

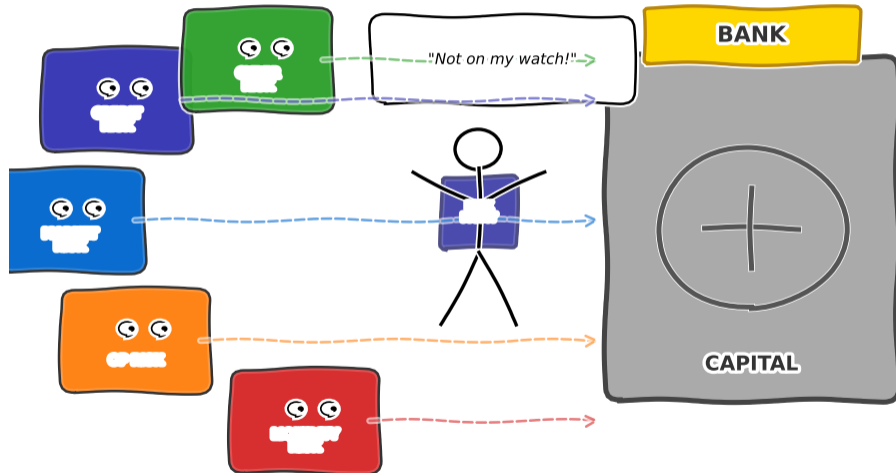
## Lesson 4.3: Institutional Risk Management

### Module 4: The Risk Problem

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Digital Finance — BSc Course

# How Banks Really Think About Risk



**Risk management: keeping ALL the threats out of the vault at once**

After completing this lesson, you will be able to:

- ① **Explain** the three pillars of the Basel III/IV framework and their purpose [Understand]
- ② **Calculate** Risk-Weighted Assets (RWA) and the Capital Adequacy Ratio (CAR) [Apply]
- ③ **Describe** the components of the regulatory capital stack (CET1, AT1, T2) [Understand]
- ④ **Apply** stress testing and scenario analysis to a bank balance sheet [Apply]
- ⑤ **Evaluate** how banks aggregate risks across credit, market, and operational categories [Analyze]

**Bloom's levels covered:** Understand, Apply, Analyze

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Objectives follow Bloom's taxonomy: Understand → Apply → Analyze.

# Bridge: From Individual Risk to Institutional Risk

## Previous lessons:

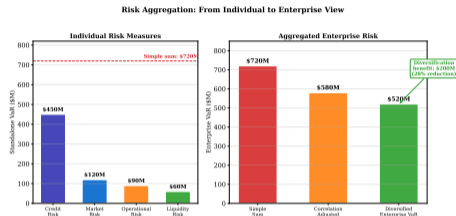
- We learned to **price** individual risks (VaR, Greeks)
- We learned to **hedge** specific exposures

## The institutional question:

- A bank faces **thousands** of risks simultaneously
- Credit, market, operational, liquidity — all at once
- How much capital does the bank need to survive?
- Who decides? How is compliance enforced?

**Central question:** We can price and hedge individual risks. How do institutions manage all risks together?

Individual risk management is necessary but not sufficient — institutions need a holistic framework.



Individual risks combine into an institution-wide risk profile.

## The Core Problem

Banks are inherently **leveraged**: they hold thin equity cushions against large asset portfolios. Without regulation, market pressure incentivizes *excessive leverage* to maximize return on equity.

### What happens without adequate capital?

- **Small losses** → **insolvency**: A 3% asset loss wipes out a bank with 3% equity
- **Contagion**: One bank's failure triggers losses at counterparties
- **Deposit runs**: Creditors flee, creating a liquidity crisis on top of a solvency crisis
- **Taxpayer bailouts**: Governments forced to rescue “too big to fail” institutions

**2008 lesson**: Major banks operated with leverage ratios of 30:1 to 50:1. When housing assets fell 5%, equity was wiped out multiple times over.

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Capital regulation forces banks to hold enough equity to absorb losses without becoming insolvent.

