Course 2023-2024 in Financial Risk Management
Lecture 1. Introduction

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[1] The opinions expressed in this presentation are those of the authors and are not meant to represent the opinions or official positions of Amundi Asset Management.

General information

1. **Overview**
   The objective of this course is to understand the theoretical and practical aspects of risk management
2. **Prerequisites**
   M1 Finance or equivalent
3. **ECTS**
   4
4. **Keywords**
   Finance, Risk Management, Applied Mathematics, Statistics
5. **Hours**
   Lectures: 36h, Training sessions: 15h, HomeWork: 30h
6. **Evaluation**
   There will be a final three-hour exam, which is made up of questions and exercises
7. **Course website**
   `http://www.thierry-roncalli.com/RiskManagement.html`

Objective of the course

The objective of the course is twofold:

1. knowing and understanding the financial regulation (banking and others) and the international standards (especially the Basel Accords)
2. being proficient in risk measurement, including the mathematical tools and risk models

Class schedule

Course sessions

- September 15 (6 hours, AM+PM)
- September 22 (6 hours, AM+PM)
- September 19 (6 hours, AM+PM)
- October 6 (6 hours, AM+PM)
- October 13 (6 hours, AM+PM)
- October 27 (6 hours, AM+PM)

Tutorial sessions

- October 20 (3 hours, AM)
- October 20 (3 hours, PM)
- November 10 (3 hours, AM)
- November 10 (3 hours, PM)
- November 17 (3 hours, PM)

Class times: Fridays 9:00am-12:00pm, 1:00pm–4:00pm, University of Evry, Room 209 IDF

Agenda

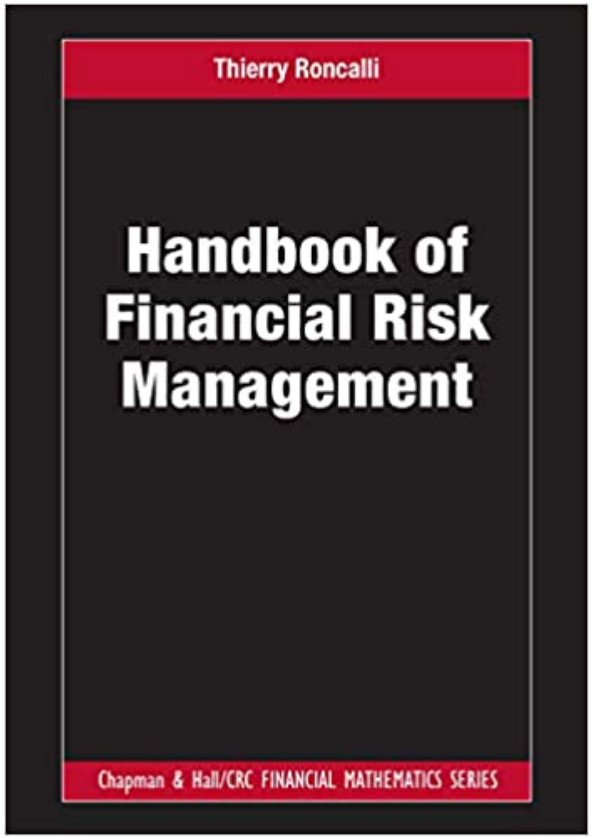
- Lecture 1: Introduction to Financial Risk Management
- Lecture 2: Market Risk
- Lecture 3: Credit Risk
- Lecture 4: Counterparty Credit Risk and Collateral Risk
- Lecture 5: Operational Risk
- Lecture 6: Liquidity Risk
- Lecture 7: Asset Liability Management Risk
- Lecture 8: Model Risk
- Lecture 9: Copulas and Extreme Value Theory
- Lecture 10: Monte Carlo Simulation Methods
- Lecture 11: Stress Testing and Scenario Analysis
- Lecture 12: Credit Scoring Models

Agenda

- Tutorial Session 1: Market Risk
- Tutorial Session 2: Credit Risk
- Tutorial Session 3: Counterparty Credit Risk and Collateral Risk
- Tutorial Session 4: Operational Risk & Asset Liability Management Risk
- Tutorial Session 5: Copulas, EVT & Stress Testing

Textbook

- Roncalli, T. (2020), *Handbook of Financial Risk Management*, Chapman & Hall/CRC Financial Mathematics Series.



Additional materials

- Slides, tutorial exercises and past exams can be downloaded at the following address:

  `http://www.thierry-roncalli.com/RiskManagement.html`

- Solutions of exercises can be found in the companion book, which can be downloaded at the following address:

  `http://www.thierry-roncalli.com/RiskManagementBook.html`

Agenda

- **Lecture 1: Introduction to Financial Risk Management**
- Lecture 2: Market Risk
- Lecture 3: Credit Risk
- Lecture 4: Counterparty Credit Risk and Collateral Risk
- Lecture 5: Operational Risk
- Lecture 6: Liquidity Risk
- Lecture 7: Asset Liability Management Risk
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- Lecture 12: Credit Scoring Models

