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## CQF: Certificate in Quantitative Finance

# Financial Regulation and Basel III

Dr Jon Gregory  
[jon@solum-financial.com](mailto:jon@solum-financial.com)

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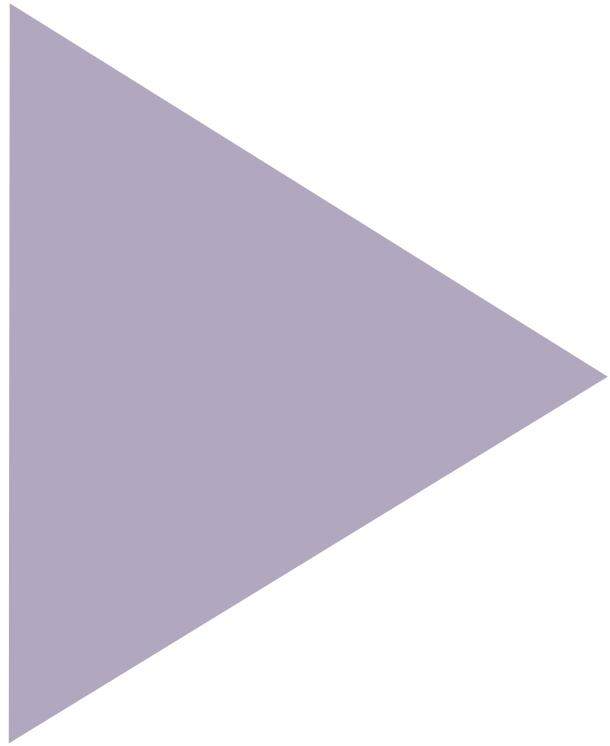
Professor Dr Hermann Schulte-Mattler explains: “Currently, every European bank must observe approximately 40,000 legally binding requirements of the European Union. In the field of banking supervision, four thousand and one different rules have been set down on 34,019 pages ... Today it is almost impossible to find any banking supervisor or bank practitioner who is able to explain exactly the supervisory rules and their consequences. The scope and complexity of the rules are just too great.”

*Neisen M, Roth S. Basel IV: The Next Generation of Risk Weighted Assets.*  
Wiley, 2017

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# Content

- Financial Regulation
- Types of Risk in Banks
- The BIS and Banking Regulation
- Minimum Capital Requirements
- Liquidity Risk
- Case Study: The Internal Ratings Based Approach (IRB)
  
- Appendix: Example Regulatory References



# Financial Regulation

# Financial Regulation: Is it Possible?

The Tulip and Bulb Craze, 1634-1637 (first recorded ban regulation on short selling was enacted by the Dutch authorities as early at 1610).

Wall Street Crash: Black Tuesday (October 29, 1929)

The Fix: The Glass–Steagall legislation

The Improvement(?): The Gramm–Leach–Bliley Act (GLBA) of 1999

Global Financial Crisis (GFC)  
2007 onwards

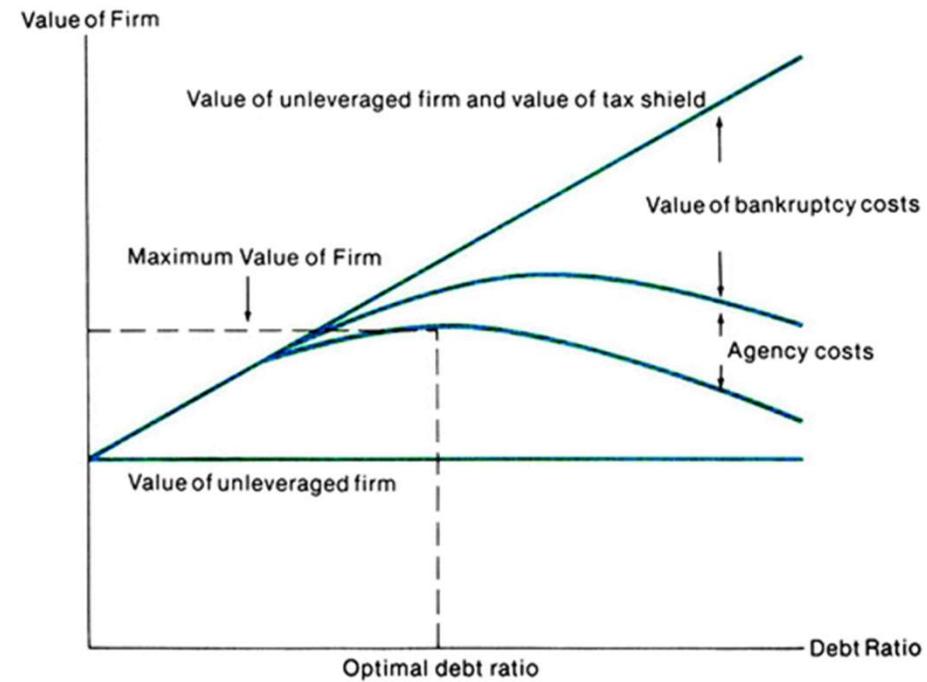


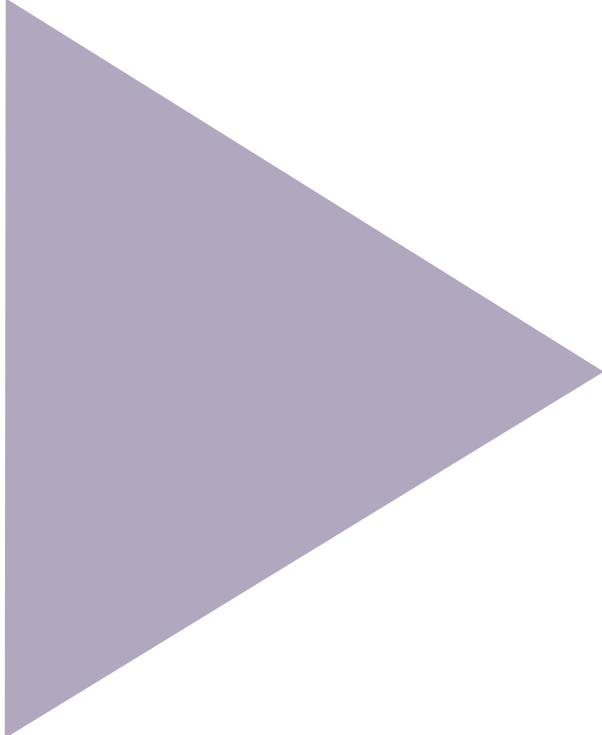
The Wall Street Crash of 1929

# Financial Regulation: Is it Necessary?

## Modigliani–Miller theorem (1958)

- In the absence of taxes, bankruptcy costs, agency costs, and asymmetric information, and in an efficient market, the value of a firm is unaffected by how that firm is financed





## **Types of Risk in Banks**

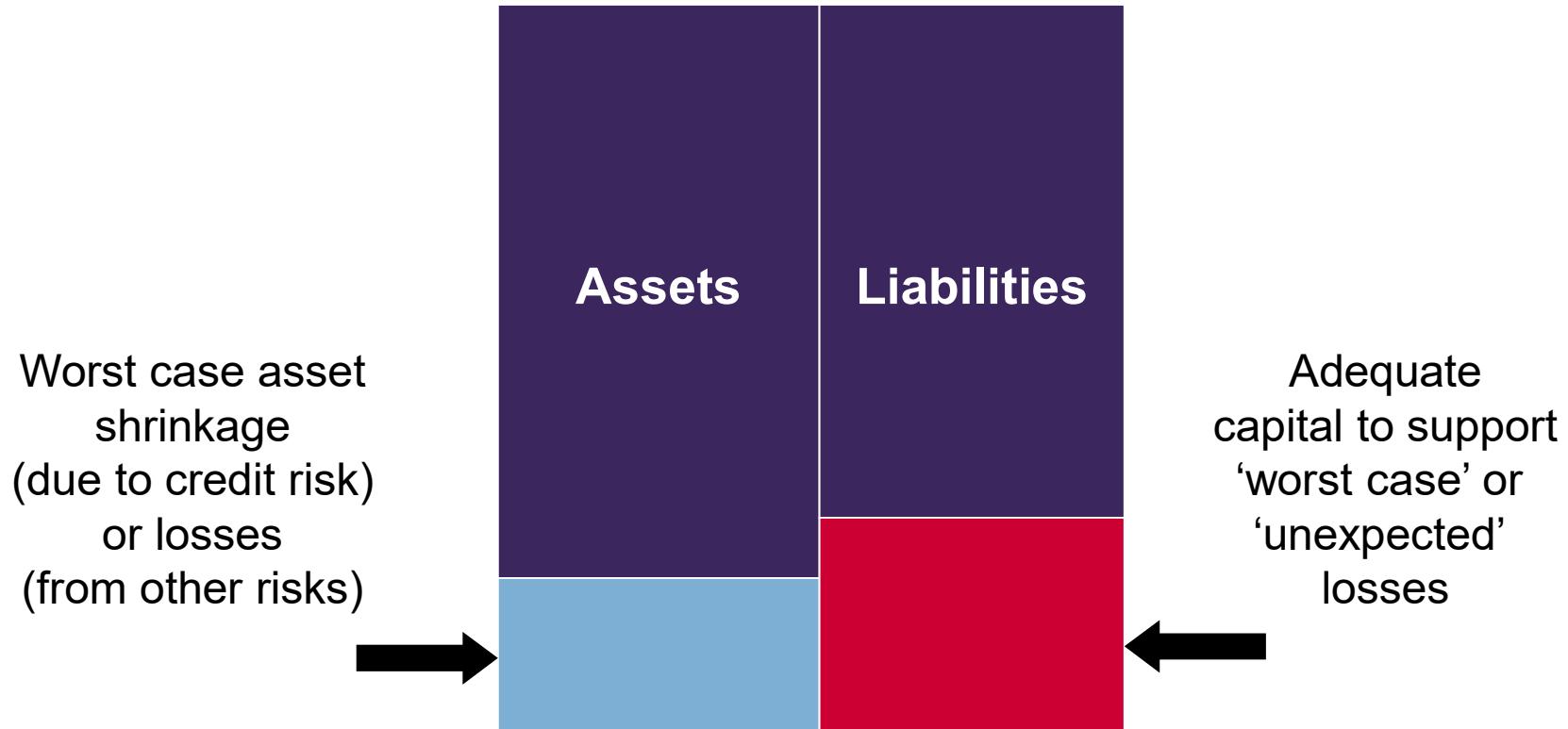
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# Risk Types and Capital in Banks

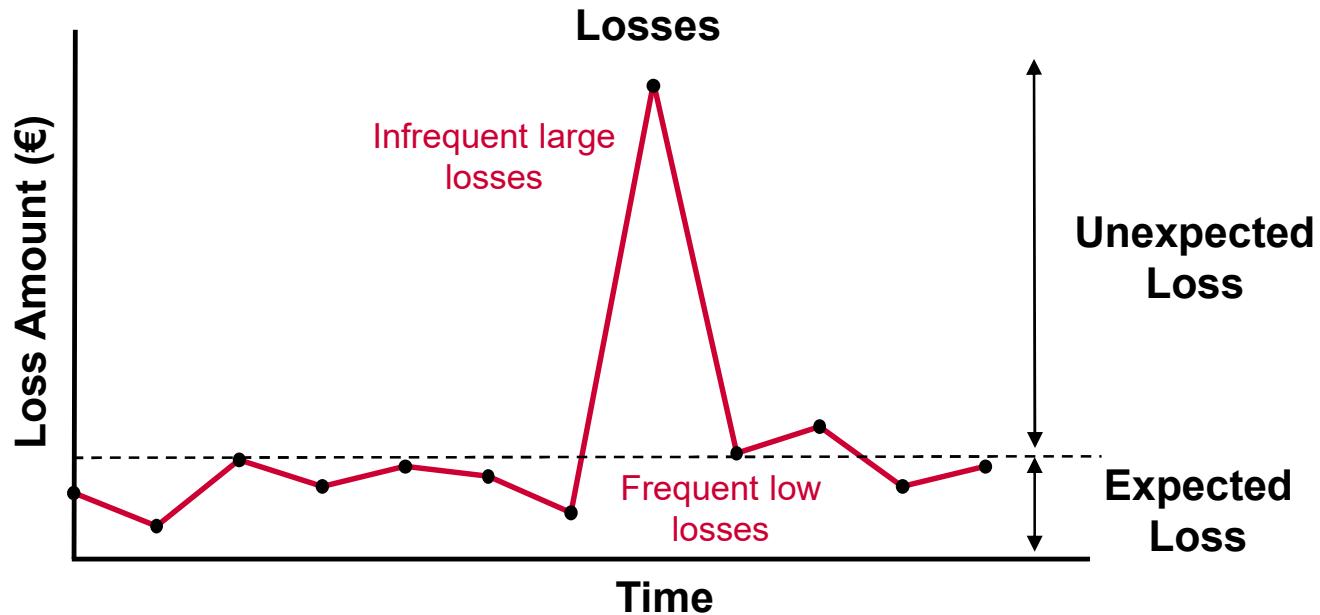
## Major risk types:

- Credit (usually the main one)
- Counterparty (may be defined within credit risk, it is a subset of credit risk)
- Market
- Operational
- Liquidity
- Other
  - Legal
  - Reputational

# Importance of Capital



# Economic Capital: Concept of Unexpected Loss



## Expected Loss (EL)

- Most years, losses are low
- Acceptable cost of doing business
- Absorbed by reserves / provisions

## Unexpected Loss (UL)

- Large losses punctuate business cycle
- Absorbed by capital

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# Definition of Economic Capital

“The amount of capital a bank would voluntarily set aside to support its business independent of any regulatory requirement”

Capital required:

- To support the business
- To absorb unexpected losses
- At specified probability of default
- Or required rating level, e.g. AA
  - Confidence level associated with AA rating is 99.95%
  - Requires capital sufficient to cover all but 5 out of 10,000 risk scenarios over a 1 year horizon

# Economic Capital

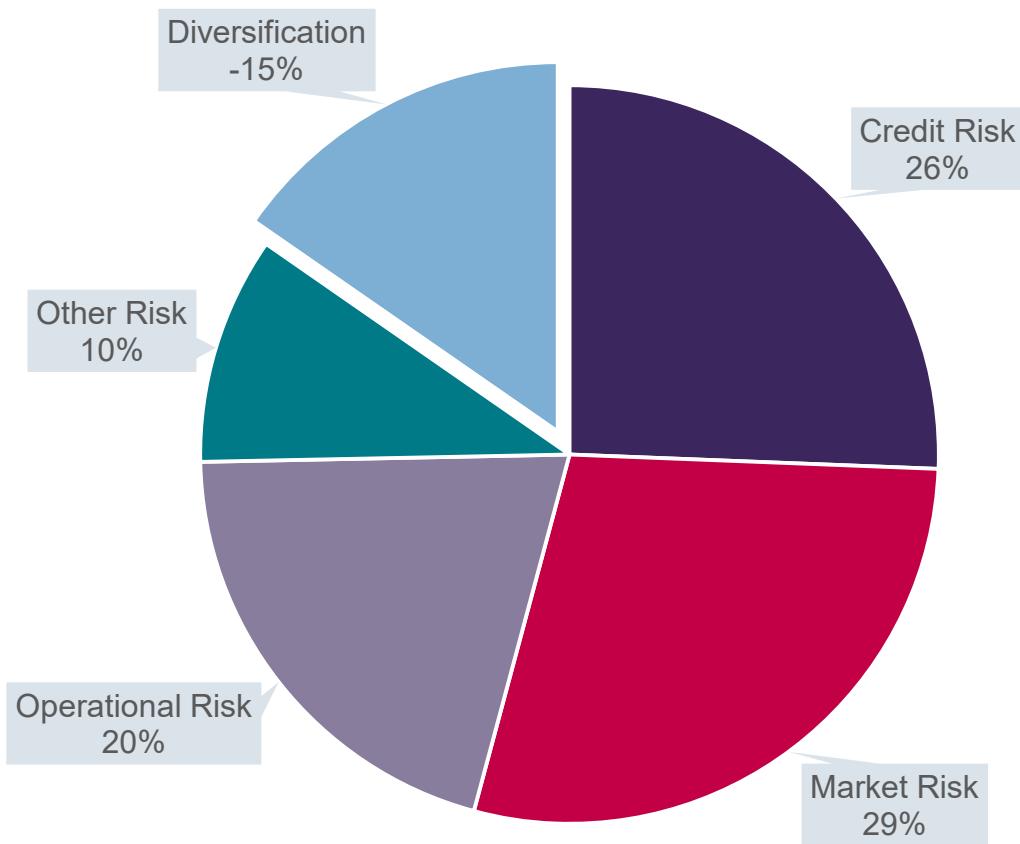
The capital required to absorb unexpected (very severe) losses



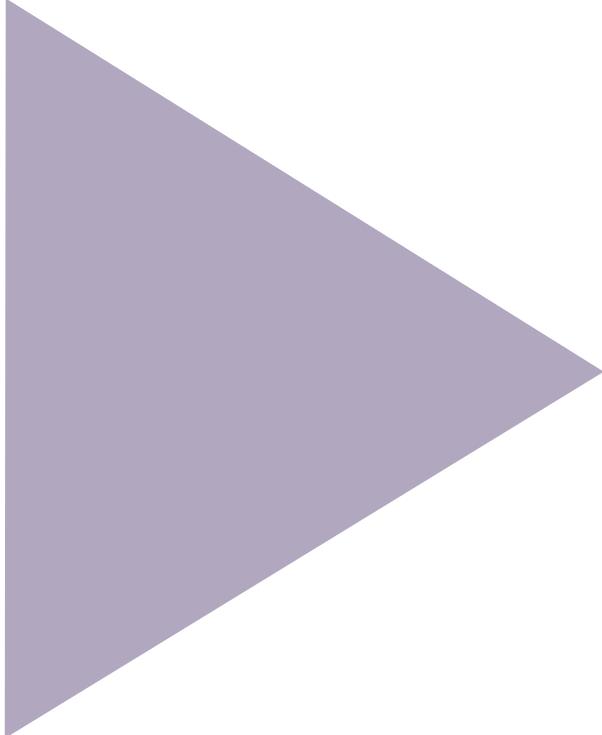
Used for internal capital allocation and risk-adjusted profitability measurement.

