 50

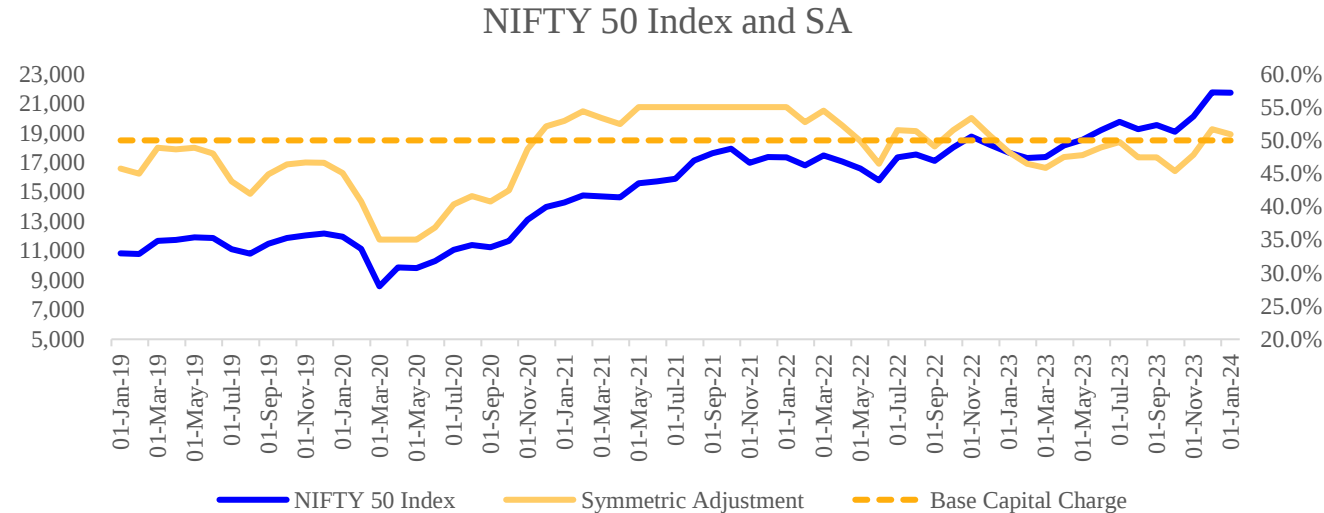
- Benchmark return for NIFTY50 – 18% (calculated as NIFTY 50 return for 1.5 yr holding)
- Below graph shows effectiveness of SA in Indian context (uncapped and capped)



Market Risk – Equity

Symmetric Adjustment

Illustrative example for Symmetric Adjustment (SA) – Based on NIFTY 50

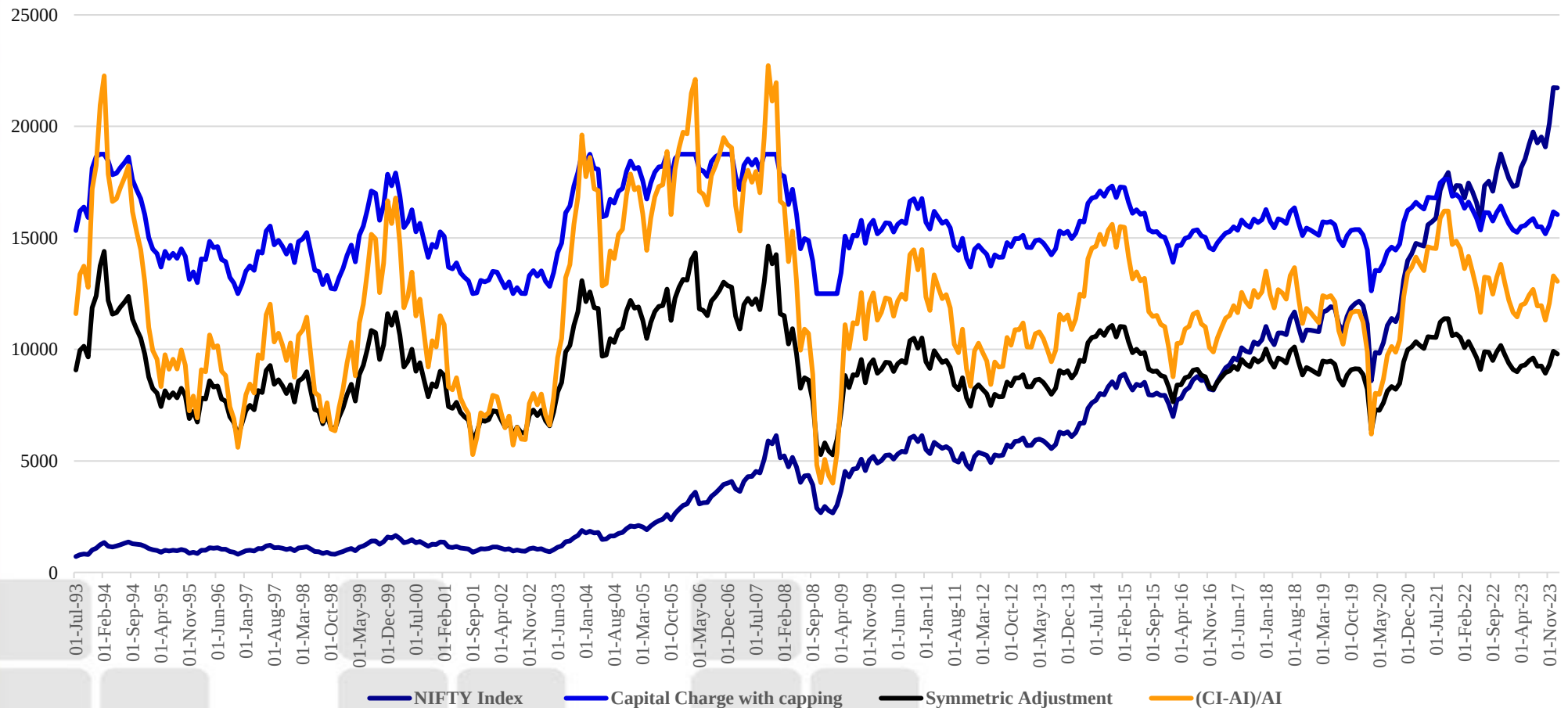


	1 Jan 2019	31 March 2019	31 March 2020	31 March 2021	31 March 2022	31 March 2023
NIFTY Index	10,910	11,669	8,598	14,691	17,465	17,360
Market Value of Investment	10,000	10,696	7,881	13,465	16,008	15,912
Base Capital Charge Factor				50%		
Capital Charge		5,348	3,940	6,733	8,004	7,956
Symmetric Adjustment		1%	-19%	5%	6%	-2%
Revised Capital Charge Factor		51%	31%	55%	56%	48%
Revised Capital Charge		5,418	2,426	7,425	9,011	7,576

Market Risk – Equity

Symmetric Adjustment

Movement of NIFTY 50 with symmetric adjustment



Market Risk – Equity

Amendment in Treatment of Equities in Solvency II



Variables	Charge	Symmetric Equity Adjustment	Description
Type 1 equities	39%	Yes	Equities listed in regulated EEA or OECD markets
Type 2 equities	49%	Yes	Non-OECD listed equities, unlisted equities, private equity, commodities and all other assets where look-through is unavailable regardless of underlying (eg hedge funds without transparency)
Strategic equities	22%	No	Includes equity holdings in subsidiaries of a strategic nature.
Duration-based equities	22%	No	Only applicable for equities held for some types of pension business within a life insurer where it can be demonstrated that the equities can be held for a period consistent with the liability duration. Treatment requires pre-approval from regulator.
Qualifying infrastructure project equities	30%	Yes	Equity in e.g. SPV's with sole purpose of owning, financing, developing or operating an infrastructure asset located in the EEA or OECD (see below for qualification criteria).
Qualifying infrastructure corporate equities	36%	Yes	EEA or OECD infrastructure corporate equities, having majority revenue from owning, financing, developing or operating infrastructure assets.
Qualifying unlisted equities	39%	Yes	A portfolio of unlisted EEA equities meeting prescribed criteria
Long-term equities	22%	No	A subset of EEA equities permanently assigned to a specific line of insurance business and held for at least 5 years

Market Risk – Equity

Conclusion



Key Summary

- **Total Equity Risk Charge:** Base Risk Charge + Symmetric Adjustment (SA).
- **Symmetric Adjustment:** The Symmetric Adjustment captures the pro-cyclicality of equity markets, making equity more expensive during bull markets and cheaper during bear markets.
- **Capping Impact on Symmetric Adjustment:** Capping the Symmetric Adjustment limits its effectiveness in influencing market participant behavior during both bull and bear market conditions.
- **Calibration of unlisted Equities:** Calibration is primarily focused on listed equities, but due to data limitations, appropriate adjustments must be made for unlisted equities.

Spread Risk - Calibration Techniques



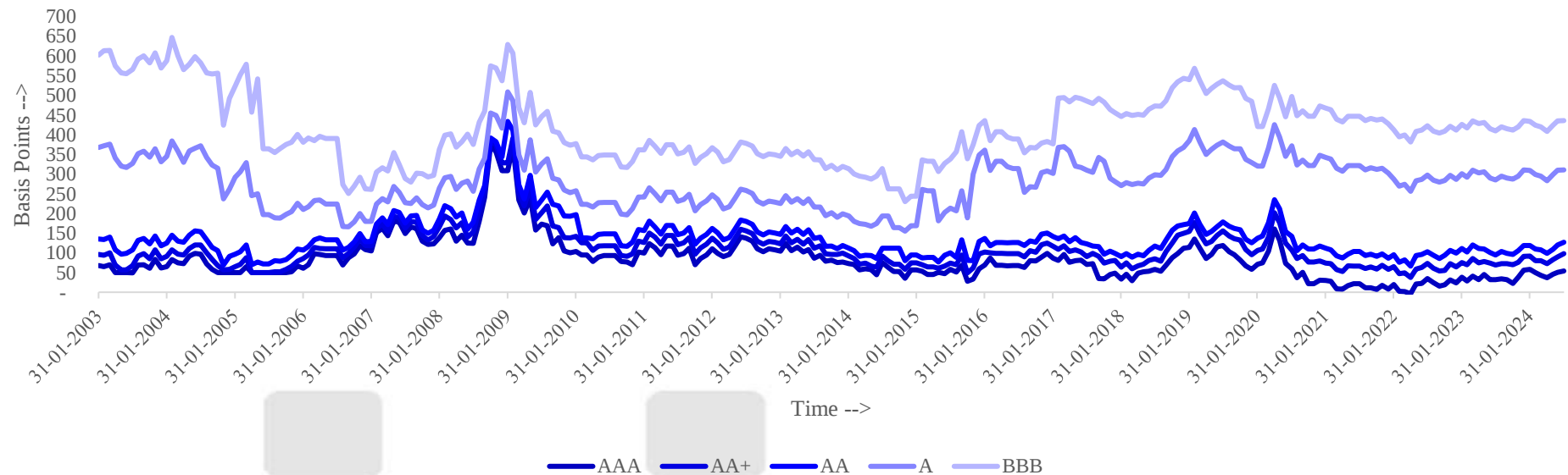
Market Risk – Spread Risk

Introduction

Background

- Spread risk refers to the potential losses that can arise from changes in the value of bond due to fluctuations in the spread between the **asset yield** and the risk-free term structure.
- It captures spread variations **in the yields of** corporate bond influenced by factors like interest rates, economic uncertainty, credit quality, liquidity, and global dynamics.

