MFE 409 Lecture 4
Regulation of Financial Institutions

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Spring 2019

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Lecture Objectives

Regulation of Financial Institutions

- Risk regulations faced by financial institutions
- What are these regulations trying to capture?
- How to measure the various risks faced by financial institutions

Types of risk

- Market Risk

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- Market Risk
- Credit Risk
- Liquidity Risk
- Operational Risk

History of Regulation

- 1988: Basel I, BIS Accord
- 1996: 1996 Amendment
- 1999: Basel II (implemented in 2007)
- 2011: Basel II.5
- 2009: Basel III (implemented by 2019)
- 2010: Dodd-Frank act (US)
- 2014: Fundamental Review of the Trading Book

History of Regulation

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→ *Study them in order as they build on each other*

Why Regulate Banks?

- Main goal of regulation: eliminate risk of bank failure
  - Create a stable economic environment where private individuals and businesses have confidence in the banking system
- Why don't bank do it themselves?
  1. Externalities: Do not take into account the effect of their failure on the rest of the financial system and the economy
  2. Moral hazard:
     - ⋆ Because of deposit insurance, depositors do not care about bank default.
     - ⋆ Banks take risk because they know they will be bailed out.

Outline

Basel Committee

- Formed in 1974, under patronage of the Bank for International Settlements
- Belgium, Canada, France, Germany, Italy, Japan, Luxembourg, the Netherlands, Sweden, Switzerland, UK, US
- "International Convergence of Capital Measurement and Capital Standards" aka "The 1998 BIS Accord" aka "The Accord" aka Basel I

The Cooke Ratio

- Basel I is focused on credit risk
- Impose a lower bound on the Cooke Ratio:

$$\text{Cooke Ratio} = \frac{\text{Capital}}{\text{Risk-weighted Assets}}$$

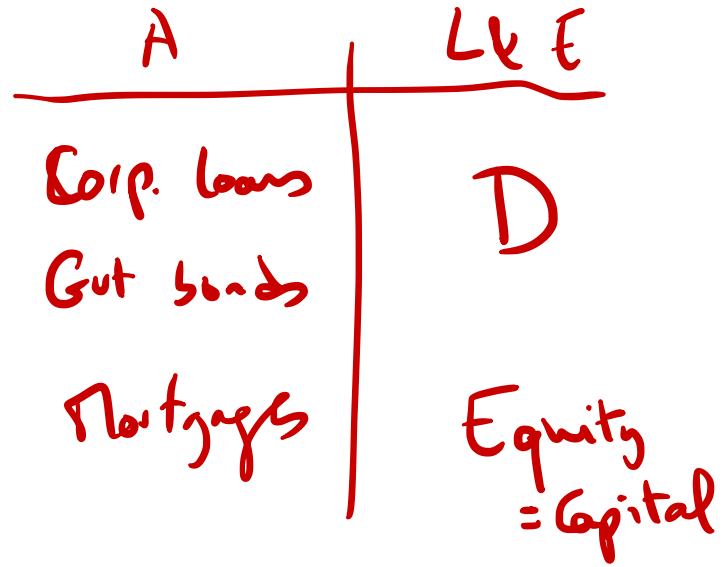
- *Capital*: can be lost without the firm failing
- *Risk-weighted assets*: quantity of assets that can default

Risk-Weighted ~~Capital~~ Assets

- Each asset receives a weight according to its risk: larger for more risky assets
- On-balance sheet exposures:
  - 0%: cash, gold, OECD government claims or insured residential mortgages
  - 20%: claims on OECD banks or OECD public secor entities (GSEs, munis, ...)
  - 50%: uninsured residential mortgages
  - 100%: all other claims
- Off-balance sheet exposures
  - Bankers' acceptances, guarantees, loan commitments, ...

Example

- Bank holds:
  - $100 million of corporate loans
  - $10 million of OECD government bonds
  - $50 million of residential mortgages
- Total assets? Risk-weighted assets?



uninsured

↳ 160

↳ 100 + 0 + 25 = 125

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  - $100 million of corporate loans
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  - $50 million of residential mortgages
- Total assets? Risk-weighted assets?

$$\text{Total Assets} = 100 + 10 + 50 = \$160\text{m}$$

$$\text{Risk-weighted Assets} = 1 \times 100 + 0 \times 10 + 0.5 \times 50 = \$125\text{m}$$

Risk-Weighted Capital for Derivatives

- Credit equivalent amount:

current price of the contract

$$\underbrace{\max(V, 0)}_{\text{current exposure}} + \underbrace{aL}_{\text{add-on}}$$

