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2 Introduction to Banks

2.1 Nature of Banking

- **Commercial Banking:**
  - Taking deposits and making loans (wholesale or retail).
  - Money center banks operate in the wholesale market and often fund loans by borrowing.
- **Investment Banking:**
  - Raising debt and equity for companies.
  - Advice on mergers and acquisitions, restructurings, trading, etc.

2.2 Structure of Banking in the US

- Large international banks (small number).
- Regional banks (several hundred).
- Small community banks (several thousand).

2.3 History of Bank Regulation in the US

- McFadden Act (1927, 1933).
- Douglas Amendment (1956).
- Bank Holding Companies Act (1970).
- Riegel-Neal Interstate Banking and Branching Efficiency Act (1994).

2.4 Example of Simple Bank Balance Sheet (End 2023)

- **Assets:**
  - Cash: 5.
  - Marketable Securities: 10.
  - Loans: 80.
  - Fixed Assets: 5.
  - Total: 100.

- **Liabilities:**
  - Deposits: 90.
  - Subordinated Long Term Debt: 5.
  - Equity Capital: 5.
  - Total: 100.

2.5 Income Statement (2023)

- Net Interest Income: 3.00.
- Provision for Loan Losses: -0.80.
- Non-Interest Income: 0.90.
- Non-Interest Expense: -2.50.
- Pre-Tax Operating Income: 0.60.

2.6 Year 2024 Scenario

- Similar to 2023, except provision for loan losses increases to 4.0 from 0.8.

2.7 Deposit Insurance

- Insures depositors against losses up to a certain level.
- In the US, FDIC has provided protection since 1933.
- Coverage increased from $2,500 (1933) to $250,000 (2008).
- Raises the question: Why might deposit insurance encourage risk-taking?

2.8 Investment Banking

- Methods of raising debt or equity:
  - Public Offering.
  - Private Placement.
  - Best Efforts.
  - Firm Commitment.

2.9 Initial Public Offering (IPO)

- Often done on a best efforts basis.
- Banks set offering price low to ensure sales.
- Shares often rise in price post-IPO.

2.10 Securities Trading

- Exchange-traded vs Over-the-Counter (OTC).
- Brokerage Services:
  - Full Service.
  - Discount.
  - Online.

2.11 Potential Conflicts of Interest

- Bank recommending securities it is trying to sell.
- Passing confidential client information between commercial and investment banks.
- Stock recommendations influenced by investment banking business goals.

2.12 The Originate-to-Distribute Model

- Popular for handling mortgages (2000–2007).
- Banks originate loans and package them into products sold to investors.
- Frees up funds for further lending.

3 Securitization and the Global Financial Crisis

3.1 What Happened

- Starting in 2000, mortgage originators in the US relaxed lending standards and created large numbers of subprime first mortgages.
- Low interest rates increased the demand for real estate, leading to rising prices.
- Market features included:
  - 100% mortgages, ARMs, teaser rates.
  - NINJAs, liar loans, non-recourse borrowing.
- In 2007, the bubble burst:
  - Borrowers struggled to afford payments after teaser rates ended.
  - Negative equity led borrowers to exercise put options.
  - Real estate prices fell, and products previously thought safe became risky.
- A "flight to quality" ensued, with increased credit spreads.

3.2 Asset-Backed Securities (ABS)

- Structured with a "waterfall" for allocating cash flows to tranches.
- Example structure:
  - Senior Tranche: \$75 million, Return = 6%.
  - Mezzanine Tranche: \$20 million, Return = 10%.
  - Equity Tranche: \$5 million, Return = 30%.

3.3 ABS CDOs or Mezz CDOs

- Composed of subprime mortgages:
  - Senior Tranche: 75%, rated AAA.
  - Mezzanine Tranche: 20%, rated BBB.
  - Equity Tranche: 5%, not rated.
- Loss distributions varied based on subprime portfolio performance.

3.4 Regulatory Arbitrage

- Capital requirements for securities created from mortgage portfolios were significantly lower than keeping mortgages on balance sheets.

3.5 Role of Incentives

- Valuers, ABS creators, and rating agencies contributed to the crisis through flawed incentives.
- Compensation plans for traders encouraged short-term decision-making.