The development of financial markets

Table: Some financial innovations

1970	Mortgage-backed securities
1971	Equity index funds
1972	Foreign currency futures
1973	Stock options
1979	Over-the-counter currency options
1981	Interest rate swaps
1982	Equity index futures
1983	Equity index options
	Interest rate caps/floors
	Collateralized mortgage obligations
1985	Swaptions
	Asset-backed securities
1987	Path-dependent options (Asian, look-back, etc.)
	Collateralized debt obligations
1994	Credit default swaps
2004	Volatility index futures

The development of financial markets

- Organized markets (on-exchange)
- Over-the-counter markets or OTC markets (off-exchange)

Contract	Futures	Forward	Option	Swap
On-exchange	✓		✓	
Off-exchange		✓	✓	✓

The development of financial markets

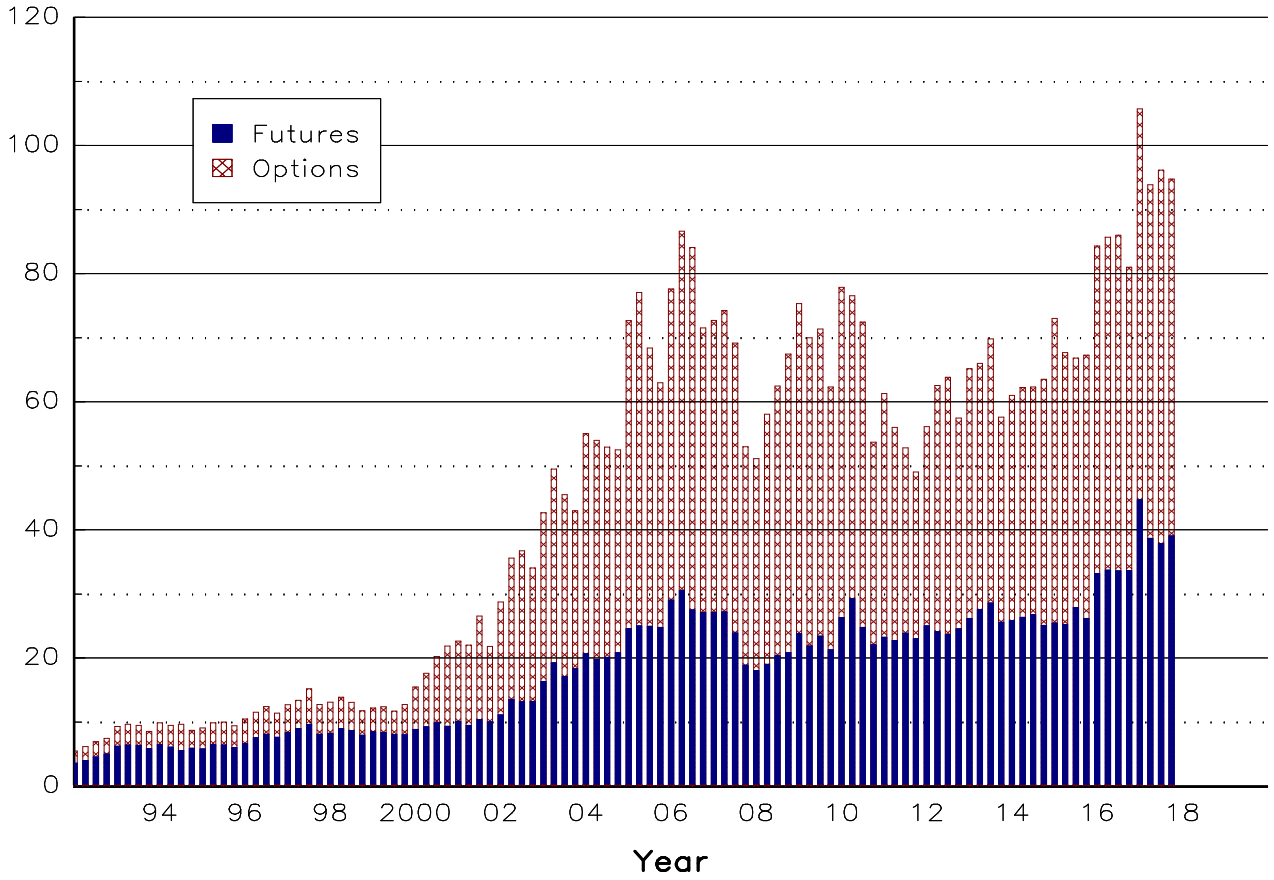

Figure: Notional outstanding amount of exchange-traded derivatives (in $ tn)

Financial crises and systemic risk

Table: Some financial losses

1974	Herstatt Bank: $620 mn (foreign exchange trading)
1994	Metallgesellschaft: $1.3 bn (oil futures)
1994	Orange County: $1.8 bn (reverse repo)
1994	Procter & Gamble: $160 mn (ratchet swap)
1995	Barings Bank: $1.3 bn (stock index futures)
1997	Natwest: $127 mn (swaptions)
1998	LTCM: $4.6 bn (liquidity crisis)
2001	Dexia Bank: $270 mn (corporate bonds)
2006	Amaranth Advisors: $6.5 bn (gaz forward contracts)
2007	Morgan Stanley: $9.0 bn (credit derivatives)
2008	Société Générale: $7.2 bn (rogue trading)
2008	Madoff: $65 bn (fraud)
2011	UBS: $2.0 bn (rogue trading)
2012	JPMorgan Chase: $5.8 bn (credit derivatives)

