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Internal model for estimating risks of non-life insurance companies for developing countries

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Solvency II Structure

Three pillars:

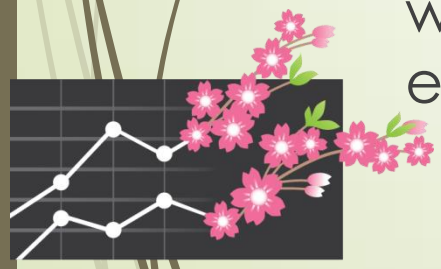
- Quantitative requirements (technical provisions and SCR)
- Qualitative requirements (governance, supervisory review of capital adequacy).
- Disclosure requirements (reporting and transparency).

Internal model

- Standard and internal models, partial internal models.
- Should include insurance risk, market risk, credit risk, operational risk etc.
- The decision to apply can be taken by the company or the regulator.
- Gives more freedom to the companies and helps to show economic substance of the reserves.
- IAIS standards

What is Internal Model?

"An internal model is a risk measurement system developed by an insurer to analyse its overall risk position, to quantify risks and to determine the economic capital required to meet those risks. Internal models may also include partial models which capture a subset of the risks borne by the insurer using an internally developed measurement system which is used in determining the insurer's economic capital '' (IAIS, 2008, Page 4)



BAS standards

According to BAS's (Board for Actuarial Standards) Consultation Paper on Modelling actuarial internal models should:

- Reflect relevant aspects of the real world on which actuarial decision was based
- Explain the way of deriving the inputs of the model and what the results of the model depict
- Be applicable both in theory and in practice
- Give explanation of important limitations of the model

Data Quality

- According to the article 121 on statistical quality standards data for Internal Model should be
  - accurate
  - complete
  - appropriate
- Insurance and reinsurance companies must establish, implement and maintain policies which cover these criteria

Data Accuracy

- Data Accuracy for internal model means:
  - No significant errors in data
  - Data is gathered over time in the same format and structure
  - Data is consistent
- Hard to achieve in developing countries

Problems with implementation in Azerbaijan

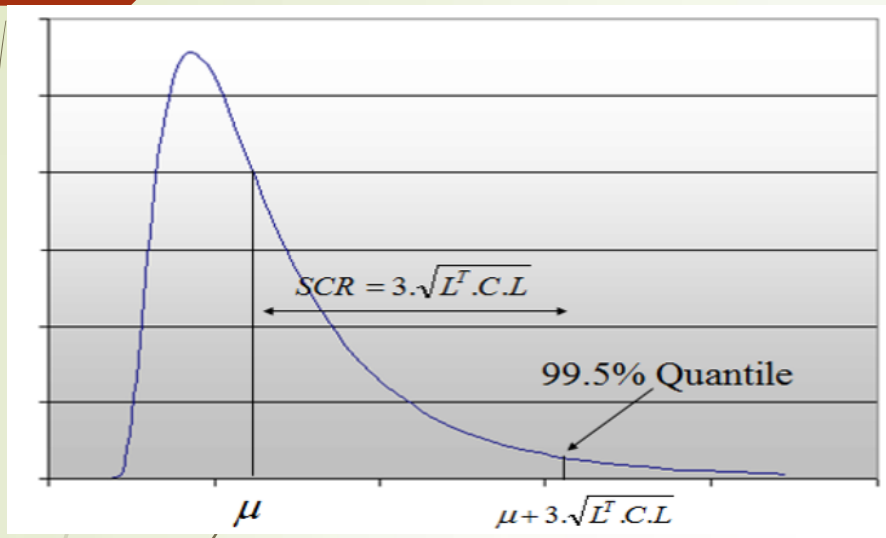
- Insurance market is not developed
- Data
  - availability
  - quality
  - choice
- Lack of qualified human resources and infrastructure
  - choice of the model
  - expert judgment
- Investment portfolio not diversified