3.6 Importance of Transparency

- ABSs and ABS CDOs were complex, inter-related products.
- Once perceived as risky, AAA tranches became difficult to trade due to a lack of understanding.
- Simpler credit-related products, like credit default swaps, continued to trade during the crisis.

3.7 Lessons from the Global Financial Crisis

- Beware of irrational exuberance.
- Do not underestimate default correlations in stressed markets.
- Recovery rates depend on default rates.
- Compensation structures must align with proper incentives.
- Deals too good to be true (e.g., AAA earning LIBOR + 100 bp) likely are.
- Do not rely solely on ratings.
- Transparency is crucial in financial markets.
- Resecuritization was fundamentally flawed.

4 Operational Risk

4.1 Definition of Operational Risk

> "Operational risk is the risk of loss resulting from inadequate or failed internal processes, people, and systems, or from external events."
> – Basel Committee, Jan 2001

4.2 What It Includes

- People risks.
- Technology and processing risks.
- Physical risks.
- Legal risks.

Exclusions: Reputation risk and strategic risk.

4.3 The Biggest Risk?

- Operational risk is difficult to quantify but regarded as the biggest risk facing banks.
- Cyber risk is a significant concern for financial institutions.
- Compliance risks can lead to substantial losses (e.g., BNP Paribas, $9 billion in 2014).

4.4 Categories of Operational Risk

- Internal fraud.
- External fraud.
- Employment practices and workplace safety.
- Clients, products, and business practices.
- Damage to physical assets.
- Business disruption and system failures.
- Execution, delivery, and process management.

4.5 Loss Severity vs Loss Frequency

- Loss frequency estimation:
  - Based on the bank's own data.
  - Often modeled using a Poisson distribution.
- Loss severity estimation:
  - Based on internal and external historical data.
  - Often modeled using a lognormal distribution.

4.6 Monte Carlo Simulation

1. Sample from the frequency distribution to determine the number of loss events (n).
2. Sample n times from the severity distribution to determine the loss severity for each event.
3. Sum the loss severities to determine total loss.

4.7 SMA (Standard Measurement Approach)

- **Business Indicator (BI):**
  - Reflects net interest income, other operating income, and net P&L.
  - BI Component (BIC) is a piecewise linear function of BI.
- **Loss Component (LC):**
  - 15 times the average annual operational risk losses over the last 10 years.

  - Transition period allows for 5 years of losses if 10 years are unavailable.

- **Internal Loss Multiplier (ILM):**

$$ILM = \ln\left[e^{-1} + \left(\frac{LC}{BIC}\right)^{0.8}\right]$$

- **Capital Requirements:**
  - Equal to BIC for small banks.
  - Product of BIC and ILM for large banks.
  - National regulators may adjust these requirements.

4.8 Loss Prevention

- Establish causal relationships.
- Risk Control Self-Assessment (RCSA).
- Key Risk Indicators (KRI).
- Educate employees on appropriate communication (emails and phone calls).
- Allocate operational risk capital to encourage risk reduction.

4.9 Power Law

$$Prob(v > x) = Kx^{-a}$$

- Effective for modeling operational risk losses.
- Distributions with heavy tails (low a) define the 99.9% worst-case scenario.

4.10 Insurance

- Design factors:
  - Moral hazard.
  - Adverse selection.
- Risk management tools:
  - Deductibles.
  - Co-insurance provisions.
  - Policy limits.

4.11 Sarbanes-Oxley Act

- CEOs and CFOs held accountable for financial statements.
- Increased SEC powers.
- Prohibited auditors from performing significant non-audit tasks.
- Required audit committees to consider alternative accounting treatments.
- Mandated return of bonuses if financial statements are restated.

5 Liquidity Risk

5.1 Types of Liquidity Risk

- Liquidity Trading Risk.
- Liquidity Funding Risk.

5.2 Liquidity Trading Risk

- The price received for an asset depends on:
  - The mid-market price.
  - The amount to be sold.
  - How quickly it is to be sold.
  - The economic environment.
- Transparency, as seen during the GFC, is also a factor affecting liquidity.