Financial crises and systemic risk

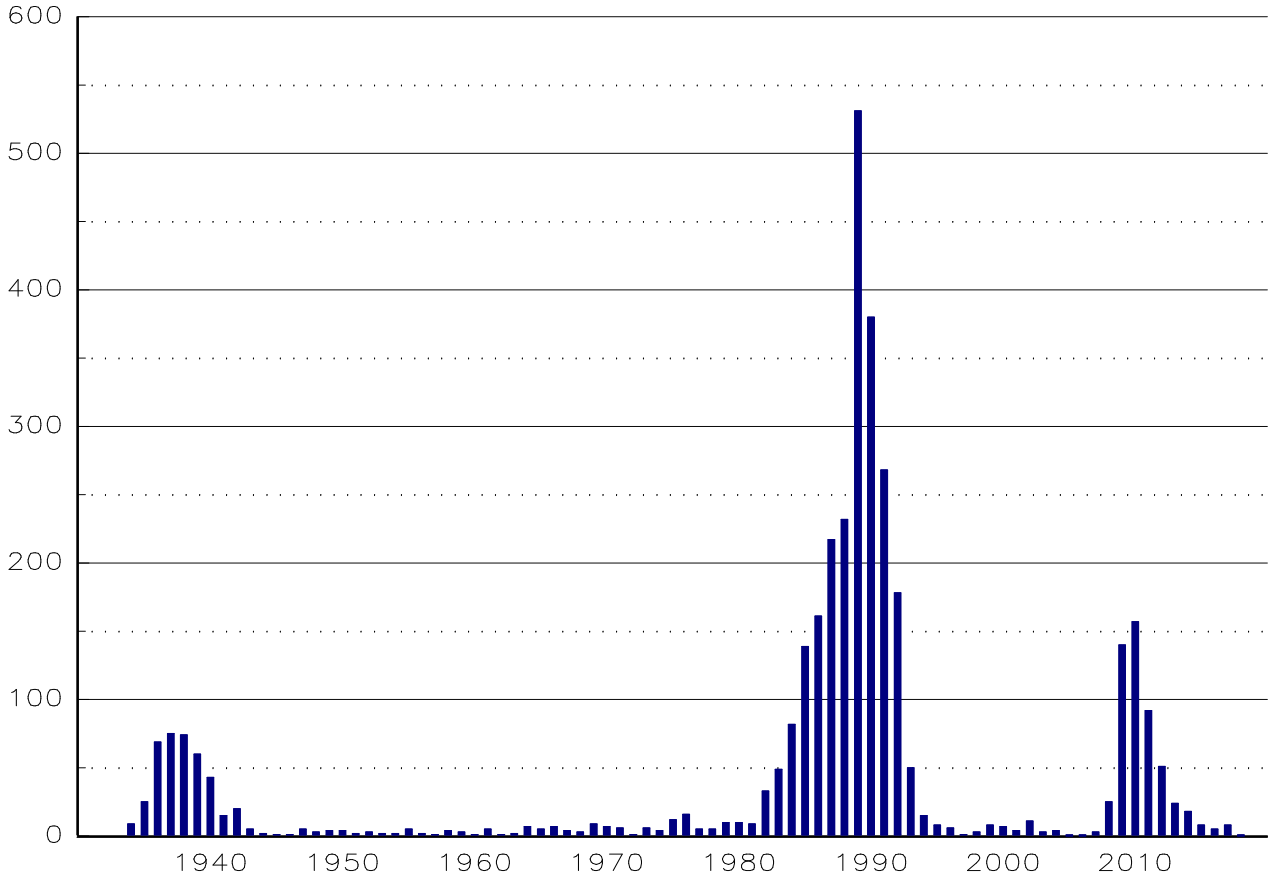

Figure: Number of bank defaults in the US

International authorities

1. The Basel Committee on Banking Supervision (BCBS)
2. The International Association of Insurance Supervisors (IAIS)
3. The International Organization of Securities Commissions (IOSCO)
4. The Financial Stability Board (FSB)

Table: The supervision institutions in finance

	Banks	Insurers	Markets	All sectors
Global	BCBS	IAIS	IOSCO	FSB
EU	EBA/ECB	EIOPA	ESMA	ESFS
US	FDIC/FRB	FIO	SEC	FSOC

Banking regulation

1988 Publication of "*International Convergence of Capital Measurement and Capital Standards*", which is better known as "*The Basel Capital Accord*". This text sets the rules of the Cooke ratio.

1996 Publication of "*Amendment to the Capital Accord to incorporate Market Risks*". This text includes the market risk to compute the Cooke ratio.

2004 Publication of "*International Convergence of Capital Measurement and Capital Standards – A Revisited Framework*". This text establishes the Basel II framework.

2010 Publication of the Basel III framework.

2019 Publication of "*Minimum Capital Requirements for Market Risk*". This is the final version of the Basel III framework for computing the market risk.