## The Basel Framework: A Brief History

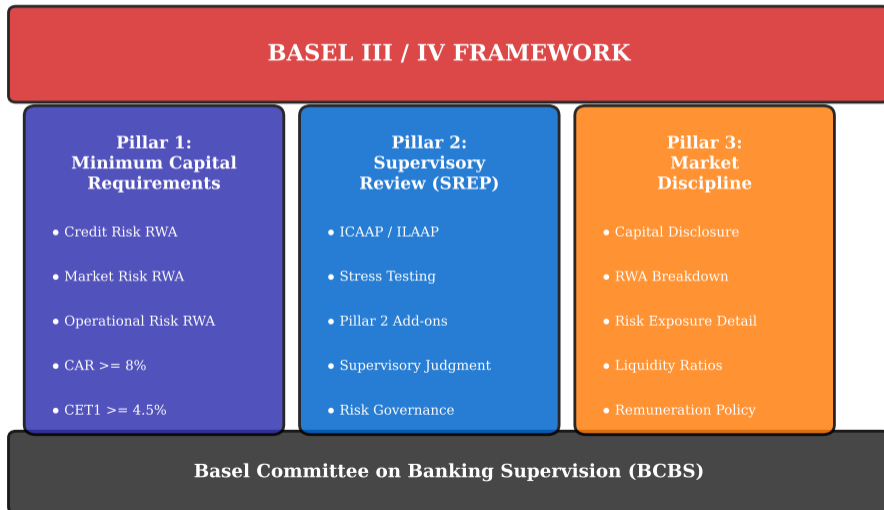
Version	Year	Key Innovation
Basel I	1988	First international capital standard; simple risk weights (0%, 50%, 100%)
Basel II	2004	Three-pillar structure; internal models allowed; operational risk added
Basel III	2010–2019	Higher capital ratios; liquidity rules (LCR, NSFR); leverage ratio
Basel III.1 / “IV”	2023+	Output floor; revised standardized approaches; reduced model reliance

**Key institution:** The Basel Committee on Banking Supervision (BCBS), hosted by the Bank for International Settlements (BIS) in Basel, Switzerland.

Basel standards are **not law**. They are recommendations adopted into national regulation (e.g., Capital Requirements Regulation / Capital Requirements Directive or CRR/CRD in the EU). In the US, Basel III was implemented by the joint 2013 Final Rule from the Federal Reserve, OCC, and FDIC (12 CFR Part 217), *not* by Dodd–Frank directly. Dodd–Frank (2010) added enhanced prudential standards for large banks (Title I) that run alongside the Basel capital stack.

Each Basel version responded to a crisis: Basel I (Latin American debt), Basel II (model innovation), Basel III (2008 GFC).

## The Three Pillars of Basel



## The Capital Adequacy Ratio (CAR)

$$\text{CAR} = \frac{\text{Regulatory Capital}}{\text{Risk-Weighted Assets (RWA)}} \geq 8\%$$

Three risk categories contribute to the denominator:

Risk Type	Measures	Typical Share of RWA
Credit risk	Borrower default losses	80–85%
Market risk	Trading portfolio losses	5–10%
Operational risk	Fraud, IT failures, legal	8–12%

$$\text{RWA}_{\text{total}} = \text{RWA}_{\text{credit}} + \text{RWA}_{\text{market}} + \text{RWA}_{\text{operational}}$$

The 8% minimum means a bank needs at least **\$8** of capital for every **\$100** of risk-weighted assets.

## Risk-Weighted Assets: Converting Exposure to Risk

**Idea:** Not all assets are equally risky. A government bond is safer than a corporate loan. Risk weights reflect this.

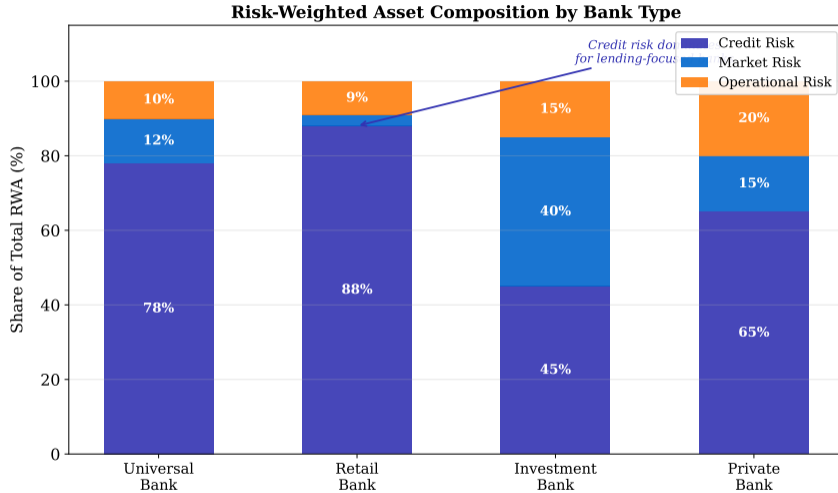
Asset Class	Risk Weight	RWA per \$100 Exposure
Cash / central bank reserves	0%	\$0
OECD sovereign bonds (AAA–AA)	0%	\$0
Claims on OECD banks	20%	\$20
Residential mortgages	35%	\$35
Corporate loans (investment grade)	50–100%	\$50–\$100
Unsecured consumer loans	75–100%	\$75–\$100
Equity investments	100–250%	\$100–\$250
Past-due loans (>90 days)	150%	\$150

**Example:** A \$10M mortgage portfolio at 35% risk weight = \$3.5M RWA. Required capital at 8%:  $\$3.5\text{M} \times 8\% = \$280,000$ .

