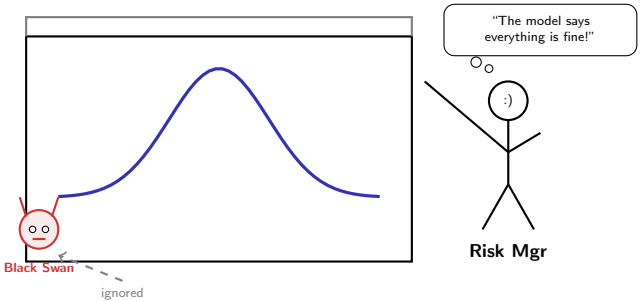
Risk Management & Regulation

Lesson 07

Digital Finance



The model says everything is fine. The tail says otherwise.

Learning Objectives

By the end of this lesson, you will be able to:

1. Identify and classify the major types of financial risk (market, credit, operational, liquidity)
2. Explain statistical foundations (distributions, mean, standard deviation, confidence levels) needed for risk measurement
3. Interpret Value at Risk (VaR) and Expected Shortfall (ES) at a conceptual level
4. Describe the Basel III regulatory framework and explain why banks are regulated
5. Evaluate how digital technology is transforming risk management practices

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This lesson builds the foundations for understanding how banks measure, manage, and are regulated for risk.

What Is the Difference Between Risk and Uncertainty?

Banks make money by taking risks. But when they take too much risk, the bill is paid by depositors, taxpayers, and the entire economy.

Risk vs. uncertainty: The Knightian distinction

- **Risk** (measurable): Probability distributions are known or estimable
- **Uncertainty** (unmeasurable): Probabilities unknown or unknowable
- Financial risk management assumes we can measure and price risk

Why risk management matters: Bank failures create systemic damage

- **Negative externalities** from Lesson 04 (information asymmetry, market failure)
- Individual bank's risk-taking can harm entire financial system
- **2008 Global Financial Crisis:** Lehman collapse triggered worldwide recession
- Risk management is both private concern (profitability) and public concern (stability)

Risk is measurable uncertainty – and the 2008 crisis showed we were measuring it poorly.

Why Are Banks the Most Heavily Regulated Firms?

Banks are special: Four reasons for heavy regulation

1. **Hold deposits (principal-agent problem):** Banks use other people's money
   - Depositors lack expertise to monitor bank risk-taking
   - Information asymmetry creates moral hazard (risk shifting)
2. **Interconnected (systemic risk):** Interbank lending creates contagion channels
   - One bank's failure can cascade through the system
   - "Too big to fail" externality
3. **Deposit insurance creates moral hazard:** Protection reduces depositor monitoring
   - If deposits are insured, why would depositors discipline banks?
   - Banks then take excessive risk (moral hazard from Lesson 04)
4. **Failures create externalities:** Credit crunch, unemployment, recession

Prudential regulation aligns bank behavior with social welfare

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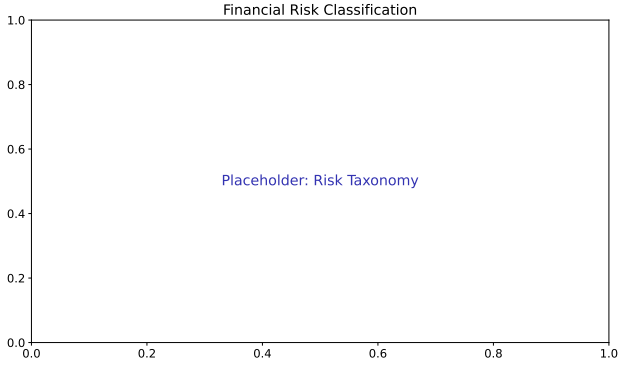
Banks are the most heavily regulated firms in the economy – these four reasons explain why.

How Do the Four Types of Financial Risk Interact?



Four major risk types:

- **Market risk:** Losses from adverse price movements (interest rates, FX, equities, commodities)
- **Credit risk:** Losses from borrower default or credit quality deterioration
- **Operational risk:** Losses from failed processes, systems, people, or external events
- **Liquidity risk:** Inability to meet obligations when due, or forced asset sales at fire-sale prices

Key insight: These risks are interconnected – operational failures can trigger liquidity crises, which then create credit events

These four risk types interact – operational failures can trigger liquidity crises and credit events.