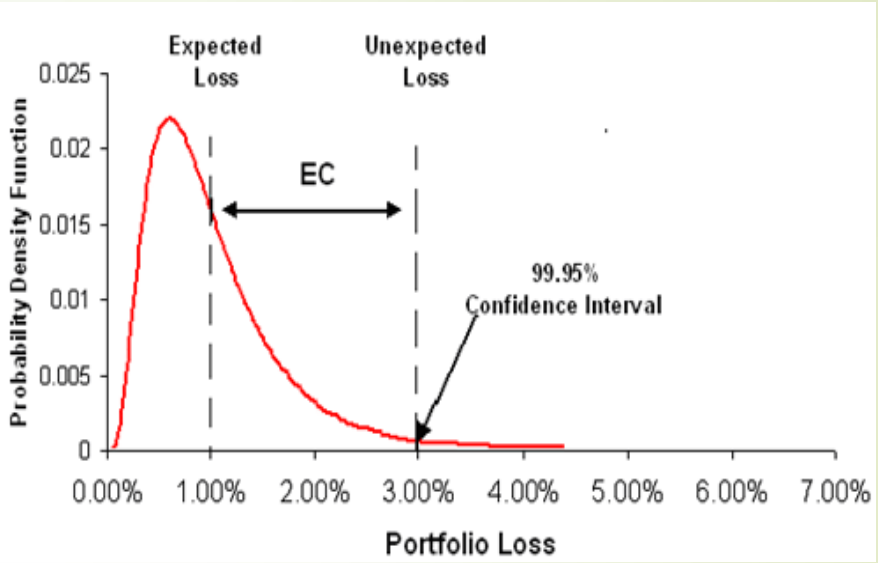
MCR and SCR

- **Minimum Capital Requirement (MCR)**
  - The minimum amount below which the reserves should not fall(with 85% probability).

- **Solvency Capital Requirement (SCR)**
  - The amount required to ensure that companies can meet their liabilities over the following 12 months with a probability at least 99.5% .(Article 122 on calibration standards)

SCR in Solvency II and EC in banking industry





- This is similar to unexpected and expected loss method in banking sector
- EC- economic capital is analogue of SCR

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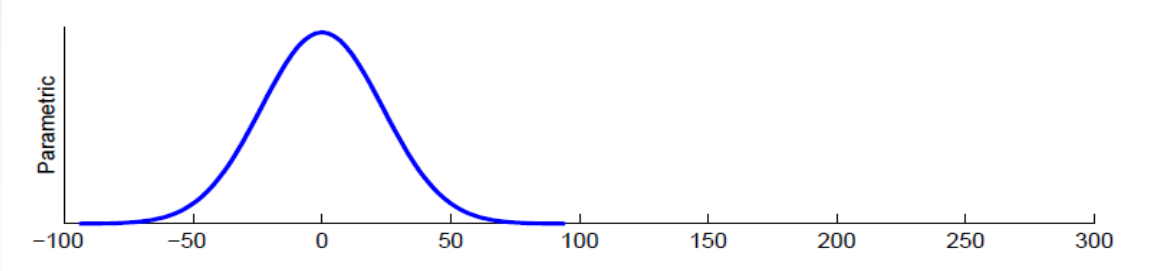
Methods for VaR calculation