*Historical note:* Basel I (1988–2006) assigned 0% risk weight to all OECD sovereigns. The 2012 Greek debt restructuring (53% haircut on private holdings) exposed this as a dangerous simplification. Basel III replaced blanket treatment with credit-rating-driven weights; the EU's CRR still permits 0% for EU-denominated sovereign debt (a political carve-out widely criticized).

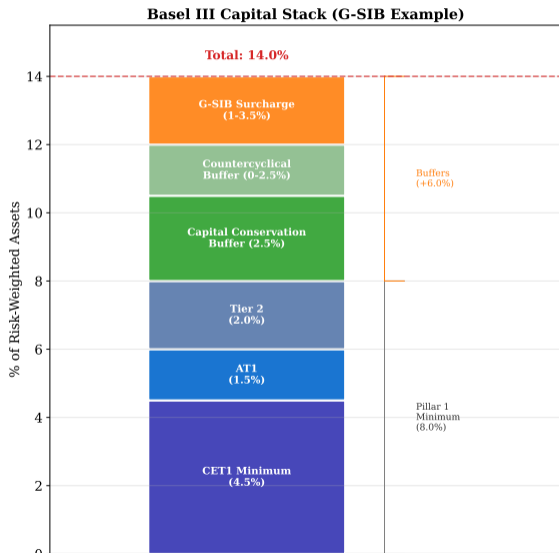
Risk weights incentivize banks to hold safer assets — but also create regulatory arbitrage opportunities.

# RWA Composition: Where Does Risk Come From?



**Key insight:** Credit risk dominates RWA for most commercial banks. Investment banks have a larger share from market risk.

# The Capital Stack: What Counts as Capital?



## Basel III minimum ratios (of RWA):

Component	
CET1 (highest quality)	
+ AT1	
+ Tier 2	
Capital conservation buffer	
Countercyclical buffer	
Global Systemically Important Bank (G-SIB) surcharge	
<b>Effective total (G-SIB)</b>	<b>1</b>

Common Equity Tier 1 (CET1) = retained earnings + common shares. Additional Tier 1 (AT1) = contingent convertible bonds.  
 Tier 2 (T2) = subordinated debt.

## CAR Calculation: Worked Example

**Scenario:** A mid-size bank has the following simplified balance sheet (synthetic data):

<b>Asset</b>	<b>Exposure (\$M)</b>	<b>Risk Weight</b>	<b>RWA (\$M)</b>
Government bonds	200	0%	0
Interbank lending	150	20%	30
Residential mortgages	400	35%	140
Corporate loans	600	100%	600
Consumer credit	100	75%	75
<b>Total</b>	<b>1,450</b>		<b>845</b>

The bank has CET1 capital of \$55M, AT1 of \$8M, and Tier 2 of \$12M.

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The bank has CET1 capital of \$55M, AT1 of \$8M, and Tier 2 of \$12M.

$$\text{CAR} = \frac{55 + 8 + 12}{845} = \frac{75}{845} = 8.88\% \quad (\text{just above the 8\% minimum})$$

$$\text{CET1 ratio} = \frac{55}{845} = 6.51\% \quad (\text{above the 4.5\% minimum})$$

**This bank meets minimums but lacks a buffer — a moderate loan loss could breach the conservation buffer.**

### Purpose

Pillar 2 ensures that banks hold capital **beyond the Pillar 1 minimum** to cover risks not fully captured by the standardized framework.

### Key components of the Supervisory Review and Evaluation Process (SREP):

- **ICAAP:** Internal Capital Adequacy Assessment Process — the bank's own risk assessment
- **ILAAP:** Internal Liquidity Adequacy Assessment Process — the bank's own liquidity assessment
- **Stress testing:** Supervisor-defined adverse scenarios the bank must survive
- **Pillar 2 add-ons:** Extra capital requirements imposed by the supervisor

**Typical Pillar 2 add-on:** 1–3% of RWA, varying by bank risk profile.

**Key principle:** If the supervisor believes a bank's internal models underestimate risk, they can demand more capital.

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Pillar 2 is where supervisory judgment supplements the mechanical calculations of Pillar 1.