5.3 Cost of Liquidation in Stressed Markets

- The cost of liquidation is influenced by the mean and standard deviation of the bid-offer spread, as well as the required confidence level.

5.4 Liquidity-Adjusted VaR

- Adjusted Value at Risk (VaR) incorporates liquidity costs into traditional risk measures.
- It accounts for both the dollar bid-offer spread and market price deviations.

5.5 Unwinding a Position Optimally

- Traders aim to minimize costs by optimizing the amounts traded daily, factoring in price impacts and market volatility.

5.6 Other Measures of Trading Liquidity

- Volume of trading per day.
- Price impact of a trade.
- Absolute daily return divided by daily dollar volume (Amihud measure, 2002).
- Research indicates expected asset returns increase as liquidity decreases.

5.7 Liquidity Funding Risk

- Sources of liquidity:
  - Cash and Treasury securities.
  - Liquidation of trading positions.
  - Borrowing ability.
  - Retail and wholesale deposits.
  - Securitization.
  - Central bank borrowing.

5.8 Regulation

- Liquidity Coverage Ratio (LCR): Ensures the bank can survive a 30-day period of acute stress.
- Net Stable Funding Ratio (NSFR): Ensures funding sources align with asset permanence over the long term.

5.9 Liquidity Black Holes

- Occur when most market participants want to take one side of the market, leading to dried-up liquidity.
- Examples:
  - 1987 Market Crash.
  - LTCM collapse.
  - British Insurance Companies.

5.10 Positive and Negative Feedback Trading

- Positive feedback traders:
  - Buy after a price increase.
  - Sell after a price decrease.
- Negative feedback traders:
  - Buy after a price decrease.
  - Sell after a price increase.
- Positive feedback trading can exacerbate liquidity black holes.

5.11 The Leveraging and Deleveraging Cycles

- Leveraging:
  - Increased leverage allows investors to buy more assets.
  - Asset prices rise, reducing leverage.
- Deleveraging:
  - Investors reduce leverage by selling assets.
  - Asset prices decline, increasing leverage.

5.12 Is Liquidity Improving?

- Spreads are narrowing, suggesting improved liquidity.
- However, risks of liquidity black holes may be greater due to lack of diversity in financial market participants.

6 Credit Value at Risk (Credit VaR)

6.1 Rating Transitions

- One-year rating transition probabilities are published by rating agencies.
- Assuming independence of rating transitions between periods, multi-period transitions can be calculated.
- The phenomenon of "ratings momentum" indicates that the independence assumption is not perfectly accurate.

6.2 Rating Transition Matrices

- **One-Year Transition Matrix:** See Table 19.1.
- **Five-Year Transition Matrix:** Derived from one-year transitions (Table 19.2).
- **One-Month Transition Matrix:** Calculated from one-year transitions (Table 19.3).

6.3 Credit VaR

- Defined analogously to Market Risk VaR.
- A one-year Credit VaR at 99.9% confidence represents the loss level not expected to be exceeded within the year.

6.4 Vasicek's Model

- For a large loan portfolio:

$$WCDR = N^{-1}\left[N^{-1}(PD) + \sqrt{r}N^{-1}(X)\right]$$

- N^{-1} is the inverse cumulative normal distribution, PD is the probability of default, and r is the Gaussian copula correlation.

6.5 VaR Model

- Credit VaR is calculated as:

$$VaR = LGD \times EAD \times WCDR$$

- Extended by Gordy for more complex portfolios.

6.6 Credit Risk Plus

- Default rate modeled using Poisson distribution.
- If default rate has a gamma distribution, defaults follow a negative binomial distribution.

6.7 Monte Carlo Simulation for Credit Risk Plus

1. Sample overall default rate.
2. Sample probability of default for each counterparty category.
3. Sample number of losses for each category.
4. Sample loss size for each default.

5. Calculate total loss from defaults.

Repeated multiple times to create a total loss probability distribution.

6.8 CreditMetrics

- Calculates Credit VaR based on possible rating transitions.
- Uses a Gaussian copula model to define correlations between rating transitions of different companies.

6.9 Credit Risk in the Trading Book

- Two alternatives for calculating 10-day 99% VaR:
  - Historical simulation to analyze potential credit spread changes.
  - Transition matrix combined with the CreditMetrics approach.