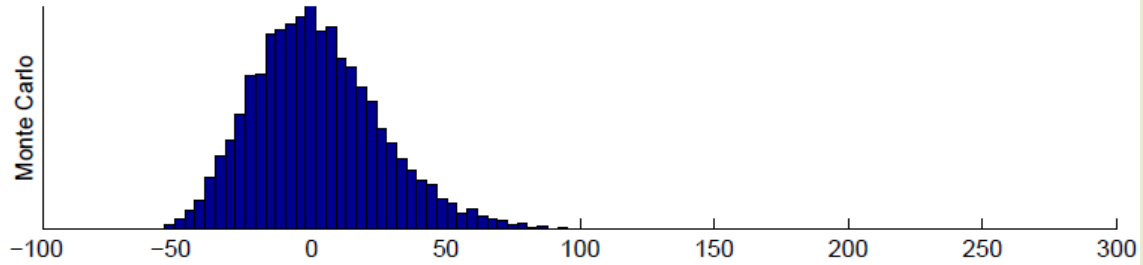
- **Parametric distribution**

  No data



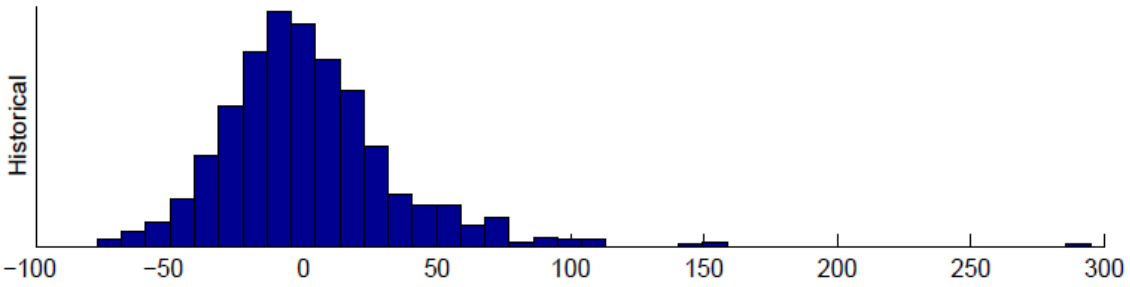
- **Monte Carlo simulation**

  Future data



- **Historical simulation**

  Historical data



Drawbacks of different methods

- Non - Parametric
  - Difficulty of selecting the historical period
  - Risk estimates from historical simulation could present large differences based on the specific period chosen
  - Scarcity of historical data
  - Laborious
- Parametric
  - Not very accurate

Insurance risk

- Arise from insurance losses
- N is a random number of claims, frequency
- X is size of claims, severity
- Aggregate claims

$$S = X_1 + \ldots + X_N$$

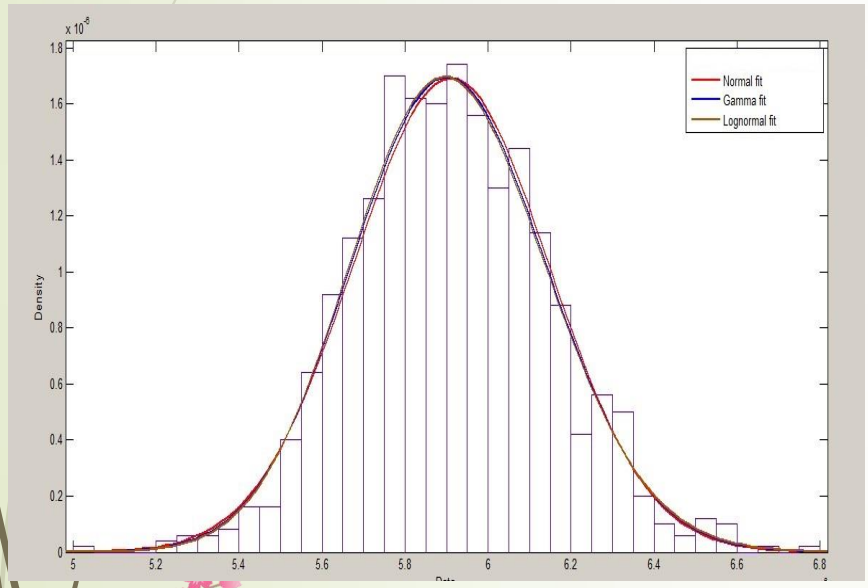
- Monte Carlo simulation Value at Risk method for loss estimation

Calculation of SCR

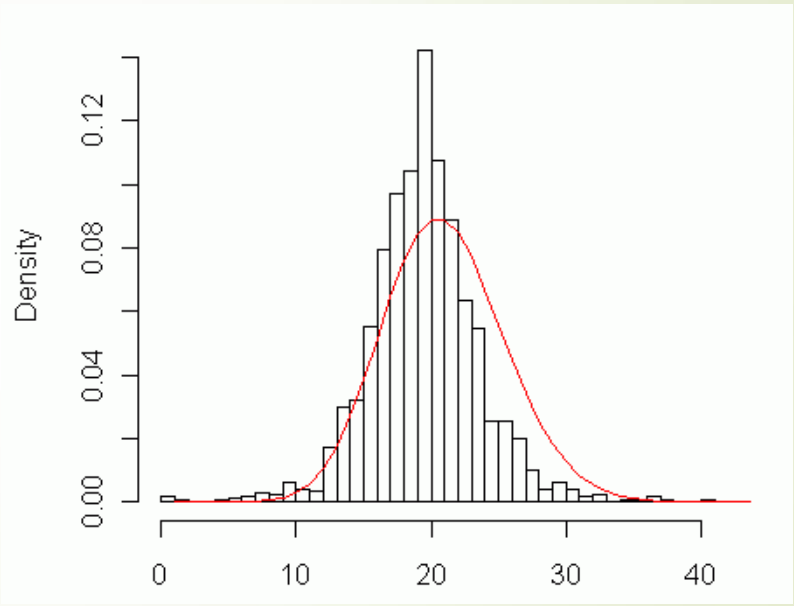
- Gather and examine data, correct inaccuracy, bring it to the form needed for actuarial calculations.
- Determine characteristics of empirical distribution of number and severity of claims: expectation, variance, skewness, kurtosis.
- Use different tests to fit a parametric distribution (Pearson chi-squared test, Kolmogorov-Smirnov test, Anderson-Darling test).
- Simulate future aggregate losses.
- Calculate VaR 99.5% (99.5%th quantile) and deduct mean