### Purpose

Pillar 3 requires banks to publicly disclose detailed information about their risk exposures, capital adequacy, and risk management practices, enabling **market participants** to assess bank soundness.

#### Required disclosures include:

- Capital composition (CET1, AT1, T2) and capital ratios
- RWA by risk type and asset class
- Credit risk: exposure by geography, industry, maturity, and credit quality
- Market risk: VaR, stressed VaR, back-testing results
- Liquidity: LCR and NSFR ratios
- Remuneration policies for senior management

**Logic:** If investors and analysts can see a bank's true risk profile, they will demand higher returns from riskier banks, creating a **market-based incentive** for prudent risk management.

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Pillar 3 turns risk information into a competitive signal — well-managed banks should benefit from lower funding costs.

# Credit Risk: From Single Loan to Portfolio

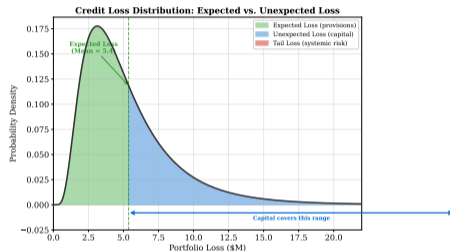
## Single loan risk factors:

- **PD:** Probability of Default (e.g., 2% annual)
- **LGD:** Loss Given Default (e.g., 40%)
- **EAD:** Exposure at Default (e.g., \$1M)
- **Expected Loss** =  $PD \times LGD \times EAD$

## Portfolio considerations:

- **Correlation:** Do borrowers default together? (systemic risk)
- **Concentration:** How much exposure to a single borrower, industry, or region?
- **Diversification:** A well-diversified portfolio has lower unexpected losses

**Key insight:** Expected losses are covered by **loan loss provisions** (pricing). Unexpected losses are covered by **capital**. Extreme losses require **systemic intervention**.



The fat tail is what capital must cover.

Capital exists to absorb unexpected losses — the tail of the credit loss distribution.

# Credit Loss Distribution: Expected vs. Unexpected



- Expected Loss (EL): The mean of the loss distribution — priced into loan spreads

## Definition: Stress Test

A **stress test** evaluates a bank's capital adequacy under hypothetical adverse economic scenarios. It answers: "If conditions deteriorate sharply, does the bank still have enough capital?"

### Major supervisory stress test programs:

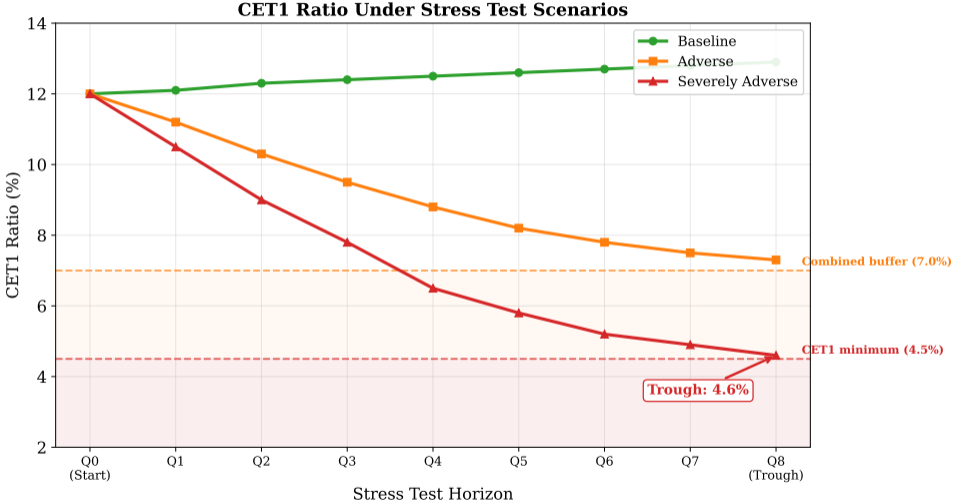
Program	Jurisdiction
Comprehensive Capital Analysis and Review (CCAR) / Dodd-Frank Act Stress Tests (DFAST)	United States (Federal Reserve)
EBA Stress Test	European Union
BoE Stress Test	United Kingdom

### Typical adverse scenario elements:

- GDP decline of 3–6% over two years
- Unemployment increase of 3–5 percentage points
- Equity market decline of 30–50%
- Interest rate shock (sudden rise or prolonged low rates)
- Real estate price decline of 20–30%

Stress tests are forward-looking — they ask “what if?” rather than relying on historical patterns.