Banking regulation

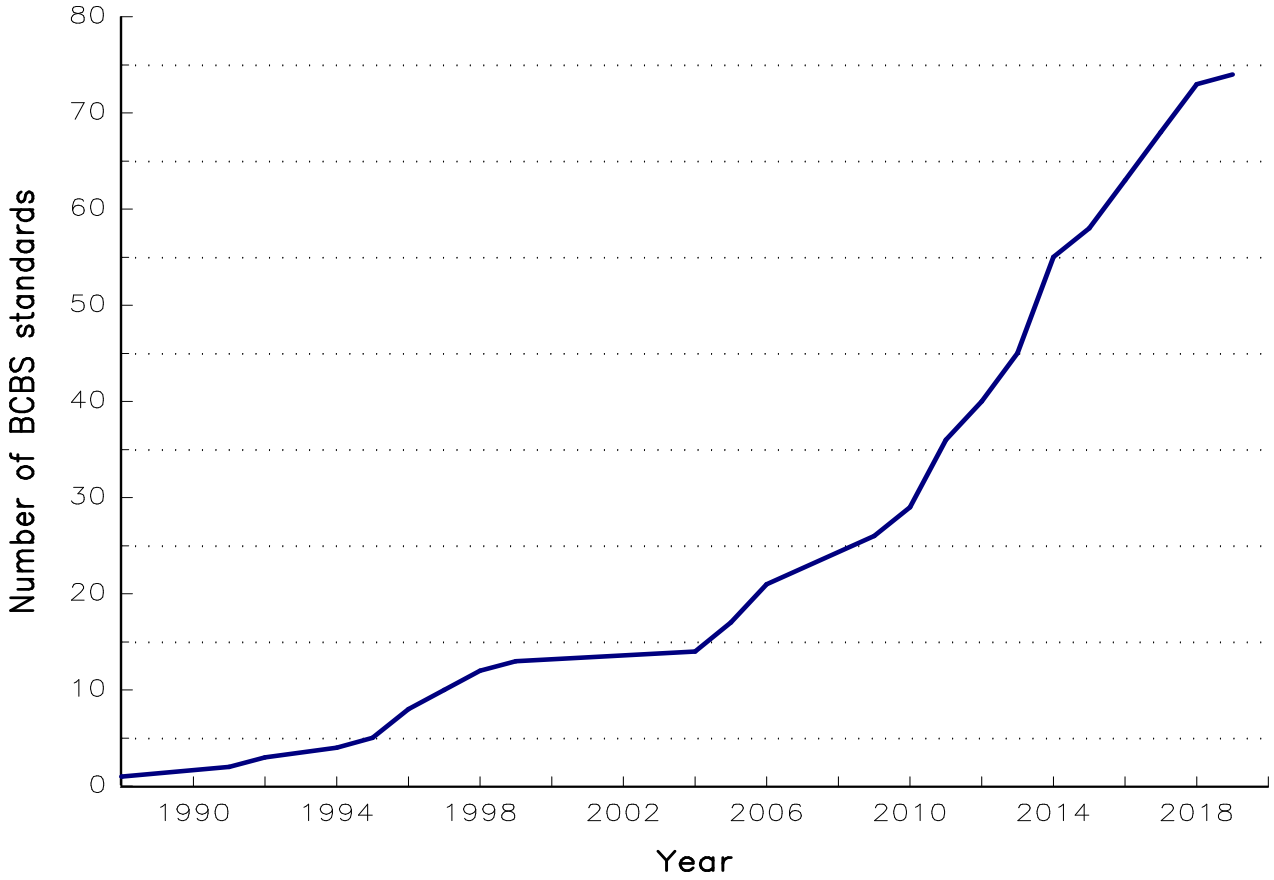

Figure: The huge increase of the number of banking supervision standards

Basel I

- Cooke ratio:

$$\text{Cooke Ratio} = \frac{C}{\text{RWA}}$$

where C and RWA are the capital and the risk-weighted assets of the bank.

- A risk-weighted asset is simply defined as a bank's asset weighted by its risk score or risk weight (RW):

$$\text{RWA} = \text{EAD} \cdot \text{RW}$$

where EAD is the exposure at default

$\Rightarrow$ Cooke Ratio $\geq 8\%$ (Tier one $\geq 4\%$)

Risk weight

For categories:

1. $\mathrm{RW} = 0\%$
   cash, gold, claims on OECD governments and central banks, claims on governments and central banks outside OECD and denominated in the national currency
2. $\mathrm{RW} = 20\%$
   claims on all banks with a residual maturity lower than one year, longer-term claims on OECD incorporated banks, claims on public-sector entities within the OECD
3. $\mathrm{RW} = 50\%$
   loans secured on residential property
4. $\mathrm{RW} = 100\%$
   others

Computing the RWA

Example

The assets of a bank are composed of \$100 mn of US treasury bonds, \$100 mn of Brazilian government bonds, \$50 mn of residential mortgage, \$300 mn of corporate loans and \$20 mn of revolving credit loans. The bank liability structure includes \$25 mn of common stock and \$13 mn of subordinated debt.

We obtain the following results:

Asset	EAD	RW	RWA
US treasury bonds	100	0%	0
Brazilian Gov. bonds	100	100%	100
Residential mortgage	50	50%	25
Corporate loans	300	100%	300
Revolving credit	20	100%	20
Total			445

and:

$$\text{Cooke Ratio} = \frac{38}{445} = 8.54\%$$

Amendment to incorporate market risks

Two approaches:

- The standardized measurement method (SMM)
- The internal model-based approach[2] (IMA)

$\Rightarrow$ external weights vs internal model (99% value-at-risk for a holding period of 10 trading days)

[2] The use of the internal model-based approach is subject to the approval of the national supervisor.