How Do You Calculate Expected Loss on a Loan?

A bank holds CHF 1 million in corporate loans. If the borrower defaults, how much does the bank lose? It depends on three numbers that every risk manager memorizes.

Market risk (price risk): Losses from adverse movements in market prices

- **Interest rate risk:** Bond portfolio value falls when rates rise
- **FX risk:** Losses on foreign currency positions from exchange rate changes
- **Equity risk:** Stock price declines
- **Commodity risk:** Oil, gold, agricultural products (less common for banks)

Credit risk (default risk): Three key components determine credit loss

- **PD** (probability of default): Likelihood borrower fails to repay
- **LGD** (loss given default): Fraction lost if default occurs (1 – recovery rate)
- **EAD** (exposure at default): Amount outstanding when default happens
- **Expected loss** = PD $\times$ LGD $\times$ EAD

Example: CHF 1M loan, PD = 2%, LGD = 40%, EAD = CHF 800k $\Rightarrow$ Expected loss = $0.02 \times 0.40 \times 800\text{k}$ = CHF 6,400

Expected loss = PD $\times$ LGD $\times$ EAD – this simple multiplication underlies all credit risk management.

Can a Bank Run Become a Self-Fulfilling Prophecy?

Operational risk (process risk): Losses from failures in people, processes, or systems

- **Failed processes:** Settlement errors, accounting mistakes, control breakdowns
- **Cyberattacks:** Data breaches, ransomware, system outages
- **Fraud:** Rogue trading (Nick Leeson, Barings 1995), employee theft
- **Human error:** "Fat finger" trades, compliance violations
- **Legal risk:** Lawsuits, regulatory fines
- Growing importance: cyberattacks now dominate operational risk landscape

Liquidity risk (funding risk): Two types

- **Funding liquidity risk:** Inability to roll over short-term debt or meet withdrawals
- **Market liquidity risk:** Inability to sell assets without large price concessions
- **Bank run dynamics:** Self-fulfilling prophecy (Diamond-Dybvig model)
  - If enough depositors believe bank will fail, they withdraw
  - Withdrawals force asset fire sales, creating losses, confirming beliefs

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Liquidity risk can be self-fulfilling – if enough depositors believe a bank will fail, it will.

Why Do Risk Managers Need Statistics?

Why statistics? To measure risk, we need to quantify uncertainty

Distribution (probability distribution): Shows all possible outcomes and their likelihoods

- Horizontal axis: possible returns or losses
- Vertical axis: how likely each outcome is
- Area under curve sums to 100% (all probabilities)

Mean (μ): Center of distribution = **expected outcome**

- The average return if we repeat the investment many times
- Mean = 5% means we expect 5% return on average

Standard deviation (σ): Spread of distribution = **risk**

- Measures how far outcomes typically deviate from the mean
- **Larger σ = more uncertainty = more risk**
- Two assets with 5% expected return: one with $\sigma = 2\%$, other $\sigma = 20\%$
- The second is far riskier (wider range of possible outcomes)

Standard deviation measures risk – wider distributions mean more uncertain outcomes.

Why Do Risk Managers Care Most About the Tails?

Confidence level: Statistical statement about likelihood of outcome

Example interpretation: "I am 95% confident losses will not exceed CHF 10M"

- Means: In 95 out of 100 days, losses $\leq$ CHF 10M
- But in 5 out of 100 days, losses WILL exceed CHF 10M
- We don't know WHICH 5 days, or HOW BAD those days will be

Tail risk: Extreme outcomes in the "tails" of the distribution

- **Left tail:** Large losses (what risk managers care about)
- **Right tail:** Large gains (less concerning)
- **Financial crises happen in the tails:** 2008, COVID-19, 2022 crypto winter
- Models often underestimate tail risk ("fat tails" vs. normal distribution assumption)

Visual: Bell curve with shaded 5% left tail beyond threshold

- 95% of outcomes inside threshold (calm days)
- 5% of outcomes beyond threshold (crisis days) $\leftarrow$ this is what we measure

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Risk managers care most about the tails – because that is where crises happen.