6.10 Constant Level of Risk Assumption

- For a BBB bond with a 3-month liquidity horizon:
  - If the bond deteriorates, it is replaced at the end of each 3-month period.
  - The one-year loss is then represented as four consecutive 3-month losses.

7 Economic Capital and RAROC

7.1 Economic Capital

- Defined as a bank's own assessment of the capital required to cover risks.

7.2 Model Used for Economic Capital

- Similar to the model for regulatory capital.
- Capital is chosen based on a desired confidence level (e.g., 99.98%) and a one-year time horizon.
- AA-rated companies have a 0.02% probability of defaulting in one year.

7.3 Basel II Regulatory Environment

- Risks categorized into:
  - Non-Business Risk (regulatory capital): Credit risk, market risk, operational risk.
  - Business Risk (no regulatory capital): Risk from strategic decisions, reputation risk.

7.4 Characteristics of Risk Distributions

- **Market Risk:** High variance, zero skewness, low kurtosis.
- **Credit Risk:** Moderate variance, moderate skewness, moderate kurtosis.
- **Operational Risk:** Low variance, high skewness, high kurtosis.

7.5 Interactions of Risks

- Credit and market risks influence each other (e.g., LGD and PD depend on market value).
- Operational risks can depend on market moves or credit events.

7.6 Integrated Risk Management

- Economic capital is calculated for different risks and business units.
- Aggregation of risks involves dealing with correlations between them.

7.7 Combining Distributions

- Perfect correlation overstates capital by 40%.
- Assuming normal distributions understates capital by 40%.
- A hybrid approach provides more accurate results.

7.8 Example: Economic Capital Estimates

- Economic capital estimates for two business units:
  - **Business Unit 1:** Market risk = 30, credit risk = 70, operational risk = 30.
  - **Business Unit 2:** Market risk = 40, credit risk = 80, operational risk = 90.
- Total economic capital:
  - **Business Unit 1:** 100.

  - **Business Unit 2:** 153.7.
  - **Whole bank:** 203.2.

7.9 RAROC (Risk-Adjusted Return on Capital)

- Measures return on economic capital allocated to a business unit.
- Calculated as:
$$RAROC = \frac{ExpectedProfit}{EconomicCapital}$$
- Expected profit may include risk-free interest on economic capital.

7.10 Example: Lending in a Region

- AA-rated bank estimates average losses from defaults as 1% of outstanding loans annually.
- Worst-case loss at 99.98% confidence: 5%.
- Economic capital per \$100 of loans = \$4.
- Spread between cost of funds and interest charged = 2.5%, administrative costs = 0.7%.

7.11 Ex-ante vs Ex-post RAROC

- Ex-ante: Used for forecasting and capital allocation.
- Ex-post: Used for performance evaluation, replacing expected loss with realized loss.

8 Climate Risk, ESG, and Sustainability

8.1 Major Cause of Climate Change

- Tens of billions of tons of greenhouse gases are emitted annually due to:
  - Burning fossil fuels.
  - Manufacturing cement, concrete, steel, and plastics.
  - Raising animals for food.
- These gases trap heat, reducing the radiation back into space, leading to global warming.

8.2 Paris and Glasgow Agreements

- **Paris Agreement (2015):** Aims to limit temperature rise to 1.5°C above pre-industrial levels.
- **Glasgow Agreement (2021):** Strengthened 2030 targets to achieve net-zero emissions by 2050.

8.3 IPCC Sixth Assessment Report (2021)

- Highlights five Shared Socioeconomic Pathways (SSPs):
  - **SSP1:** CO_2 emissions net zero by 2050, warming: 1.4°C (2081–2100).
  - **SSP5:** CO_2 emissions triple by 2075, warming: 4.4°C (2081–2100).

8.4 Greenhouse Gas Emissions by Sector

- **Transportation:** 27%.
- **Electricity:** 25%.
- **Industry:** 24%.
- **Commercial and Residential:** 13%.
- **Agriculture:** 11%.

8.5 Costly Results of Climate Change

- Rising sea levels.
- Ocean acidification.
- Increased storms, heatwaves, wildfires, hurricanes, and tornadoes.