# Stress Test Impact: How Capital Erodes Under Stress



The stress test reveals how quickly capital erodes — banks that breach minimum CET1 must raise capital or reduce risk.

## Scenario Analysis vs. Stress Testing

Dimension	Stress Test	Scenario Analysis
Purpose	Regulatory compliance; “can you survive this?”	Strategic planning; “what should we do if. . .?”
Scenarios	Prescribed by supervisor	Designed internally by the bank
Scope	Typically macro-economic shocks	Can include geopolitical, technology, or climate risks
Output	CET1 ratio at trough	Strategic recommendations and contingency plans
Frequency	Annual/biennial	Ongoing

### Common scenario types:

- **Historical:** Replay a past crisis (e.g., 2008 GFC, 2020 COVID)
- **Hypothetical:** Design a plausible future crisis (e.g., cyber-attack on payment systems)
- **Reverse stress test:** “What scenario would cause the bank to fail?” — work backwards

Reverse stress tests are especially powerful: they reveal hidden vulnerabilities by starting from failure.

## Definition (Basel)

**Operational risk** is the risk of loss resulting from inadequate or failed internal processes, people, and systems, or from external events. It includes legal risk but excludes strategic and reputational risk.

## Operational Risk Event Type Taxonomy



## Definition

A **Key Risk Indicator (KRI)** is a metric used to monitor changes in risk exposure or the effectiveness of controls. KRIs provide early warning signals *before* losses materialize.

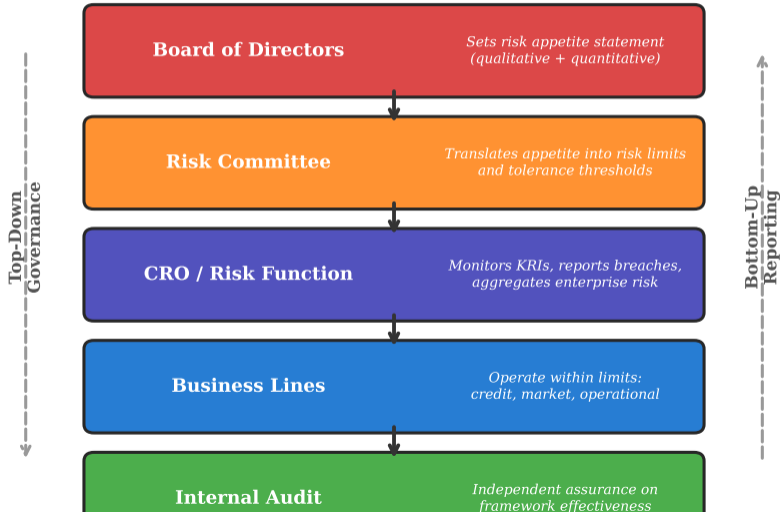
## Examples by risk category:

Risk Type	KRI Example	Threshold
Credit	Non-performing loan (NPL) ratio	>5% = warning
Credit	Loan loss provision coverage	<80% = warning
Market	VaR breaches per quarter	>3 = investigate
Operational	Number of IT incidents/month	>10 = escalate
Operational	Staff turnover in risk functions	>20% annual = concern
Liquidity	LCR	<110% = watch list

**Risk appetite:** KRI thresholds are set according to the bank's **risk appetite statement** — the level of risk the board is willing to accept.

KRIs are leading indicators — they warn of trouble before it appears in financial statements.

## Risk Appetite Framework: Governance Cascade

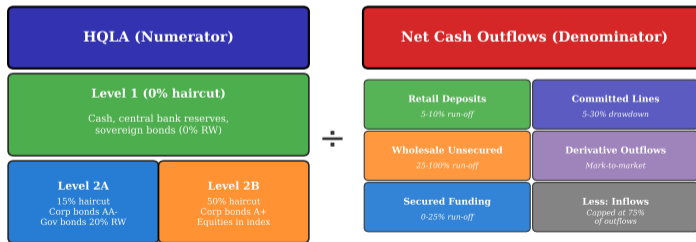


# Liquidity Risk: The Liquidity Coverage Ratio (LCR)

## Definition: LCR

$$\text{LCR} = \frac{\text{High-Quality Liquid Assets (HQLA)}}{\text{Total Net Cash Outflows over 30 days}} \geq 100\%$$

**Purpose:** Ensure the bank has enough liquid assets to survive a **30-day severe stress scenario** (deposit run, market freeze, credit downgrade).