How Bad Could a Normal Bad Day Get?

Your bank's CEO asks: "How much could we lose tomorrow?" You need to answer with a single number that captures the entire portfolio's risk — and that number is VaR.

Value at Risk (VaR): Maximum potential loss over a time horizon at a given confidence level

Conceptual definition using scaffolding:

- "I am X% confident that losses will not exceed \$Y over Z days"
- VaR is the threshold \$Y that makes this statement true

Example: 1-day 95% VaR of CHF 10M means:

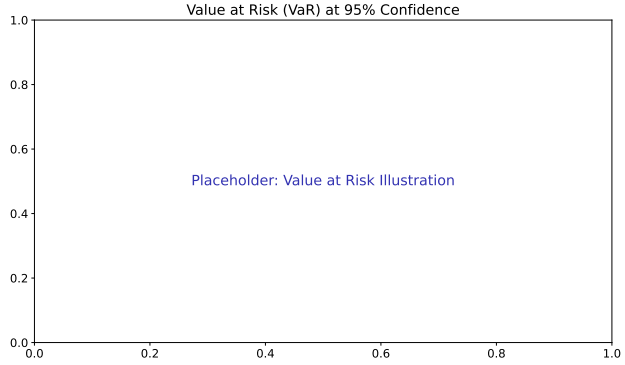
- Time horizon: 1 day
- Confidence level: 95%
- Maximum loss (with 95% confidence): CHF 10M
- **Interpretation:** "95% confident we will not lose more than CHF 10M in one day"
- Or equivalently: "On 19 out of 20 days, losses will be $\leq$ CHF 10M"

Three key parameters:

1. **Time horizon** (1 day, 10 days, 1 month): How long we hold the position
2. **Confidence level** (90%, 95%, 99%): How confident we want to be
3. **Loss amount** (CHF 10M): The VaR threshold

VaR answers: how bad could it get on a normal bad day? But it says nothing about catastrophic days.

Which VaR Method Should You Use – and Why?



Visual interpretation:

- Distribution of portfolio returns or losses
- VaR threshold marks 5th percentile (95% confidence)
- 95% of outcomes to the right (smaller losses or gains)
- 5% of outcomes to the left (larger losses) ← tail risk

Three approaches to calculating VaR:

1. **Historical:** Past 250 days, find 5th percentile
   - Pro: No assumptions; Con: Past $\neq$ future
2. **Parametric:** Assume normal distribution
   - Pro: Fast; Con: Underestimates tails
3. **Monte Carlo:** Generate 10,000 scenarios
   - Pro: Flexible; Con: Computationally intensive

Each VaR method makes different assumptions – the choice depends on the data available.

If VaR Is the Cliff Edge, How Far Is the Fall?

VaR limitation: Tells us the threshold, but nothing about HOW BAD things get beyond it

- 95% VaR = CHF 10M means: 5% chance of exceeding CHF 10M
- But in those worst 5% of cases, is the loss CHF 11M or CHF 100M?
- VaR is silent on this – dangerous for tail risk

Expected Shortfall (ES) (also called **Conditional VaR** or **CVaR**):

- **Conceptual definition FIRST:** "If VaR is the cliff edge, ES tells you how far the fall is"
- ES = average loss in the worst α% of cases
- Answers: "Given we are in the bad tail, how bad is it on average?"

Formula:

$$\text{ES}_\alpha = \mathbb{E}[\text{Loss} \mid \text{Loss} > \text{VaR}_\alpha]$$

Example: 95% VaR = CHF 10M, 95% ES = CHF 15M

- 95% of days, losses $\leq$ CHF 10M
- In worst 5% of days, average loss is CHF 15M

Regulatory preference: Basel Committee shifted from VaR to ES (Basel III.1, 2023+)

ES is now preferred by regulators because it captures the severity of tail losses, not just their threshold.

What Happens When Model Assumptions Break Down?

VaR tells you about normal bad days. But 2008, COVID, and SVB were not normal bad days. What if the assumptions behind your model break down?