Spread for 5YR Maturity for AAA, AA+, AA, A and BBB ratings

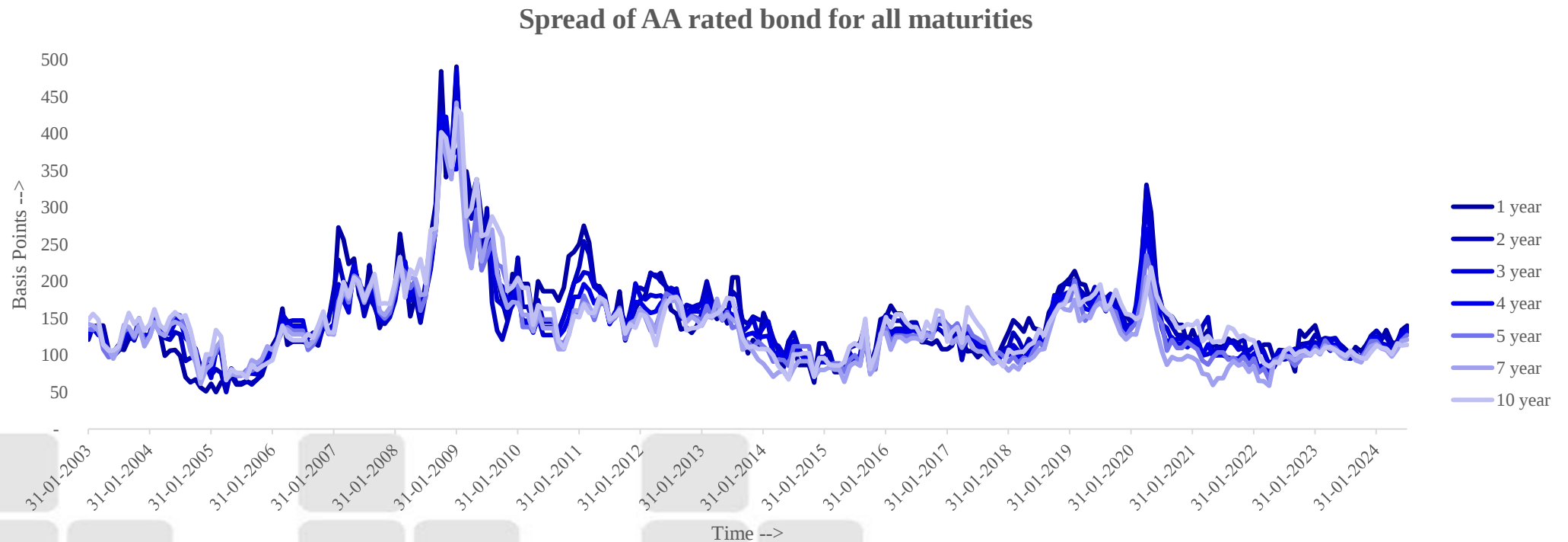


Market Risk – Spread Risk

Introduction

Background

- The spread is influenced by both the credit rating and maturity/**tenure**. Similarly, it is expected that risk charges will vary according to both the maturity and duration.



Market Risk – Spread Risk Risk Charge Calibration Approach

Approach

- By first principle,

Spread Risk Charge = Market Value_{stressed yield} – Market Value_{current yield},
where stressed yield = current yield + spread shock

$$P_{\text{current}} = \sum_{t=1}^T \frac{C}{(1 + Y_{\text{current}})^t} + \frac{F}{(1 + Y_{\text{current}})^T}$$

$$P_{\text{stressed}} = \sum_{t=1}^T \frac{C}{(1 + Y_{\text{stressed}})^t} + \frac{F}{(1 + Y_{\text{stressed}})^T}$$

Where P represents price of bond, C represents coupon payment, F represents maturity amount, Y_{current} represents current yield and Y_{stressed} represents current yield + spread shock

$$\text{Spread Risk Charge} = P_{\text{stressed}} - P_{\text{current}}$$

- It accounts for the full impact of the yield change across all future cash flows.
- The exact calculation requires discounting each cash flow (coupon and principal) at the respective yields (current and stressed). This process can be computationally intensive but delivers a more accurate result.

Market Risk – Spread Risk

Risk Charge Calibration Approach



Approach considered in IRBCF

- An alternative approach, which is easier to implement, relies on the **current price of the bond** and its **modified duration**.
- This approach ignores the convexity effect, which captures the non-linear relationship between interest rate changes and bond values **when the interest change is more than 100 basis points** and can lead to inaccurate results for very large movements in spreads.

$$\text{Change in bond price } (\Delta P) \cong (\text{Change in Yield}) 99.5 \text{ Percentile (VaR)} * \text{Modified Duration} * \text{Current Price of bond}$$

- Modified Duration indicates the change in bond value resulting from a unit change in interest rate yield.
- The change in bond price represents the potential losses in bond value at the 99.5th percentile Value at Risk (VaR).
- To determine the risk charge factor for each rating and maturity, it is crucial to calculate the change in the absolute spread at the 99.5th percentile VaR.

Market Risk – Spread Risk Risk Charge Calibration Approach

Sample Illustration for Spread Risk Charge

Ground-up Approach	
Current Market Value of bond (a)	108.00
Current Yield (b)	7.70%
Spread Shock (c)	0.90%
Revised Yield (d = b+c)	8.60%
Coupon Payment	8.5
Tenure	20Y
Revised Market Value of bond (e)	99.03
Spread Risk Charge (e-a)	8.97

Simplified Approach	
Current Market Value of Bond (a)	108.0
Modified Duration (b)	9.9
Spread Shock (c)	0.90%
Spread Risk Charge (d = a*b*c)	9.58

Comparison of Spread Risk Charge	
using ground-up approach (a)	8.97
using simplified approach (b)	9.58
Difference (a-b)	0.61
Difference (as % of MV of bond) = (-0.61/108)	-0.56%

- The above illustration demonstrates that both the ground-up approach and the simplified approach yield similar results for calculating the spread risk charge.

Market Risk – Spread Risk

Risk Charge Calibration Approach



Approach

- **Objective:** Determine change in absolute spread at the 99.5th percentile level of VaR based on historical data for each rating and maturity.
- **Data Series :**
 - Change in rolling annual spread (absolute terms) are plotted for each day or each month end for each rating and maturity.
- **Parametric vs Non-parametric approach:**
 - (i) **Parametric approach:**
 - Assumes appropriate distributions such as Normal, Lognormal distributions etc
 - Selection of distributions based on Probability-Probability (PP) plots, Q-Q plots, and other goodness-of-fit tests to evaluate and compare the fit of different distributions to the data
 - Select best-fit distribution and calculate the Value-at-Risk (VaR) at the 99.5th percentile using the fitted distribution.
 - (ii) **Non-parametric approach:**
 - Doesn't rely on any assumptions about the underlying distribution of the data.
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 - It is sensitive to data size and tends to be less smooth compared to parametric models.

Market Risk – Spread Risk

Approach in various jurisdictions



Approach in various jurisdictions

Approach in IRBCF is similar to approach considered in EU Solvency II.

Jurisdictions	Risk Charges																
IRBCF (QIS-1)	- No spread Risk charge for central government securities - State government securities and other municipal bodies are classified as rating 1																
	<table><tr><th>Rating</th><th>AAA</th><th>AA+ to AA-</th><th>A+ to A-</th><th>BBB+ to BBB-</th><th>BB+ to BB-</th><th>B+ and Below B+</th><th>Unrated</th></tr><tr><th>Risk Charge</th><td>0.9%</td><td>1.1%</td><td>1.4%</td><td>2.5%</td><td>4.5%</td><td>7.5%</td><td>7.5%</td></tr></table>	Rating	AAA	AA+ to AA-	A+ to A-	BBB+ to BBB-	BB+ to BB-	B+ and Below B+	Unrated	Risk Charge	0.9%	1.1%	1.4%	2.5%	4.5%	7.5%	7.5%
	Rating	AAA	AA+ to AA-	A+ to A-	BBB+ to BBB-	BB+ to BB-	B+ and Below B+	Unrated									
Risk Charge	0.9%	1.1%	1.4%	2.5%	4.5%	7.5%	7.5%										
Economic Capital (India)	- Insurance companies are required to adhere to investment and prudential norms set by the IRDA. - As a result, the spread risk is minimal and is effectively considered negligible.																
NAIC	- The base risk charge factor is determined by the credit rating. Additionally, a bond size factor is applied, which is influenced by the number of bond issuers. - A higher number of bond issuers results in a lower bond size factor, reflecting level of diversification.																
AM Best (Credit Rating Agency)	- Interest rate risk and spread risk charges are determined through multiple simulations generated by the Economic Scenario Generator (ESG). - ESG helps to create probability distributions for the potential movements in the market value of fixed-income securities.																

Market Risk – Spread Risk

Approach in various jurisdictions

Jurisdictions

Risk Charges

Solvency II

- Spread Risk Charges depends on rating and tenure/maturity of bond.
- Spread Risk charges are calculated using modified duration approach.

Spread Risk Charge factor - Solvency II (EU)						
	Rating					
Tenure	0	1	2	3	4	5
1	0.90%	1.10%	1.40%	2.50%	4.50%	7.50%
2	0.90%	1.10%	1.40%	2.50%	4.50%	7.50%
3	0.90%	1.10%	1.40%	2.50%	4.50%	7.50%
4	0.90%	1.10%	1.40%	2.50%	4.50%	7.50%
5	0.90%	1.10%	1.40%	2.50%	4.50%	7.50%
6	0.83%	1.02%	1.28%	2.33%	4.17%	6.95%
7	0.79%	0.96%	1.20%	2.21%	3.93%	6.56%
8	0.75%	0.91%	1.14%	2.13%	3.75%	6.26%
9	0.72%	0.88%	1.09%	2.06%	3.61%	6.03%
10	0.70%	0.85%	1.05%	2.00%	3.50%	5.85%

Market Risk – Spread Risk

Conclusion



Key Summary

- Spread Risk Charge can be calculated using modified duration-based approach.
- In general, spread risk charges tend to decrease as the tenure of a bond increases for a given rating. This may be attributed to the fact that longer-term bonds are relatively less sensitive to short-term market fluctuations leading to lower volatility in higher tenures in stressed scenario.
- Spread risk charges should increase as the credit rating of the bond decreases for a fixed maturity. This may be attributed to less liquidity of lower rated bonds in the market.