Example: Histograms based on historical data

Claim size

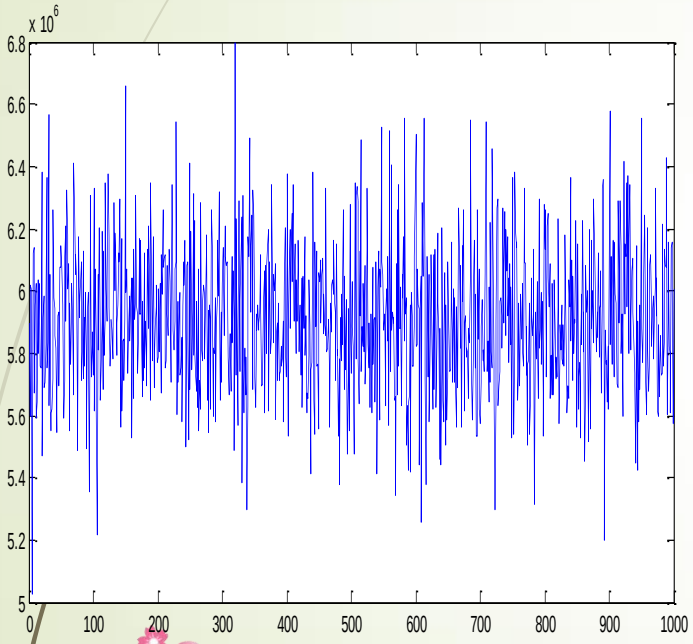


Number of claims

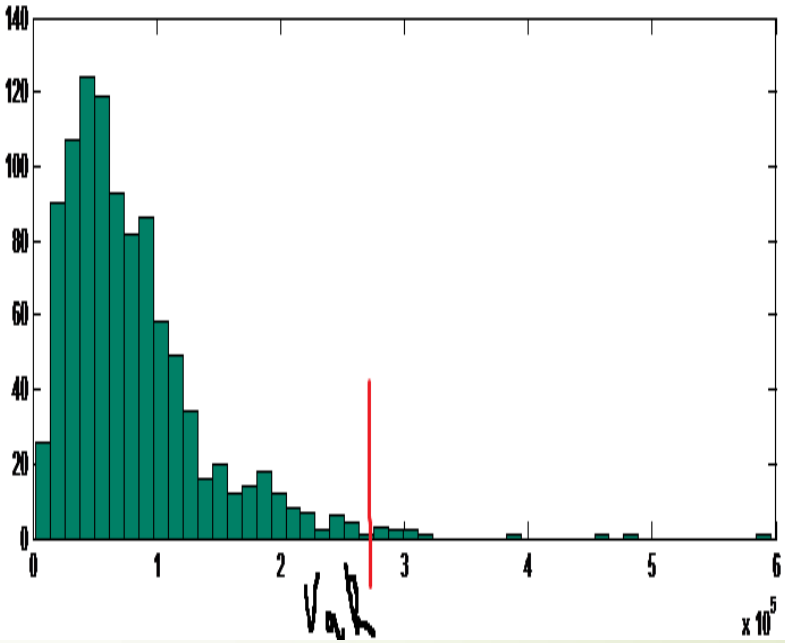


Example: Aggregate claims

Monte Carlo simulation of aggregate claims



Simulated distribution of aggregate claims



Credit Risk

- Reinsurance Risk
- Recoverable, Exposure and Loss Given Default are random variables and depend on insurance claims
- Probability of Default depends on the rating of the counterparty and its solvency ratio
- In the case of Stop Loss Reinsurance

$$Z=\begin{cases} 0, & S \le R \\ (1-c)(S-R), & R < S < R+L \\ (1-c)L, & S \ge R+L \end{cases}$$