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  - a: add-on factor. Varies by asset class and maturity: 0% for $<$1 year interest rate swap; 0.5% for a 1-5 year interest rate swap; 5.0% for a 1-5 year foreign currency swap

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- Apply the risk-weight of the counterparty

Capital Requirement

- Two types of capital
  - *Tier 1 Capital*: common equity, non-cumulative perpetual preferred shares
  - *Tier 2 Capital*: cumulative preferred stock, certain types of 99-year debentures, subordinated debt with an original life of more than 5 years

- **Capital requirement: Cooke ratio above 8%, half of it from Tier 1 capital**

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- Current exposure: replace $\sum \max(V_i, 0)$ by $\max(\sum V_i, 0)$
- Add-on: replace $\sum a_i L_i$ by $(0.4 + 0.6 \times \text{NRR}) \sum a_i L_i$
  - Net Replacement Ratio

$$\text{NRR} = \frac{\max(\sum V_i, 0)}{\sum \max(V_i, 0)}$$

Netting Example

- Assume the following portfolio of derivatives with one counterparty
  - 3-year interest rate swap, principal 1,000, current value -60, add-on amount 5 $= a_i L_i$
  - 6-year foreign exchange forward, principal 1,000, current value 70, add-on amount 75
  - 9-month option on a stock, principal 500, current value 55, add-on amount 30
- Original credit equivalent amount? Credit equivalent amount with netting?

w/o netting: $0 + 70 + 55 + 5 + 75 + 30 = 235$

w/ netting: $\max(-60 + 70 + 55, 0) + (0.4 + 0.6 \text{NR})(5 + 75 + 30)$

65 $\qquad$ 0.712

$= 143.32$ $\qquad$ $\frac{65}{70+55} = 0.52$

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- Original credit equivalent amount? Credit equivalent amount with netting?
- Original amount $0 + 5 + 70 + 75 + 55 + 30 = 235$
- With netting:

$$\text{NRR} = \frac{65}{125} = 0.52$$

$$\text{Credit equivalent} = 64 + (0.4 + 0.6 \times 0.52) \times 110 = 143.32$$

1996 Amendment

- Account for market risk, implemented in 1998
- Assets of banks in two parts
  - *Trading book*: marketable securities, derivatives. Marked to market.
  - *Banking book*: assets expected to be held until maturity. Held at historical cost.

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- Two ways to compute the market risk charge:
  - Standardized approach: capital for each security class, not accounting for correlation
  - Internal model-based approach: use model to compute VaR

Market Risk Capital Charge

- Capital requirement for market risk:

$$\max(\text{VaR}_{t-1}, m_c \times \text{VaR}_{\text{avg}}) + SRC$$

- VaR:
  - 10-day 99%.
  - Can use $\sqrt{10}\times$ 1-day VaR
  - Average over past 60 days