8.6 Organizations Addressing Climate Risk

- **Task Force on Climate-Related Financial Disclosures (TCFD):** Led by Michael Bloomberg.
- **Glasgow Financial Alliance for Net Zero (GFANZ):** Led by Mark Carney.

8.7 Physical vs. Transition Risks

- **Physical Risks:** Costs from extreme climate events (e.g., floods, hurricanes).
- **Transition Risks:** Costs of reducing emissions (e.g., carbon taxes, plant closures).

8.8 Impact on Financial Institutions

- **Banks:** Climate risks affect credit, market, liquidity, operational, and reputational risks.
- **Insurance Companies:** Challenges for property, casualty, and life insurance sectors.

8.9 Institutional Investors

- Institutional investors significantly influence company climate risk policies.
- Examples: California State Teachers Retirement System, BlackRock.

8.10 ESG (Environmental, Social, and Governance)

- **Environmental:** Includes climate change and resource use.
- **Social:** Covers diversity, equity, inclusion, and worker well-being.
- **Governance:** Involves transparent and socially responsible policies.

8.11 Sustainability

- Defined as meeting present needs without compromising future generations.
- Focus areas include pollution, soil and water contamination, overfishing, and deforestation.

8.12 Greenwashing

- Companies make misleading claims about their environmental friendliness.
- Examples discussed in Section 23.4.

9 Model Risk Management

9.1 Uses of Models

- Credit decisions and exposures.
- Liquidity management.
- Derivatives valuation.
- Calculation of risk measures such as VaR and ES.
- Asset management.
- Fraud detection.

9.2 SR 11-7 Guidance

- Issued by the U.S. Board of Governors, providing guidance on model risk management.
- **Definition of Model Risk:** The potential for adverse consequences due to incorrect or misused model outputs.
- Sources of model risk:
  - Fundamental errors: data, calculations, numerical procedures, assumptions.
  - Inappropriate use of the model.
- Directives include:
  - Model development, testing, and documentation.
  - Role of model validation groups.
  - Use of vendor models.

9.3 Finance vs Physics

- Physics models describe physical processes and are highly accurate with unchanging parameters.
- Finance models describe human behavior and are approximations with parameters that evolve over time.

9.4 Linear Products

- Little uncertainty about the correct model.
- Mistakes still occur (e.g., Kidder Peabody, In Arrears Swaps).
- Monitoring trading patterns is critical; unusual activity may indicate model inaccuracies.

9.5 Models for Pricing Actively Traded Products

- Market prices are often directly available.
- Models serve as communication tools (e.g., implied volatilities) or interpolation tools (e.g., strike prices and maturities).
- Hedging performance depends on model accuracy.

9.6 Models for Less Actively Traded Products

- Models are essential for both pricing and hedging.
- Pricing risks can be managed by:
  - Using multiple models calibrated to actively traded instruments.
  - Establishing reserve accounts to delay profit recognition.
  - Using weighted Monte Carlo to identify consistent pricing models.

9.7 Marking the Prices of an Instrument to Market

- Sources include:
  - Market maker quotes.
  - Recent trades by the financial institution.
  - SEFs or interdealer brokers.
  - Price indications or models.

9.8 Accounting Standards

- FASB 157 and IASB 39 classify instruments as "held for sale" or "held to maturity."
- Mark-to-market requirements:
  - Level 1: Quoted prices in active markets.
  - Level 2: Quoted prices for similar products in active markets.
  - Level 3: Requires valuation assumptions.

9.9 Model Building Missteps

- Common issues:
  - Overfitting.
  - Overparametrization.
  - Excessive complexity, making the model unusable for its intended users.
- Simpler models, like Black-Scholes, succeed due to their practical usability.

10 Value at Risk and Expected Shortfall

10.1 The Question in VaR

"What loss level is such that we are $X\%$ confident it will not be exceeded in N business days?"

10.2 VaR and Regulatory Capital

- VaR traditionally used for calculating required regulatory capital.
- Market-risk capital: Based on a 10-day VaR with 99% confidence.
- Credit and operational risk capital: Based on a one-year 99.9% VaR.
- Recently, regulators have shifted to Expected Shortfall (ES) for market risks.