# Economic Capital: Deutsche Bank Allocation by Risk Type

**2016:**  
**Total EUR35.4 billion**  
**(EUR43.3 billion gross**  
**before diversification)**



Source: Deutsche Bank 2016 Annual Report, page 92



# **The BIS and Banking Regulation**

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# The Basel Committee for Banking Supervision (BCBS)

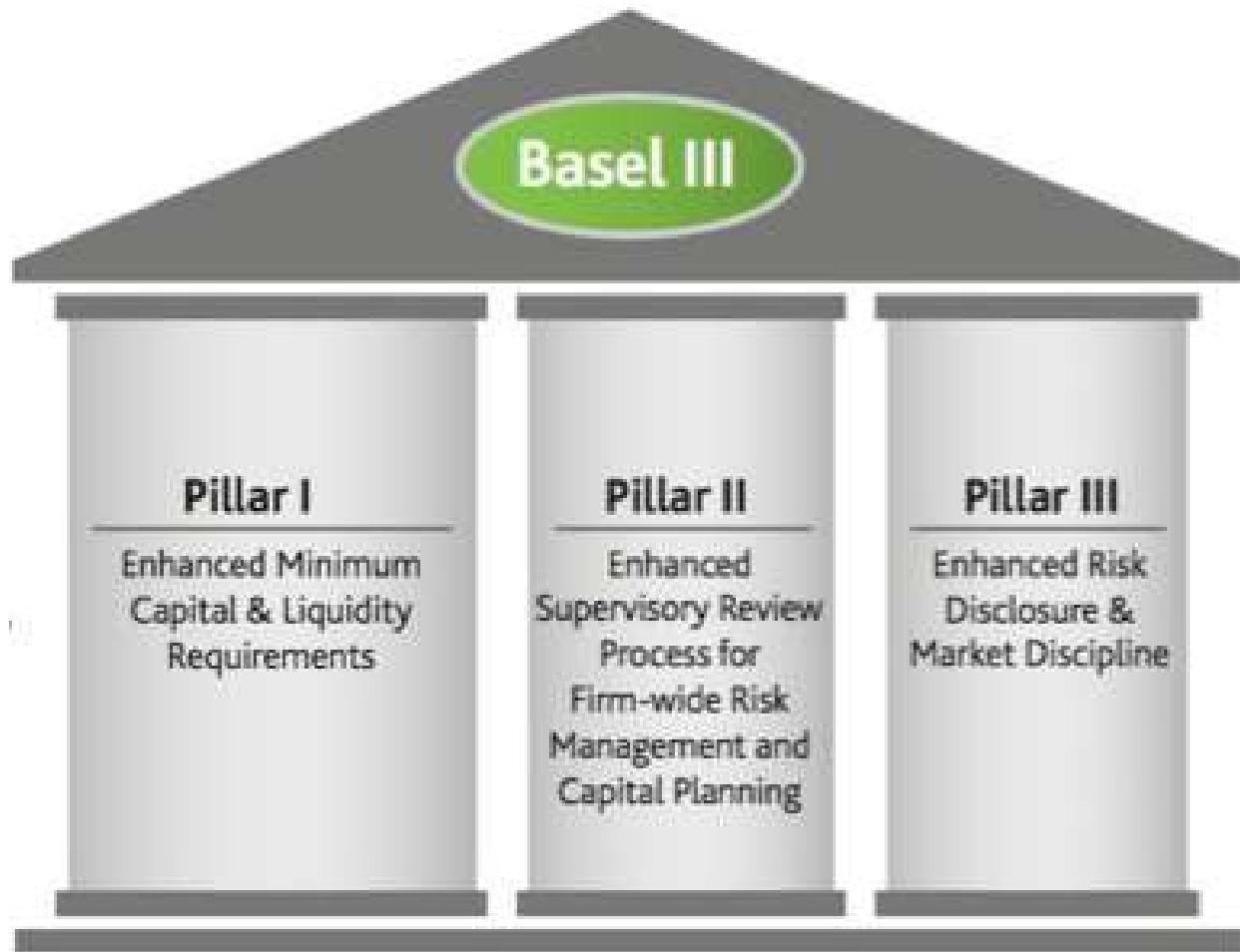
The Basel Committee – initially named the Committee of Banking Regulations and Supervisory Practices – was established by the central bank Governors of the Group of Ten countries at the end of **1974** in the aftermath of serious disturbances in international currency and banking markets (notably the failure of Bankhaus Herstatt in West Germany).

The Committee, headquartered at the Bank for International Settlements (**BIS**) in Basel, was established to enhance financial stability by improving the quality of banking supervision worldwide, and to serve as a forum for regular cooperation between its member countries on banking supervisory matters.

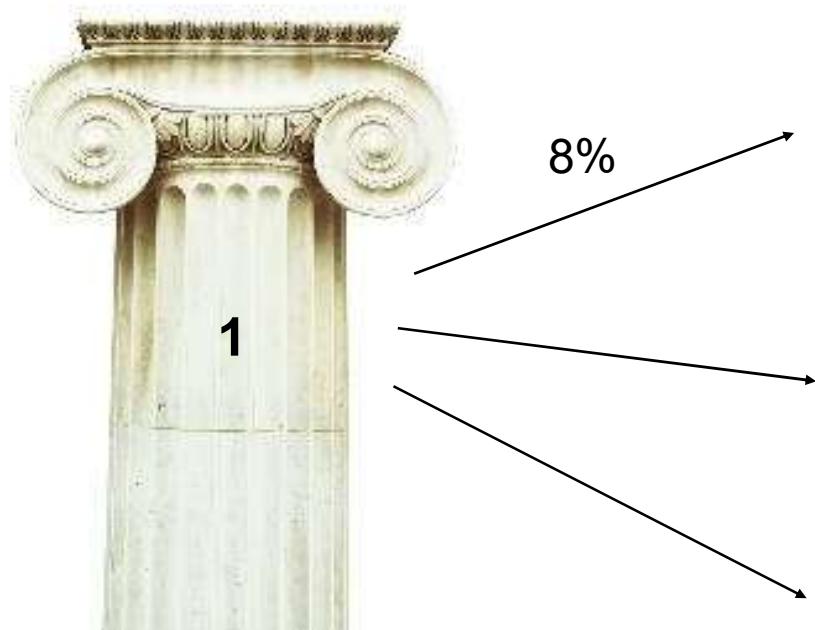
Since its inception, the Basel Committee has expanded its membership from the G10 to 45 institutions from 28 jurisdictions. The Committee has established a series of international standards for bank regulation, most notably its landmark publications of the accords on capital adequacy which are commonly known as Basel I, Basel II and, most recently, Basel III.

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# Basel III: The Three Pillars



# The First Pillar: Minimum Capital Requirement



8%

## Credit risk:

- |          |  |
|----------|--|
| Basel 1: | Standardised                             |
| Basel 2: | Different more risk sensitive approaches |
| Basel 3: | Enhanced counterparty risk requirements  |

## Market risk:

- |           |  |
|-----------|--|
| Basel 2   | VAR models                             |
| Basel 2.5 | Additional requirements                |
| Basel 4   | Fundamental review of the trading book |

## Operational risk:

New in Basel 2, unchanged Basel 3

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# Capital Methodologies

**Huge amount of complexity due to:**

- Different risk types requiring different approaches
  - VAR for market risk, ratings-based for credit risk
  - Market risk generally quite quantitative, operational risk much more basic
- Different methodologies to suit different banks
  - Generally basic, standardised and advanced (don't always get three choices)
  - Sometimes the challenge is to represent the risk of a complex system with maths that an 10-year old could understand!
- Regulatory change
  - Improvements and changes to methodologies (e.g. FRTB)
  - Not as simple as Basel 1, Basel 2, Basel 3, .....
- New initiatives
  - Leverage ratio, CVA capital charge

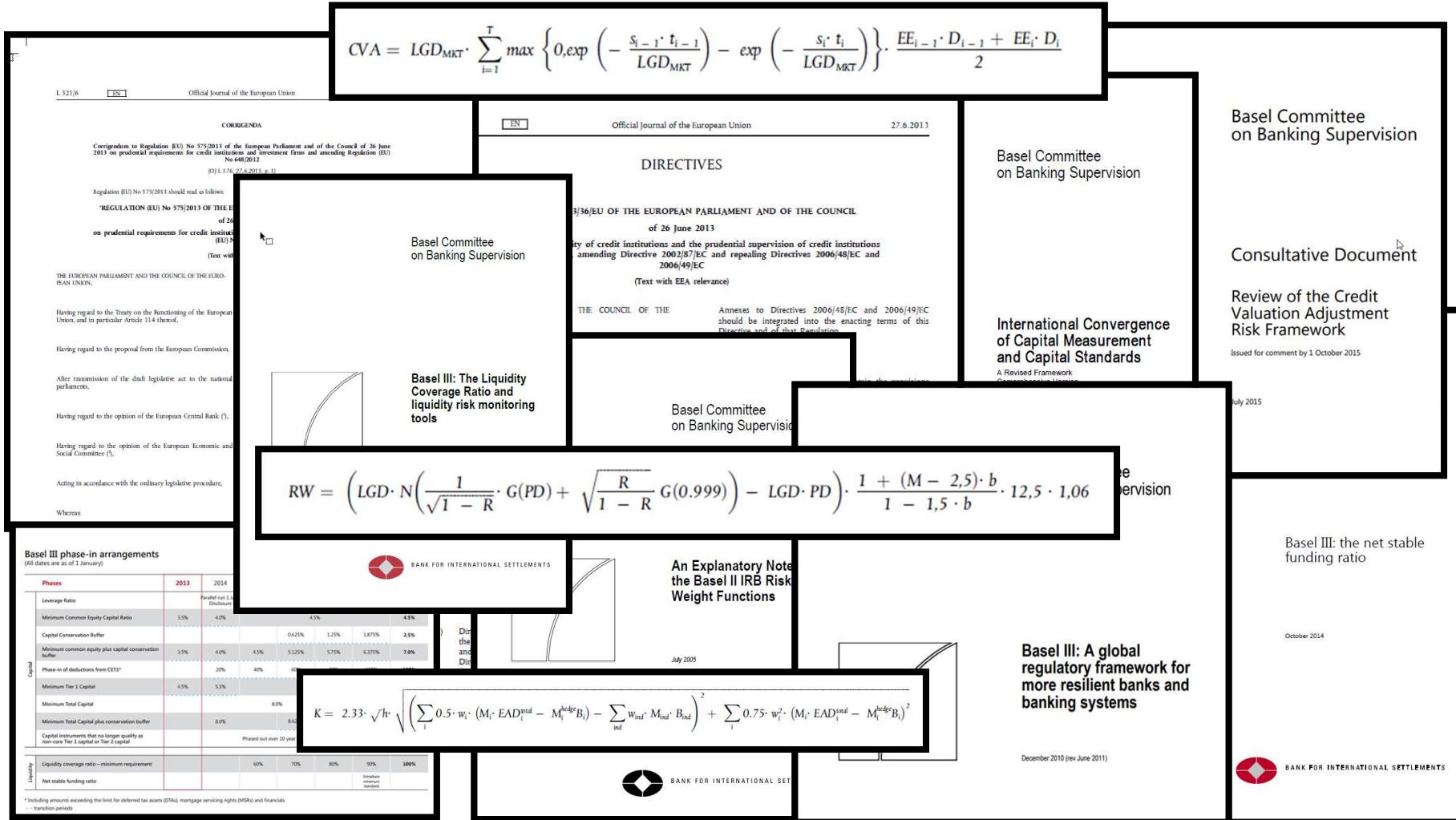
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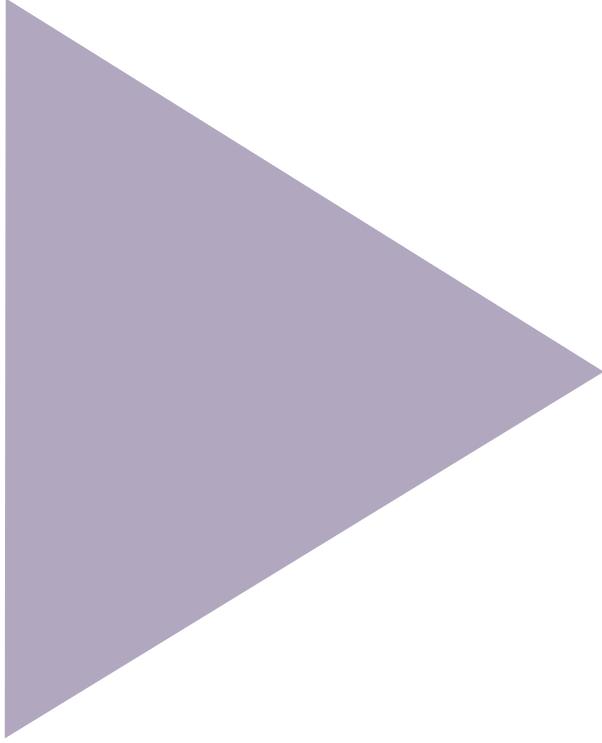
# Capital Methodologies

**Huge amount of complexity due to:**

- Internal model or not?
  - Internal models can be sophisticated and risk sensitive but are subjective and benchmarking exercises show wide variation
  - Simpler approaches are objective but not as risk sensitive
- Data
  - Depends on risk type
  - Plentiful for market risk, supporting more model-based approaches
  - Sparse for credit and operational risk leading to simpler approaches
- Quant angle
  - Lots of jobs requiring regulatory expertise
  - Can be quite mathematical and model intensive in the standardised and advanced methodologies but rarely logical!