L2 total capped at 40% of HQLA; L2B capped at 15%

$$\text{LCR} = \text{HQLA} / \text{Net Cash Outflows (30 days)} \geq 100\%$$

# The Net Stable Funding Ratio (NSFR)

## Definition: NSFR

$$\text{NSFR} = \frac{\text{Available Stable Funding (ASF)}}{\text{Required Stable Funding (RSF)}} \geq 100\%$$

**Purpose:** Ensure the bank's **long-term** asset–liability structure is sustainable. Prevents excessive reliance on short-term wholesale funding.

Funding Source	ASF Factor	Rationale
Regulatory capital	100%	Permanent
Retail deposits (>1 year)	95%	Very stable
Retail deposits (<1 year)	90%	Stable (insured)
Wholesale funding (>1 year)	50%	Less stable
Wholesale funding (<6 months)	0%	Volatile — not counted

**Complementary pair:** LCR ensures **short-term** survival (30 days). NSFR ensures **structural** funding stability (1 year+).

NSFR addresses the maturity mismatch problem: banks borrow short and lend long.

## LCR Calculation: Worked Example

**Scenario:** A bank holds the following liquid assets and faces these 30-day outflow assumptions (synthetic data):

	<b>Asset</b>	<b>Value (\$M)</b>
<b>HQLA:</b>	Government bonds (L1)	80
	Corporate bonds AA (L2A)	30
	Equities in major index (L2B)	10
	<b>Total HQLA</b>	<b>120</b>

L2A receives a 15% haircut; L2B receives a 50% haircut.

<b>30-day net outflows:</b>	
<b>Source</b>	<b>Outflow (\$M)</b>
Retail deposits (5% run-off)	25
Wholesale unsecured (40%)	60
Committed credit lines (10%)	15
<b>Total outflows</b>	<b>100</b>

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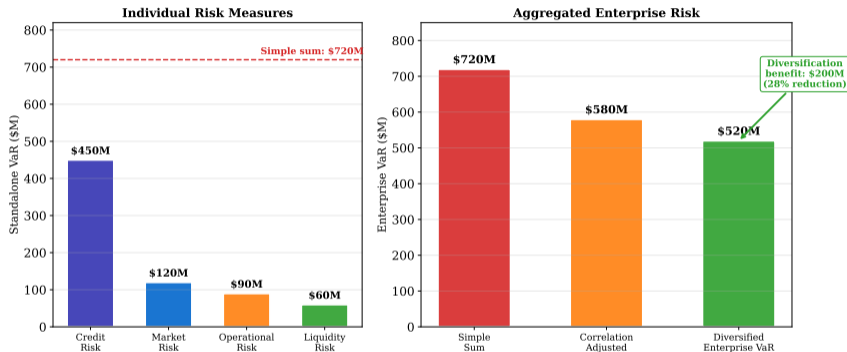
**Adjusted HQLA:**  $\$80 + \$30 \times 0.85 + \$10 \times 0.50 = \$80 + \$25.5 + \$5 = \$110.5\text{M}$

$$\text{LCR} = \frac{110.5}{100} = 110.5\% \quad (\text{above } 100\% \text{ minimum})$$

The bank can survive a 30-day stress scenario with a 10.5% buffer above the regulatory minimum.

# Risk Aggregation: Combining All Risks

## Risk Aggregation: From Individual to Enterprise View



### Challenges in risk aggregation:

- **Correlation:** Risks are not independent — credit and market risk spike together in a crisis
- **Non-linearity:** Tail risks do not add linearly;  $VaR(A + B) \neq VaR(A) + VaR(B)$
- **Data gaps:** Operational risk events are sparse; historical data is limited
- **Model risk:** Aggregation models themselves introduce uncertainty

Simple summation of individual risk measures overestimates total risk (ignores diversification) but is conservative.

**Setup.** Credit Suisse reported a CET1 ratio of 14.1% on 9 March 2023, well above the Basel III minimum. Six trading days later it ceased to exist as an independent institution.