10.3 Advantages of VaR

- Captures risk in a single number.
- Easy to understand.
- Answers the question: "How bad can things get?"

10.4 VaR vs Expected Shortfall

- **VaR:** The loss level not expected to be exceeded with a given probability.
- **ES (Expected Shortfall):** Expected loss given that the loss exceeds the VaR level.
- ES is more coherent and satisfies properties such as subadditivity.
- Regulators now use ES for determining market risk capital.

10.5 Spectral Risk Measures

- Assign weights to quantiles of the loss distribution.
- VaR: All weight assigned to the X-th percentile.
- ES: Equal weight assigned to percentiles greater than the X-th percentile.
- Coherent measures require weights to be non-decreasing functions of percentiles.

10.6 Normal Distribution Assumption

- Losses/gains are assumed normally distributed with mean μ and standard deviation σ.
- VaR and ES can be calculated using:

$$VaR = \mu + \sigma Z$$

$$ES = \mu + \frac{\sigma e^{-Z^2/2}}{\sqrt{2\pi}(1 - X)}$$

- Z is the X-th percentile of the standard normal distribution.

10.7 Changing the Time Horizon

- For independent, normally distributed daily losses:

$$VaR_{T-day} = \sqrt{T} \times VaR_{1-day}$$

$$ES_{T-day} = \sqrt{T} \times ES_{1-day}$$

- With autocorrelation r, adjust by incorporating autocorrelation terms.

10.8 Aggregating VaRs

- Total VaR can be approximated using:

$$VaR_{total} = \sqrt{\sum_i VaR_i^2 + \sum_{i \neq j} \rho_{ij} VaR_i VaR_j}$$

- ρ_{ij}: Correlation between losses from segments i and j.

10.9 VaR Measures for Portfolios

- **Marginal VaR:** Sensitivity of VaR to a small change in portfolio weight.
- **Incremental VaR:** Change in VaR due to inclusion/exclusion of an asset.
- **Component VaR:** Allocates total VaR to portfolio components.

10.10 Back-testing and Bunching

- Back-testing involves checking how often losses exceed VaR (exceptions).
- Statistical tests, such as those by Christoffersen, can identify bunching (clustering of exceptions).

11 Basel I, Basel II, and Solvency II

11.1 History of Bank Regulation

- Pre-1988: Banks regulated using balance sheet measures such as capital-to-assets ratio.
- 1988: Introduction of BIS Accord (Basel I).
- 1996: Amendment to BIS Accord.
- 1999: Basel II first proposed.

11.2 1988: BIS Accord

- Capital must be at least 8% of risk-weighted assets (RWA).
- At least 50% of capital must be Tier 1 capital.

11.3 Types of Capital

- **Tier 1 Capital:** Common equity and non-cumulative perpetual preferred shares.
- **Tier 2 Capital:** Includes cumulative preferred stock, 99-year debentures, and subordinated debt with an original life exceeding 5 years.

11.4 Risk-Weighted Capital

- Risk weights assigned based on asset risk (e.g., 0% for cash, 100% for corporate loans).
- For OTC derivatives and off-balance-sheet commitments:
  - Calculate credit equivalent amount using current exposure method (CEM).
  - Apply a risk weight to the credit equivalent amount.

11.5 Netting

- Netting clauses allow OTC derivatives with a counterparty to be treated as a single transaction in case of default.
- 1995 modification to allow reduction in credit equivalent totals with bilateral netting agreements.

11.6 1996 Amendment

- Implemented in 1998.
- Required capital for market risk for all instruments in the trading book (on and off-balance-sheet).

11.7 Basel II

- Implemented in 2007.
- **Three Pillars:**
  - **Pillar 1:** New capital requirements for credit and operational risk.
  - **Pillar 2:** Supervisory review for uniform enforcement.
  - **Pillar 3:** Market discipline with increased disclosure requirements.

11.8 New Capital Requirements

- Two approaches for risk weighting:
  - **Standardized Approach:** Based on external credit ratings.
  - **IRB Approach:** Based on internal ratings (Advanced and Foundation IRB).
- Separate capital charge for operational risk.