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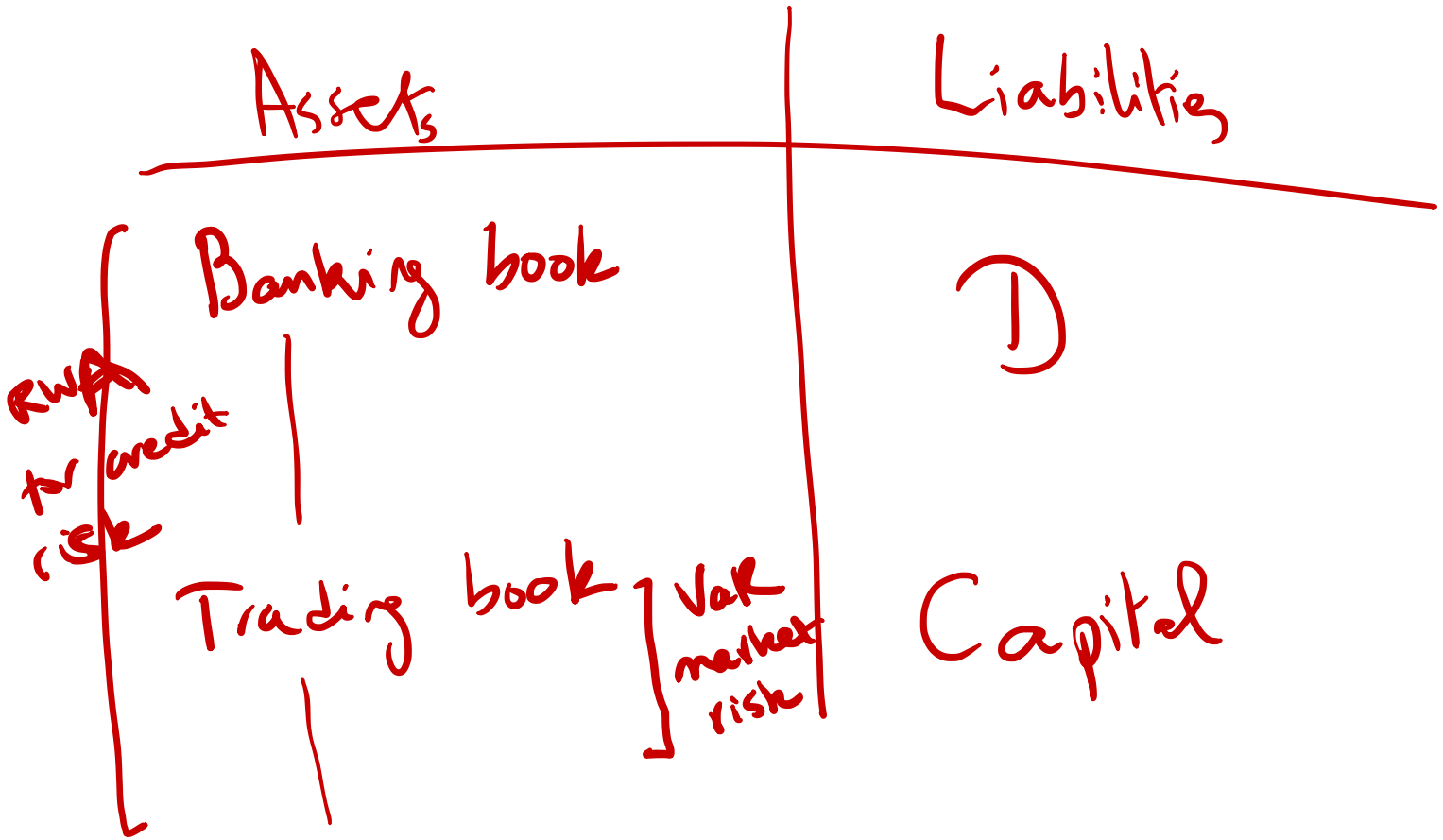

Capital $\geq$ 8% Risk-weighted Assets

+ VaR

Capital $\geq$ 8% (RWA + 12.5 VaR) - credit-equivalent amount

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- SRC: specific risk charge, for risks with particular companies

Outline

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  1. Minimum Capital Requirements
  2. Supervisory Review
  3. Market Discipline

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- **Three pillars**:
  1. Minimum Capital Requirements: modifies credit risk, adds operational risk
  2. Supervisory Review: communicate with supervisor, early intervention
  3. Market Discipline: communicate with investors

Credit Risk Capital Under Basel II

- Much finer risk-weighting, account for correlation
- Three methods:
  - Standardized Approach
  - Foundation Internal Ratings Based (IRB) Approach
  - Advanced IRB Approach

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Standardized Approach

- Risk-weights depends of rating
- Adjustment for collateral

Rating	AAA to AA-	A+ to A-	BBB+ to BBB-	BB+ to BB-	B+ to B-	Below B-	Unrated
Country	0%	20%	50%	100%	100%	150%	100%
Banks	20%	50%	50%	100%	100%	150%	50%
Corporates	20%	50%	100%	100%	150%	150%	100%

IRB Approach

- One-year 99.9% VaR for credit risk
  - One in a thousand years loss
- Minus expected one-year loss
  - "Typical loss": already priced in contract rates
- Compute the VaR using the one-factor Gaussian copula model

Expected Loss

- Expected loss from defaults:

$$\sum_i \text{EAD}_i \times \text{LGD}_i \times \text{PD}_i$$

- PD: probability that the counterparty will default within one year
- EAD: exposure at default
- LGD: loss given default = 1 - recovery

VaR for Credit Risk

- Approximation for 99.9% VaR:

$$\sum_i \text{EAD}_i \times \text{LGD}_i \times \text{WCDR}_i$$

- WCDR: worst-case default rate, default rate in the 99.9th percent worst aggregate outcome

$$\text{WCDR}_i = \mathcal{N}\left[\frac{\mathcal{N}^{-1}(PD_i) + \sqrt{\rho}\,\mathcal{N}^{-1}(0.999)}{\sqrt{1-\rho}}\right]$$

  - ρ (sometimes R): copula correlation

Loan i → Default 1%

→ No default 99%

$Z_i \sim N(0,1)$

if $Z_i \leq -2.32$ default

if $Z_i > -2.32$ No def.