Z is reinsurer's share in aggregate claims

S is aggregate claim amount

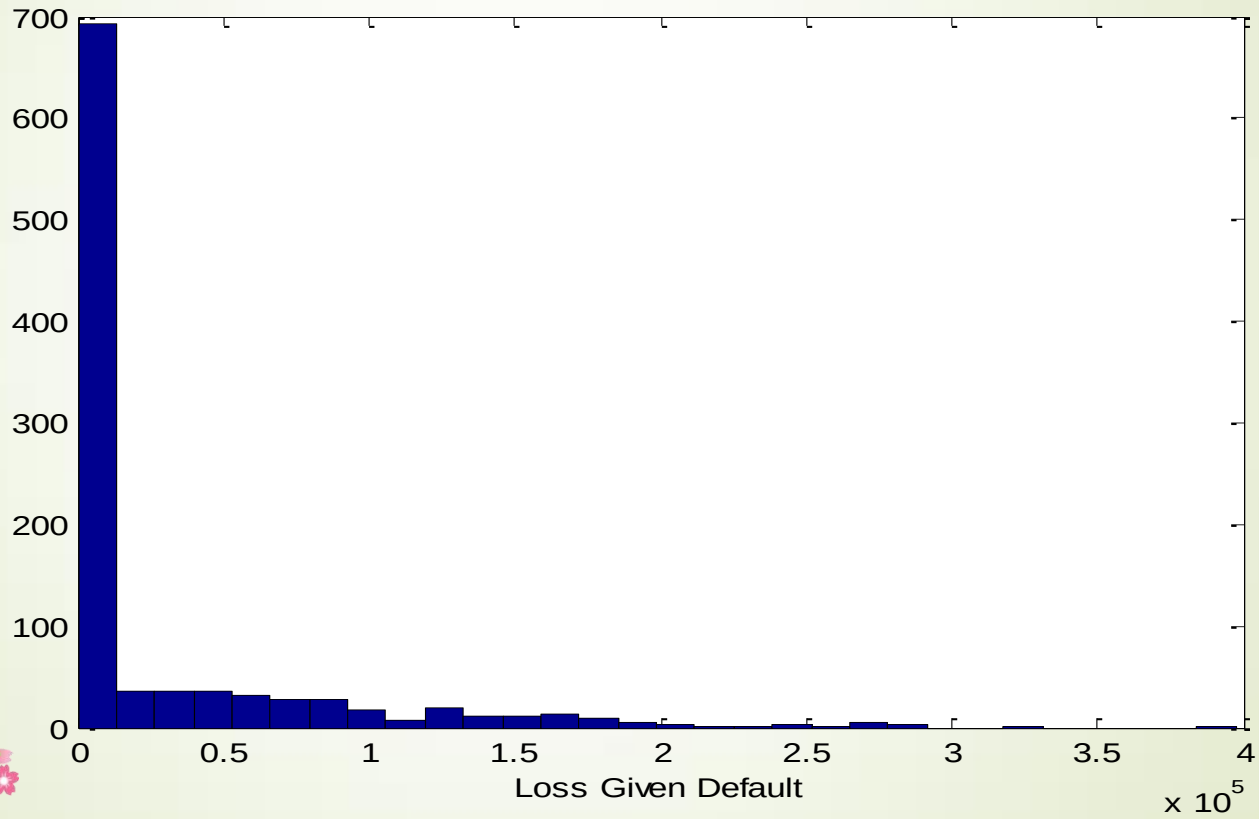
R is retention level

L is Limit

c is the share of cedent (insurer) in *S-R*

- Mixture distribution for Loss Given Default

Example: Simulated aggregate Loss Given Default



Operational risks

- "SCR.3.1. Operational risk is the risk of loss arising from inadequate or failed internal processes, or from personnel and systems, or from external events. Operational risk should include legal risks, and exclude risks arising from strategic decisions, as well as reputation risks. The operational risk module is designed to address operational risks to the extent that these have not been explicitly covered in other risk modules." (QIS5, Technical Specifications).

- Parametric distribution for operational risks due to data shortage.

- Best industry practice is Poisson distribution for number of losses, and Lognormal distribution for severity.