$$b = (0.11852 - 0.05478 \cdot \ln(PD))^2$$



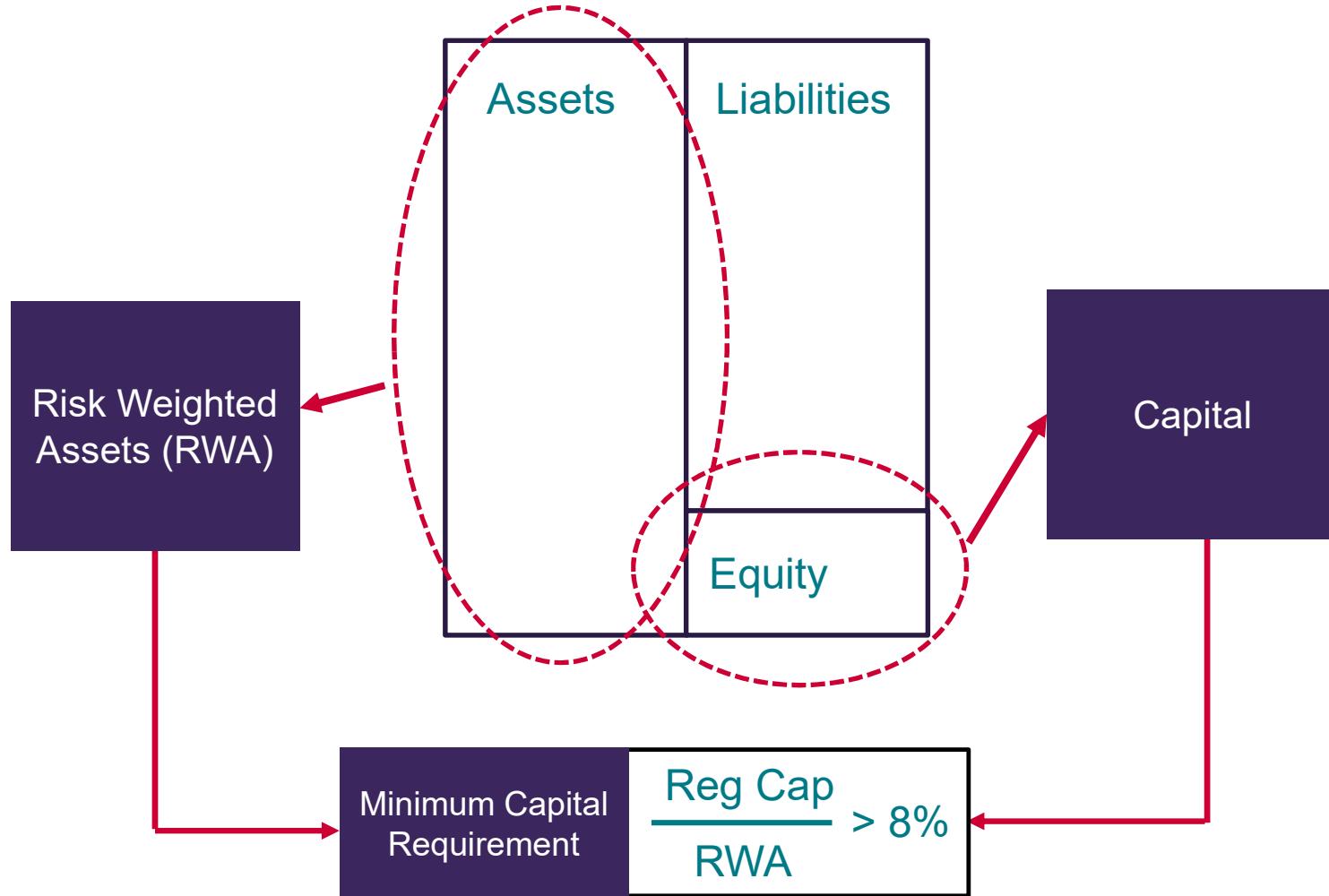


# **Minimum Capital Requirements**

# Assets and Risk

December 31, (in millions, except share data)	2019	2018
<b>Assets</b>		
Cash and due from banks	\$ 21,704	\$ 22,324
Deposits with banks	241,927	256,469
Federal funds sold and securities purchased under resale agreements (included \$14,561 and \$13,235 at fair value)	249,157	321,588
Securities borrowed (included \$6,237 and \$5,105 at fair value)	139,758	111,995
Trading assets (included assets pledged of \$111,522 and \$89,073)	411,103	413,714
Investment securities (included \$350,699 and \$230,394 at fair value and assets pledged of \$10,325 and \$11,432)	398,239	261,828
Loans (included \$7,104 and \$3,151 at fair value)	959,769	984,554
Allowance for loan losses	(13,123)	(13,445)
Loans, net of allowance for loan losses	946,646	971,109
Accrued interest and accounts receivable	72,861	73,200
Premises and equipment	25,813	14,934
Goodwill, MSRs and other intangible assets	53,341	54,349
Other assets (included \$9,111 and \$9,630 at fair value and assets pledged of \$3,349 and \$3,457)	126,830	121,022
<b>Total assets<sup>(a)</sup></b>	<b>\$ 2,687,379</b>	<b>\$ 2,622,532</b>

# The Basel Solution for Capital Adequacy



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# The Three Risks: Credit, Market and Operational

- Credit Risk (including counterparty risk)
- Market Risk
- Operational Risk

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# The Three Risks: Credit, Market and Operational

## Credit Risk Management

*Credit risk arises from the potential that a borrower or counterparty will fail to perform on an obligation. For most banks, loans are the largest and most obvious source of credit risk. However, there are other sources of credit risk both on and off the balance sheet. Off-balance sheet items include letters of credit unfunded loan commitments, and lines of credit. Other products, activities, and services that expose a bank to credit risk are credit derivatives, foreign exchange, and cash management services.*

[https://www.federalreserve.gov/supervisionreg/topics/credit\\_risk.htm](https://www.federalreserve.gov/supervisionreg/topics/credit_risk.htm)

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# The Three Risks: Credit, Market and Operational

## Market Risk Management

*Market risk encompasses the risk of financial loss resulting from movements in market prices. Market risk is rated based upon, but not limited to, an assessment of the following evaluation factors: The sensitivity of the financial institution's earnings or the economic value of its capital to adverse changes in interest rates, foreign exchanges rates, commodity prices, or equity prices. The ability of management to identify, measure, monitor, and control exposure to market risk given the institution's size, complexity, and risk profile. The nature and complexity of interest rate risk exposure arising from nontrading positions.*

[https://www.federalreserve.gov/supervisionreg/topics/market\\_risk\\_mgmt.htm](https://www.federalreserve.gov/supervisionreg/topics/market_risk_mgmt.htm)

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# The Three Risks: Credit, Market and Operational

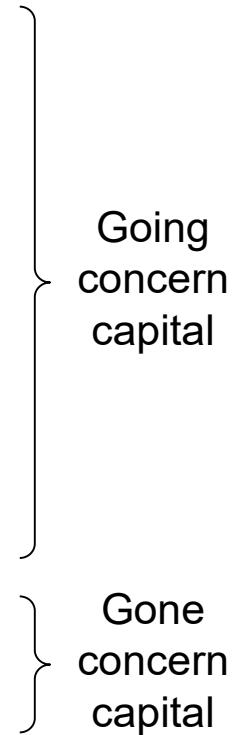
## Operational Risk Management

*Operational risk arises from the potential that inadequate information systems, operational problems, breaches in internal controls, fraud, or unforeseen catastrophes will result in unexpected losses (SR 95-51). Although operational risk does not easily lend itself to quantitative measurement, it can result in substantial costs through error, fraud, or other performance problems. The growing dependence of banking organizations on information technology emphasizes one aspect of the need to identify and control this risk.*

[https://www.federalreserve.gov/supervisionreg/topics/op\\_risk\\_mgmt.htm](https://www.federalreserve.gov/supervisionreg/topics/op_risk_mgmt.htm)

# Types of Capital

- Tier 1
  - Common equity tier 1 (CET1)
    - Examples: common equity and some other components (e.g. retained earnings)
  - Additional tier 1
    - Examples: contingent convertibles and hybrid securities which are perpetual and are converted into equity when CET1 falls below a certain level
- Tier 2
  - Examples: preference shares, subordinated term debt

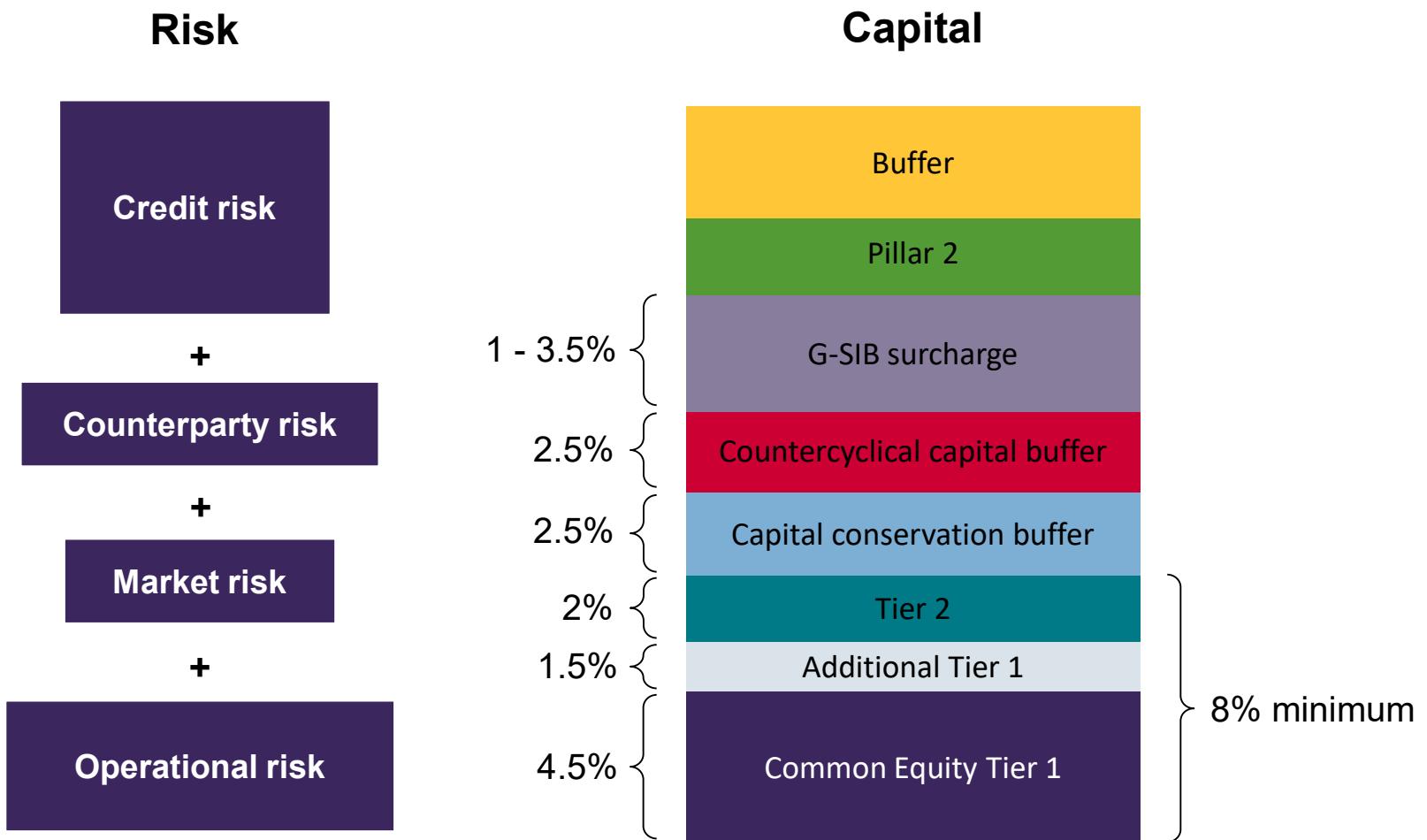


The diagram illustrates the classification of capital into two main categories: **Going concern capital** and **Gone concern capital**. A large brace on the right side groups the first two items under **Going concern capital**, while the third item is grouped under **Gone concern capital**.