Value-at-risk (VaR)

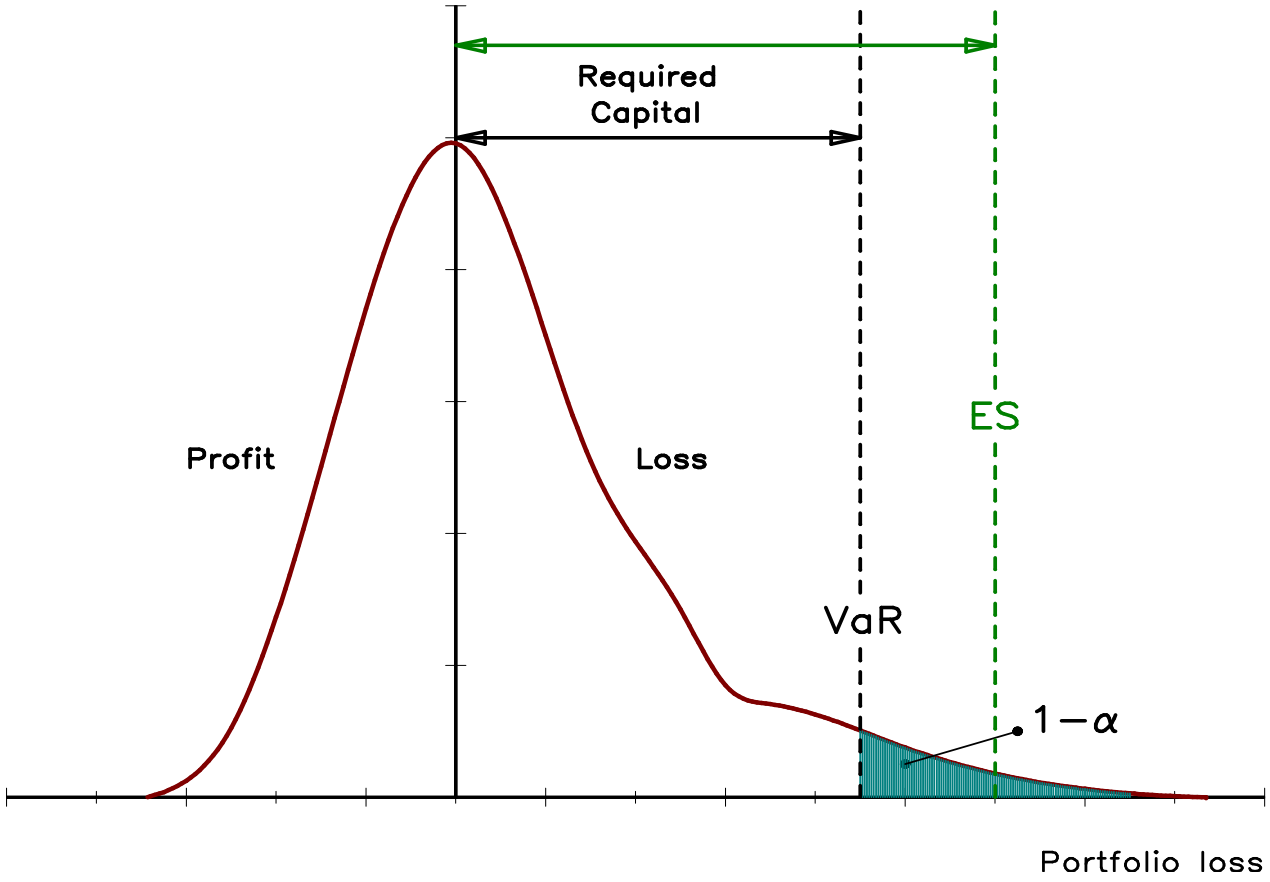

Figure: Probability distribution of the portfolio loss

Impact of market risks on the Cooke ratio

The Cooke ratio becomes:

$$\frac{C_{\text{Bank}}}{\text{RWA} + 12.5 \times \mathcal{K}_{\text{MR}}} \geq 8\%$$

We deduce that:

$$C_{\text{Bank}} \geq \underbrace{8\% \times \text{RWA}}_{\mathcal{K}_{\text{CR}}} + \mathcal{K}_{\text{MR}}$$

meaning that $8\% \times \text{RWA}$ can be interpreted as the credit risk capital requirement $\mathcal{K}_{\text{CR}}$, which can be compared to the market risk capital charge $\mathcal{K}_{\text{MR}}$.

Basel II

Table: The three pillars of the Basel II framework

Pillar 1 Minimum Capital Requirements	Pillar 2 Supervisory Review Process	Pillar 3 Market Discipline
Credit risk Market risk Operational risk	Review & reporting Capital above Pillar 1 Supervisory monitoring	Capital structure Capital adequacy Models & parameters Risk management

Basel II

The new Accord consists of three pillars:

1. the first pillar corresponds to *minimum capital requirements*, that is, how to compute the capital charge for credit risk, market risk and operational risk;
2. the second pillar describes the *supervisory review process*; it explains the role of the supervisor and gives the guidelines to compute additional capital charges for specific risks, which are not covered by the first pillar;
3. the *market discipline* establishes the third pillar and details the disclosure of required information regarding the capital structure and the risk exposures of the bank.