Stress testing: Evaluate portfolio performance under extreme but plausible scenarios

- Goes beyond VaR and ES (which assume normal market conditions)
- Asks: "What if our model assumptions break down?"

Types of scenarios:

- **Historical scenarios:** Re-run past crises
  - 2008 Global Financial Crisis (Lehman collapse, credit freeze)
  - COVID-19 pandemic (March 2020 market crash)
  - SVB collapse (March 2023): +200bps rate shock + deposit flight
- **Hypothetical scenarios:** Designer stress events
  - +300bps interest rate shock
  - 30% equity market crash + credit spread widening
  - Simultaneous FX, equity, and credit shocks

Regulatory requirement:

- Basel III: Banks must conduct regular stress tests
- Supervisors (FINMA, EBA, Fed) run parallel stress tests
- Results inform capital buffer requirements (Pillar 2)

Stress tests complement VaR: VaR = normal bad day, stress test = catastrophic day

Stress tests ask: what happens if the assumptions behind our VaR model break down?

How Do You Know If Your Risk Model Is Any Good?

Backtesting: Compare VaR predictions to actual losses over time

- **Purpose:** Verify that the risk model is accurate
- If 95% VaR is correct, we should see breaches (actual loss $>$ VaR) on 5% of days
- If breaches happen more often, model **underestimates risk** (dangerous)
- If breaches happen less often, model **overestimates risk** (costly, ties up capital)

Traffic light system (Basel regulation):

- **Green zone:** 0–4 breaches in 250 days (expected: 12–13 for 95% VaR)
- **Yellow zone:** 5–9 breaches $\rightarrow$ model suspect, supervisor investigates
- **Red zone:** 10+ breaches $\rightarrow$ model clearly wrong, higher capital charges

Key insight: Backtesting is retrospective validation

- Requires at least 250 days of data for statistical significance
- Model may still fail in unprecedented crisis (tail risk)

Backtesting is the reality check – a model that consistently underestimates risk is worse than no model.

Why Does Every Basel Accord Follow a Crisis?

After every major financial crisis, regulators write new rules. Latin American debt crisis gave us Basel I. The 2008 crash gave us Basel III. Each crisis exposed gaps in the previous framework.

Basel Committee on Banking Supervision (BCBS): International regulatory body (1974–)

- No legal authority, but member countries implement its standards
- Secretariat at Bank for International Settlements (BIS), Basel, Switzerland

Evolution of Basel Accords – each triggered by a crisis:

Accord	Year	Key Innovation & Crisis Trigger
Basel I	1988	Minimum capital ratio 8% (Tier 1 + Tier 2) / RWA. Triggered by Latin American debt crisis (1980s)
Basel II	2004	Three Pillars: (1) risk-sensitive capital, (2) supervisory review, (3) market discipline. More sophisticated risk weights
Basel III	2010	Response to 2008 GFC: higher capital quality (CET1), liquidity rules (LCR, NSFR), leverage ratio
Basel III.1 / IV	2023+	Finalizes Basel III reforms: ES replaces VaR for market risk, output floor, operational risk framework

Pattern: Each iteration tightens rules in response to observed failures

Each Basel iteration was triggered by a crisis that exposed gaps in the previous framework.

How Do Three Pillars Work Together to Keep Banks Safe?

Pillar 1: Minimum Capital Requirements

- **CET1 (Common Equity Tier 1):** 4.5% of RWA (risk-weighted assets)
  - Highest quality capital: common shares + retained earnings
  - Can absorb losses while bank remains going concern
- **Tier 1 capital:** 6% of RWA (CET1 + Additional Tier 1)
- **Total capital:** 8% of RWA (Tier 1 + Tier 2)
- **Capital conservation buffer:** +2.5% CET1 (total CET1 requirement: 7%)
- **Countercyclical buffer:** 0–2.5% (activated in booms)
- **G-SIB surcharge:** +1–3.5% for systemically important banks