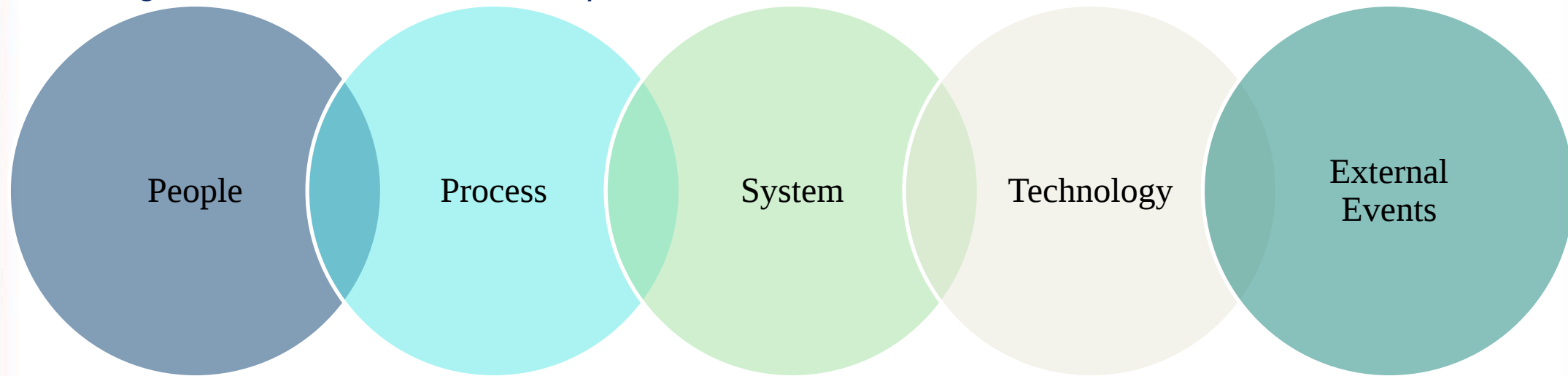
Operational Risk



Operational Risk under risk-based capital regime



Operational risk under the Risk-Based Capital (RBC) framework refers to the risk of financial loss due to failures in internal processes, systems, people, or from external events. It requires insurers and financial institutions to hold capital proportional to the level of operational risk they face, ensuring sufficient buffers to absorb potential losses.



The framework requires companies to hold capital based on losses from 1 in 200 years event, ensuring that the company can continue operations even after significant operational disruptions.

Capital Charge for Operational Risk



Capital Charge for Operational Risk



Difficult to quantify

Data Gaps: Limited historical loss data makes it difficult to accurately estimate potential operational risk capital.

Model Complexity: The diversity of operational risks and the need for advanced statistical models (e.g., EVT, Monte Carlo) increases complexity.

Subjectivity in Risk Assessment: Variability in risk identification and classification can lead to inconsistent quantification across institutions.

Solution

- Operational risk capital can be estimated as a percentage of Gross Written Premium (GWP), reflecting the scale of the business and associated risks.
- Best Estimate Liabilities (BEL) and growth in GWP help adjust the capital charge, accounting for potential future losses tied to business expansion and liability changes.

Operational risk charge in major jurisdictions is defined using GWP, BEL or GWP growth

Capital requirement for Operational Risk (as per RBC - QIS1)



Capital requirement for Operational Risk (as per RBC - QIS1)



Indian Risk Based Capital Requirement (IRBCR) is calculated as:

$$IRBCR_{op} = \text{Min} (30\% \times IRBCR_{MID}, Cap_{op})$$

- $IRBCR_{MID}$ is the diversified IRBCR for
 - ☐ M - Market Risk
 - ☐ I - Non-Life Insurance Risk
 - ☐ D - Counterparty Default Risk
- Cap_{op} is Cap_{op_NL} for Non-Life insurance.
 Cap_{op_NL} is the exposure-based Capital Requirement for Operational Risk.

Capital requirement for Operational Risk (as per RBC - QIS1)

Cap_{op_NL}

$$= \text{Max} \left(\text{OpPremium}_{Non-Life}, \text{OpLiability}_{Non-Life} \right) + \text{OP_Premium_Growth}_{Non-Life}$$

$$\text{Op_Premium}_{Non-Life} = 2.75\% \times (\text{GWP of Non-life business during the year end})$$

$$\text{Op_Liability}_{Non-Life} = 2.75\% \times (\text{BEL} - \text{NLP}_t + \text{BEL} - \text{NLP}_{t-1} + \text{BEL} - \text{NLP}_{t-2})/3$$

Gross best estimate liability
at the valuation date (t), (t-1), (t-2) years respectively

$$\text{OP_Premium_Growth}_{Non-Life} = 2.75\% \times \text{Max}(0, \text{NLP}_t - (1 + 20\%) \text{NLP}_{t-1})$$

NLP_t & NLP_{t-1} : Gross written premium of Non-Life insurance business during current valuation year and previous valuation year, respectively.

Capital Charge for Operational Risk as per various Jurisdictions



Capital Charge for Operational Risk as per various Jurisdictions (ASIA)

Operational risk capital for each fund as the higher of

- 4% of $GP1$ +
 $Max (0.4\% \times ((GP1 - GP0) - 20\% \times GP0))$
- 0.5% of Gross policy liabilities

Singapore

- $GP1$: GWP for 12 months preceding valuation
- $GP0$: GWP for 12 months preceding $GP1$

Hong Kong

Operational risk capital for General Insurers
 $= 2.75\%$ of $max (GWP, Policy Reserve + Claims Reserve)$

Capital Charge for Operational Risk as per various Jurisdictions (ASIA contd.)

Operational risk capital for General Insurers

$$= 1\% \text{ of } GWP$$

Thailand

- *GWP* : GWP for 12 months preceding reporting date
- *GCE* : Gross Central Estimate liabilities at the reporting date

Malaysia

Operational risk capital charge for General Insurers:

$$ORCC = \text{Max} [2.75\% \times GWP, 2.75\% \times GCE]$$

Capital Charge for Operational Risk as per various Jurisdictions (EU & US)

Operational Risk Capital Charge is minimum of

- 30% of Basic SCR
- 3% of $\text{Max} \left(\text{GEP}(n) \times \text{Max} \left(1, 2 - 1.2 \times \frac{\text{GEP}(n-1)}{\text{GEP}(n)} \right), \text{Max}(0, \text{Tech prov}) \right)$

European Union

$\text{GEP}(n)$ & $\text{GEP}(n-1)$: Gross Earned Premium for 12 months preceding valuation & 12 months preceding 'n' respectively

United States

Operational Risk Capital Charge
 $= 3\% \text{ of } RBC$

No diversification benefit (with other Risk Charges)

Standard formula SCR: Diversification

- Overall SCR is calculated as

$$SCR = BSCR + Adj + SCR_{Op}$$

- Basic Solvency Capital Requirement is

$$BSCR = \sqrt{\sum_{i,j} Corr_{i,j} \times SCR_i \times SCR_j}$$

- $Corr_{i,j}$ entries in a pre-specified correlation matrix
- SCR_i and SCR_j capital requirements for individual SCR risks according to corresponding rows and columns of $Corr_{i,j}$
- SCR_i calculated in modular fashion, i.e. like $BSCR$ but with different correlations
- SCR_{Op} capital requirement for operational risk
- Adj adjustment for risk absorbing effect of technical provisions and deferred taxes

Interest Rate Risk – Calibration Techniques



Market Risk – Interest rate Risk

Introduction



Background

- Under IRBCF principles, all assets and liabilities are measured at fair value
 - ⇒ Fixed income assets and technical liabilities are valued based on market-driven interest rates
 - ⇒ Sensitive towards changes in interest rate fluctuations
- Interest rate risk stems from mismatch between fixed income assets and technical liabilities in terms of:
 - (i) Duration
 - (ii) Timing of cashflows as well as
 - (iii) Value
- Interest rate risk can result from both upward and downward stress scenarios, depending on the mismatch
- Interest arises from both risk free and spread components
 - ⇒ This module looks at only risk-free rate component

Market Risk – Interest rate Risk

Approaches in Various Jurisdictions

Approaches in various jurisdictions

Jurisdiction Approach

IRBCF (QIS-1) • Δ NAV approach

- B/s is restated by revaluing assets and liabilities based on stressed interest rate
 - Both for upward and downward stress scenarios, where:

$$\text{Stressed Interest Rate} = \text{Current Interest Rate} * \text{Prescribed Stress Factor}$$

- The capital charge is the largest NAV drop between the two scenarios compared to the unstressed scenario

Example:

	Unstressed Scenario	Interest Rate Upward Stress Scenario	Interest Rate Downward Stress Scenario
Assets	100	95	110
Liabilities	80	78	84
NAV	20	17	26
Delta NAV		-3 (=17-20)	6 (=26-20)
Risk Charge	3 (highest drop observed between the two scenarios)		

- Different stress factors are applied based on maturity for both upward and downward scenarios

Solvency II • Same as in IRBCF

US NAIC • Not applied since assets are valued on book value basis and liabilities are not discounted

Market Risk – Interest rate Risk

Preliminary Risk Charge

Significance of upward and downward stress scenarios

- Following are the results of interest rate stresses under different scenarios around duration mismatch

Scenario #1: Duration of Assets < Duration of Liabilities

	Average Duration in Yrs	Valuation @No Stress	Valuation @Upward Stress	Valuation @Downward Stress
Assets	2	900	826	948
Liabilities	4	600	524	659
NAV		300	302	289
Delta NAV			2	-14

Risk Charge arises under **Downward Stress** Scenario

Scenario #2: Duration of Assets > Duration of Liabilities

	Average Duration in Yrs	Valuation @No Stress	Valuation @Upward Stress	Valuation @Downward Stress
Assets	5	900	773	1003
Liabilities	4	600	524	659
NAV		300	249	344
Delta NAV			-51	95