Basel II

- Credit risk
  - The standardized approach (SA)
  - The internal ratings-based approach (IRB)
    - Foundation IRB (FIRB or IRB-F)
    - Advanced IRB (AIRB ou IRB-A)
- Market risk
  - The standardized measurement method (SMM)
  - The internal model-based approach (IMA)
- Operational risk
  - The Basic Indicator Approach (BIA)
  - The Standardized Approach (TSA)
  - Advanced Measurement Approaches (AMA)

Basel II

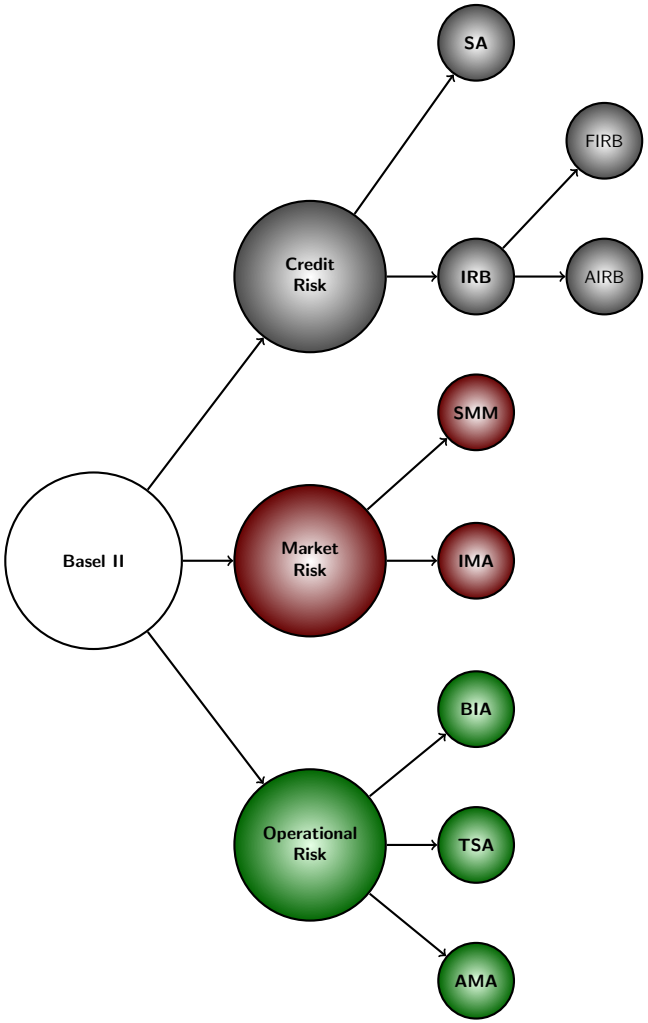

Figure: Minimum capital requirements in the Basel II framework

Basel 2.5

2008 Global Financial Crisis $\Rightarrow$ measures to strengthen the rules governing trading book capital, particularly the market risk associated to securitization and credit-related products:

1. the incremental risk charge (IRC), which is an additional capital charge to capture default risk and migration risk for unsecuritized credit products
2. the stressed value-at-risk requirement (SVaR), which is intended to capture stressed market conditions
3. the comprehensive risk measure (CRM), which is an estimate of risk in the credit correlation trading portfolio (CDS baskets, CDO products, etc.)
4. new standardized charges on securitization exposures, which are not covered by CRM

Basel III

In December 2010, the Basel Committee published a new regulatory framework in order to enhance risk management, increase the stability of the financial markets and improve the banking industry's ability to absorb macro-economic shocks

The Basel III (2010) framework consists of **micro-prudential** and **macro-prudential** regulation measures concerning;

- a new definition of the risk-based capital
- the introduction of a leverage ratio
- the management of the liquidity risk

Basel III also includes (2013-2019):

- Revision of MR, CR, CCR, CVA and OR standards
- Interest Rate Risk in the Banking Book (IRRBB)

Basel III

Table: Basel III capital requirements

Capital ratio	2013	2014	2015	2016	2017	2018	2019
CET1	3.5%	4.0%		4.5%			**4.5%**
CB				0.625%	1.25%	1.875%	**2.5%**
CET1 + CB	3.5%	4.0%	4.5%	5.125%	5.75%	6.375%	**7.0%**
Tier 1	4.5%	5.5%		6.0%			**6.0%**
Total				8.0%			**8.0%**
Total + CB		8.0%		8.625%	9.25%	9.875%	**10.5%**
CCB				**0% – 2.5%**			

- CET1: Common Equity Tier 1
- AT1: Additional Tier 1
- T1: Tier 1
- T2: Tier 2
- CB: Capital Conservation Buffer
- CCB: Countercyclical Conservation Buffer (**macro-prudential** measure)

Basel III

- Credit Valuation Adjustment (CVA)
- Leverage ratio (**macro-prudential** measure) to prevent the build-up of excessive on- and off-balance sheet:

$$\text{Leverage ratio} = \frac{\text{Tier 1 capital}}{\text{Total exposures}} \geq 3\%$$

where the total exposures is the sum of on-balance sheet exposures, derivative exposures and some adjustments concerning off-balance sheet items