Pillar 2: Supervisory Review Process

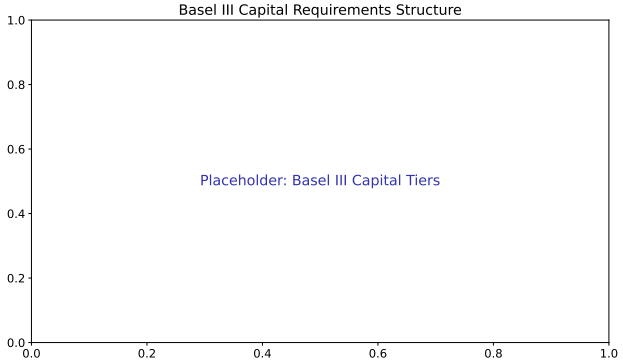
- **ICAAP** (Internal Capital Adequacy Assessment Process): Bank's own risk assessment
- **SREP** (Supervisory Review and Evaluation Process): Supervisor evaluates ICAAP
- Supervisor can impose Pillar 2 add-ons if Pillar 1 insufficient

Pillar 3: Market Discipline

- Mandatory public disclosure of capital, risk exposures, governance
- Transparency reduces information asymmetry, empowers market monitoring

The three pillars work together: minimum standards, supervisory judgment, and market transparency.

How Much Capital Must a Bank Hold – and Why?



Capital stack visualization:

- **CET1 (4.5%):** Core equity, loss-absorbing
- **AT1 (1.5%):** Perpetual bonds (convert in crisis)
- **Tier 2 (2%):** Subordinated debt
- **Buffers (+2.5 to +8.5%):** Conservation, countercyclical, G-SIB

Total requirement: 8–15.5% depending on buffers

Key insight: Capital absorbs losses BEFORE depositors harmed

- Loss waterfall: shareholders $\rightarrow$ AT1 $\rightarrow$ Tier 2 $\rightarrow$ depositors

Why risk-weighted?

- RWA adjusts for asset risk: govt bonds = 0%, corporate loans = 100%
- Less capital needed for safer assets

Capital buffers absorb losses before depositors are harmed – they are the first line of defense.

Can a Bank Survive 30 Days Without New Funding?

New in Basel III: Quantitative liquidity standards (2008 crisis revealed liquidity risk)

1. Liquidity Coverage Ratio (LCR): Survive 30-day stress

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

- **HQLA:** Cash, central bank reserves, government bonds (can be sold immediately)
- **Net cash outflows:** Deposits withdrawn – new funding in stress scenario
- **Interpretation:** Bank must hold enough liquid assets to survive 30 days without new funding

2. Net Stable Funding Ratio (NSFR): Structural funding over 1 year

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

- **ASF:** Long-term deposits, long-term debt (stable funding sources)
- **RSF:** Illiquid assets (long-term loans) require stable funding
- **Interpretation:** Prevents maturity mismatch (borrow short, lend long)

Swiss context: FINMA "Swiss finish" – stricter than Basel minimums

- UBS, Credit Suisse (before collapse): higher capital and liquidity buffers

Switzerland's 'Swiss finish' means Swiss banks must hold more capital and liquidity than Basel minimums.

How Does MiFID II Protect Investors Across Europe?

A broker routes your stock order to a trading venue that pays them a kickback. MiFID II says that's not allowed — and it goes much further in protecting investors.

MiFID II (Markets in Financial Instruments Directive II, 2018): EU investor protection

- **Objective:** Transparency, competition, investor protection
- Applies to investment firms, trading venues, financial instruments

Key provisions:

1. **Pre- and post-trade transparency:** Publish quotes and trade prices
   - Reduces information asymmetry (Lesson 04 theme)
   - Makes markets more efficient
2. **Best execution:** Firms must obtain best possible price for clients
3. **Product governance:** Identify target market before selling products
4. **Inducements:** Restrictions on commissions and kickbacks (reduces conflicts of interest)
5. **Algorithmic trading:** Disclosure and safeguards for algo and HFT

Other EU regulation:

- **GDPR** (General Data Protection Regulation): Data privacy (Lesson 06)
- **DORA** (Digital Operational Resilience Act): Cyber and operational risk (see Frame 20)
- **SFDR** (Sustainable Finance Disclosure Regulation): ESG disclosure

MiFID II is the most comprehensive investor protection regulation in the world.