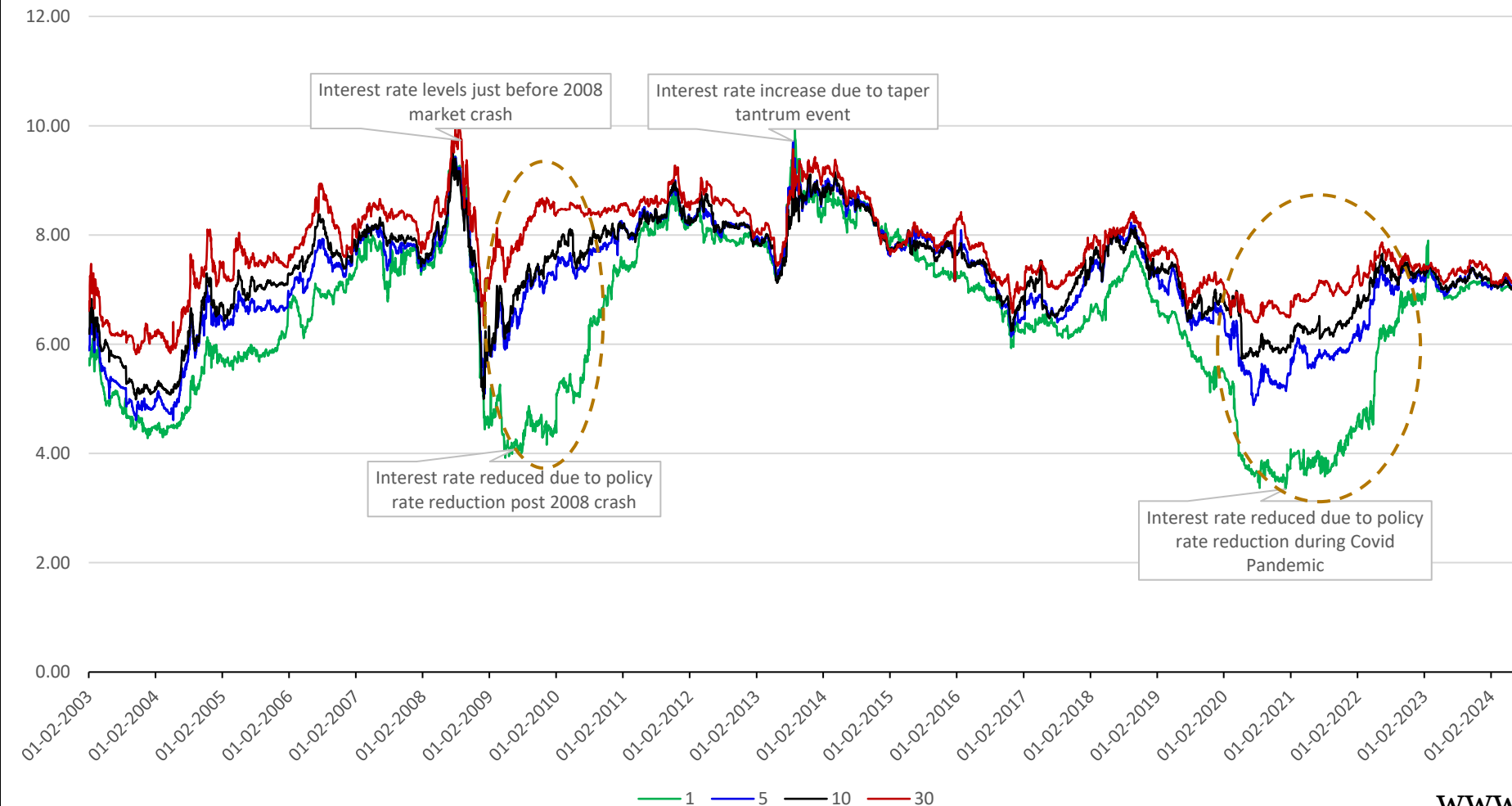
Risk Charge arises under **Upward Stress** Scenario

Market Risk – Interest rate Risk

Preliminary Analysis

Brief overview of historical term structure

Time Series of interest rates (%) across maturity in years



Interest rates due to RBI's intervention post 2008 market crash and during 2020 Covid Pandemic

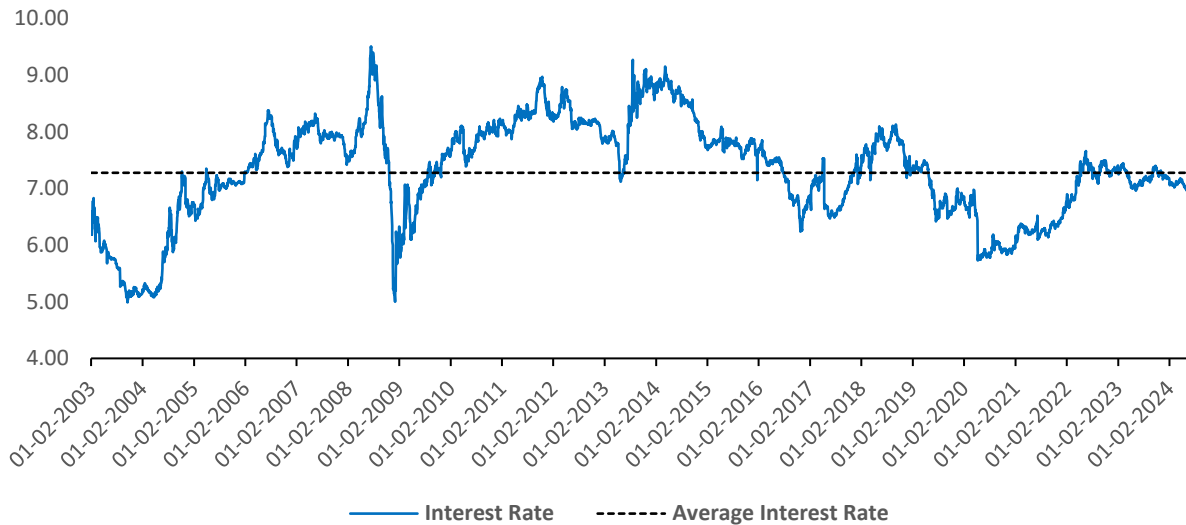
Differential market response to short-term versus long-term bonds during periods of stress

Market Risk – Interest rate Risk

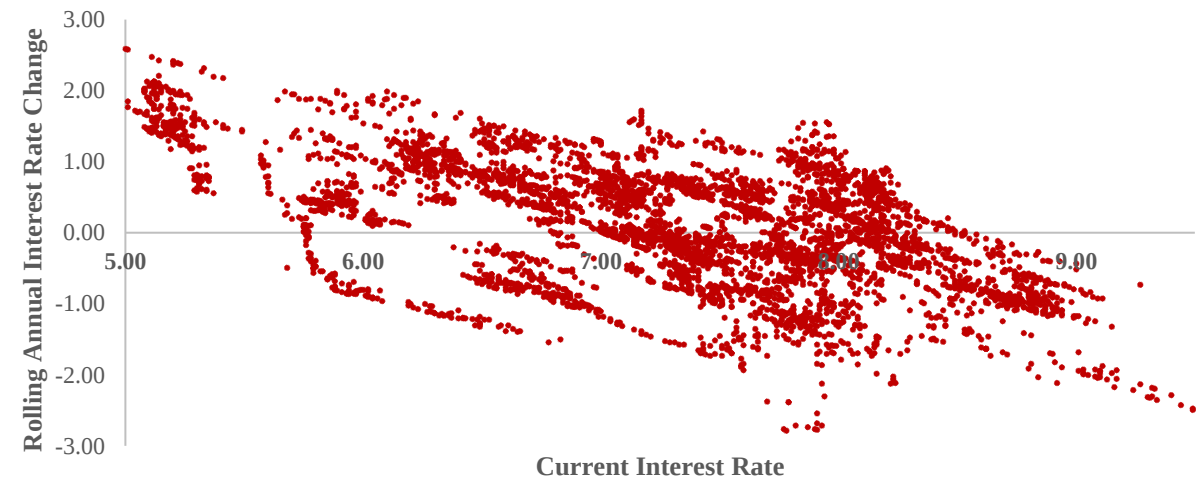
Preliminary Analysis

Study for presence of mean reversion behavior

Time Series of interest rates (%) for 10yr maturity



Scatter plot of “Rolling annual interest rate return” vs ‘Current Interest Rate’ on daily basis for 10yr maturity



Interest rate has consistently remained within their respective bounds over the period

Low current interest rate levels
⇒ High annual changes
High current interest rate levels
⇒ Low annual changes

Presence of Mean Reversion

Market Risk – Interest rate Risk

Preliminary Analysis

Testing for mean reversion behavior using Augmented Dickey Fuller (ADF) test

Regression is performed with the following setup:

$$\Delta r_t = c + \alpha r_t + \varepsilon_t$$

Where:

r_t is the current interest rate at time t and

Δr_t is defined as $r_{t+1yr} - r_t$

If $\hat{\alpha} < 0$ & associated $p - value < 0.05$
 $\Rightarrow$ “**Mean reversion is significant**”

Following are the results across different maturities:

Maturity in yrs	$\hat{c}$	$\hat{\alpha}$	$p - value$	Test Remarks
0.5	6.36	-0.52	0.00 ($<<0.05$)	Mean Reversion is significant
1	6.49	-0.53	0.00 ($<<0.05$)	Mean Reversion is significant
2	6.69	-0.55	0.00 ($<<0.05$)	Mean Reversion is significant
3	6.89	-0.58	0.00 ($<<0.05$)	Mean Reversion is significant
4	7.05	-0.61	0.00 ($<<0.05$)	Mean Reversion is significant
5	7.18	-0.62	0.00 ($<<0.05$)	Mean Reversion is significant
7	7.35	-0.63	0.00 ($<<0.05$)	Mean Reversion is significant
10	7.34	-0.62	0.00 ($<<0.05$)	Mean Reversion is significant
15	7.65	-0.63	0.00 ($<<0.05$)	Mean Reversion is significant
30	7.78	-0.60	0.00 ($<<0.05$)	Mean Reversion is significant

Market Risk – Interest rate Risk

Preliminary Analysis

Implications of mean reversion behavior

Presence of Mean Reversion $\Rightarrow$ Volatility depends on Current Interest Rate

$\Rightarrow$ Models that do not incorporate dependency will results in inconsistent results

Example: Consider a simple non-parametric method of estimation of $VaR_{99.5}$ (for maturity 10yrs)

Under this method, we select the rate stress as the 99.5th percentile point of rolling annual rate changes observed from the daily data using two different approaches.

- (i) A single risk factor independent of the current interest rate based on all data points observed from 2003 to 2024
- (ii) Separate risk charge factors by cohorts defined based on the current interest rate levels

S. No.	Current Level of Interest Rate	Average interest rate observed (i_{base})	0.5 th percentile of Rolling Annual Price Returns (Price Stress)
1	≤ 5.93	5.51	-20.6%
2	5.93 to 6.51	6.25	-16.4%
3	6.51 to 6.85	6.68	-13.1%
4	6.85 to 7.15	7.03	-12.5%
5	7.15 to 7.4	7.28	-13.8%
6	7.4 to 7.64	7.52	-11.2%
7	7.64 to 7.86	7.76	-11.4%
8	7.86 to 8.06	7.96	-13.1%
9	8.06 to 8.34	8.19	-7.8%
10	>8.34	8.69	-1.6%

Method (i): Single factor independent of current interest rate	
Rate Stress (Rate Var)	Implied Price Stress
140.3%	-18.8%
	-20.9%
	-22.1%
	-23.0%
	-23.7%
	-24.3%
	-24.9%
	-25.4%
	-26.0%
	-27.2%

Method (ii): Separate factors dependent on current interest rate	
Rate Stress (Rate Var)	Implied Price Stress
147.8%	-21.9%
131.5%	-16.8%
123.0%	-13.3%
120.4%	-12.4%
122.4%	-14.0%
117.2%	-11.3%
116.7%	-11.3%
119.2%	-13.1%
110.8%	-7.8%
102.0%	-1.6%

Price is a simple transformation of interest rate...
 $\Rightarrow$ The results of price stress derived from the analysis of direct price changes and those implied from the rate changes should converge, which is not the case in method (i)

Rate stress is into implied price stress as: $Implied\ Price\ Stress = \frac{(1+i_{base} \cdot Rate\ Stress)^{-10}}{(1+i_{base})^{-10}} - 1$

Market Risk – Interest rate Risk

Risk Charge Calibration Approach



Fundamentals of calibration techniques

- **Objective:** Calibrate the interest rate stress factor that reflect a 99.5% confidence level over a one-year horizon both in case of upward and downward stress scenarios
- **Data:** Time series of interest rates and corresponding rolling annual rate returns of rates on daily basis across different maturities
 - Based on daily published ZCYC curves by Financial Benchmarks India Pvt Ltd (FIBL) from 2003 to 2024
- **Calibration techniques explored:**