Total SCR

- Total Solvency Capital Requirement

$$SCR = BSCR + Adj + SCROp$$

Adj = Adjustment for the risk absorbing effect of technical provisions and deferred taxes

- Basic Solvency Capital Requirement

$$BSCR = \sqrt{\sum_{ij} Corr_{ij} * SCR_i * SCR_j} + SCR_{intangibles}$$

BSCR is Basic Solvency Capital Requirement

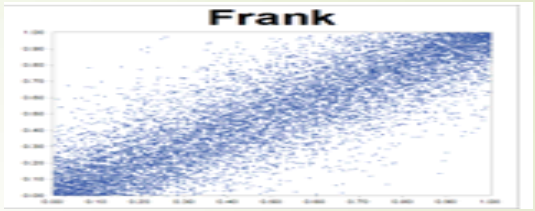
SCROp – Solvency Capital Requirement for operational risk,

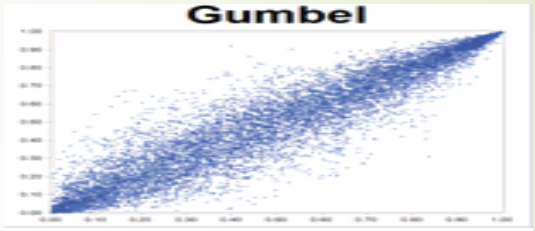
$SCR_{intangibles}$ – Solvency Capital Requirement for intangible asset risk

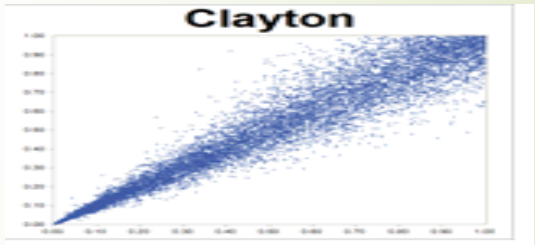
- If dependence is not Gaussian(normal), use multivariate copulas to find joint distribution of the risks

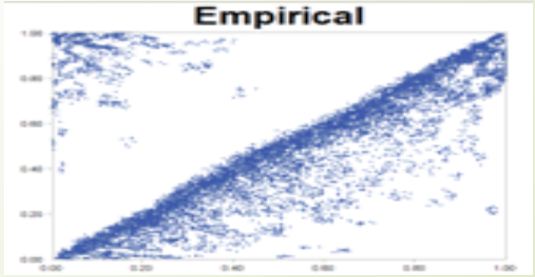
Copulas

- Frank Copula
  - Symmetric
- Gumbel Copula
  - Exhibits greater dependence in the positive tail
- Clayton Copula
  - Exhibits greater dependence in the negative tail
- Empirical Copula
  - Based on data







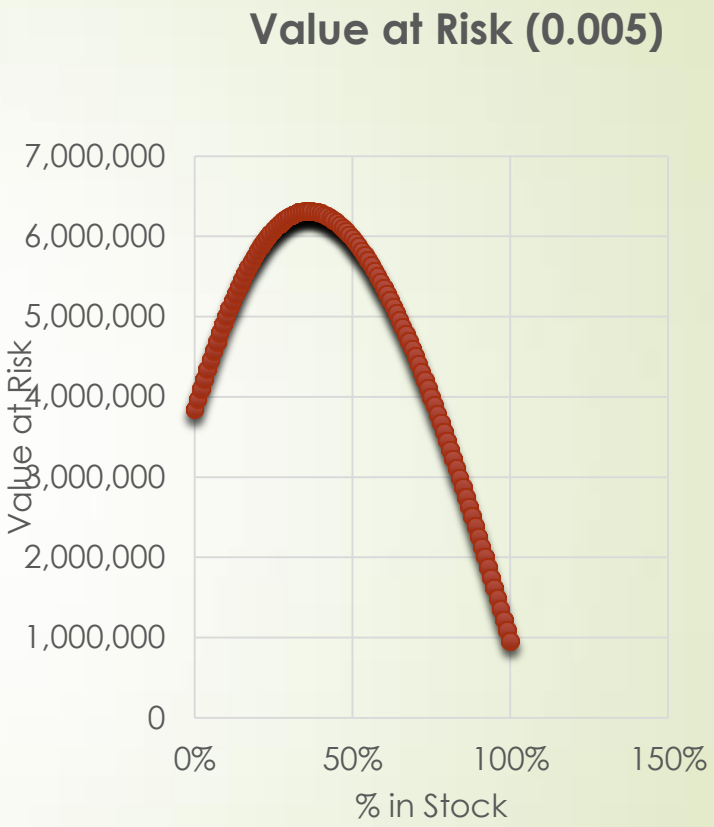


Enhanced Markowitz model for asset allocation (with SCL)