What Changed When Research Was Unbundled from Trading?

Theory: MiFID II (2018) is the most comprehensive securities regulation globally. Key provisions beyond basic transparency:

Research unbundling:

- Investment banks must separate research from execution fees
- No more "free" research bundled with trading commissions
- Impact: independent research providers emerged; buy-side pays explicitly
- Reduces conflict of interest (principal-agent problem from L04)

Additional provisions:

- **Systematic internaliser regime:** Firms executing client orders against own inventory must meet transparency obligations
- **Product governance:** Manufacturers define target market; distributors ensure suitability
- **Cost disclosure:** Total cost (including implicit costs like bid-ask spread) disclosed ex-ante to retail clients
- **Transaction reporting:** Every trade reported to national competent authority within T+1

MiFID II's research unbundling fundamentally changed how investment research is produced and consumed.

How Do Europe's Three Major Regulations Fit Together?

Theory: Three major EU regulatory frameworks serve different purposes but interact.

Dimension	PSD2	MiFID II	Basel III
Scope	Payment services	Securities, investment	Banking prudential
Primary goal	Competition, innovation	Investor protection	Financial stability
Target entities	Payment providers, banks	Investment firms, exchanges	Banks, SIFIs
Key mechanism	Mandated API access	Disclosure, conduct rules	Capital, liquidity req.
Information problem	Data monopoly, switching costs	Principal-agent conflicts	Moral hazard, systemic risk
Effective	2018	2018	2013 (phased)

Interactions: PSD2 opens data for MiFID II-regulated investment advice; Basel III capital rules constrain banks providing PSD2 APIs; all three require KYC/AML (Lesson 04).

Swiss equivalents: FinSA (similar to MiFID II), FINMA implementing Basel III, no PSD2 equivalent (market-driven Open Banking).

PSD2 opens markets, MiFID II protects investors, Basel III ensures stability—together they form the EU financial regulatory architecture.

Why Is a Messaging Standard Transforming Global Payments?

Theory: ISO 20022 is a global standard for financial messaging that replaces legacy formats, transforming payment infrastructure.

Why it matters:

- **Richer data:** Structured XML/JSON format carries more information per message (remittance data, purpose codes, end-to-end references)
- **Interoperability:** Single standard across payment types (RTGS, instant payments, securities settlement)
- **Enables automation:** Machine-readable messages support straight-through processing and RegTech compliance

Migration timeline:

- SWIFT migrating from MT to MX (ISO 20022) format; coexistence period 2022–2025
- Impact on banks: legacy core banking systems must be updated; significant IT investment
- Impact on FinTech: standardized data enables better analytics, fraud detection, compliance automation

Swiss context: SIC (Swiss Interbank Clearing) migrated to ISO 20022 in 2016—an early global adopter. SEPA payments already use ISO 20022.

Connection to traditional infrastructure (LO7): ISO 20022 is a critical evolution of the core banking payment processing described in Lesson 01.

ISO 20022 is not just a format change—it enables the data-driven transformation of payment processing.

What Makes Switzerland's Regulatory Approach Unique?

FINMA (Swiss Financial Market Supervisory Authority): Integrated supervisor

- Supervises banks, insurance, securities firms, exchanges
- Mandate: protect creditors, investors, policyholders; ensure financial stability

Key Swiss legislation:

- **Banking Act (BA):** Licensing, capital, governance, supervision
- **Financial Market Infrastructure Act (FMIA):** Trading venues, CCPs, trade repositories
- **Financial Services Act (FinSA):** Client protection, conduct rules (Swiss equivalent of MiFID II)
- **Financial Institutions Act (FinIA):** Licensing and supervision of asset managers, trustees

Swiss finish: Switzerland often exceeds international minimums

- Higher capital and liquidity buffers than Basel III
- Rationale: Swiss banking sector large relative to GDP (systemic risk)
- UBS, Credit Suisse designated as G-SIBs (global systemically important banks)

DLT Act (from Lesson 05): Switzerland as crypto-friendly jurisdiction

- Legal framework for tokenized securities, DLT trading venues

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Switzerland's approach: principles-based regulation with outcomes focus, not rules-based prescription.