S No	Model Description	Methodology	Provisions to account for Mean Reversion
1	Non-parametric (independent of current interest rate)	Non-parametric	No
2	Non-parametric (dependent of current interest rate)	Non-parametric	Yes
3	Vasicek	Parametric	Yes
4	Cox-Ingersoll-Ross (CIR)	Parametric	Yes
5	Principle Component Analysis	Parametric	No

- **Diversification across different maturities:** The factors calibrated for each maturity are adjusted to account for diversification benefits among them

Market Risk – Interest rate Risk

Risk Charge Calibration Approach

Non-parametric calibration techniques

1) Non-parametric (independent of current interest rate):

- A rate stress factor independent of the current interest rate is calculated for each maturity separately
- The rate stresses are calibrated as the 99.5th percentile and 0.5th percentile points rolling annual return of interest observed from the daily data

Stress Scenario \ Maturity in Yrs	1	5	10
Upward Stress	173%	141%	140%
Downward Stress	46%	72%	75%

2) Non-parametric cohort based (dependent on current interest rate):

- In order to implicitly create dependency on currently interest level, the available daily data is divided in 10 equal cohorts depending on the current interest rates
- Rate stress is calibrated individually for each cohort using the percentile approach discussed above

Definition of cohort in terms of current interest rate			
Cohort \ Maturity in yrs	1	5	10
1	3.35 to 4.35	4.61 to 5.51	4.99 to 5.93
2	4.35 to 4.82	5.51 to 6.26	5.93 to 6.51
3	4.82 to 5.69	6.26 to 6.61	6.51 to 6.85
4	5.69 to 6.21	6.61 to 6.93	6.85 to 7.15
5	6.21 to 6.59	6.93 to 7.24	7.15 to 7.4
6	6.59 to 6.99	7.24 to 7.49	7.4 to 7.64
7	6.99 to 7.39	7.49 to 7.79	7.64 to 7.86
8	7.39 to 7.82	7.79 to 8.01	7.86 to 8.06
9	7.82 to 8.21	8.01 to 8.35	8.06 to 8.34
10	8.21 to 10.15	8.35 to 9.72	8.34 to 9.51

Stress Factors under Upward Scenario			
Cohort \ Maturity in yrs	1	5	10
1	179.3%	144.3%	147.8%
2	173.2%	131.3%	131.5%
3	162.3%	125.5%	123.0%
4	141.5%	122.3%	120.4%
5	129.6%	117.4%	122.4%
6	134.1%	125.9%	117.2%
7	132.4%	124.5%	116.7%
8	123.3%	117.4%	119.2%
9	123.2%	113.2%	110.8%
10	99.2%	100.9%	102.0%

Stress Factors under Downward Scenario			
Cohort \ Maturity in yrs	1	5	10
1	89.2%	86.2%	85.8%
2	80.8%	79.0%	80.2%
3	61.7%	75.9%	79.1%
4	58.8%	76.1%	81.9%
5	58.9%	77.9%	78.9%
6	61.9%	75.7%	75.4%
7	61.1%	70.6%	67.5%
8	51.4%	74.2%	65.6%
9	50.5%	73.4%	74.7%
10	43.4%	68.1%	74.2%

Market Risk – Interest rate Risk Risk Charge Calibration Approach

Parametric mean reversion short rate models

Item	Vasicek	Cox Ingersoll Ross (CIR)s
Stochastic process assumed	$dr = \alpha(\mu - r_t) + \sigma dW_t$	$dr = \alpha(\mu - r_t) + \sqrt{r_t}\sigma dW_t$
Description	μ indicated long term mean of interest rate, α represents the speed of mean reversion, σ represents instantaneous volatility and W_t represent Brownian motion/Weiner process	
Distribution of future interest rate	$r_{t+1} r_t \sim r_t e^{-\alpha} + (1 - e^{-\alpha}) + \frac{\sigma}{\sqrt{2\alpha}} \text{sqrt}(1 - e^{-2\alpha})Z$ Where: $Z \sim N(0,1)$	$r_{t+1} r_t \sim \frac{1}{2C} \chi_d^2(\lambda)$ Where: $C = \frac{2\alpha}{\sigma^2(1 - e^{-\alpha})}$, $d = \frac{4\alpha\mu}{\sigma^2}$ and $\lambda = \frac{4\alpha}{\mu^2(1 - e^{-\alpha})} e^{-\alpha} r_s$
Parameter Estimation Method	Maximum Likelihood Estimation (MLE)	Maximum Likelihood Estimation (MLE)

Market Risk – Interest rate Risk Risk Charge Calibration Approach



Parametric mean reversion short rate models continue...

Item	Vasicek	Cox Ingersoll Ross (CIR)s
Derivation of Stress Factor	r_{t+1} corresponding to the 99.5th and 0.5th percentiles are calculated by assuming r_t equals the average interest rate for each cohort, as defined earlier, based on the distribution assumptions for the upward and downward stress scenarios, respectively. $\text{Final Stress Factor (Upward)} = \hat{r}_{t+1@99.5\%} / r_t$ $\text{Final Stress Factor (Downward)} = \hat{r}_{t+1@0.5\%} / r_t$	

Parameter estimates of Vasicek model across different cohorts for each maturity

Parameter / Maturity in yrs	1	5	10
$\hat{\alpha}$	0.71	0.69	0.77
$\hat{\mu}$	6.7	7.3	7.5
$\hat{\sigma}$	1.7	1.1	1.0

Parameter estimates of Vasicek model across different cohorts for each maturity

Parameter / Maturity in yrs	1	5	10
$\hat{\alpha}$	0.51	0.50	0.54
$\hat{\mu}$	6.86	7.34	7.46
$\hat{\sigma}$	0.47	0.30	0.26

Upward Scenario Interest Rate Stress Factors based on Vasicek model

Cohort \ Maturity in yrs	1	5	10
1	217.8%	161.3%	151.7%
2	192.9%	146.6%	139.3%
3	173.0%	138.1%	133.2%
4	159.6%	134.2%	128.9%
5	151.5%	130.0%	126.0%
6	144.9%	127.0%	123.5%
7	140.1%	124.1%	121.1%
8	135.4%	121.9%	119.3%
9	131.0%	119.5%	117.2%
10	124.9%	115.2%	113.1%

Upward Scenario Interest Rate Stress Factors based on CIR model

Cohort \ Maturity in yrs	1	5	10
1	188.5%	147.1%	139.4%
2	172.0%	136.9%	130.8%
3	158.7%	131.0%	126.6%
4	149.7%	128.3%	123.5%
5	144.2%	125.3%	121.5%
6	139.7%	123.2%	119.7%
7	136.4%	121.2%	118.0%
8	133.1%	119.7%	116.7%
9	130.2%	118.0%	115.3%
10	125.9%	114.9%	112.3%

Market Risk – Interest rate Risk

Risk Charge Calibration Approach



Principle Component Analysis (PCA)

- Theoretically, the eigenvectors obtained from the covariance matrix of a dataset reveal the directions of a new feature space with desirable properties, where the new dimensions are independent and uncorrelated. Specifically, when the eigenvector matrix/rotation matrix is multiplied by the original dataset, it transforms the data into a new dimensional space in which the columns of the resulting dataset are uncorrelated. Each column in this new space is known as a principal component (PC) as described, and these components are expected to capture specific characteristics of the original dataset.

$$[\textit{Eigen or Rotation Vectors}] * [\textit{Original Dataset}] = [\textit{PCs in New Dimensional Space}]$$

Furthermore, the eigenvalues associated with each eigenvector (or rotation vector) indicate the variance attributed to their respective PCs.

- In the context of interest rate risk analysis, our goal is to derive principal components (PCs) based on the rolling annual percentage rate changes. To achieve this, we calculate the rotation/eigenvectors and their corresponding variances/eigenvalues using the variance-covariance matrix of the dataset, which consists of rolling annual percentage rate changes on daily basis. To facilitate further analysis, the principal components (PCs) are derived such that their mean is zero. To achieve this, the rolling annual percentage rate changes used in the dataset are centered around zero.

Market Risk – Interest rate Risk

Risk Charge Calibration Approach

Principle Component Analysis (PCA) continued...

Retention of essential PCs:

Rotation/Eigen Vectors										
Tenure / PC	PC1	PC2	PC3	PC4	PC5	PC6	PC7	PC8	PC9	PC10
0.5	0.49	-0.51	-0.45	-0.16	-0.29	0.42	-0.03	0.05	-0.05	0.03
1	0.47	-0.35	-0.02	0.27	0.22	-0.72	0.11	-0.08	0.01	-0.03
2	0.38	-0.05	0.51	0.01	0.56	0.37	-0.33	0.18	0.00	0.03
3	0.32	0.14	0.40	-0.24	-0.22	0.10	0.56	-0.25	0.43	-0.21
4	0.29	0.25	0.23	-0.23	-0.33	-0.18	-0.09	-0.02	-0.31	0.71
5	0.26	0.30	0.09	0.00	-0.26	-0.07	-0.13	0.12	-0.57	-0.64
7	0.22	0.33	-0.19	-0.03	-0.21	-0.19	-0.53	0.24	0.62	-0.08
10	0.21	0.34	-0.14	0.82	-0.08	0.29	0.18	-0.09	0.01	0.16
15	0.16	0.32	-0.37	-0.25	0.37	0.03	-0.15	-0.71	-0.07	-0.03
30	0.14	0.34	-0.36	-0.25	0.37	-0.04	0.46	0.56	-0.05	0.08

Importance order and variance statistics of PCs										
PC	PC1	PC2	PC3	PC4	PC5	PC6	PC7	PC8	PC9	PC10
Standard Deviation/Eigen Value	0.51	0.18	0.05	0.03	0.02	0.02	0.02	0.01	0.01	0.01
Variance	0.26	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Proportion of Variation	87.8%	10.6%	0.8%	0.3%	0.2%	0.1%	0.1%	0.1%	0.1%	0.0%
Cumulative Proportion of Variation Explained	87.8%	98.4%	99.1%	99.4%	99.6%	99.8%	99.8%	99.9%	100.0%	100.0%

- First three PCs explain about 99.1% of the total variance and therefore, they are retained for further analysis

Market Risk – Interest rate Risk

Risk Charge Calibration Approach

Principle Component Analysis (PCA) continued...

Regression of annual changes with PCs:

- Annual percentage changes across different maturities are regressed against the three PCs.

Maturity (i)	Summary of regression between the annual percentage changes an PCs across maturities				
	Intercept	Coefficient of PC1	Coefficient of PC2	Coefficient of PC3	Standard error of residuals
	($\hat{c}$)	(β_1)	(β_2)	(β_3)	SE
0.5	0.06	0.49	-0.51	-0.45	0.01
1	0.05	0.47	-0.35	-0.02	0.02
2	0.04	0.38	-0.05	0.51	0.02
3	0.03	0.32	0.14	0.40	0.01
4	0.03	0.29	0.25	0.23	0.01
5	0.03	0.26	0.30	0.09	0.01
7	0.02	0.22	0.33	-0.19	0.01
10	0.02	0.21	0.34	-0.14	0.02
15	0.02	0.16	0.32	-0.37	0.02
30	0.01	0.14	0.34	-0.36	0.02

Market Risk – Interest rate Risk Risk Charge Calibration Approach



Principle Component Analysis (PCA) continued...