- Optimal weight of each asset class in the portfolio.
- Assets cover liabilities with 99.5% probability in one year time horizon.
- $VaR_{0.005}$ of asset portfolio should equal to liabilities
- Choose combination of assets such that $VaR_{0.005}$ (Value of the portfolio)is maximum
- Asset Allocation based on shortfall risk: Determine risk and return characteristics of this portfolio (Should lie on the efficient frontier and intersect shortfall constraint line)

Example

% in Stocks	% in Bonds	Expected Portfolio return	Portfolio Volatility	$VaR_{0.005}$
0%	100%	8.00%	32.62%	3,835,654
10%	90%	10.50%	30.77%	4,999,085
20%	80%	13.00%	29.77%	5,813,832
30%	70%	15.51%	29.70%	6,244,447
36%	**64%**	**17.01%**	**30.11%**	**6,315,785**
40%	60%	18.01%	30.56%	6,288,174
50%	50%	20.51%	32.29%	5,976,083
60%	40%	23.01%	34.75%	5,361,169
70%	30%	25.52%	37.81%	4,502,504
80%	20%	28.02%	41.32%	3,454,055
90%	10%	30.52%	45.19%	2,260,052
100%	0%	33.02%	49.33%	954,704



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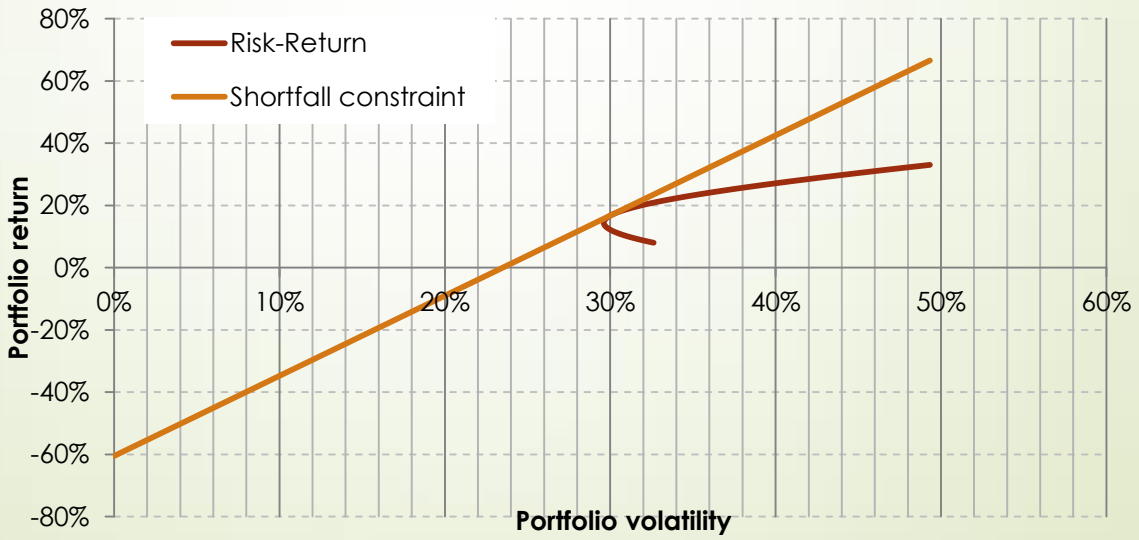
Shortfall Constraint Line

- Here risk is defined as the probability of failing to earn the minimum return
- The main criterion in this case is the risk tolerance of the investor, which is the condition that the assets do not fall under $VaR_{0.995}$ of liabilities with 99.5% probability
- Shortfall constraint Line (SCL) should cross Risk-Return line at that point of the efficient frontier where portfolio mean and variance maximized $VaR_{0.005}$ of assets which is equal to $VaR_{0.995}$ of liabilities



Challenges

- Complex and time consuming process
- Price of products
- Investments
- Human resources
- IT infrastructure and software

Benefits

- Effective risk management system
- Optimal Asset Liability Management system
- Increased transparency for investors and policyholders
- Support for strategic decision-making process

Thank you!

Sources

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