Going concern capital

Gone concern capital

# Basel III – New Minimum Ratios (Fully Loaded)



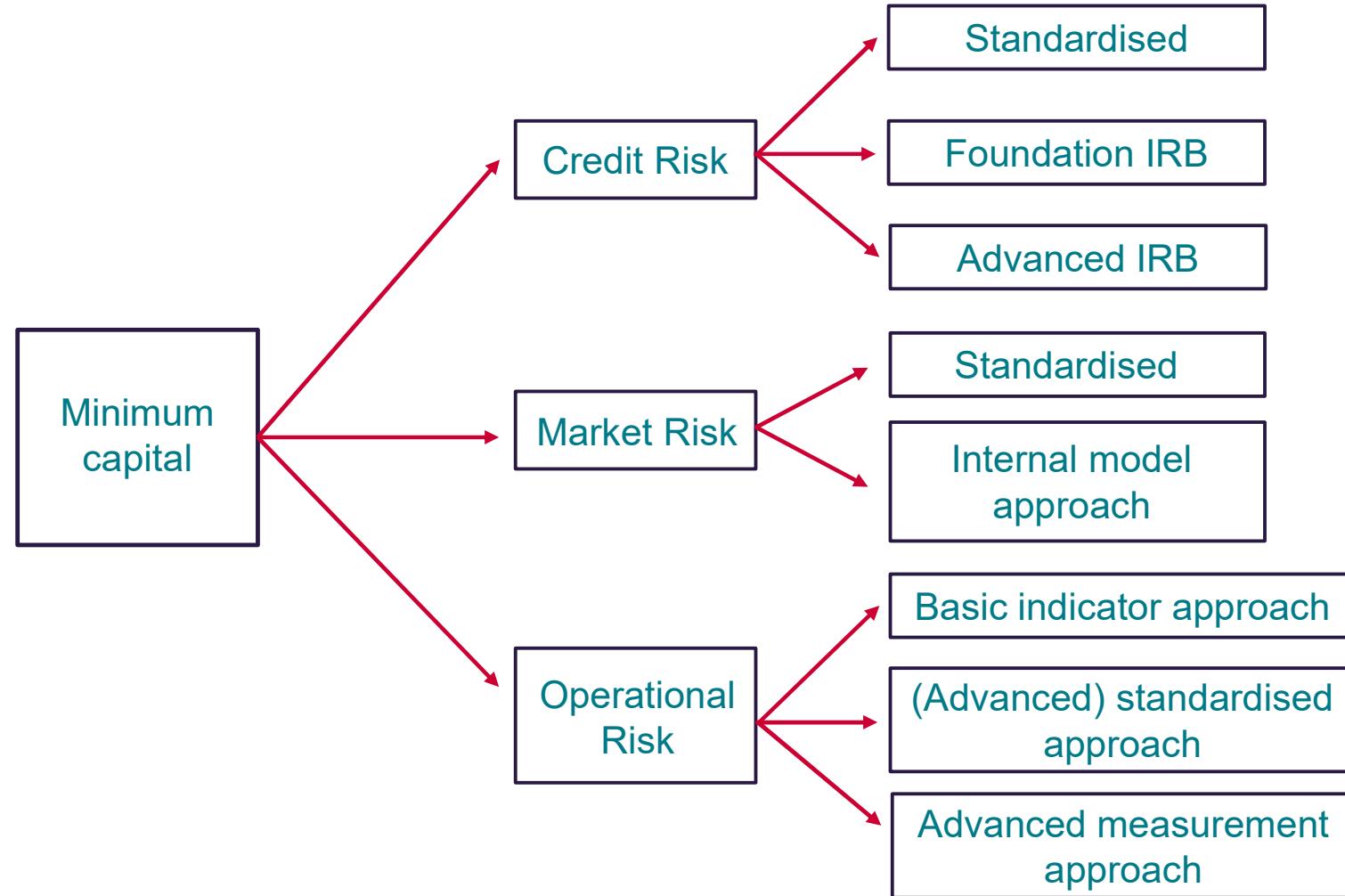
# JP Morgan Liabilities

Selected Consolidated balance sheets data

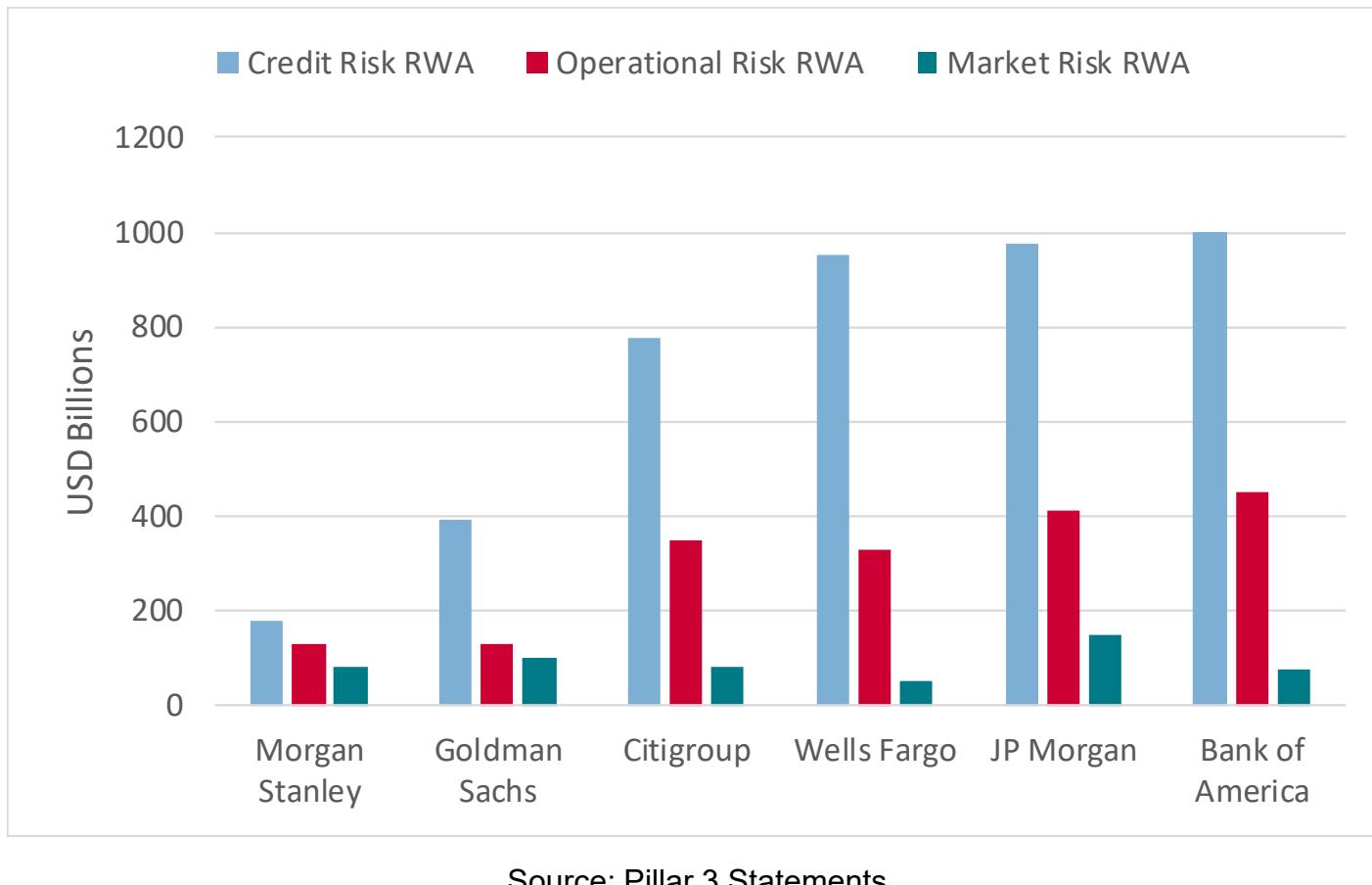
December 31, (in millions)	2019	2018	Change
<b>Liabilities</b>			
Deposits	\$ 1,562,431	\$ 1,470,666	6
Federal funds purchased and securities loaned or sold under repurchase agreements	183,675	182,320	1
Short-term borrowings	40,920	69,276	(41)
Trading liabilities	119,277	144,773	(18)
Accounts payable and other liabilities	210,407	196,710	7
Beneficial interests issued by consolidated variable interest entities ("VIEs")	17,841	20,241	(12)
Long-term debt	291,498	282,031	3
<b>Total liabilities</b>	<b>2,426,049</b>	<b>2,366,017</b>	<b>3</b>
Stockholders' equity	261,330	256,515	2
<b>Total liabilities and stockholders' equity</b>	<b>\$ 2,687,379</b>	<b>\$ 2,622,532</b>	<b>2%</b>

Source: RBS Pillar 3 Report 2017

# Methodology Menu



# How Much of Each Risk Type does a Bank Take?



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# Basel Capital Adequacy Accords: Timeline (1)



## Basel I

- 1988: Accord agreed
- 1992: Implemented in most mature markets
- 1995: Netting of off-balance sheet items
- 1996: Market risk incorporated

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# Basel Capital Adequacy Accords: Timeline (2)

## Basel 2.5 and Basel III



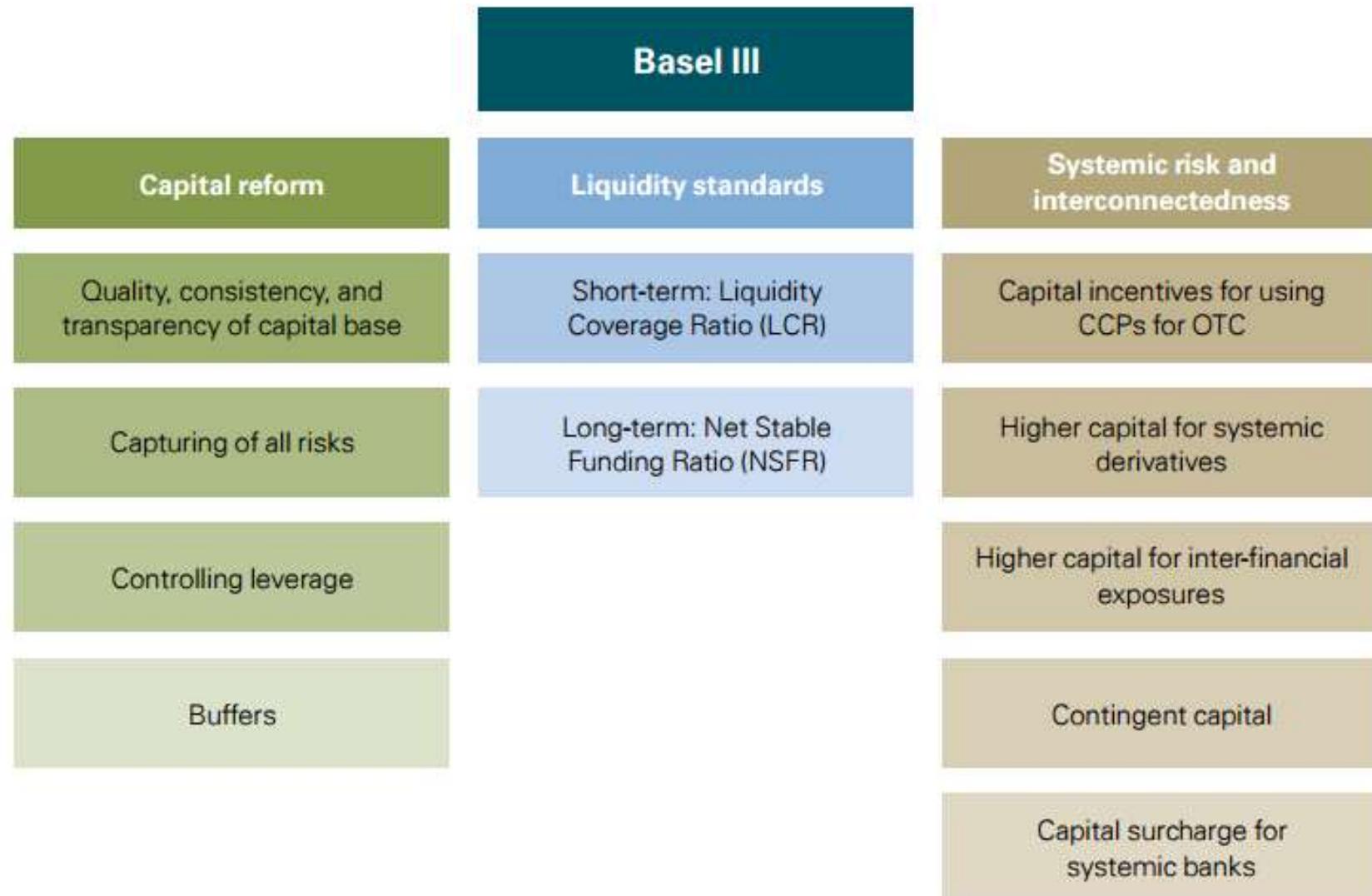
- 2005      Provisional discussions around changes to market risk treatment
- 2007      Financial crisis starts
- 2009      Basel 2.5 proposals (market risk)
- 2010      Basel III accord announced
- 2011      Incremental risk charges for market risk  
Revised treatment for securitisation
- 2013      Higher weightings for counterparty risk
- 2013-19     Basel III implementation

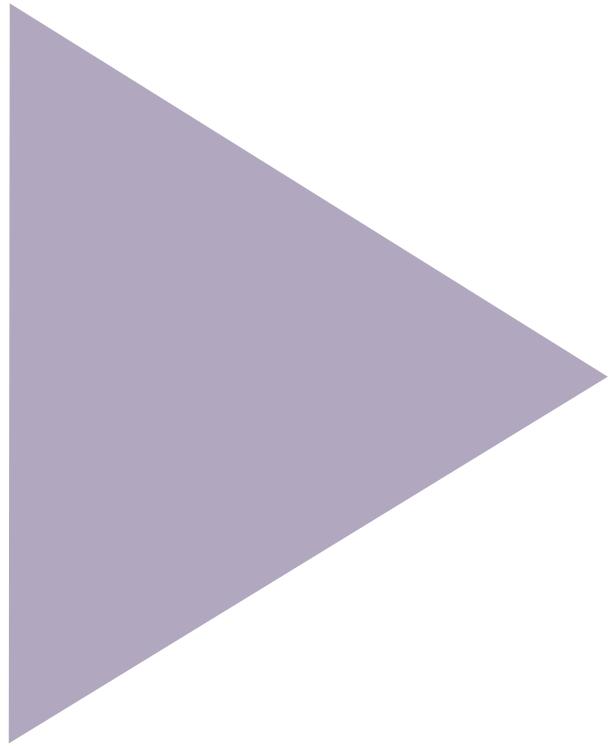
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# Key Elements of Basel III

- Enhanced risk coverage
- Capital adequacy
  - Higher minimum capital requirements
  - Better capital quality
  - Revised deductions
- Leverage
- Liquidity
  - Liquidity coverage ratio
  - Net stable funding ratio

# Basel III Proposals





## Liquidity Risk

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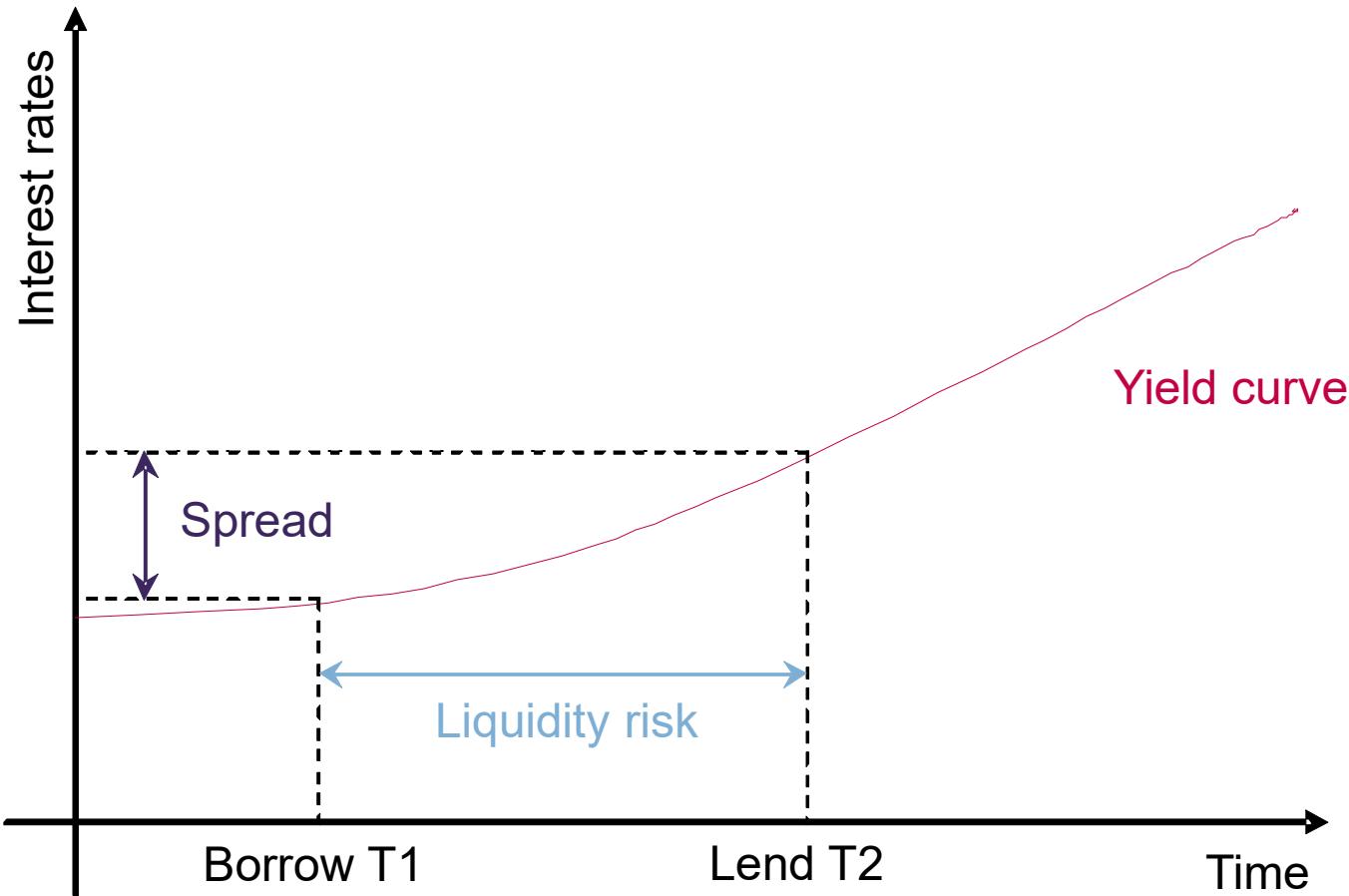
# Liquidity Risk and Capital Adequacy

## Should there be a capital requirement for liquidity?

- Basel liquidity principles paper acknowledges this is not appropriate:
  - ‘Capital is not a solution for inadequate liquidity’
- But states that requiring capital is one of the available responses to supervisors for banks with weak liquidity position and management:
  - ‘A bank’s capital position can affect its ability to obtain liquidity, especially in a crisis’
- Liquidity risk is fundamentally different from other risk types, such as market, credit and operational:
  - Not related to an expected loss
  - Related to soundness of balance sheet structure
- **Two measures of liquidity risk exposure**
  - Liquidity coverage ratio
  - Net stable funding ratio

# Liquidity Risk: Inherent in Banking

## Maturity transformation



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# Liquidity Coverage Ratio

Stock of high quality liquid assets       $\geq 100\%$   
Net cash outflows over a 30-day time period

- Short-term liquidity horizon (30 days)
- Sufficient liquid assets to cover stress scenario
  - Run off of retail deposits
  - Loss of wholesale funding
  - Additional collateralisation
  - Draws on contingent obligations
- Based on experience of 2007-2009
- Phased implementation from 2015

# LCR Example

## Compliance with internal and regulatory stress tests

	Barclays' LRA (one month Barclays specific requirement) <sup>a</sup> £bn	CRD IV Interim LCR <sup>b</sup> £bn
<b>As at 31 December 2015</b>		
Total eligible liquidity pool	145	147
Asset inflows	1	18
Stress outflows		
Retail and commercial deposit outflows	(50)	(72)
Wholesale funding	(15)	(12)
Net secured funding	(12)	(1)
Derivatives	(8)	(6)
Contractual credit rating downgrade exposure	(6)	(5)
Drawdowns of loan commitments	(7)	(32)
Intraday	(13)	–
<b>Total stress net cash flows</b>	<b>(110)</b>	<b>(110)</b>
Surplus	35	37
Liquidity pool as a percentage of anticipated net cash flows	131%	133%
As at 31 December 2014	124%	124%

# Net Stable Funding Ratio

Available amount of stable funding (ASF) >100%  
Required amount of stable funding (RSF)

- Liquidity out to **one-year horizon**
- Funding required to finance assets:
  - Which cannot be sold
  - Are utilised as collateral
  - Netted vs. liabilities
- Assumes post-stress scenarios
  - Retail deposit outflows
  - Inability to access wholesale refinancing, etc.
  - Illiquidity of assets
- Effective from 2018