Basel III

- Liquidity Coverage Ratio (LCR)
  The objective of the LCR is to promote short-term resilience of the bank's liquidity risk profile:

$$\text{LCR} = \frac{\text{HQLA}}{\text{Total net cash outflows}} \geq 100\%$$

  where HQLA is the stock of high quality liquid assets and the denominator is the total net cash outflows over the next 30 calendar days

- Net Stable Funding Ratio (NSFR)
  NSFR is designed in order to promote long-term resilience of the bank's liquidity profile:

$$\text{NSFR} = \frac{\text{Available amount of stable funding}}{\text{Required amount of stable funding}} \geq 100\%$$

  ASF and RSF are calculated for the next year

Basel III

Basel III also includes new standards (the Basel IV package):

- Credit Risk: revision to SA and IRB approaches
- Market Risk: SMM is replaced by SA-TB, IMA is revisited, VaR is replaced by ES (expected shortfall), etc.
- CVA $\Rightarrow$ SA-CVA and BA-CVA
- Operational Risk: BIA, TSA and AMA are replaced by SMA (Standardized Measurement Approach)
- Introduction of capital floors (with respect to SA)

Insurance regulation

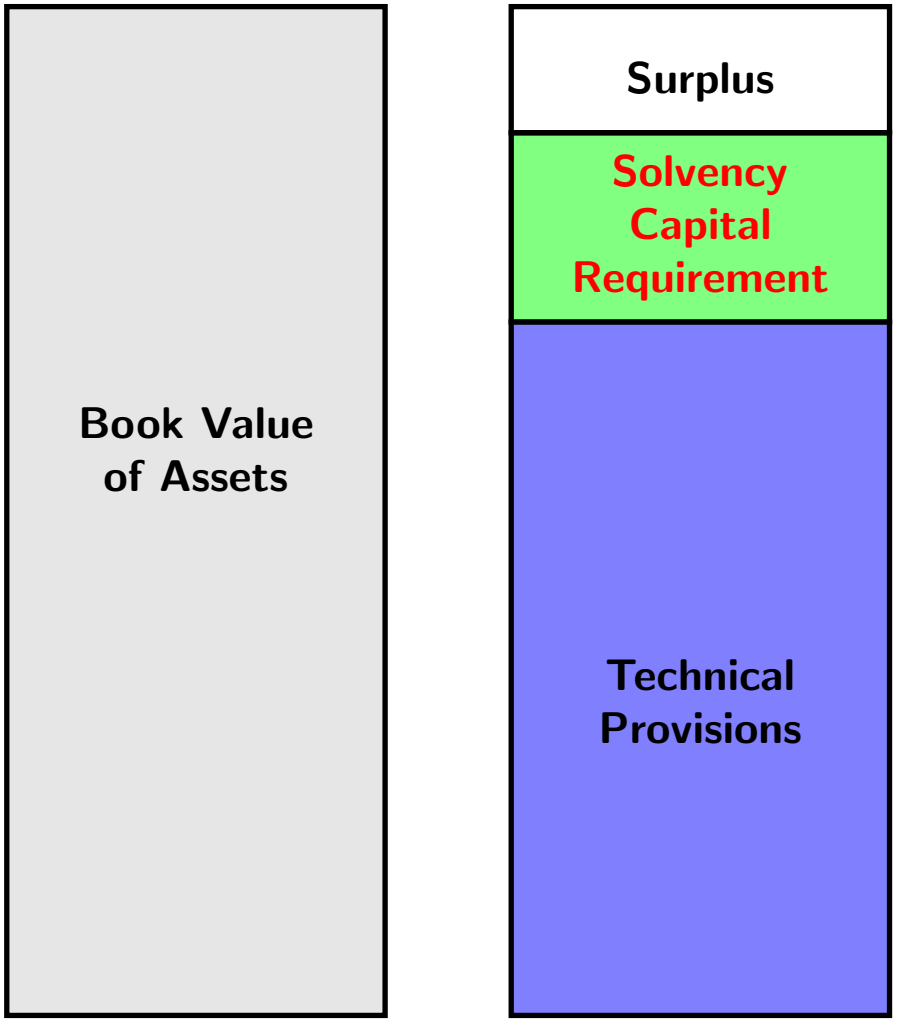

Figure: Solvency I capital requirement

Insurance regulation

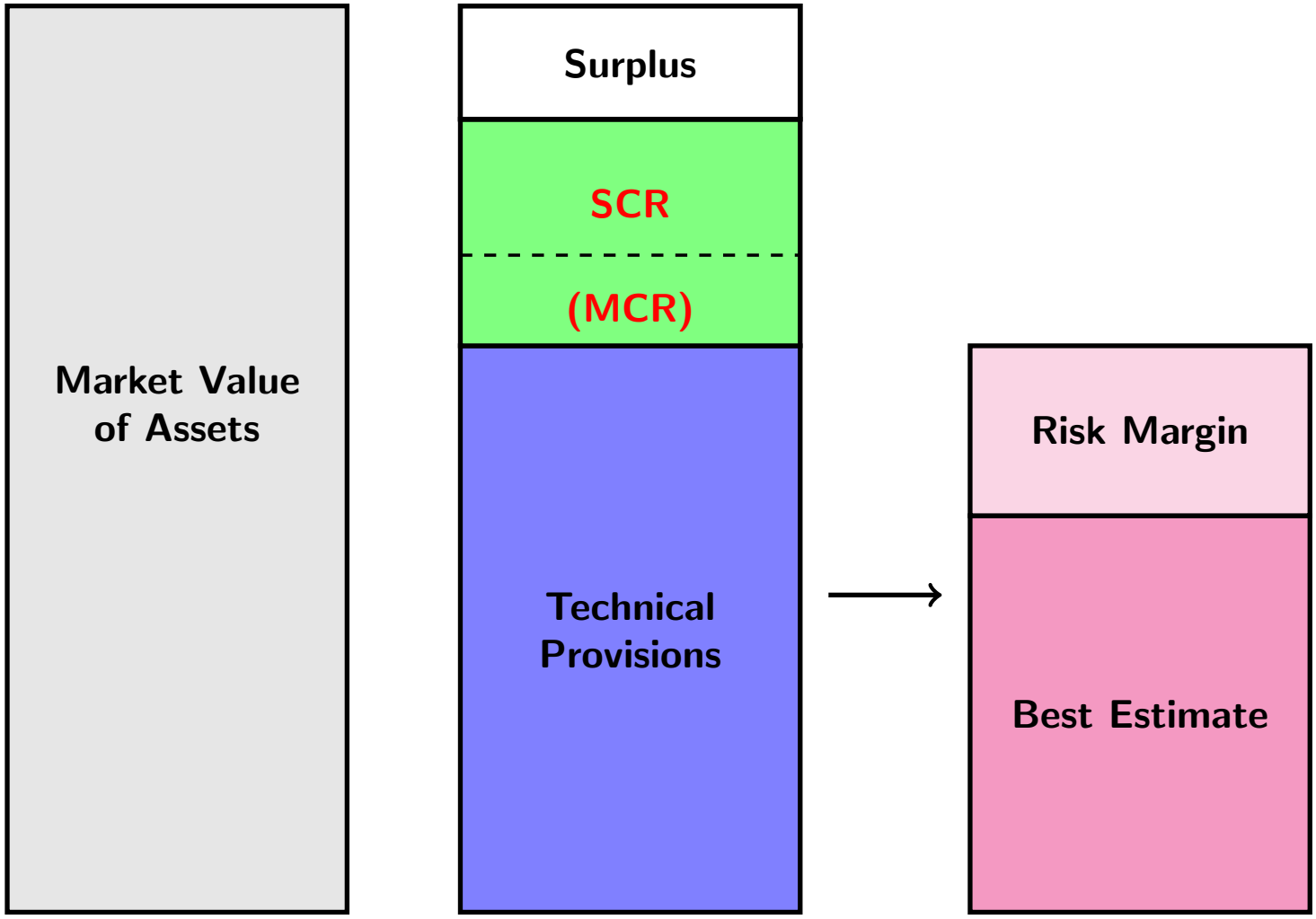

Figure: Solvency II capital requirement

Insurance regulation

Risk components:

1. Underwriting risk (non-life, life, health, etc.)
2. market risk,
3. Default risk
4. Counterparty credit risk

In the case of the standard formula method, the SCR of the insurer is equal to:

$$\mathrm{SCR} = \sqrt{\sum_{i,j}^{m} \rho_{i,j} \cdot \mathrm{SCR}_i \cdot \mathrm{SCR}_j} + \mathrm{SCR}_{\mathrm{OR}}$$

where SCR_i is the SCR of the risk module i, $\mathrm{SCR}_{\mathrm{OR}}$ is the SCR associated to the operational risk and $\rho_{i,j}$ is the correlation factor between risk modules i and j.

Insurance regulation

The solvency ratio is then defined as:

$$\text{Solvency Ratio} = \frac{C}{\text{SCR}}$$

where C is the capital. This solvency ratio must be larger than 33% for tier 1 and 100% for the total own funds.

Market regulation

Europe

- 2007: MiFID (Markets in Financial Instruments Directive)
- 2012: EMIR (European Market Infrastructure Regulation)
- 2014: MiFID2, MiFIR (Regulation in Markets in Financial Instruments) and PRIIPS (Packaged Retail and Insurance-based Investment Products)

US

- 1930s: Securities Act, Securities Exchange Act, Trust Indenture Act, Investment Company Act, Investment Advisers Act
- Securities and Exchange Commission (SEC)
- Commodity Futures Trading Commission (CFTC)
- 2010: Dodd-Frank Wall Street Reform and Consumer Protection Act
- Financial Stability Oversight Council (FSOC)

Systemic risk

- 2009: Creation of the Financial Stability Board (FSB)
- Systemically Important Financial Institutions (SIFIs)
- A SIFI can be global (G-SIFI) or domestic (D-SIFI)
- Three categories:
  1. G-SIBs correspond to global systemically important banks
  2. G-SIIs designate global systemically important insurers
  3. The third category corresponds to non-bank non-insurer global systemically important financial institutions (or NBNI G-SIFIs)