### Timeline (10–19 March):

- 10 March: SVB fails (US), regional-bank confidence shock spreads
- 14 March: Annual report cites “material weaknesses” in internal controls
- 15 March: Saudi National Bank chair says he “absolutely will not” inject more capital. Shares fall 24% intraday
- 16 March: SNB extends CHF 50bn (*SNB press release 16 Mar, 2023*) liquidity line
- 19 March (Sunday): FINMA and the Federal Council invoke emergency law; UBS acquires Credit Suisse for CHF 3bn (*Federal Council statement 19 Mar, 2023*)

### Numbers that matter:

- Deposit outflows in Q4 2022 alone: CHF 110bn (*Credit Suisse 4Q22 results, 2024*)
- AT1 instruments fully written down: CHF 16bn (*FINMA decree 19 Mar, 2023*)
- AT1 holders ranked below equity, breaking the textbook seniority order
- Federal guarantee to UBS: up to CHF 9bn (*Federal Council statement 19 Mar, 2023*) for losses on a defined portfolio
- Liquidity backstop: up to CHF 100bn (*SNB press release 19 Mar, 2023*), with additional public-liquidity-backstop framework

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Sources: FINMA decree of 19 March 2023; Swiss Federal Council press conference 19 March 2023; SNB press releases 16 + 19 March 2023; Credit Suisse 4Q22 financial report.

### Why a fully-compliant bank still failed.

- **Solvency vs. liquidity.** CET1 measured 14.1% on 9 March; LCR measured well above 100%. Neither captures depositor confidence. Once confidence broke, deposit outflows compressed the LCR within days
- **Concentration of confidence.** Saudi National Bank (10% holder) signalling no further support functioned as a coordinating event for institutional withdrawals; capital ratios cannot price this
- **AT1 contractual reading.** Swiss AT1 prospectuses allowed write-down without equity zeroing; FINMA invoked that clause. Bondholders sued in London, New York, and Singapore (Articles 5a + 21 Banking Act, Federal Decree 13.030)
- **Resolution speed.** The Single Resolution Mechanism playbook (PONV trigger + bail-in + bridge bank) was bypassed in favour of a state-assisted merger weekend

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Take-away: Basel ratios are necessary, not sufficient. The 2023 episode triggered the “too big to fail” Swiss expert-group reform package (April 2024 report).

## What changed in Swiss banking supervision after March 2023.

- 1 **TBTF reform package** (Federal Council April 2024 report on bank stability) proposed: stronger capital for the parent of a global systemically important bank, public-liquidity-backstop framework in law, broader FINMA fining powers
- 2 **AT1 redrafting**: European Single Resolution Board issued joint statement (20 March 2023) clarifying equity-first hierarchy under the EU BRRD; Swiss decision remained an outlier
- 3 **Capital-add-on for UBS**: the merged entity (post-2023) carries roughly USD 1.7T (*UBS group reporting, 2023*) on its balance sheet relative to Swiss GDP of CHF 800bn (*Swiss Federal Statistical Office, 2023*); concentration risk to the sovereign is now the headline question
- 4 **Open question**: did the resolution preserve financial stability at the cost of property-rights certainty for hybrid-capital investors? Litigation is still active in 2026

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Sources: Federal Council "TBTF" report April 2024; SRB-EBA-ECB joint statement 20 March 2023; UBS group reporting 2023; Swiss Federal Statistical Office.

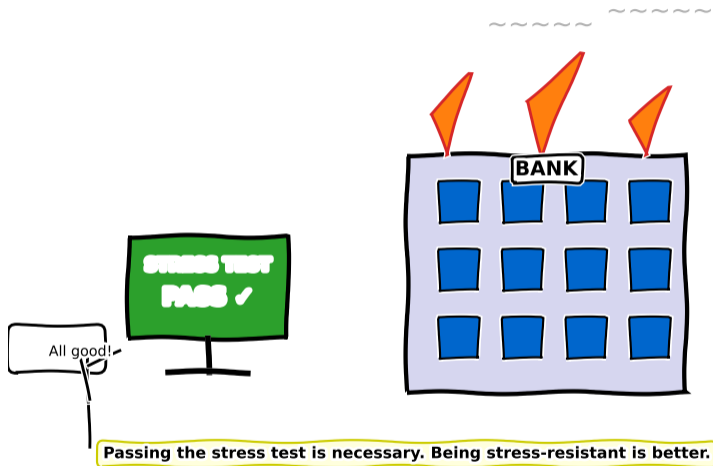
### Key reforms in the 2023+ revision:

- ① **Output floor (72.5%):** Internal-model RWA cannot be less than 72.5% of the standardized approach RWA
  - Prevents banks from using models to artificially reduce capital requirements
  - Levels the playing field between simple and sophisticated banks
- ② **Revised standardized approach:** More granular risk weights for credit risk
- ③ **Revised market risk framework (FRTB):** Fundamental Review of the Trading Book
  - Moves from VaR to **Expected Shortfall (ES)** as the primary risk measure
  - Better captures tail risk
- ④ **Standardized approach for operational risk:** Replaces internal models with a single standardized method based on a bank’s income and loss history

**Impact:** Large banks with aggressive internal models face the largest capital increases (10–30%).

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The output floor is the most significant reform: it sets a minimum “floor” below which model-based capital cannot fall.