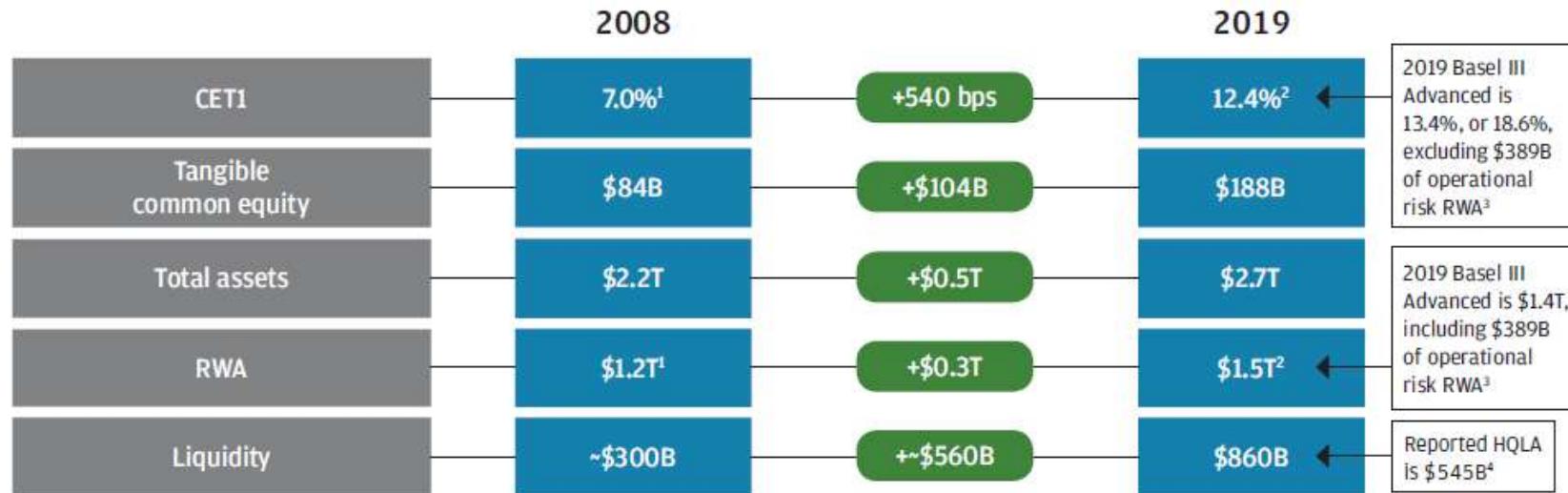
# NSFR Example

	2014 £bn	ASF/RSF (1) £bn	
<b>Equity</b>			
- regulatory capital	49	49	
- other equity	11	—	
Wholesale funding > 1 year	63	63	
Wholesale funding < 1 year	53	—	
Derivative liabilities	350	—	
Repurchase agreements	65	—	
Deposits			
- retail and SME - more stable	206	196	
- retail and SME - less stable	62	56	
- other	147	74	
Other (2)	45	—	
<b>Total liabilities and equity</b>	<b>1,051</b>	<b>438</b>	
Cash	75	—	
Inter-bank lending	25	4	
Debt securities > 1 year			
- governments AAA to AA-	46	2	
- other eligible bonds	22	3	
- other bonds	9	9	
Debt securities < 1 year	25	13	
Derivative assets			
- assets equal to derivative liabilities	350	—	
- excess over derivative liabilities	4	4	
Reverse repurchase agreements	65	7	
Customer loans and advances > 1 year			
- residential mortgages	138	90	
- other	123	105	
Customer loans and advances < 1 year	134	67	
Other (3)	35	35	
<b>Total assets</b>	<b>1,051</b>	<b>339</b>	
Derivative liabilities after mtm netting arrangements	55	11	
Undrawn commitments	215	11	
<b>Total assets and undrawn commitments</b>	<b>1,321</b>	<b>361</b>	
<b>Net stable funding ratio</b>			<b>121%</b>

# Summary – JP Morgan

## Our Fortress Balance Sheet

at December 31,



<sup>1</sup> CET1 reflects the Tier 1 common ratio under the Basel I measure.

B = Billions

<sup>2</sup> Reflects the Basel III Standardized measure, which is the firm's current binding constraint.

T = Trillions

<sup>3</sup> Operational risk RWA is a component of RWA under the Basel III Advanced measure.

bps = basis points

<sup>4</sup> Represents quarterly average HQLA included in the liquidity coverage ratio. Refer to Liquidity Coverage Ratio on page 94 for additional information.

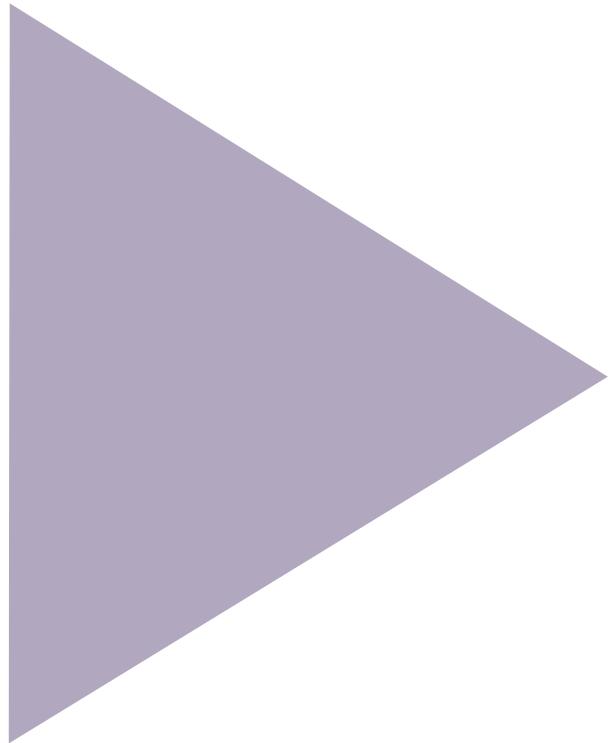
CET1 = Common equity Tier 1 ratio. Refer to Regulatory capital on pages 86-90 for additional information

RWA = Risk-weighted assets

Liquidity = HQLA plus unencumbered marketable securities, which includes excess liquidity at JPMorgan Chase Bank, N.A.

HQLA = High quality liquid assets include cash on deposit at central banks and highly liquid securities (predominantly U.S. Treasuries, U.S. government-sponsored enterprises and U.S. government agency mortgage-backed securities, and sovereign bonds)

LCR = Liquidity coverage ratio



## **Case Study: The Internal Ratings Based Approach (IRB)**

# Credit Ratings: Agency Definitions

Description	Fitch and S&P		Moody's		Short term	Explanation
Highest credit quality	AAA		Aaa		F1	Exceptionally strong capacity for timely payment of financial commitments which is highly unlikely to be adversely affected by foreseeable events.
Very high credit quality	AA	AA+ AA AA-	Aa	Aa1 Aa2 Aa3		Very strong capacity for timely payment of financial commitments which is not significantly vulnerable to foreseeable events.
High credit quality	A	A+ A A-	A	A1 A2 A3	F2	Strong capacity for timely payment of financial commitments which may be more vulnerable to changes in circumstances/ economic conditions.
Good credit quality	BBB	BBB+ BBB BBB-	Baa	Baa1 Baa2 Baa3	F3	Adequate capacity for timely payment of financial commitments but adverse changes in circumstances/ economic conditions are more likely to impair this capacity.
Speculative	BB	BB+ BB BB-	Ba	Ba1 Ba2 Ba3		Possibility of credit risk developing, particularly due to adverse economic change over time. Business/financial alternatives may be available to allow financial commitments to be met.
Highly speculative	B	B+ B B-	B	B1 B2 B3	B	Significant credit risk with a limited margin of safety. Financial commitments currently being met; however, continued payment is contingent upon a sustained, favourable business and economic environment.
High default risk	CCC		Caa		C	Default is a real possibility. Capacity for meeting financial commitments is solely reliant upon sustained, favourable business or economic developments.
Probable default	CC		Ca			Default of some kind appears probable.
Likely default	C		C			Default imminent.

# Risk Weights

## Basel 1

	AAA to AA-	A+ to A-	BBB+ to BBB-	BB+ to BB-	B+ to B-	Below B-	Unrated
Country							
Bank							
Corporation							
				100%			

## Basel 2

	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%
Bank	20%	50%	50%	100%	100%	150%	50%
Corporation	20%	50%	100%	100%	150%	150%	100%

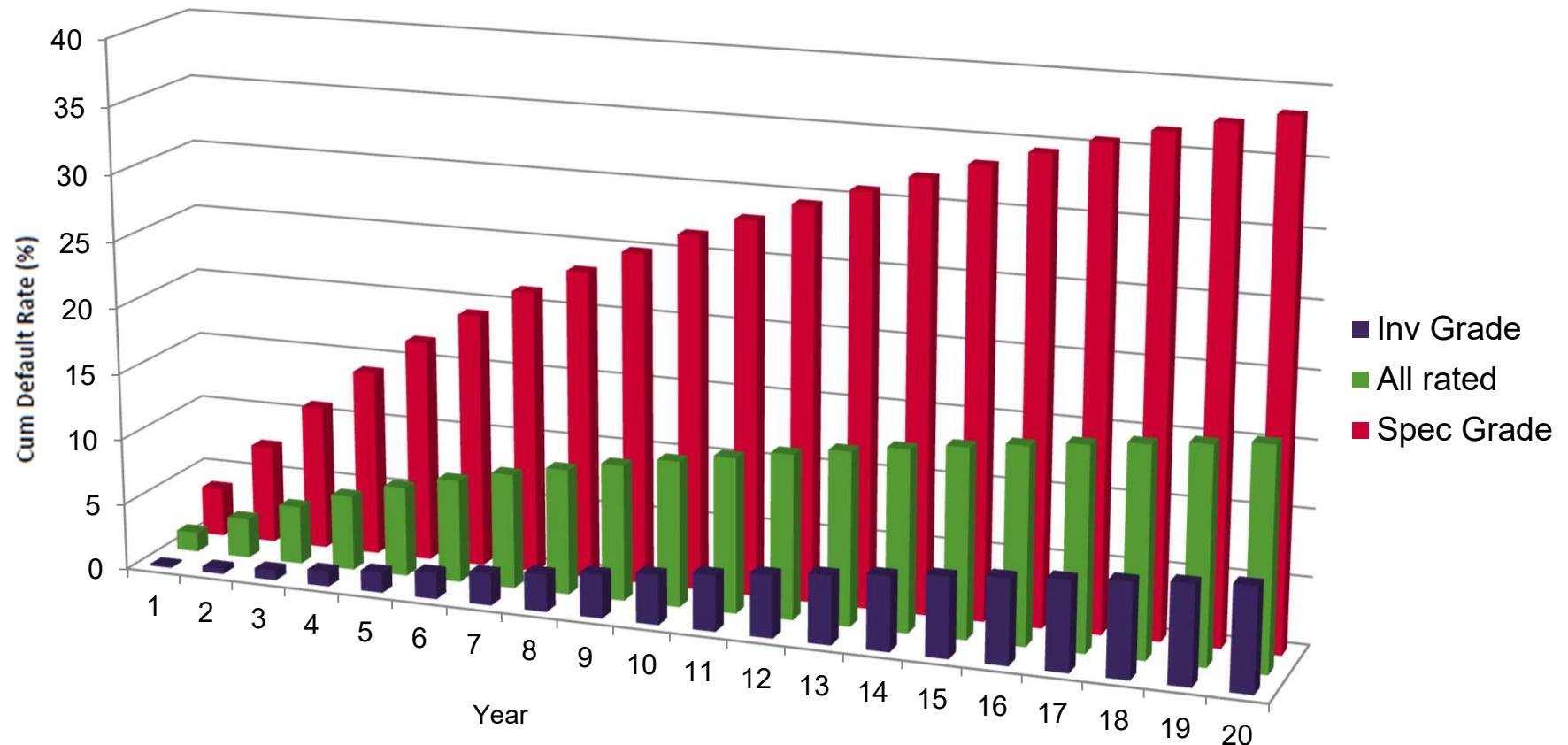
# Average One-Year Rating Transition Matrix 1970-2015

## Global Corporate Bonds

Rating to:	Aaa	Aa	A	Baa	Ba	B	Caa	Ca-C	D	WR
Aaa	87.48	8.14	0.59	0.06	0.02	0.00	0.00	0.00	0.00	3.71
Aa	0.83	85.15	8.45	0.44	0.06	0.04	0.02	0.00	0.02	4.99
A	0.06	2.57	86.60	5.37	0.51	0.11	0.04	0.01	0.06	4.68
Baa	0.04	0.16	4.30	85.44	3.74	0.69	0.16	0.02	0.18	5.26
Ba	0.01	0.04	0.47	6.17	76.17	7.17	0.68	0.12	0.92	8.25
B	0.01	0.03	0.15	0.45	4.78	73.52	6.49	0.56	3.41	10.60
Caa	0.00	0.01	0.03	0.11	0.42	7.02	66.77	2.81	8.52	14.32
Ca-C	0.00	0.00	0.06	0.00	0.62	2.46	9.47	39.59	24.09	23.71

Source: Moody's Investors Services: Corporate Default and Recovery Rates, 1920-2015 (Moody's, February 2016)

# Cumulative Default Rates: Corporates Summary



Source: Moody's Investors Services: Corporate Default and Recovery Rates, 1920 - 2015 (Moody's - February 2016)

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## IRB Study: Key Features

- The most advanced approach for credit risk
- Balance between sophistication and simplicity
- Model-based but doesn't use a model
- Banks can model some parameters
  - PD and LGD where there is reasonable data
  - Not allowed to model (default) correlations where limited data exists

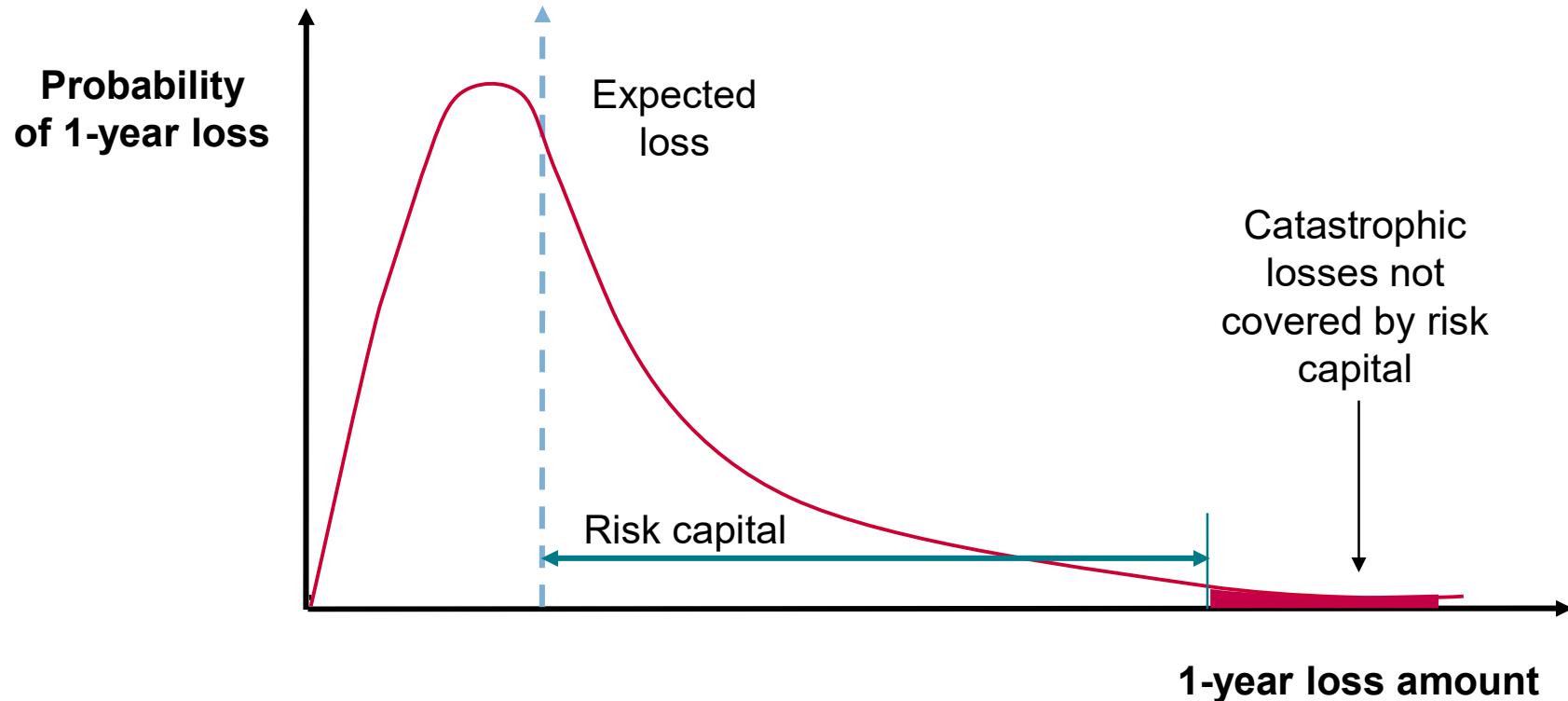
# Quantifying Credit Risk – Expected Loss

$$\text{Expected loss} = \underbrace{\text{PD}}_{\text{Probability of default}} \times \underbrace{\text{LGD}}_{\text{Loss given default}} \times \underbrace{\text{EaD}}_{\text{Exposure at default}}$$

- Note that this also holds for a portfolio, i.e. we just need to sum all of the above components over each obligor
- But for the unexpected loss, correlation is important

