What is Economic Capital?

- Capital available to the bank to absorb losses to stay solvent

Economic capital can be defined as the methods or practices that allow banks to attribute capital to cover the economic effects of risk-taking activities –Bank for International Settlements, 2008

- Economic capital = UL (when reserves for EL are taken)
  = VaR (when reserves are not taken)
Components of Economic Capital

- Risk Identification
  - Risk Measurement
  - Risk-based Decision Making
  - Risk Monitoring & Control
  - Risk Reporting

- Credit risk
- Market risk
- Operational Risk
- Business/Reputation/Strategic Risk
- Liquidity Risk
- Interest Rate Risk
Regulatory vs. Economic Capital

- Regulatory capital is conceptually similar to Economic Capital

- Regulators, through Basel Accord, prescribe measurement approach and/or parameters that may not be based on the bank’s individual risk profile
  - Basel I
  - Basel II
  - Basel III

- Economic capital is based on bank’s internally derived risk measurement methodology and parameters that may not align with the framework prescribed by the regulators

- Economic capital may calculate VaR at a different percentile than regulatory capital

- Banks may use the more conservative of the two capital estimates in assessing its capital requirements
Credit Risk

- Credit Risk is the risk of default or downgrade by obligor

- Measurement of credit risk requires three parameters, which should be empirically based long run averages which include economic downturns
  - Probability of Default (PD)
  - Loss Given Default (LGD)
  - Exposure at Default (EAD)

- Methods of estimating the above parameters vary by portfolio
  - Retail Portfolio
  - Wholesale Portfolio
  - Other
    - Securitization
    - Equity
Asymptotic Single Risk Factor Model

- Basel Committee on Banking Supervision specified model based on Merton’s option theoretic framework that links asset values to credit quality

- Changes in asset value for each sub-portfolio are linked to one latent factor which drives the changes in returns in the following manner:

\[ X_i = \sqrt{\rho_i Y} + \sqrt{1 - \rho_i} \varepsilon_i \]

where \( X_i \) is the return on asset \( i \), \( \rho_i \) or \( R_j \) is correlation between asset \( i \) and factor \( Y_k \), \( \varepsilon_i \) is idiosyncratic risk associated with security \( i \), \( X_i, Y_k \), and \( \varepsilon_i \sim N(0,1) \)

- Credit Risk VaR is given by simple analytical formula:

\[
K = \left[ LGD \times N \left( \frac{N^{-1}(PD) + \sqrt{R} \times N^{-1}(0.999)}{\sqrt{1 - R}} \right) - (LGD \times PD) \right] \quad \text{For Retail Portfolios}
\]

\[
K = \left[ LGD \times N \left( \frac{N^{-1}(PD) + \sqrt{R} \times N^{-1}(0.999)}{\sqrt{1 - R}} \right) - (LGD \times PD) \right] \times \left( \frac{1 + (M - 2.5) \times b}{1 - 1.5 \times b} \right) \quad \text{For Wholesale Portfolios}
\]
Internal Credit Risk Models

- Address certain limitations of the Basel ASRF model
  - Bank’s credit portfolio is infinitely granular
  - Loan defaults at a bank are driven by a single systematic risk factor
  - Systematic and non-systematic risk factors are log-normal random variables
  - Assumptions regarding correlations among credit losses on various types of assets

- Provide flexibility in modeling through explicitly accounting for the macroeconomic drivers and bank's own risk profile

- These models account for loan characteristics, borrower characteristics, and macroeconomic environment
Operational Risk

- Risk of loss due to errors, infringements, interruptions, damages caused by internal processes, personnel or systems, or caused by external events
  - Technology and Infrastructure Failure
  - Damage to Physical Assets
  - Clients Products and Business Practices
  - Employment and Workplace Safety
  - Execution Delivery and Process Management
  - Internal Fraud
  - External Fraud

- Three approaches to modeling operational risk
  - Basic Indicator Approach
  - Standardized Approach
  - Advanced Measurement Approach (AMA)

- Under AMA operational losses are not segregated by “portfolios” but by clusters of homogeneous loss events called Units of Measure
Operational Risk Data Elements

- Key challenge in modeling operational risk is data scarcity and incompleteness

- Key inputs used in measurement

<table>
<thead>
<tr>
<th>Internal Losses</th>
<th>External Losses</th>
<th>Scenarios</th>
<th>Business Environment &amp; Internal Control Factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Best historic measure of bank’s</td>
<td>Not fully relevant for bank’s internal use</td>
<td>Management’s assessment of operational risk</td>
<td>Forward looking</td>
</tr>
<tr>
<td>operational risk profile</td>
<td>Other institutions may have loss profile affected</td>
<td>Suffers from cognitive biases</td>
<td>Based on bank’s own assessments</td>
</tr>
<tr>
<td></td>
<td>by unobservable factors</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fully observable</td>
<td>Partly observable</td>
<td>Forward looking</td>
<td>Qualitative measure with limited quantitative use</td>
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<td>Sparse</td>
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</tbody>
</table>
Modeling Operational Risk