Derivation of stress factor based on the regression coefficient:

$$\text{Rate VaR}_i = \hat{c}_i + \text{sqrt}[\beta_{1i}^2 \text{Var}(PC1) + \beta_{2i}^2 \text{Var}(PC2) + \beta_{3i}^2 \text{Var}(PC3) + SE_i^2] * z_\alpha$$

Where

$\hat{c}_i$ is the intercept estimated in the regression model of maturity i ,

β_{ji} is the coefficient estimate of j th PC in the regression model of maturity i ,

$\hat{SE}_i$ is the standard error estimated in regression model of maturity i ,

$\text{Var}(PC_j)$ = square of the eigen value associated with j th PC,

and z_α represents the z-score corresponding to standard normal distribution for confidence level α .

The resulting stress factor can be calculated by adding 1 to the rate VaR.

Market Risk – Interest rate Risk Risk Charge Calibration Approach

Principle Component Analysis (PCA) continued...

Risk charge factors derived:

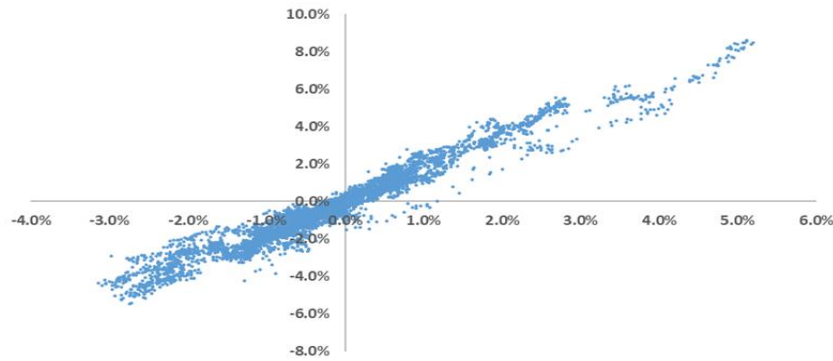
Stress Scenario	1	5	10
Upward Stress	169%	140%	135%
Downward Stress	42%	66%	70%

Results are very similar to the Non-parametric (independent of current interest rate) method. This is due to the fact that (i) both models do not assume dependency on current level of interest rate and (ii) PCs are able to explain 99.1% of the variability of interest rate changes.

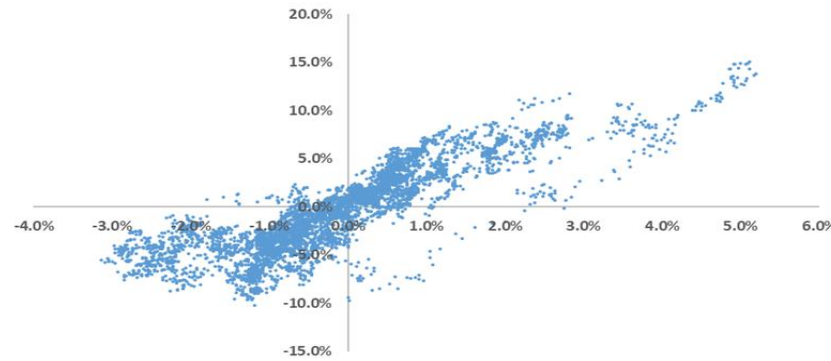
Market Risk – Interest rate Risk Risk Charge Calibration Approach

Diversification benefits across maturities

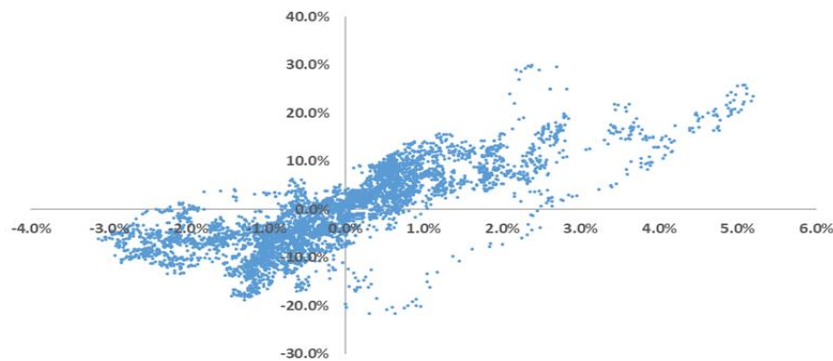
Scatter Plot of Price Changes (1Y vs 2Y)



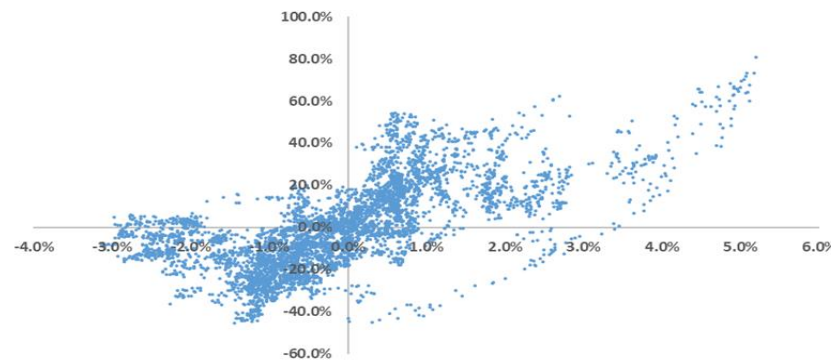
Scatter Plot of Price Changes (1Y vs 5Y)



Scatter Plot of Price Changes (1Y vs 10Y)



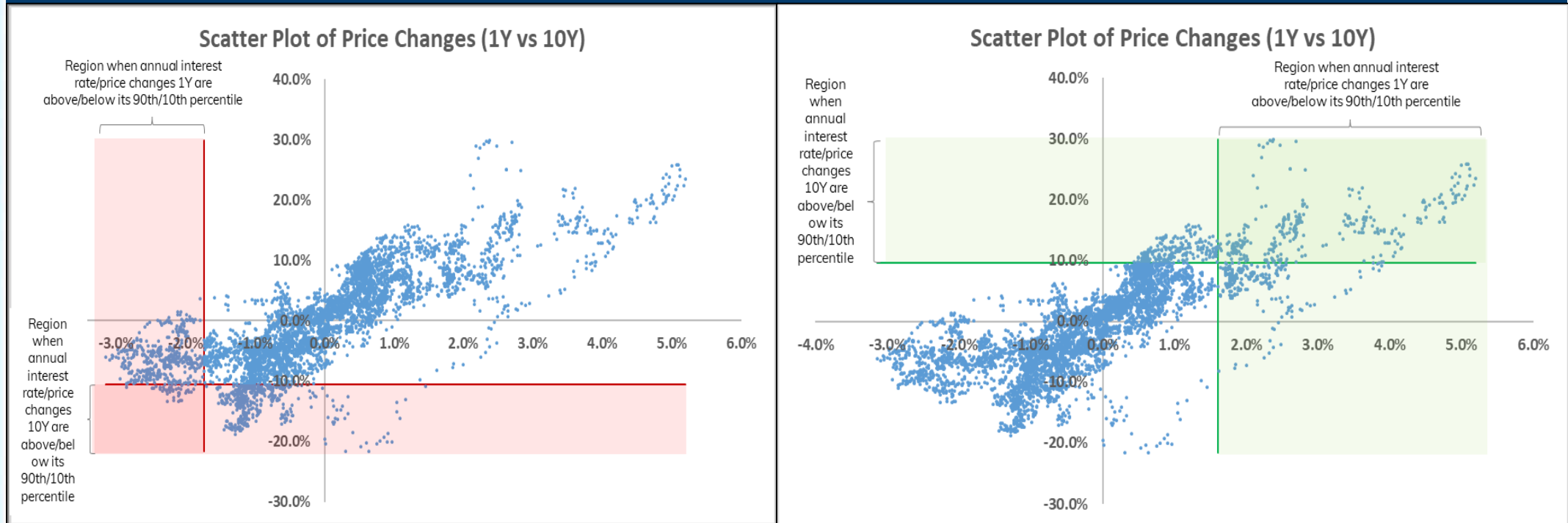
Scatter Plot of Price Changes (1Y vs 30Y)



The correlation clearly decreases as the difference between maturities increases

Market Risk – Interest rate Risk Risk Charge Calibration Approach

Diversification benefits across maturities continue...



Correlation in the tail scenarios appears to be lower than in normal scenarios, which is particularly relevant in the context of RBC.

Market Risk – Interest rate Risk Risk Charge Calibration Approach

Diversification benefits across maturities continue...

Pearson Linear Correlation of Annual Price Changes based on overall level			
Maturity	1	5	10
1	1.00	0.82	0.74
5	0.82	1.00	0.97
10	0.74	0.97	1.00

Pearson Linear Correlation of Annual Price Changes [among the data points given the price decline below 10th percentile			
Maturity	1	5	10
1	1.00	0.08	0.33
5	0.08	1.00	0.70
10	0.33	0.70	1.00

Pearson Linear Correlation of Annual Price Changes [among the data points given the price decline is beyond 90th percentile			
Maturity	1	5	10
1	1.00	-0.33	-0.51
5	-0.33	1.00	0.70
10	-0.51	0.70	1.00

Adjustments to base stress factors to accommodate for the diversification:

- To simplify the prescription, the diversification benefit is implicitly accounted for by reducing the derived stress factors to reflect the expected diversification benefit based on the average industry profile. This can be done using below setup.

$$\sum_i \text{Delta NAV}_i @ \text{Adjusted Stress Factors}$$

$$= \text{sqrt} \left(\sum_{i,j} \rho_{ij} * \text{Delta NAV}_i @ \text{Stress Factors}^{\frac{w}{o} \text{diversification}} * \text{Delta NAV}_j @ \text{Stress Factors}^{\frac{w}{o} \text{diversification}} \right)$$

Where $\text{Adjusted Stress Factor}_i = (\text{Stress Factor w/o diversification}_i - 1) * k + 1$, for a constant k while i indicates maturity and ρ_{ij} is the correlation assumed between the price change corresponding to maturity i and j.

- As a conservative approach, the correlations corresponding to the overall data may be assumed. Approx... diversification expected is around 2% to 3% across the industry.