# Unexpected Loss

**Portfolio credit loss distribution: Highly skewed and fat-tailed**

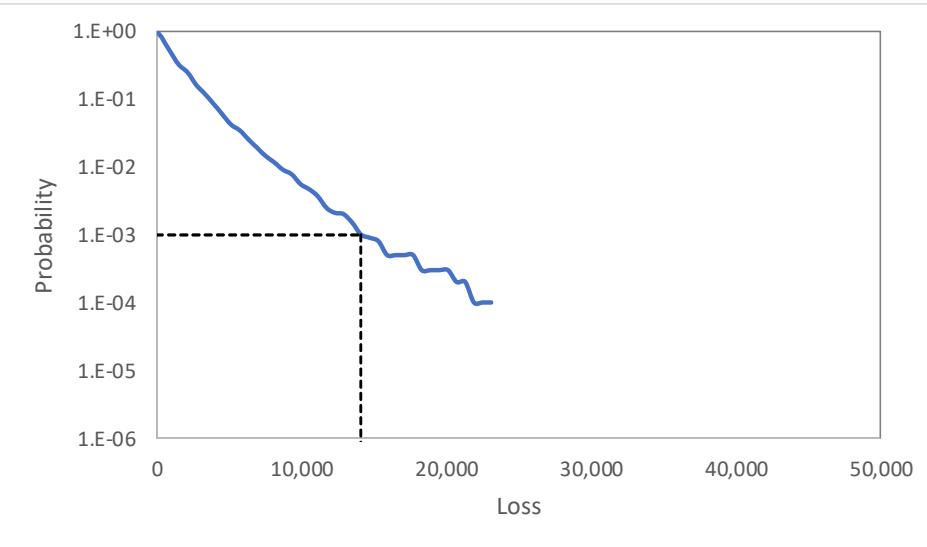
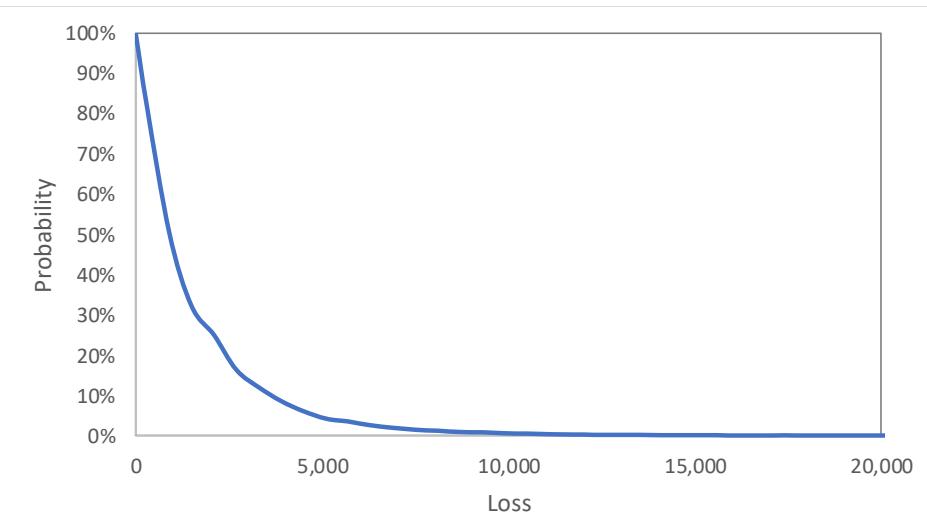


# Simple CPM Model

## Model portfolio:

- 160 loans in 8 rating bands
- Total portfolio size USD300,000

Rating	PD	LGD	EAD	EL	UL (99.9%)
1	0.05%	30%	5,000	8.75	?
2	0.10%	40%	2,500	30.00	?
3	0.20%	40%	2,500	120.00	?
4	1.00%	50%	2,500	250.00	?
5	3.00%	65%	1,000	315.00	?
6	4.00%	65%	1,000	420.00	?
7	5.00%	65%	1,000	175.00	?
8	10.00%	65%	1,000	175.00	?
				1,493.75	14,100



---

# Simple One Factor Model

$$X_i = \sqrt{\rho}Z + \sqrt{1 - \rho}Y_i$$

**Where:**

$X_i$  = Simulated asset value

$\rho$  = Correlation (factor sensitivity)

$Z$  = Systematic shock factor (random variable)

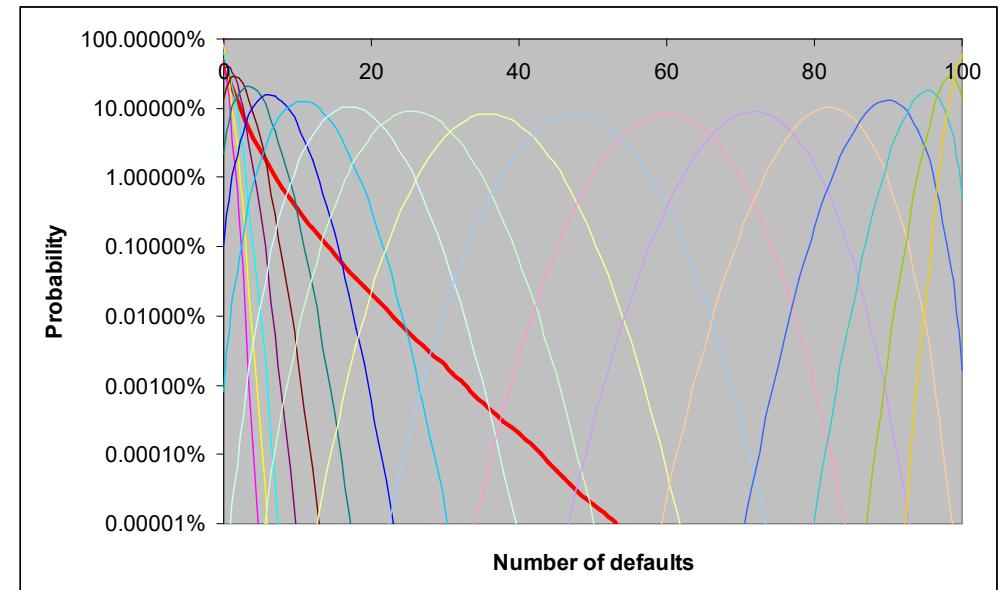
$Y_i$  = Idiosyncratic shock factor (random variable)

- Shocks are standard normally distributed
- We can write down default probabilities conditional on the systematic factor  
(this is useful)

$$p_i = \Phi\left(\frac{\Phi^{-1}(p_i) - \sqrt{\rho}Z}{\sqrt{1 - \rho}}\right)$$

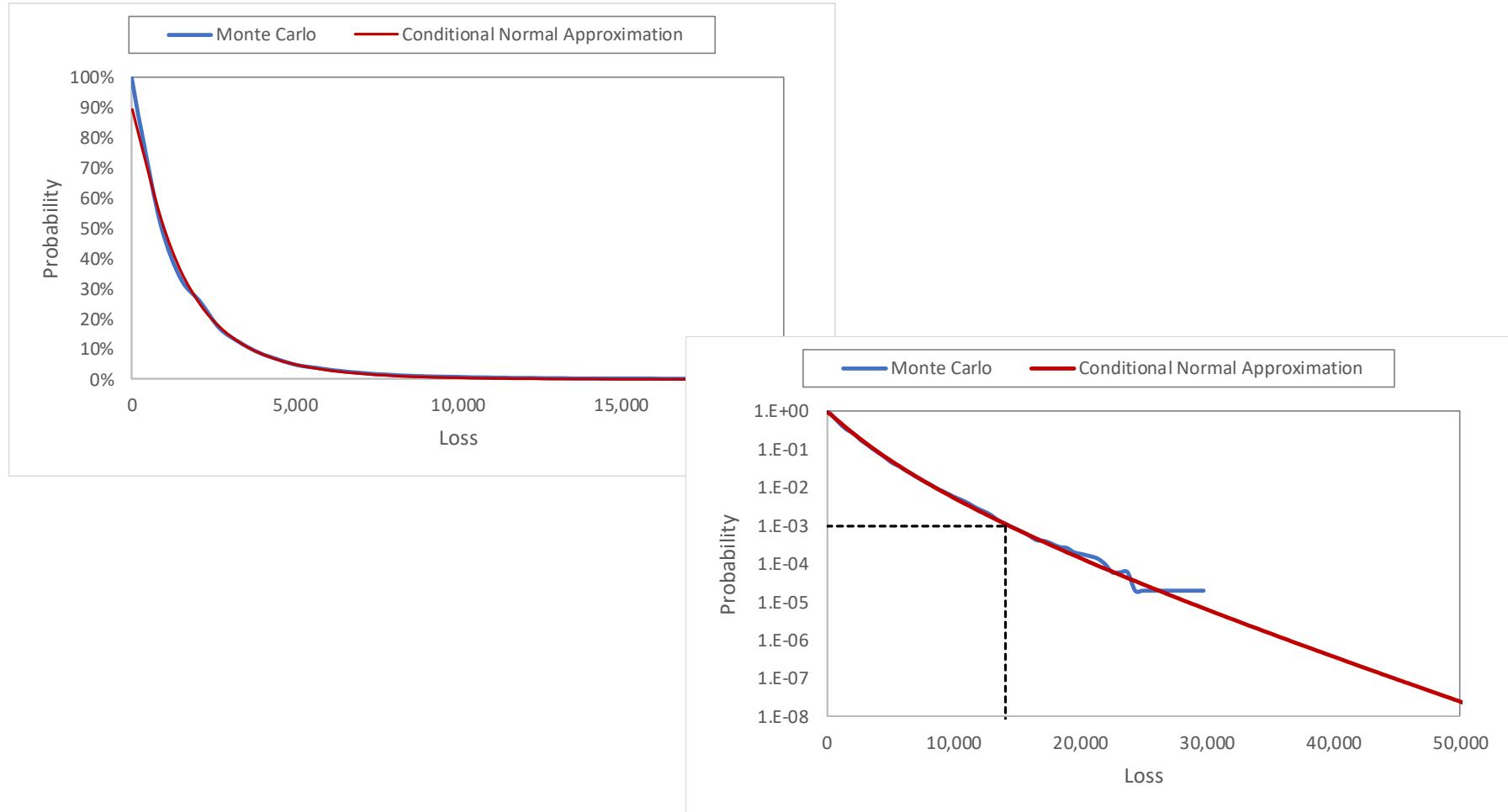
# Factor Model Interpretation

- Default probabilities are independent conditional on a latent variable(s)
  - The latent variable ( $Z$ ) can be thought of as a state of the world, bad states of the world lead to high default probabilities
- The actual world is a weighted average of all of these worlds different underlying default probabilities and independent defaults
- This leads to some tractable implementation procedures
  - For example, for equal default probabilities the actual loss distribution is a linear combination of binomial distributions



# Analytical Factor Models

- Can now calculate loss distribution accurately without Monte Carlo simulation



---

## UL Allocation

- Suppose we want to allocate the risk of a portfolio (e.g. unexpected loss) in a way which is
  - Fair
  - Theoretically robust
  - Sums to the total risk
- Euler allocation allows this
  - Involves calculating derivatives with respect to the amount of each exposure
  - Numerical calculation involving sequentially changing each position by a small amount
  - Not very easy to do with Monte Carlo simulation

$$UL^*(i) = \frac{\partial UL(N_1, N_2, \dots, N_n)}{\partial N_i} \quad UL_{portfolio} = \sum_{i=1}^n UL^*(i)$$

# Simple CPM Model

## Model portfolio:

- 160 loans in 8 rating bands
- Total portfolio size USD300m

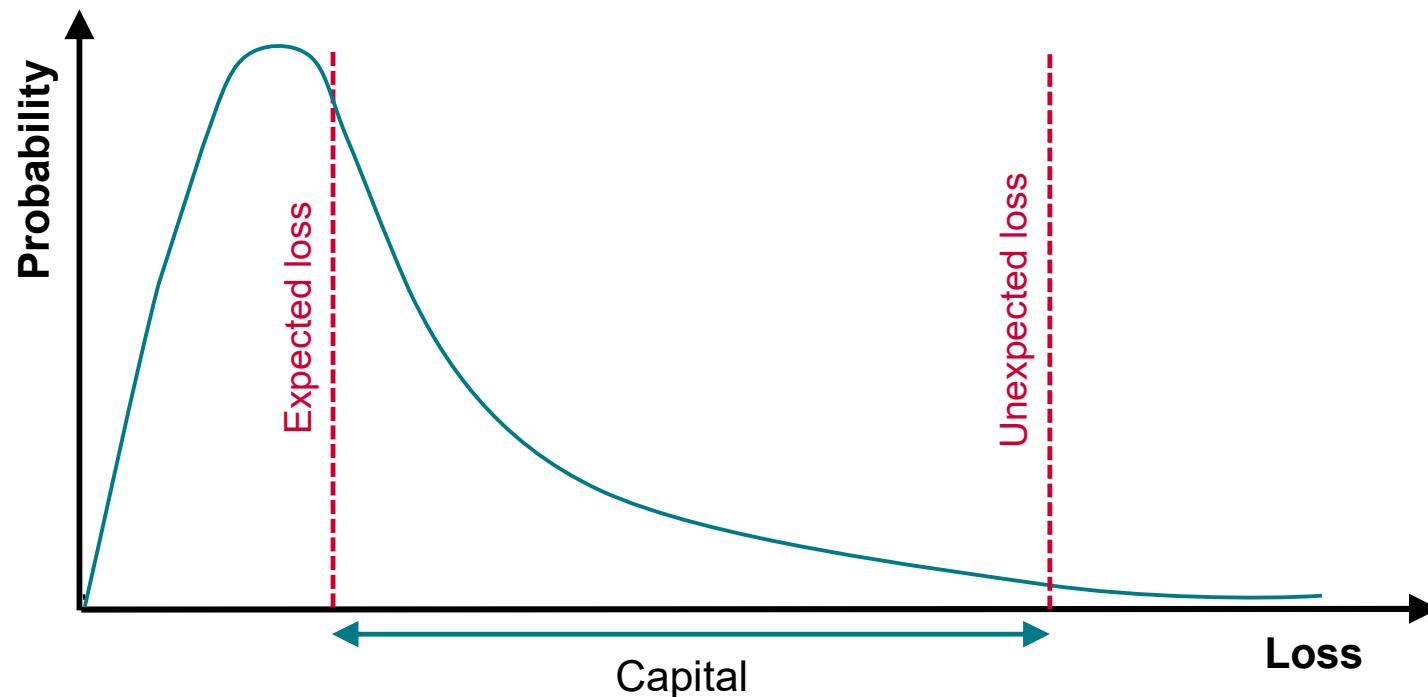
Rating	PD	LGD	EAD	No. of loans	EL	UL	UL/EL
1	0.05%	30%	5,000	5	8.75	342.0	39.08
2	0.10%	40%	2,500	20	30.00	742.7	24.76
3	0.20%	40%	2,500	40	120.00	2,565.4	21.38
4	1.00%	50%	2,500	20	250.00	3,364.8	13.46
5	3.00%	65%	1,000	30	315.00	2,412.4	7.66
6	4.00%	65%	1,000	30	420.00	2,893.0	6.89
7	5.00%	65%	1,000	10	175.00	1,105.2	6.32
8	10.00%	65%	1,000	5	175.00	819.1	4.68
					1,493.75	14,244.3	

