# Module 4 Summary: The Risk Problem

Prof. Dr. Joerg Osterrieder

Digital Finance — BSc Course

# Key Concepts by Lesson

## L1: Measuring Market Risk

- Value-at-Risk (VaR): maximum loss at a given confidence level
- Three methods: historical simulation, variance-covariance, Monte Carlo
- Expected Shortfall (ES/CVaR): average loss beyond VaR

## L2: Derivatives & Options

- Options: calls, puts, payoff diagrams
- Greeks: Delta ($\Delta$), Gamma ($\Gamma$), Vega, Theta ($\Theta$)
- Greeks are sensitivities read from tables, not derived by hand

## L3: Institutional Risk Management

- Basel I $\rightarrow$ II $\rightarrow$ III $\rightarrow$ III.1/IV evolution
- Three pillars: minimum capital, supervisory review, market discipline
- Liquidity rules: LCR (Liquidity Coverage Ratio), NSFR

## L4: New Risk Landscape

- Cyber risk violates stationarity assumptions
- Flash crashes: intraday losses exceed daily VaR
- Algorithmic/model risk: cascading failures from correlated models

---

**Module 4 answers: How do we measure, price, and manage financial risk — and where do traditional models break down?**

# Key Formulas and Definitions

## Value-at-Risk (VaR)

$$\text{VaR}_\alpha = -\inf\{x : P(L \leq x) > \alpha\}$$

Intuition: sort 1,000 returns worst-to-best; the 50th worst is your 95% VaR.

## Expected Shortfall (ES / CVaR)

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

Average of all losses in the tail beyond VaR. Always $\geq$ VaR. Basel III requires ES at 97.5%.

## The Greeks

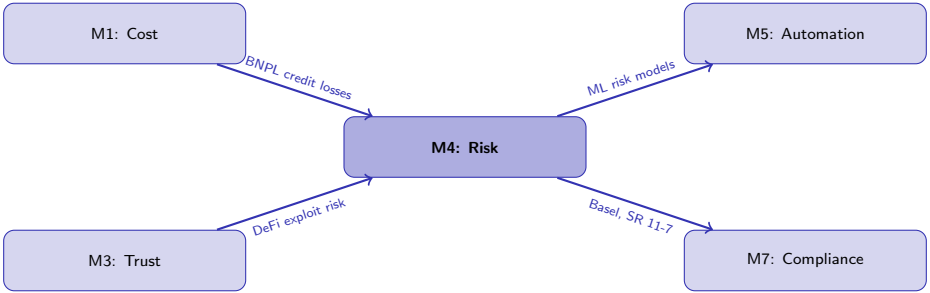
| | | | |
|---|---|---|---|
| $\Delta = \frac{\partial V}{\partial S}$ | stock exposure | $\Gamma = \frac{\partial^2 V}{\partial S^2}$ | convexity |
| $\mathcal{V} = \frac{\partial V}{\partial \sigma}$ | volatility exposure | $\Theta = \frac{\partial V}{\partial t}$ | time decay |

## Basel III Capital Requirement

$$\text{CET1 Ratio} = \frac{\text{Common Equity Tier 1 Capital}}{\text{Risk-Weighted Assets}} \geq 4.5\%$$

**VaR tells you the door of the tail; ES tells you what is behind it.**

# Connections to Other Modules




- **Cost → Risk (M1):** BNPL providers bear credit risk funded by MDR revenue — thin margins amplify default losses
- **Trust → Risk (M3):** Smart contract exploits, oracle manipulation, and impermanent loss are risk categories absent from traditional frameworks
- **Risk → Automation (M5):** ML models predict default, detect fraud, and estimate VaR — but introduce model risk and overfitting
- **Risk → Compliance (M7):** Basel III/IV mandates capital buffers; SR 11-7 governs model risk; each Basel version responded to a financial crisis

**Risk is the bridge between theory and regulation: measure it (M4), model it (M5), regulate it (M7).**