Sometimes the best way to remember a concept is to laugh about it.

- 1 **Basel III/IV** is the global framework for bank capital regulation, built on **three pillars**: minimum capital, supervisory review, and market discipline
- 2 The **Capital Adequacy Ratio (CAR)** =  $\text{Regulatory Capital} / \text{RWA} \geq 8\%$  — but effective requirements reach 11.5–16% for large banks
- 3 **Risk-Weighted Assets** convert gross exposures into risk-adjusted equivalents using risk weights (0%–250%)
- 4 **CET1 capital** (common equity) is the highest-quality loss absorber and the most closely watched ratio
- 5 **Stress testing** evaluates bank survival under adverse scenarios; reverse stress tests identify breaking points
- 6 **Operational risk** covers process, people, system, and external event failures — hardest to model
- 7 **LCR** ensures 30-day liquidity survival; **NSFR** ensures long-term funding stability
- 8 **Basel III.1 output floor** limits the benefit banks derive from internal models

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Institutional risk management integrates credit, market, operational, and liquidity risk under a unified regulatory framework.

**This lesson:** We examined how institutions manage risk holistically through the Basel framework, capital requirements, stress testing, and liquidity ratios.

### Key vocabulary:

- Basel III / Basel IV
- Three pillars
- Capital Adequacy Ratio (CAR)
- Risk-Weighted Assets (RWA)
- CET1, AT1, Tier 2
- Stress testing / CCAR
- Scenario analysis / reverse stress test
- Operational risk / KRI
- Liquidity Coverage Ratio (LCR)
- Net Stable Funding Ratio (NSFR)
- Risk appetite framework
- Output floor (72.5%)

**Next lesson (M4L4): *Technology Risk and Cyber Resilience*** — We will examine how digital transformation creates new risk categories: cyber risk, third-party/vendor risk, cloud concentration, and the emerging regulatory frameworks (DORA, NIST) that address them.

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**Review:** Can you calculate a bank's CET1 ratio and LCR from balance sheet data?

## What happened

- Family office run by Bill Hwang built large concentrated positions via total-return swaps
- Swaps mask the underlying position from public 13F disclosure: prime brokers each saw only their slice
- ViacomCBS secondary offering 22 March 2021 broke the price; margin calls cascaded across brokers
- Credit Suisse lost USD 5.5bn (*Paul, Weiss independent report July, 2021*)
- Nomura lost USD 2.9bn (*Nomura FY21 results, 2024*); Morgan Stanley and Goldman exited faster with smaller losses

## Why it matters here

- Worked example of M4L3 institutional risk: counterparty + concentration + leverage interact non-linearly
- Shows why Basel III added the Standardised Approach for Counterparty Credit Risk (SA-CCR)
- Direct contributor to the Credit Suisse decline that culminated in the March 2023 takeover

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Full writeup: [v4/cases/case\\_M4\\_archegos.md](#). Host: M4 L3 Institutional Risk.

- Family-office regulatory perimeter: Dodd-Frank exemptions left Archegos outside SEC adviser registration
- Prime-brokerage disclosure: each broker's risk model under-counted aggregate exposure
- Total-return swaps replicate equity exposure without 13F filing; the SEC's 2023 swap-reporting amendments respond directly
- Risk-control quality is observable post-hoc: brokers that called margin earliest lost least

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See also: **M4 L3 Institutional Risk; full writeup at [v4/cases/case\\_M4\\_archegos.md](#).**

**Attempt these before turning the page.**

- 1 [Understand] Distinguish CET1 capital from Tier 2 capital. Why is CET1 considered “loss-absorbing” in stress?
- 2 [Apply] Bank has: CET1 \$8B, AT1 \$2B, Tier 2 \$1B, Risk-Weighted Assets (RWA) \$100B. Compute CET1 ratio, Tier 1 ratio, and Total Capital ratio. Does the bank meet Basel III minimums (4.5%, 6%, 8% + 2.5% conservation buffer)?
- 3 [Evaluate] Credit Suisse (March 2023) was fully CET1-compliant days before collapse. What does this say about CET1 ratios as a stability signal?

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Solutions hidden unless `\solutionstrue` is set before compiling.