Market Risk – Interest rate Risk

Other Key Aspects of Calibration



Other Key Aspects

- Parameterization based on the overall characteristics and shape of the current term structure (rather than one factor model which is currently implemented)
 - Increases complexity
 - Based on different check, the volatility primarily depends on the current interest rate of the same maturity only
- Diversification with other market risk particularly spread risk is very critical

Risk margin

Risk Margin in Actuarial Pricing and Reserving

Risk margin in risk-based capital refers to the additional buffer required to ensure that an insurer can meet its future liabilities, accounting for uncertainties in risk estimates.



$$\text{Technical Provisions} = \text{Best Estimate Liability} + \text{Risk Margin}$$



Underwriting Risk



Operational Risk



Reinsurance Credit Risk



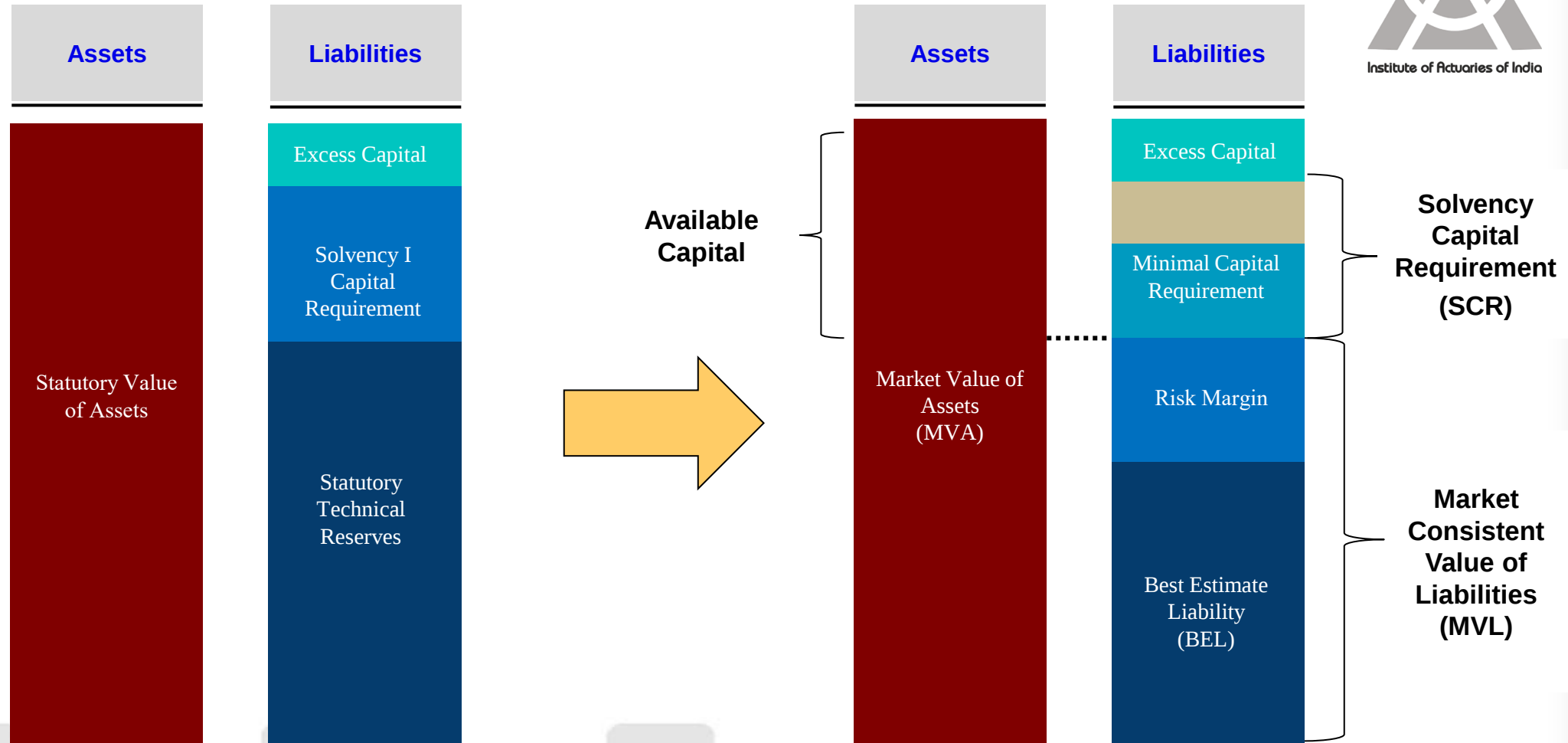
Unavoidable Market Risk (10%)

RBC ensures that insurers have capital to meet liabilities in extreme scenarios, typically at a 99.5% confidence level.

Risk Margin

RM is kept against non-hedgeable risks only, which can potentially affect the ability of an insurance company to service the policyholders' liabilities.

Balance Sheet View under Solvency I vs Solvency II



Statutory Balance Sheet

Solvency II Balance Sheet

These balance sheets are on solvency basis, which might be different from accounting basis

Gensis of Risk Margin prescription under SII



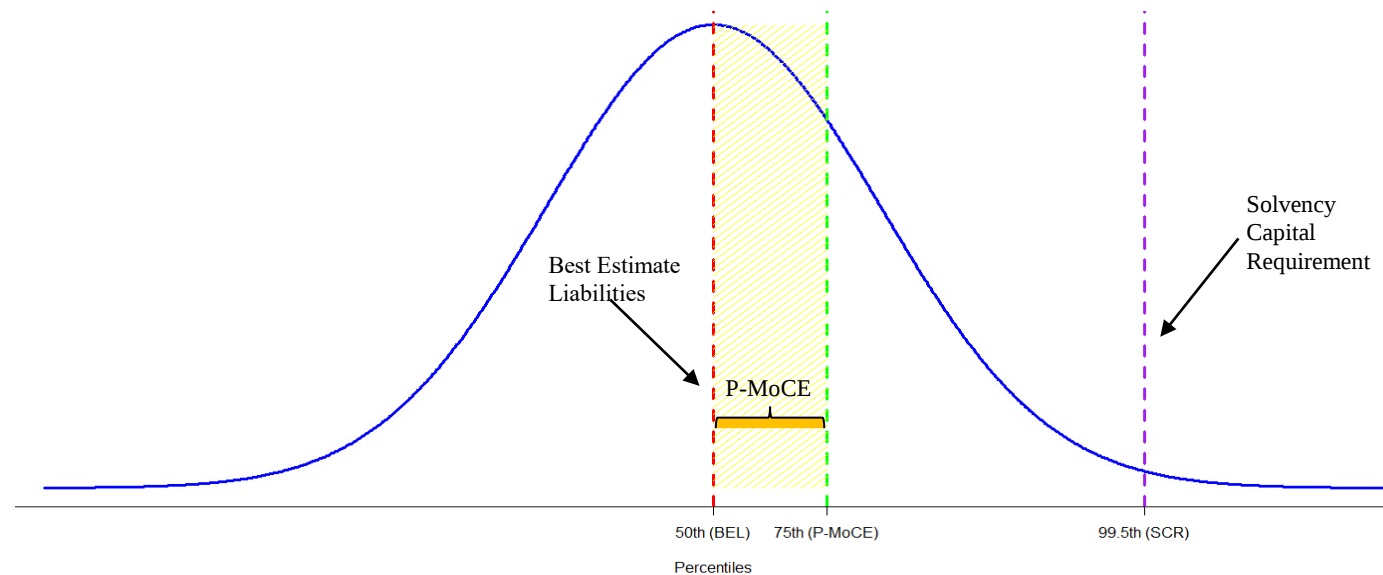
Gensis of Risk Margin prescription under SII

CoC vs MoCE

The guidance provided in “Amended Framework for Consultation on Solvency II” (European Commission, 2006) has two possible approach of risk margin computation.

Approach 1: Prudence Margin over current estimate (P-MoCE)

- MoCE represents a provision for the uncertainty in Best Estimate Liabilities (BEL). It is based on a specific percentile of a given loss distribution.



- The 50th percentile BEL is assumed to have a 50% chance of being inaccurate. The 75th percentile ensures 75% confidence that the firm can meet its liabilities over the full run-off after an adverse event.

Gensis of Risk Margin prescription under SII

CoC vs MoCE (Continued)



Approach 2: Cost of Capital (CoC)

- The Cost of Capital approach was adopted by the Solvency II regulations. It estimates the cost of capital required to support insurance and reinsurance obligations for non-hedgeable risks which includes underwriting risk, reinsurance credit risk, operational risk and "unavoidable market risk".
- Under this approach the risk margin is defined as the discounted value of the cost of providing capital equal to the non-hedgeable part of the SCR, over the full lifetime of the portfolio.
- This is based on the concept of what a rational investor would demand in excess of the best estimate in order to take over the liabilities.

$$\text{Risk Margin} = \sum \left(\frac{SCR_t}{(1+r)^t} \times \text{Cost of Capital Rate} \right)$$

Where,

- SCR_t is the solvency capital requirement for each future time period t ,
- r is the risk-free interest rate
- The sum is taken over the relevant time horizon

Why did CoC approach prevailed over MoCE under Solvency II



Why did CoC approach prevailed over MoCE under Solvency II?



- MoCE is beneficial as it estimates volatility in Best Estimate Liabilities (BEL) based on historical data. It may provide a better approach in some cases compared to the cost of capital method.

Challenges & Shortcomings

knowledge of the probability distribution and their parameters estimation requires internal capital modelling exercise

There is no clear connection between MoCE and the actual cost to transfer liabilities to a third party.

MoCE requires full knowledge of the probability distribution of liabilities

There may be challenges in applying a standard loss distribution across all companies

- In the original study, CEIOPS found no evidence that MoCE was consistent with market prices for transferring liabilities.
- The second Quantitative Impact Study (QIS2) showed that, overall, MoCE produced similar results to the Cost of Capital approach for EU insurers.

Why did CoC approach prevailed over MoCE under Solvency II?



- The 75th percentile MoCE is based on a full run-off distribution and may not necessarily be lower than the SCR, which is based on a 99.5th percentile over a one-year horizon.
- CEIOPS rejected MoCE due to the lack of evidence of its link to market transfer prices, concluding that it represented an "own fulfilment" value rather than a market-consistent exit value.
- CEIOPS adapted the Cost of Capital (CoC) approach, which satisfies both transfer to another insurer and own run-off requirements.
- The CoC method is easier to implement and remains consistent across companies due to its standardized nature.
- Although more theoretically market-consistent, CoC has faced criticism in practice by the UK life insurance industry in particular for the following reasons.
 - The risk margin is considered too large.
 - It is deemed too volatile.
 - It may incentivize risk transfer to jurisdictions outside Solvency II.
 - It is seen as too inflexible.

Potential Issue of Double Counting



Potential Issue of Double Counting



There is a possibility of double counting in risk margin as the capital charge against reserve risks may also have the same purpose, which is **protection against volatilities of policyholder's liabilities** (over and above same BEL).

While the risk margin is to manage the volatility of the best estimates till the liabilities are fully run off even after an extreme event in next one year, the reserve risk charges are primarily for managing sustainability against extreme events in near future only (one year).

Additionally distinct views are observed across literature groups of different geographies, primarily due to differing interpretations of whether a risk margin should be considered a loss-absorbing component or not.

Those who view the risk margin as a **loss-absorbing component** are concerned about the possibility of double counting, whereas those who do not consider it as loss-absorbing regard this as merely a **fair value adjustment** on liabilities rather than a margin for adverse deviations.

Argument against double counting



The risk margin may be treated as loss absorbing in **gone case scenario** (liquidation) and not in **ongoing scenarios** (as envisaged in Cost of Capital approach), where the liabilities are transferred to other parties for run off.

The third party will require compensation to hold solvency capital against such liabilities till they are run off.

Similarly, company needs to hold margin for adverse deviation if the company continues to fulfil liability obligations on its own after surviving such extreme events (as envisaged in P-MoCE approach).

Finally, the **objective** of risk margin is to provide **protections against volatility of best estimate liabilities till they are fully run off** versus the objective of **SCR is to provide protection against extreme volatility in next one year only** with the underlying going concern principle prevailing over gone concept.