$$Z_i = \underbrace{\rho}_{\text{rho}} F + \sqrt{1-\rho^2}\,\varepsilon_i$$

$F \sim N(0,1)$

$\varepsilon_i \sim N(0,1)$

$\text{cov}(\varepsilon_i, \varepsilon_j) = 0$

$$PD = P(Z_i \leq -2.32)$$

$$WCDR = P(Z_i \leq -2.32 \mid F \text{ being in } 99.9\% \text{ worst case})$$

$F \leq z(99.9\%)$

Copula Correlation ρ

- Assume a correlation that depends on PD based on empirical research
  - Corporate, sovereign and bank exposures:

$$\rho = 0.12\frac{1-\exp(-50\times PD)}{1-\exp(-50)} + 0.24\left[1-\frac{1-\exp(-50\times PD)}{1-\exp(-50)}\right]$$
$$\approx 0.12(1+\exp(-50\times PD))$$

  - Retail exposures ($\rho = 0.15$ for mortgages)

$$\rho = 0.03 + 0.13\exp(-35\times PD)$$

Maturity Adjustment

- The underlying risk might change over time for long-term assets
- Adjustment factor MA for maturity M

$$\text{MA} = \frac{1 + (M - 2.5) \times b}{1 - 1.5 \times b}$$

$$b = [0.11852 - 0.05478 \times \ln(PD)]^2$$

- MA $= 1$ if M $= 1$
- No adjustment for retail

Capital Requirement for Credit Risk

- Capital required:

$$\text{Capital} \geq \sum_i \text{EAD}_i \times \text{LGD}_i \times (\text{WCDR}_i - PD_i) \times \text{MA}_i$$

$$\text{Capital} \geq 8\% \times \left(12.5 \times \Sigma \text{——}\right)$$

- Risk-weighted assets: $\times 12.5$

- Foundation IRB: banks supply PD, everything else given by Basel guidelines

- Advanced IRB: everything determined by banks

Example

- Assets of the bank: \$100 millions of loans to A-rated corporations. PD for the corporations is estimated as 0.1%, and the LGD is 60%. The average maturity is 2.5 years.
- Risk-weighted assets under Basel I? Basel II?
  - Standardized: \$50m
  - IRB
  - \$100m

$$EAD \times LGD \times (WCDR - PD) \times 1.58$$

\$100m, 60%, 3.42%, 0.1%, 1.58

$= \$3.15m$

$\rho = 0.234$

$\times 12.5$

$= \$39m$

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- Risk-weighted assets under Basel I? Basel II?
- Basel I: \$100 millions
- Basel II:
  - $b = 0.247$, MA $= 1.59$
  - WCDR $= 3.4\%$
  - RWA $= 12.5 \times 100 \times 0.6 \times (0.034 - 0.001) \times 1.59 = 39.3$

Outline

Basel II.5

- Changes during the financial crisis of 2008, implemented at the end of 2011
- Stressed VaR
- Incremental risk charge
- Comprehensive risk measure for correlation instruments

Stressed VaR

- Add stressed VaR for calculation of market risk:

$$\max(\mathsf{VaR}_{t-1}, m_c \times \mathsf{VaR}_{\mathsf{avg}}) + \max(\mathsf{sVaR}_{t-1}, m_s \times \mathsf{sVaR}_{\mathsf{avg}})$$

- More than doubles the market risk charge

Incremental Risk Charge

- Asymmetry between trading book and banking book under Basel II
  - Trading: 10-day 99% VaR
  - Banking: 1-year 99.9% VaR
- IRC: adds 1-year 99.9% VaR for assets in the trading book exposed to credit
  - Allow for a liquidity horizon under *constant level of risk* assumption

Comprehensive Risk Measure

- Replace IRC by a systematic charge for correlation risk for exposed securities (ABSs, CDOs, ...)
- Two ways:
  - Standardized approach
  - Use internal models

Credit Rating	AAA or AA	A	BBB	BB	Below BB
Securitizations	1.6%	4%	8%	28%	Deduction
Resecuritizations	3.2%	8%	18%	52%	Deduction

Outline

Basel III

- Basel III: December 2010, implemented gradually between 2013 and 2019
- Six parts:
  1. Capital Definition and Requirements
  2. Capital Conservation Buffer
  3. Countercyclical Buffer
  4. Leverage Ratio
  5. Liquidity Risk
  6. Counterparty Credit Risk