# Unexpected Loss Approximations

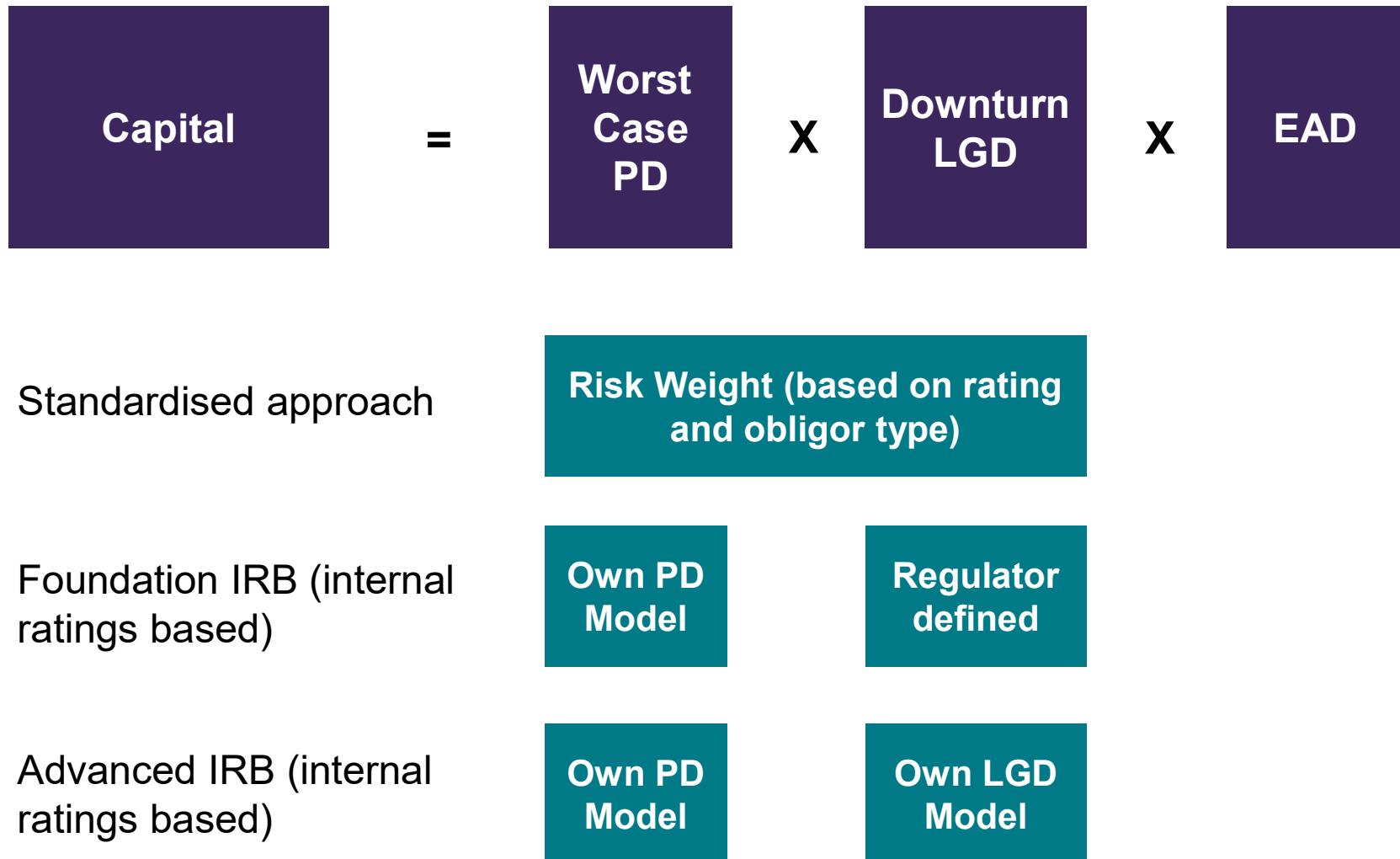
Under certain assumptions, the unexpected loss can be written as a sum over obligors

$$EL_p = \sum_{i=1}^n PD_i \times EAD_i \times LGD_i$$

$$UL_p = \sum_{i=1}^n PD_i^* \times EAD_i \times LGD_i$$



# Regulatory Capital Approaches



# Simplified Regulatory Capital Calculation

In essence the capital for each obligor is driven by an extreme default probability (99.9% confidence level)

$$Capital_i = PD_i^{99.9\%} \times EAD_i \times LGD_i$$

- The PD formula is prescriptive and depends on obligor type
  - The **maturity** of the exposure
  - The **correlation** between different exposures

$$\text{Correlation } (R) = 0.12 * \frac{1 - EXP(-50 * PD)}{1 - EXP(-50)} + 0.24 * \left[ 1 - \frac{1 - EXP(-50 * PD)}{1 - EXP(-50)} \right]$$

$$\text{Maturity adjustment } (b) = [0.11852 - 0.05478 * \ln(PD)]^2$$

Capital requirement<sup>72</sup>

$$(K) = \left\{ LGD * N \left[ \sqrt{\frac{1}{1-R}} * G(PD) + \sqrt{\frac{R}{1-R}} * G(0.999) \right] - PD * LGD \right\} * \frac{1 + (M - 2.5) * b}{1 - 1.5 * b}$$

$$\text{Risk-weighted assets } (RWA) = K \times 12.5 \times EAD$$

# Portfolio Example

- Compare real numbers with simple formula

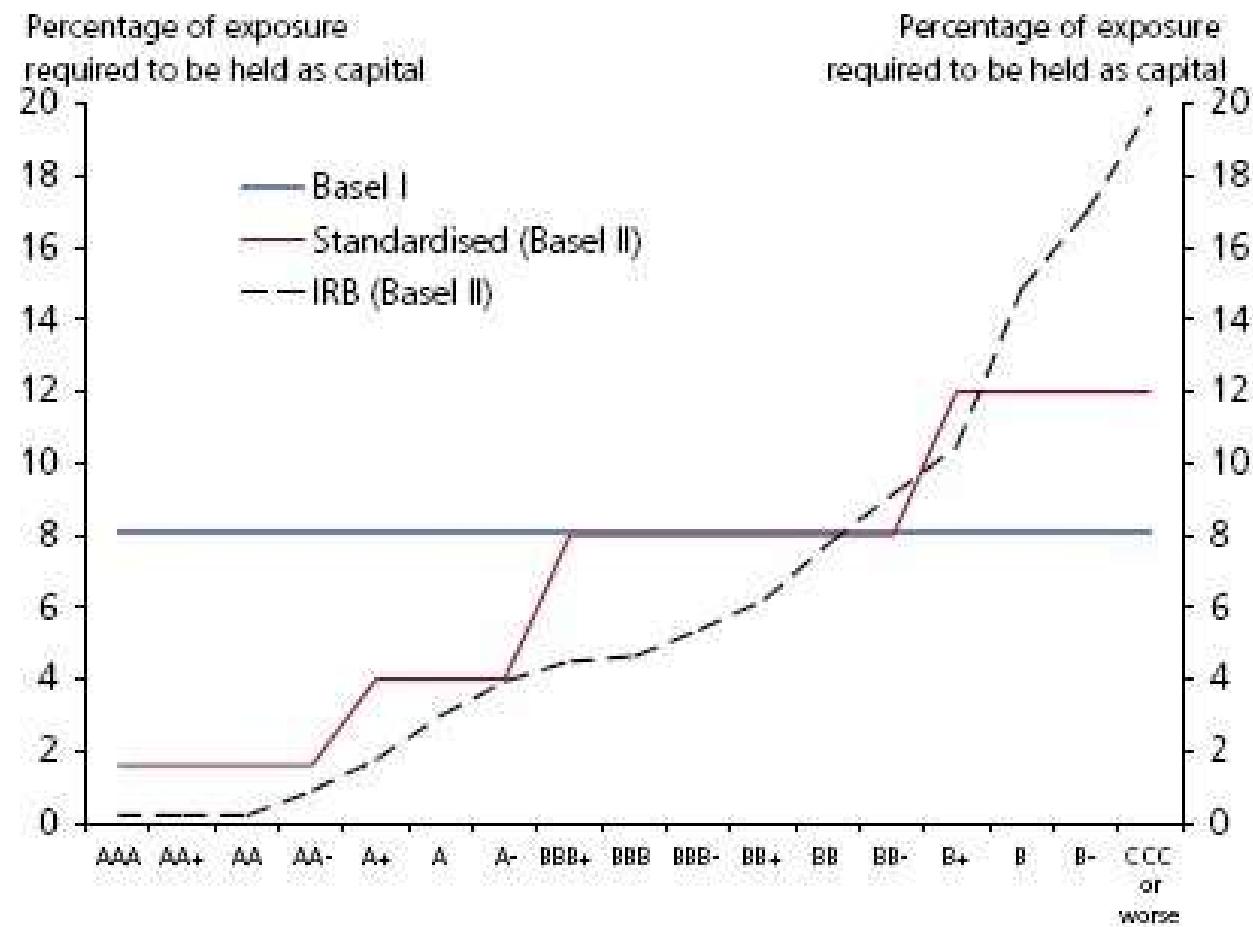
Credit	Notional	PD	EL	UL	(UL – EL)	$PD_i^{99.9\%} \times EAD_i \times LGD_i$
1	20	1.2%	0.24	6.8	6.5	6.7
2	10	1.0%	0.10	3.0	2.9	3.1
3	10	3.0%	0.30	5.2	4.9	5.1
4	50	3.0%	1.50	27.7	26.2	25.4
.						
.						
100	20	15.7%	3.13	17.6	14.5	14.6
Portfolio			132.8	1789	1,656.3	1591.1

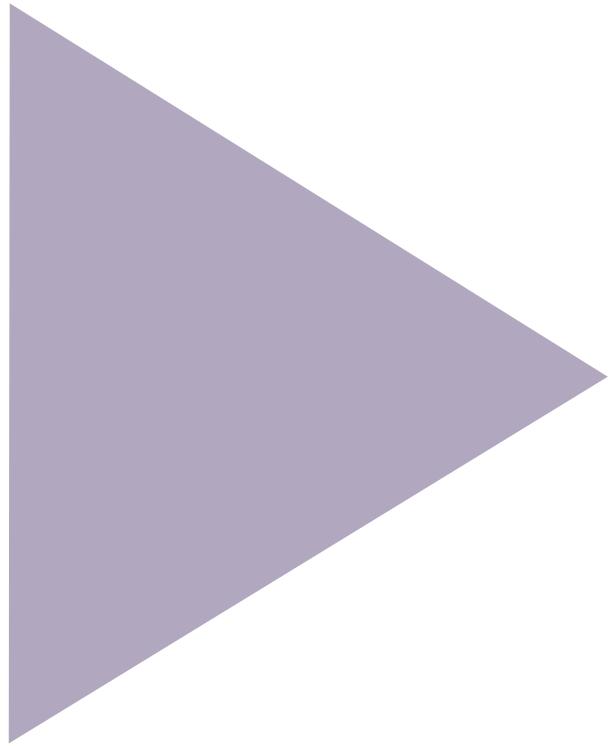
## IRB Example (Assuming unit exposure)

	Example 1	Example 2	Calculation
<b>PD (1-year)</b>	0.12% (A rating)	2.3% (BB rating)	Internal ratings
<b>Rho (<math>\rho</math>)</b>	23.3%	15.8%	$0.12 \times [1 + \exp(-50 \times PD)]$
<b>PD (99.9%)</b>	3.78%	17.86%	$\Phi\left(\frac{\Phi^{-1}(PD) + \sqrt{\rho}\Phi^{-1}(99.9\%)}{\sqrt{1 - \rho^2}}\right) - PD$
<b>LGD</b>	60%	45%	Internal calc / regulatory defined
<b>Standardised<sup>1</sup></b>	$50\% \times 8\% = 4\%$	$100\% \times 8\% = 8\%$	
<b>b</b>	0.237	0.106	$(0.11852 - 0.05478 \times \ln(PD))^2$
<b>Reg Maturity (M)</b>	5	5	Maximum of 5-years
<b>MA</b>	2.47	1.50	$\frac{1 + (M - 2.5) \times b}{1 - 1.5 \times b}$
<b>IRB Capital (K)</b>	5.6%	12.1%	$PD(99.9\%) \times LGD \times MA$

# IRB Formula

## Risk sensitivity of IRB formula



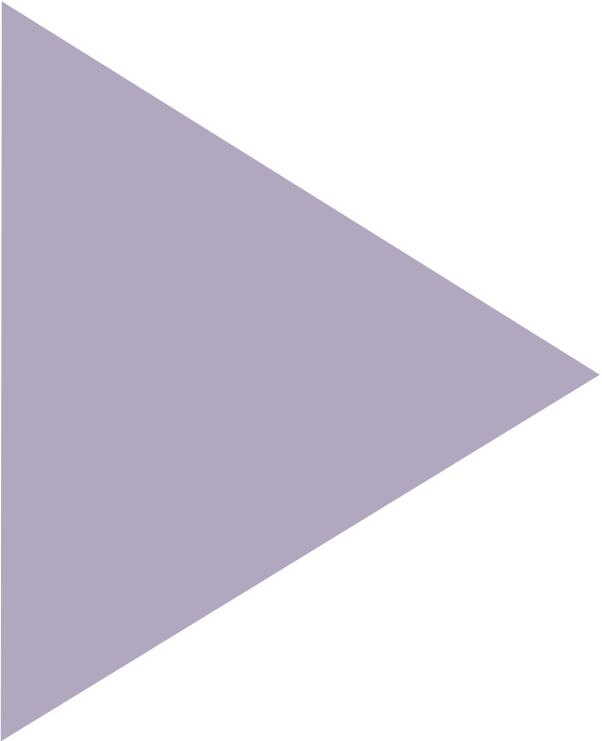


## Summary

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# Summary

- Regulation can be really boring
- However:
  - It is really important and so many jobs in banks and other financial institutions have a substantial regulatory focus
  - There are challenging areas for quants, for example:
    - Fundamental review of the trading book (market risk)
    - New CVA capital rules (SA-CVA)
  - Regulation is continuing to evolve with more complex methodologies supported by the latest innovations



## **Appendix:**

### **Example Regulatory References**

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## About the Basel Committee

Updated 10 August 2017



### The Basel Committee mandate

The Basel Committee on Banking Supervision (BCBS) is the primary global standard setter for the prudential regulation of banks and provides a forum for cooperation on banking supervisory matters. Its mandate is to strengthen the regulation, supervision and practices of banks worldwide with the purpose of enhancing financial stability.

For a detailed overview of the BCBS mandate, view the full version of the Basel Committee Charter.

### About the Basel Committee

- ♦ Charter
- ♦ Membership
- ♦ Work programme
- ♦ Organisation and governance
- ♦ Groups
- ♦ Policy development and implementation
- ♦ History

### The Basel Committee's work

The core of the work undertaken by the Basel Committee focuses on the following activities:

- ♦ **exchanging information on developments in the banking sector and financial markets** to help identify current or emerging risks for the global financial system
- ♦ **sharing supervisory issues, approaches and techniques** to promote common understanding and to improve cross-border cooperation
- ♦ **establishing and promoting global standards** for the regulation and supervision of banks, as well as guidelines and sound practices
- ♦ **addressing regulatory and supervisory gaps** that pose risks to financial stability
- ♦ **monitoring the implementation of BCBS standards** in member countries and beyond to encourage their timely, consistent and effective implementation
- ♦ **consulting with central banks and bank supervisory authorities which are not members of the BCBS** to benefit from their input into the BCBS policy formulation process and to promote the implementation of BCBS standards, guidelines and sound practices beyond BCBS member countries
- ♦ **coordinating and cooperating with other financial sector standard setters and international bodies**, particularly those involved in promoting financial stability

Visit the [Basel Committee's work programme](#) page for a detailed description of the Committee's work.

### Upcoming meetings

# The BCBS

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## Basel Committee membership

Updated 30 December 2016



### Membership - 28 jurisdictions / 45 institutions

The Basel Committee comprises 45 members from 28 jurisdictions, consisting of central banks and authorities with formal responsibility for the supervision of banking business. Additionally, the Committee has nine observers including central banks, supervisory groups, international organisations and other bodies. The Committee expanded its membership in 2009 and again in 2014.

### About the Basel Committee

- ◆ Charter
- ◆ Membership
- ◆ Work programme
- ◆ Organisation and governance
- ◆ Groups
- ◆ Policy development and implementation
- ◆ History

### Institutions represented on the Basel Committee on Banking Supervision

#### Members

##### Country/jurisdiction

Argentina

Australia

Belgium

Brazil

Canada

China

European Union

##### Institutional representative

[Central Bank of Argentina](#)

[Reserve Bank of Australia](#)

[Australian Prudential Regulation Authority](#)

[National Bank of Belgium](#)

[Central Bank of Brazil](#)

[Bank of Canada](#)

[Office of the Superintendent of Financial Institutions](#)

[People's Bank of China](#)

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[European Central Bank Single Supervisory Mechanism](#)



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## Basel III: A global regulatory framework for more resilient banks and banking systems - revised version June 2011

June 2011

[DE](#) [ES](#) [FR](#) [IT](#)

### Comments on the revision:

The Basel Committee on Banking Supervision has completed its review of and finalised the Basel III capital treatment for counterparty credit risk in bilateral trades. The review resulted in a minor modification of the credit valuation adjustment (CVA), which is the risk of loss caused by changes in the credit spread of a counterparty due to changes in its credit quality (also referred to as the market value of counterparty credit risk). See the related [press release](#).