- Measurement methodology is Loss Distribution Approach (LDA) based on collective risk model

- Frequency distributions
  - Poisson
  - Negative binomial

- Severity distributions
  - Empirical distribution
  - Single parametric distributions – Lognormal,
    - Mixture distributions
    - Piecewise distributions that use Extreme Value Theory (EVT)

- Compound Poisson Process
Market Risk

- Market risk is defined as risk of loss due to adverse movement in a market risk factors for the bank’s trading portfolios

- Key inputs are the portfolio positions and market risk drivers

- VaR Measurement methodology is fairly standard
  - Monte Carlo Simulation Method
  - Historical Simulation Method
  - Variance-Covariance Approach

- Market risk capital is 3*VaR calculated at 99th percentile with one-day horizon
Business Risk

- No consensus definition on business risk – risk of being in business
  - Reputation Risk
    the potential that negative publicity or press regarding a company’s business practices or products, whether true or not, will cause a decline in the customer base, or revenue reductions.
  - Strategic Risk/Earnings Risk
    the risk to earnings or capital arising from adverse business decisions or improper implementation of those decisions.

- No industry standard on measuring business risk.
  - Event study analysis on stock price change related to other loss-related events
  - Earnings volatility approach
  - Scenario based loss distribution models
## Risk Aggregation

<table>
<thead>
<tr>
<th>Aggregation methodology</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Summation:</strong></td>
<td>Simplicity</td>
<td>It does not discriminate across risk types; imposes equal weighting assumption</td>
</tr>
<tr>
<td>Adds together individual capital components</td>
<td>Typically considered to be conservative</td>
<td>Does not capture non-linearities</td>
</tr>
<tr>
<td><strong>Constant diversification:</strong></td>
<td>Simplicity and recognition of diversification effects</td>
<td>The fixed diversification effect is not sensitive to underlying interactions between components.</td>
</tr>
<tr>
<td>Similar to summation but subtracts fixed percentage from overall figure</td>
<td></td>
<td>Does not capture non-linearities</td>
</tr>
<tr>
<td><strong>Variance-Covariance:</strong></td>
<td>Better approximation of analytical method</td>
<td>Estimates of inter-risk correlations difficult to obtain</td>
</tr>
<tr>
<td>Weighted sum of components on basis of bilateral correlation between risks.</td>
<td>Relatively simple and intuitive</td>
<td>Does not capture non-linearities</td>
</tr>
<tr>
<td><strong>Copulas:</strong> combine marginal distributions through copula functions</td>
<td>More flexible than covariance matrix</td>
<td>Parameterisation very difficult to validate</td>
</tr>
<tr>
<td>Simulate the impact of common risk drivers on all risk components and construct the joint distribution of losses</td>
<td>Allows for non-linearities and higher order dependencies</td>
<td>Building a joint distribution very difficult</td>
</tr>
<tr>
<td><strong>Full modelling/Simulation:</strong></td>
<td>Theoretically the most appealing method</td>
<td>Practically the most demanding in terms of inputs</td>
</tr>
<tr>
<td></td>
<td>Potentially the most accurate method</td>
<td>Very high demands on IT</td>
</tr>
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<td></td>
<td>Intuitive</td>
<td>Time consuming</td>
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<td></td>
<td></td>
<td>Can provide false sense of accuracy</td>
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</tbody>
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Source: BIS
Other Risks

- Interest Rate Risk in the banking book
- Liquidity Risk
- Country Risk
- Pipeline Risk
- Model Risk
Model Risk

Model risk occurs primarily for two reasons:
- fundamental errors, inaccurate outputs – model does not meet its design objective and intended business uses
- used incorrectly or inappropriately or misunderstanding about its limitations and assumptions

Model risk can be minimized through:
- Robust model implementation
  - sensitivity analyses,
  - benchmarking (where possible),
  - stress testing.
  - explicit documentation of model assumptions and limitation
- Model validation
  - conceptual soundness,
  - performance analysis and on-going monitoring
- Sound governance, policies and controls
How is Economic Capital Used?

- Capital adequacy
- Risk-based pricing
- Credit portfolio management
- Capital budgeting, strategic planning, target setting
- Risk-based performance management
Key Stakeholders in Economic Capital

- CEO, CFO
- Business Lines
- Enterprise Risk Management
- Validators and Auditors
- Regulators