Capital Definition and Requirement

- **Tier 1 equity capital**: 4.5% of risk-weighted assets
  - Share capital and retained earnings, no goodwill or deferred tax assets, adjusted downwards if defined benefit pension plan deficits
- **Total Tier 1 capital**: 6% of risk-weighted assets
- **Total capital**: 8% of risk-weighted assets

Capital Buffers

- **Capital conservation buffer**
  - Need to accumulate additional 2.5% of risk-weighted assets in equity capital ahead of difficult times
  - Forced to retain earnings if under this threshold: 100% if $<$5.125%, ...
- **Countercyclical buffer** (CCyB)
  - Same as capital conservation but left to discretion of national authorities
  - Between 0% and 2.5% of of total risk-weighted assets

Leverage Ratio

- **Leverage ratio**: capital divided by exposure measure
  - Capital: Tier 1 capital
  - Exposure: sum of on-balance-sheet exposures, derivatives exposures, securities financing transaction exposures, off-balance sheet items
  - No risk-weighting

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  - Capital: Tier 1 capital
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  - No risk-weighting
- Minimum leverage ratio of 3%
  - Push to do more in the US, up to 5-6%
  - UK: 4.05%, possibly up to 4.95%

Capital > 3% Total Assets
~~Or~~ And
Capital > 8% / 12% RWA

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  - No risk-weighting
- Minimum leverage ratio of 3%
  - Push to do more in the US, up to 5-6%
  - UK: 4.05%, possibly up to 4.95%
- Simple broad measure of credit risk, less subject to gaming

Liquidity Risk

Liquidity Risk

- **Liquidity Coverage Ratio** (LCR)

$$\frac{\text{High-Quality Liquid Assets}}{\text{Net Cash Outflows in a 30-Day Period}}$$

  - Bank's ability to survive a 30-day period of liquidity disruptions: assume downgrade of debt by three notches, partial loss of deposits, complete loss of wholesale funding, increased haircuts on secured funding, drawdowns on lines of credit.

  - Must be greater than 100%

Liquidity Risk

- **Net Stable Funding Ratio** (NSFR)

$$\frac{\text{Amount of Stable Funding}}{\text{Required Amount of Stable Funding}}$$

  - Amount of stable funding: sources of fund weighted according to their stability
  - Required amount of stable funding: assets weighted by the facility to liquidate them
  - Must be greater than 100%

Amount of Stable Funding Factors

ASF Factor	Category
100%	Tier 1 and Tier 2 capital Preferred stock and borrowing with a remaining maturity greater than 1 year
90%	Stable demand deposits and term deposits
80%	Les stable demand deposits and term deposits
50%	Wholesale demand deposits
0%	All other liability and equity categories

Required Stable Funding Factors

RSF Factor	Category
0%	Cash and short-term instruments (<1 yr)
5%	Claims on sovereign governments with a risk weight =0% (>1 yr)
20%	Corporate bonds rating AA or higher (>1 yr) Claims on sovereigns with risk weight =20%
50%	Gold, equities, and bond rated A
65%	Residential mortgages
85%	Loans to retail and small business (<1 year)
100%	All other assets

Counterparty Credit Risk

risk of changes in counterparty risk

- Adjust profits for expected default of derivatives counterparties: **credit value adjustment** (CVA)

- CVA can change because of
  - Change in the value of the derivatives exchanged with the counterparty
  - Change in the credit quality of the counterparty
- Basel III requires CVA risk from changes in credit spreads to be included in calculation for market risk capital

distressed value adjustment (DVA)

Systematically Important Institutions

- Systemic risk particularly important coming from large institutions.
- Also large likelihood of bailouts in case of failure: "too big too fail"
- Basel III explicitly account for those:
  - SIFI: systematically important financial institution
  - G-SIBs: global systematically important bank
- Face increased capital requirement and scrutiny by regulators

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- Face increased capital requirement and scrutiny by regulators
  - G-Sib: BoA, BoNY Mellon, Citigroup, Goldman Sachs (12%), JPMorgan Chase (13%), Morgan Stanley, State Street (11.5%), and Wells Fargo
  - SIFI: Metlife, Prudential
  - D-SIBs: all other banks with assets >$22bn

Takeaways

- Identify and *measure* what can go wrong
- Make sure there is enough to survive if things go wrong

Takeaways

- Identify and *measure* what can go wrong
- Make sure there is enough to survive if things go wrong
- Measurement challenge:
  - Recognize heterogeneity in the risk of traded instruments
  - Avoid regulatory arbitrage by the banks
- Regulations flow down to individual desks
- Next: credit risk, liquidity risk