Argument in support of double counting



While the cost of capital approach looks into this estimation purely from the economic principles of a market transaction the other approaches like P-MoCE purely looks at self-run off perspective and through statistical way of determining the margin.

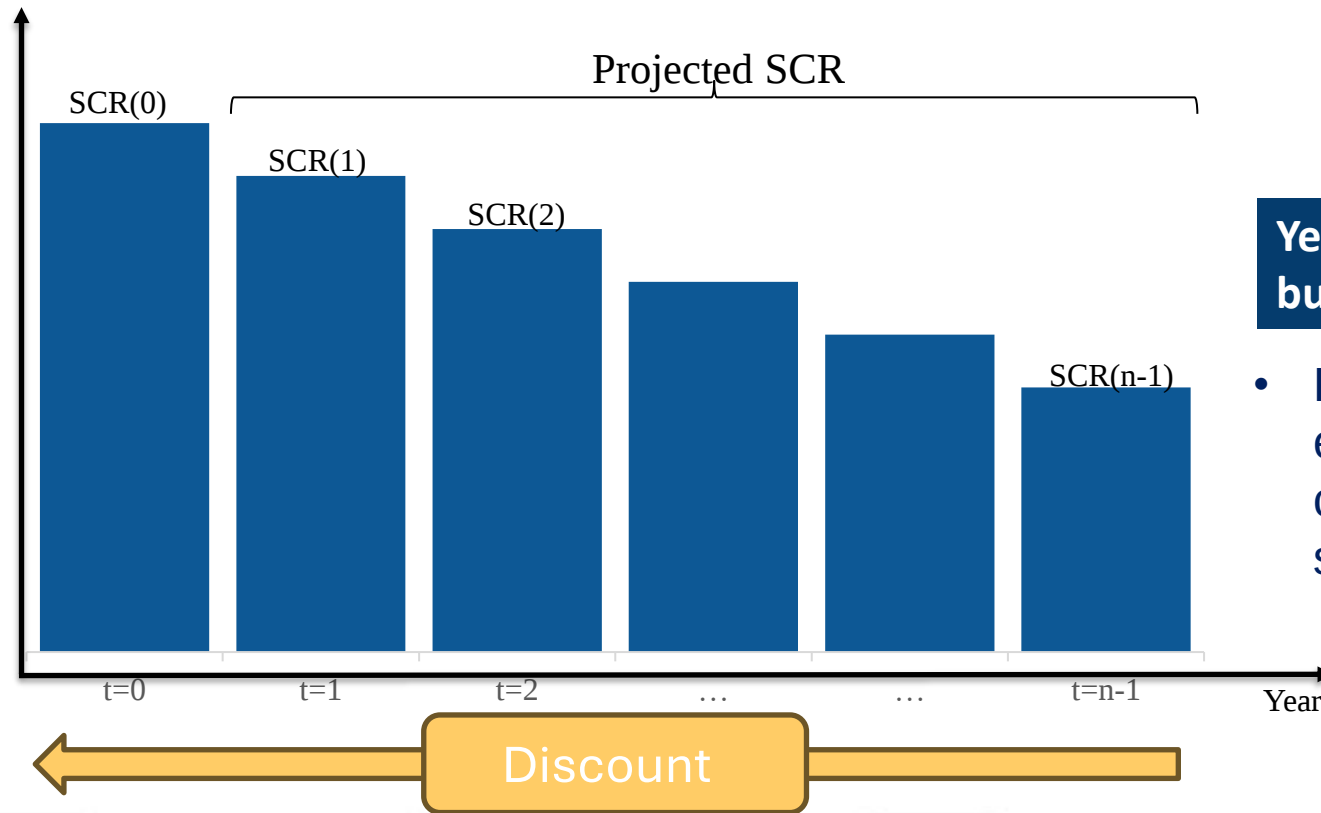
the regulators in China (China Insurance Regulatory Commission) and the United States (National Association of Insurance Commissioners) both opined that the P-MOCE should be loss absorbing, the Chinese regulator arguing that “***when a company becomes insolvent, P-MOCE can be released to absorb losses***”, as did a number of United States insurers who argued that any margins in reserves over and above best estimate represented double counting with capital requirements.

Given that the **P-MoCE is simply a subset of the SCR**, one can see why some might argue that it should be treated as a deduction from the SCR to avoid double counting.

Cost of Capital Approach in Context of Indian Insurance Industry



Cost of Capital Approach in Context of Indian Insurance Industry



Year on year SCR capital to support the business-in-force until run-off

- Risk margin calculations requires re estimations of liabilities and the corresponding SCR at every subsequent valuation date

Cost of Capital Approach in Context of Indian Insurance Industry

Cost of Capital



Any solvency regime works on the principle of going concern which means capital is to be provided at all points in time to ensure seamless servicing of policyholder's obligations even post an extreme event.



The capital whether to be provided by the existing owner or by a third-party buyer who buys the liabilities after an extreme event will come at some cost which primarily represents the investment opportunity cost.



The shareholders/owners whether the self-insurer or the third party buyer in case of a transfer always looks at the total return on equity available from the market given the nature and riskiness of their investments in the insurance entity concerned.

Cost of Capital Approach in Context of Indian Insurance Industry

Cost of Capital (Continued)



- Cost of capital can be calculated using CAPM (Capital Asset Pricing Model) model, where the CAPM helps to identify the commensurate return on capital/investments made by an investor commensurate to the riskiness of the targeted investments.
- In the next slide, we have computed cost of capital in excess of risk-free rate considering 5 year Nifty 50 average CAGR return and 15 year Nifty 50 average CAGR return as Market returns as Scenario 1 and Scenario 2, respectively, where Market return is one of components which goes into the CAPM Model.
- Each scenario has further considered Beta as observed under stressed scenario i.e. 1 where 1 reflects individual stock movements aligning completely with the market movements under stressed scenario and in the other scenario, Beta typically observed by non-life listed companies in India.



Cost of Capital Approach in Context of Indian Insurance Industry

Cost of Capital (Continued)



Scenario 1	Beta during stressed event	Beta observed by listed companies	Scenario 2	Beta during stressed event	Beta observed by listed companies
Risk Free Rate	6.50%	6.50%	Risk Free Rate	6.50%	6.50%
Market return (5 Year Nifty 50)	15%	15%	Market return (15 Year Nifty 50)	12%	12%
Beta	1	0.9	Beta	1	0.9
Cost of Capital	15.00%	14.15%	Cost of Capital	12.00%	11.45%
RM charge (CoC in excess of risk-free rate)	8.50%	7.65%	RM charge (CoC in excess of risk-free rate)	5.50%	4.95%

Two scenarios have captured impact of Beta under stressed and normal scenario keeping investment return unchanged.

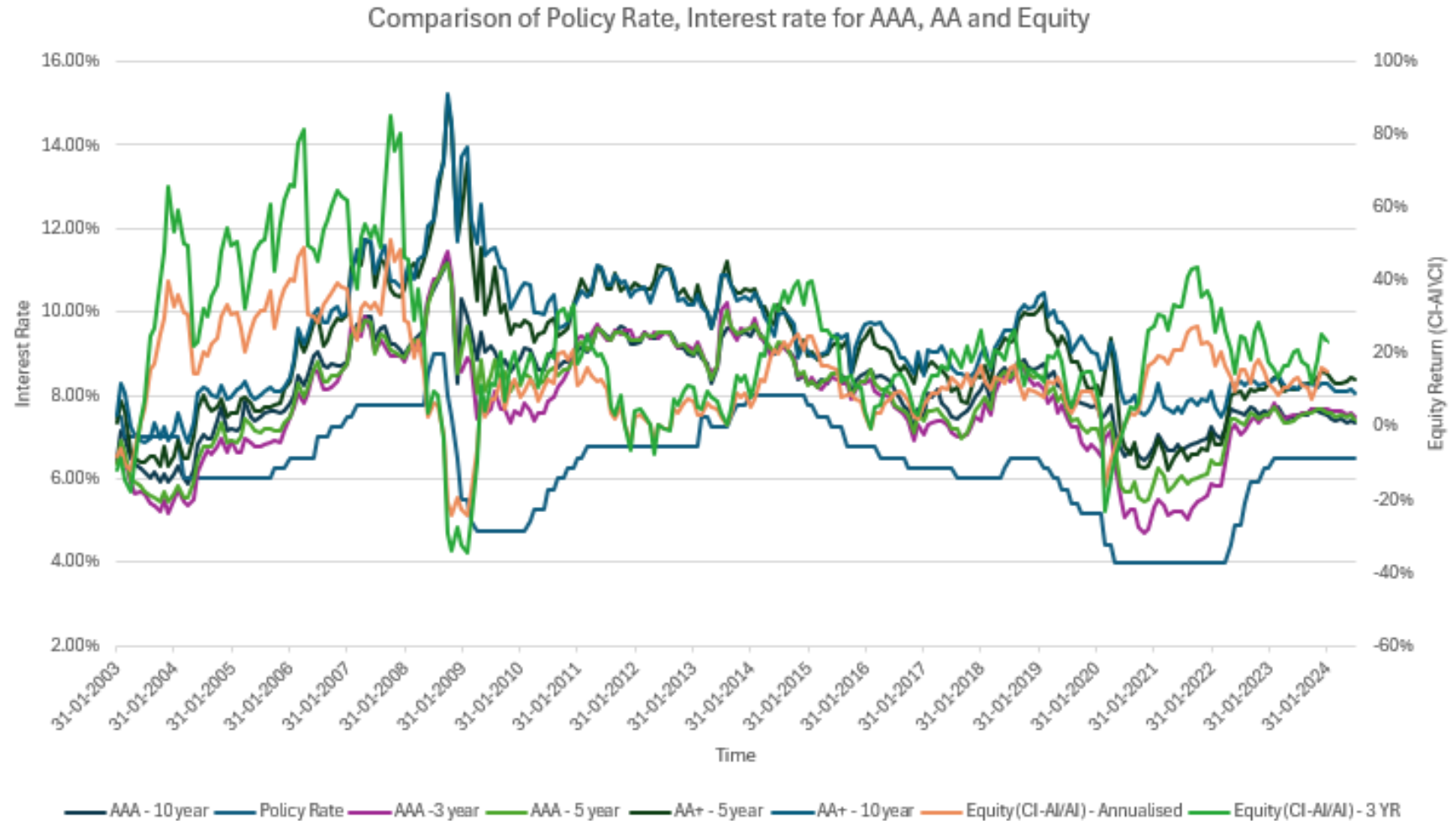
Cost of Capital Approach in Context of Indian Insurance Industry

Cost of Capital (Continued)

- This gives us CoC in excess of risk-free rate in range of 5%-8.5%.
- Although for simplistic reasons, the market returns have been kept same for both stressed and normal conditions under both the scenarios, typically under the stressed conditions the market returns may be far lower than the above figures including the risk-free rates which may also be lowered depending on the other macroeconomic parameter during or post stressed event.
- In order to capture the volatility of such returns historically we have captured all relevant indices in the next slide including the risk -free policy rates in order to capture the volatility and a potential range of cost of capital rates.



Bond and equity historic returns in Indian market



Thank you