How Is Technology Shifting Risk Management from Reactive to Real-Time?

Digital transformation in risk management: From backward-looking to real-time

Real-time monitoring (vs. end-of-day batch processing)

- VaR calculated continuously, not once per day
- Intraday position limits enforced automatically
- Early warning systems for breaches

Machine learning applications:

- **Credit scoring:** ML models predict PD from alternative data (Lesson 03: fintech lending)
  - Uplift, Affirm use transaction history, social media
  - Outperforms traditional FICO in thin-file segments
- **Fraud detection:** Anomaly detection flags unusual transactions
- **Market risk:** Neural networks for volatility forecasting

Cloud computing for Monte Carlo simulation:

- Run 1 million scenarios in minutes (vs. hours on-premise)
- Elasticity: scale compute during month-end VaR runs

NLP for sentiment analysis:

- Monitor news, social media, earnings calls for risk signals

Technology transforms risk management from backward-looking reports to forward-looking real-time monitoring.

Why Is Cyber Risk the Fastest-Growing Threat to Banks?

Cyber risk: Fastest-growing component of operational risk

- Ransomware attacks paralyze operations (Colonial Pipeline 2021)
- Data breaches expose customer information (regulatory fines, reputation damage)
- System outages disrupt trading (TSE 2020 halt)

DORA (Digital Operational Resilience Act, EU 2025): Cyber and IT risk regulation

- Applies to banks, insurers, investment firms, crypto firms
- Requirements: (1) ICT risk management framework, (2) incident reporting, (3) resilience testing, (4) third-party risk management
- **Third-party/cloud risk:** Concentration risk if everyone uses AWS, Azure, Google Cloud

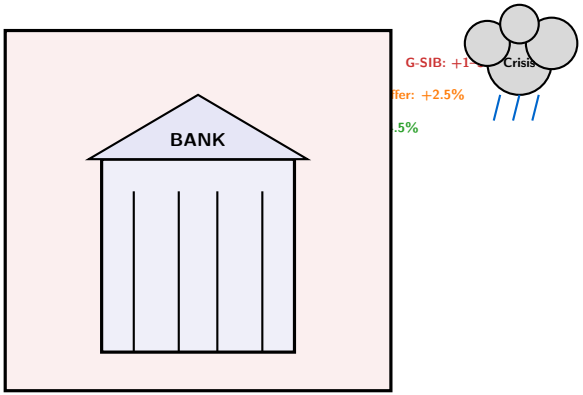
Operational resilience framework:

- Identify **important business services** (payments, lending)
- Set **impact tolerances** (max acceptable downtime)
- Map dependencies (systems, vendors, people)
- Test recovery: Can we restore service within tolerance?

Shift in mindset: From "prevent all failures" to "recover quickly"

- Cyber attacks inevitable; resilience means bouncing back

DORA makes operational resilience a regulatory requirement, not just a best practice.



More armor means more safety — but also more weight to carry.

Summary

Five key takeaways from this lesson:

1. **Risk types are interconnected:** Market, credit, operational, and liquidity risks interact in complex ways – operational failures can trigger liquidity crises and credit events
2. **Statistical foundations matter:** Risk measurement requires understanding distributions, mean, standard deviation, and confidence levels – these concepts underlie VaR, ES, and stress testing
3. **VaR and ES complement each other:** VaR tells us the threshold for bad days; ES tells us the average severity beyond that threshold – regulators now prefer ES for tail risk
4. **Basel III is a response to 2008:** Three pillars (capital, supervision, disclosure) work together to ensure banks can absorb losses and survive stress – liquidity rules (LCR, NSFR) prevent funding crises
5. **Technology transforms risk management:** Real-time monitoring, ML credit models, cloud-based Monte Carlo, and operational resilience frameworks shift risk management from reactive to proactive

Connection to earlier lessons: Information asymmetry (L04) justifies regulation; fintech (L03) uses ML for credit risk; blockchain (L05) introduces new operational and cyber risks

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Next lesson: Emerging Topics – DeFi, CBDCs, AI, and the future of digital finance.