11.9 Operational Risk Capital

- **Basic Indicator Approach:** 15% of gross income.
- **Standardized Approach:** Multiplicative factors for gross income per business line.
- **Internal Measurement Approach:** Capital equals 99.9% VaR minus expected one-year loss.

11.10 Solvency II

- Three pillars similar to Basel II:
  - **Pillar 1:** Specifies Minimum Capital Requirement (MCR) and Solvency Capital Requirement (SCR).
  - **Pillar 2:** Supervisory review.
  - **Pillar 3:** Market discipline.
- Internal models vs standardized approach.
- Capital charge for investment risk, underwriting risk, and operational risk.

12 Basel II.5, Basel III, and Other Post-Crisis Changes

12.1 Basel II.5 (Implemented December 31, 2011)

- **Stressed VaR:**
  - Calculated over a one-year period of stressed market conditions.
  - Capital requirement:

    $$Capital = \max(VaR_{t-1}, mc \times VaR_{avg}) + \max(sVaR_{t-1}, ms \times sVaR_{avg})$$
- **Incremental Risk Charge:** Ensures similar capital requirements for trading book and banking book products.
- **Comprehensive Risk Measure:** Addresses capital for instruments dependent on credit default correlations.

12.2 Basel III

- Full implementation by 2022.
- **Key Components:**
  - Capital definition and requirements.
  - Capital conservation buffer.
  - Countercyclical buffer.
  - Leverage ratio.
  - Liquidity ratios.
  - Capital for CVA (Credit Valuation Adjustment) risk.

12.3 Capital Definition and Requirements

- **Types of Capital:**
  - Common Equity Tier 1 (CET1): $\geq 4.5\%$ of RWA.
  - Tier 1: $\geq 6\%$ of RWA.
  - Tier 1 + Tier 2: $\geq 8\%$ of RWA.

12.4 Capital Buffers

- **Capital Conservation Buffer:** 2.5% extra CET1 in normal times to absorb stress losses.
- **Countercyclical Buffer:** Up to 2.5% CET1, left to national regulators, to account for cyclicality in bank earnings.

12.5 Leverage Ratio

- Minimum Tier 1 capital to total exposure ratio: $\geq 3\%$ (higher in some jurisdictions).
- Exposure includes all on-balance-sheet items, derivatives, securities financing, and off-balance-sheet items.

12.6 Liquidity Risk Ratios

- **Liquidity Coverage Ratio (LCR):** Ensures sufficient high-quality liquid assets to cover 30-day cash outflows during acute stress.
- **Net Stable Funding Ratio (NSFR):** Promotes stable funding over a one-year time horizon.

12.7 G-SIBs and D-SIBs

- **Global Systemically Important Banks (G-SIBs):**
  - Required to hold 1–3.5% additional Tier 1 capital.
  - Subject to Total Loss Absorbing Capacity (TLAC) requirements.
- **Domestic Systemically Important Banks (D-SIBs):**
  - Additional capital, disclosure, and stress testing requirements.
  - In the U.S., banks with assets over $50 billion are classified as D-SIBs.

12.8 Contingent Convertible Bonds (CoCos)

- Convert to equity under specific conditions, e.g.:
  - Tier 1 equity falls below 7% of RWA.
  - Regulatory determination of need for public sector support.

12.9 Dodd-Frank Act

- Introduced new systemic risk monitoring bodies (FSOC and OFR).
- Imposed the Volcker Rule to restrict proprietary trading.
- Required central clearing for OTC derivatives.
- Mandated "living wills" for large financial institutions.
- Increased capital requirements for Systemically Important Financial Institutions (SIFIs).
- Prohibited use of external credit ratings for regulatory purposes.

12.10 Global Regulatory Changes

- **UK:** Financial Services (Banking Reform Act) implemented in 2013.
- **European Union:** New regulations proposed in 2012 by the Liikanen Committee.

12.11 Key Issues Addressed by Regulators

- Central clearing and use of electronic trading platforms.
- Restrictions or insulation of proprietary trading from other activities.
- Enhanced transparency through living wills.
- Compensation reform (less stringent in the U.S.).