- ♦ [Revised version of the Basel III capital rules](#) reflecting the CVA modification (1 June 2011)
- ♦ [Original version](#) (December 2010)



Full text  
77 pages, 723 kb

**Full text**  
77 pages, 723 kb

### Press release

- ♦ 1 June 2011

### Revised version

- ♦ TLAC holdings standard (October 2016)

### Previous version

- ♦ [Basel III: A global regulatory framework for more resilient banks and banking systems](#) (December 2010)

### Related information

- ♦ International regulatory framework for banks (Basel III)
- ♦ Results of the comprehensive quantitative impact study
- ♦ Guidance for national authorities operating the countercyclical capital buffer
- ♦ [Basel III: International framework for liquidity risk measurement, standards and monitoring](#)

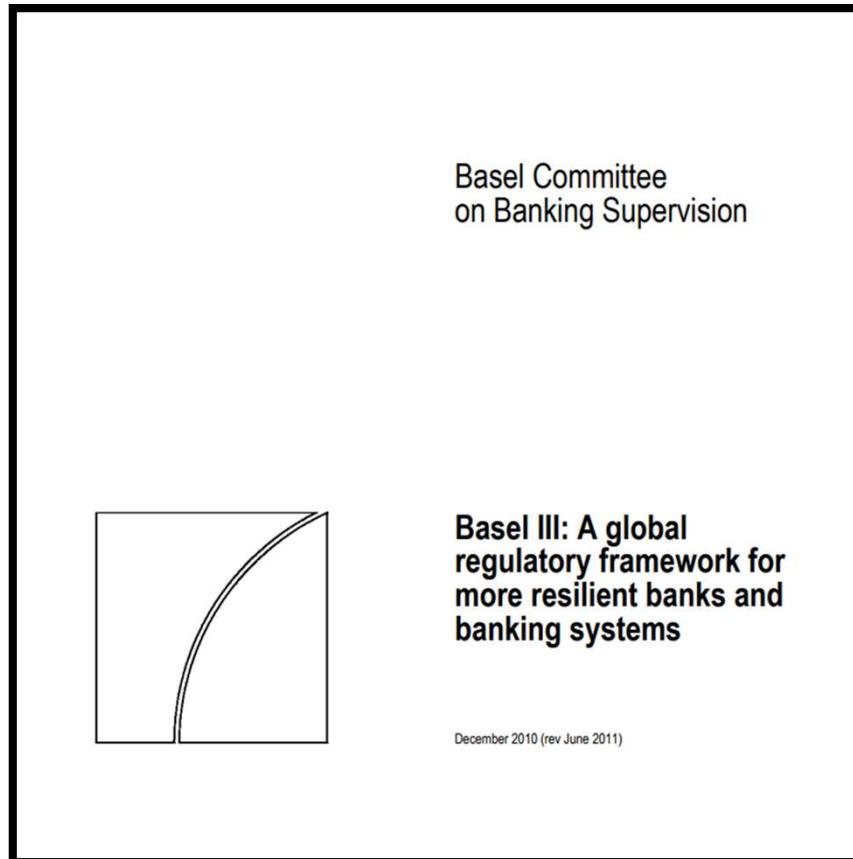
### Quick links

- ♦ [Information on implementation of the countercyclical capital buffer](#)

[Basel III definition of capital frequently asked questions](#)

This document sets out frequently asked questions on the definition of capital sections of the Basel III standard.

## Basel III: Capital



aka: bcbs189

# Basel III: LCR

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## Basel III: The Liquidity Coverage Ratio and liquidity risk monitoring tools

January 2013

[DE](#) [ES](#) [FR](#) [IT](#)

The Basel Committee has issued the full text of the revised Liquidity Coverage Ratio (LCR) following endorsement on 6 January 2013 by its governing body - the Group of Central Bank Governors and Heads of Supervision (GHOS). The LCR is an essential component of the Basel III reforms, which are global regulatory standards on bank capital adequacy and liquidity endorsed by the G20 Leaders.

The LCR is one of the Basel Committee's key reforms to strengthen global capital and liquidity regulations with the goal of promoting a more resilient banking sector. The LCR promotes the short-term resilience of a bank's liquidity risk profile. It does this by ensuring that a bank has an adequate stock of unencumbered high-quality liquid assets (HQLA) that can be converted into cash easily and immediately in private markets to meet its liquidity needs for a 30 calendar day liquidity stress scenario. It will improve the banking sector's ability to absorb shocks arising from financial and economic stress, whatever the source, thus reducing the risk of spillover from the financial sector to the real economy.

The LCR was first published in December 2010. At that time, the Basel Committee put in place a rigorous process to review the standard and its implications for financial markets, credit extension and economic growth. It committed to address unintended consequences as necessary.

The revisions to the LCR incorporate amendments to the definition of high-quality liquid assets (HQLA) and net cash outflows. In addition, the Basel Committee has agreed a revised timetable for phase-in of the standard and additional text to give effect to the Committee's intention for the stock of liquid assets to be used in times of stress. The changes to the definition of the LCR, developed and agreed by the Basel Committee over the past two years, include an expansion in the range of assets eligible as HQLA and some refinements to the assumed inflow and outflow rates to better reflect actual experience in times of stress.

Once the LCR has been fully implemented, its 100% threshold will be a minimum requirement in normal times. During a period of stress, banks would be expected to use their pool of liquid assets, thereby temporarily falling below the minimum requirement. The GHOS agreed that the LCR should be subject to phase-in arrangements which align with those that apply to the Basel III capital adequacy requirements.

Specifically, the LCR will be introduced as planned on 1 January 2015, but the minimum requirement will begin at 60%, rising in equal annual steps of 10 percentage points to reach 100% on 1 January 2019. This graduated approach is designed to ensure that the LCR can be introduced without disruption to the orderly strengthening of banking systems or the ongoing financing of economic activity.

	2015	2016	2017	2018	2019
Minimum LCR requirement	60%	70%	80%	90%	100%

The GHOS agreed that, during periods of stress it would be entirely appropriate for banks to use their stock of HQLA, thereby falling below the minimum. Moreover, it is the responsibility of bank supervisors to give guidance on usability according to circumstances.

The GHOS also agreed that, since deposits with central banks are the most - indeed, in some cases, the only - reliable form of liquidity, the

Full text  
75 pages, 376 kb

### Press release

• 7 January 2013

### Previous version

• Basel III: International framework for liquidity risk measurement, standards and monitoring (December 2010)

### Related information

- International regulatory framework for banks (Basel III)
- Frequently Asked Questions on Basel III's January 2013 Liquidity Coverage Ratio (April 2014)
- Liquidity coverage ratio disclosure standards - final document (January 2014)
- Basel III: the net stable funding ratio (October 2014)

# Basel III: NSFR

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## Basel III: the net stable funding ratio

October 2014

[ES](#)

[FR](#)

The NSFR is a significant component of the Basel III reforms. It requires banks to maintain a stable funding profile in relation to their on- and off-balance sheet activities, thus reducing the likelihood that disruptions to a bank's regular sources of funding will erode its liquidity position in a way that could increase the risk of its failure and potentially lead to broader systemic stress. The NSFR will become a minimum standard by 1 January 2018.

Proposals on the NSFR were first published in 2009, and the measure was included in the December 2010 Basel III agreement. At that time, the Committee put in place a rigorous process to review the standard and its implications for financial market functioning and the economy. In January 2014 the Committee issued a revised standard that was recalibrated to focus on the riskier types of funding profile employed by banks while improving alignment with the Liquidity Coverage Ratio (LCR) and reducing cliff effects in the measurement of available and required stable funding.

The final NSFR retains the structure of the January 2014 consultative proposal. The key changes introduced in the final standard published today cover the required stable funding for:

- short-term exposures to banks and other financial institutions;
- derivatives exposures; and
- assets posted as initial margin for derivative contracts.

In addition, the final standard recognises that, under strict conditions, certain asset and liability items are interdependent and can therefore be viewed as neutral in terms of the NSFR.

The Basel Committee wishes to thank all those who contributed time and effort to express their views during the consultation process.



Full text

17 pages, 230 kb

Full text  
17 pages, 230 kb

### Press release

- 31 October 2014

### Consultative version

- Basel III: the net stable funding ratio - consultative document, January 2014

### Related information

- Important steps towards completion of post-crisis regulatory reforms endorsed by Group of Governors and Heads of Supervision
- International regulatory framework for banks (Basel III)
- Basel III: A global regulatory framework for more resilient banks and banking systems, December 2010
- Basel III: The Liquidity Coverage Ratio and liquidity risk monitoring tools, January 2013
- Net Stable Funding Ratio disclosure standards - consultative document, December 2014
- Basel III - The Net Stable Funding Ratio: frequently asked questions (July 2016)
- Basel III - The Net Stable Funding Ratio: frequently asked questions (February 2017)

# FAQ: CCR

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**Basel III counterparty credit risk and exposures to central counterparties - Frequently asked questions (update of FAQs published in November 2012)**

December 2012

[DE](#) [ES](#) [FR](#) [IT](#)

The Basel Committee on Banking Supervision has received a number of interpretation questions related to the December 2010 publication of the Basel III regulatory frameworks for [capital](#) and [liquidity](#) as well as the July 2012 publication of the [interim framework](#) for determining capital requirements for bank exposures to CCPs.

Today's publication [\[PDF\]](#) sets out the fourth set of frequently asked questions (FAQs) that relate to Basel III counterparty credit risk requirements, including the default counterparty credit risk charge, the credit valuation adjustment capital charge and asset value correlations. It also includes FAQs relating to the interim framework for bank exposures to CCPs. FAQs that have been added since the publication of the third version of this document in [November 2012](#) are shaded yellow.



Full text

25 pages, 91 kb

**Full text**  
25 pages, 91 kb

Press release

• 28 December 2012

Previous version

• Basel III counterparty credit risk - Frequently asked questions (update of FAQs published in July 2012) (November 2012)

Related information

• Basel III: The standardised approach for measuring counterparty credit risk exposures: Frequently asked questions (August 2015)

# FAQ: Capital

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## Basel III definition of capital - Frequently asked questions (update of FAQs published in October 2011)

December 2011

[DE](#) [ES](#) [FR](#) [IT](#)

The Basel Committee on Banking Supervision has received a number of interpretation questions related to the December 2010 publication of the Basel III regulatory frameworks for [capital](#) and [liquidity](#) and the [13 January 2011 press release](#) on the loss absorbency of capital at the point of non-viability.

The Committee has reviewed frequently asked questions (FAQs) and today's publication provides answers to these together with technical elaboration of the rules text and interpretative guidance where necessary. These aim to promote consistent global implementation of Basel III.

The FAQs published in this document correspond to the definition of capital sections of the Basel III rules text. These FAQs are in addition to the first set published in [July 2011](#) and the second set published in [October 2011](#). They are grouped according to the relevant paragraphs of the rules text. FAQs that have been added since the publication of the second version of this document are shaded yellow.

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<a href="#">Paragraphs 60-61 (Provisions)</a>	6
<a href="#">Paragraphs 62-65 (Minority interest and other capital that is issued out of consolidated subsidiaries that is held by third parties)</a>	6
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28 pages, 619 kb

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### Press release

• 16 December 2011

### Revised version

• Basel III definition of capital - Frequently asked questions (September 2017)

### Previous version

• Basel III definition of capital - Frequently asked questions (October 2011)



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## Basel II: International Convergence of Capital Measurement and Capital Standards: A Revised Framework - Comprehensive Version

June 2004

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This document is a compilation of the June 2004 Basel II Framework, the elements of the 1988 Accord that were not revised during the Basel II process, the 1996 Amendment to the Capital Accord to Incorporate Market Risks, and the November 2005 paper on [Basel II: International Convergence of Capital Measurement and Capital Standards: A Revised Framework](#). No new elements have been introduced in this compilation.

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Annexes: [PDF, 91 pages, 416 kb](#)

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## Basel II



aka: bcbs128

# Basel I

*Basle Capital Accord*

## INTERNATIONAL CONVERGENCE OF CAPITAL MEASUREMENT AND CAPITAL STANDARDS (July 1988, UPDATED TO April 1998)<sup>1</sup>

### Introduction

1. This report presents the outcome of the Committee's work over several years to secure international convergence of supervisory regulations governing the capital adequacy of international banks. Following the publication of the Committee's proposals in December 1987, a consultative process was set in train in all G-10 countries and the proposals were also circulated to supervisory authorities worldwide. As a result of those consultations some changes were made to the original proposals. The present paper is now a statement of the Committee agreed by all its members. It sets out the details of the agreed framework for measuring capital adequacy and the minimum standard to be achieved which the national supervisory authorities represented on the Committee intend to implement in their respective countries. The framework and this standard have been endorsed by the Group of Ten central-bank Governors.
2. The document is being circulated to supervisory authorities worldwide with a view to encouraging the adoption of this framework in countries outside the G-10 in respect of banks conducting significant international business.
3. Two fundamental objectives lie at the heart of the Committee's work on regulatory convergence. These are, firstly, that the new framework should serve to strengthen the soundness and stability of the international banking system; and, secondly, that the framework should be fair and have a high degree of consistency in its application to banks in different

aka: bcbs11

The screenshot displays the official website of the European Banking Authority (EBA). The top navigation bar includes links for Document library, Single Rulebook Q&A, Contacts, CEBS archive, Extranet, and a language selector set to English. A search bar with a 'Search' button and an 'Advanced search' link is also present. The main menu features tabs for About us, Regulation and policy, Supervisory convergence, Risk analysis and data, Consumer corner, and News & press. Below the menu, a breadcrumb trail shows the current page path: EBA Home > Regulation and policy > Implementing Basel III in... The main content area is titled 'Implementing Basel III in Europe: CRD IV package'. It discusses the overarching goal of the Basel III agreement and its implementing act in Europe, the so-called CRD IV package, which aims to strengthen the resilience of the EU banking sector. It notes that the EBA will play a key role in the implementation of the new regulatory framework. A sidebar on the left provides links to the Single Rulebook, Implementing Basel III in Europe, Implementing FSB Key Attributes on resolution matters, and Topics. Another sidebar on the right lists 'Related links' to the European Commission website on Banking and the Basel III on the Basel committee website.

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## Implementing Basel III in Europe: CRD IV package

The overarching goal of the so-called Basel III agreement and its implementing act in Europe, the so-called CRD IV package, is to strengthen the resilience of the EU banking sector so it would be better placed to absorb economic shocks while ensuring that banks continue to finance economic activity and growth.

The European Banking Authority (EBA) will play a key role in the implementation of the new regulatory framework in the European Union.

[Related links:](#)

- European Commission website on Banking
- Basel III on the Basel committee website

### What is Basel III?

"Basel III" is a comprehensive set of reform measures in banking prudential regulation developed by the [Basel Committee on Banking Supervision](#), to strengthen the regulation, supervision and risk management of the banking sector. These measures aim to:

- improve the banking sector's ability to absorb shocks arising from financial and economic stress, whatever the source
- improve risk management and governance
- strengthen banks' transparency and disclosures.

The Basel III agreement was endorsed by the G20 in November 2010.

[Basel III overview table](#)

### The implementation of Basel III in Europe: the CRD4 package

In 2013, the European Union adopted a legislative package to strengthen the regulation of the banking sector and to implement the Basel III agreement in the EU legal framework. The new package replaces the current Capital Requirements Directives (2006/48 and 2006/49) with a Directive and a Regulation and is a major step towards creating a sounder and safer financial system.

EBA



The image shows a screenshot of a document cover page. In the top left corner, there is a small icon of a computer cursor pointing upwards. Next to it, the text "EBA REPORT ON CVA" is written in a small, black, sans-serif font. On the right side of the page, the European Banking Authority logo is displayed, consisting of the letters "EBA" in white on a blue background, with the words "EUROPEAN BANKING AUTHORITY" in smaller white text below it. Below the logo, the title "EBA Report on CVA" is centered in a bold, dark blue font. Underneath the title, the date "25 February 2015" is printed in a smaller, dark blue font. A horizontal line separates this header section from the main content. The main content area contains two sections: "EBA Report" and "EBA Review". Both sections are preceded by a short, dark blue horizontal line. The "EBA Report" section is described as "On Credit Valuation Adjustment (CVA) under Article 456(2) of Regulation (EU) No 575/2013 (Capital Requirements Regulation — CRR)" and includes the word "and". The "EBA Review" section is described as "On the application of CVA charges to non-financial counterparties established in a third country under Article 382(5) of Regulation (EU) No 575/2013 (Capital Requirements Regulation — CRR)".

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The most recent information from the Basel Committee on Banking Supervision (BCBS) can be found on the [website for the Bank for International Settlements](#).

The aggregate global indicator amounts for each systemic indicator (GSIB denominators) for use in the Board's GSIB risk-based capital surcharge can be found [here](#).

#### Basel III Implementation

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##### *Announcements*

November 18, 2014

Agencies propose technical corrections and clarifications to the capital rules applicable to advanced approaches banking organizations

[Press Release](#)

December 6, 2013

Federal Reserve Board issues final rule aligning market risk capital rule with Basel III

[Press Release](#)

October 24, 2013

Federal Reserve Board issued proposed rules to strengthen the liquidity positions of large financial institutions

[Press Release](#)

September 24, 2013

Federal Reserve Board issues interim final rules clarifying how companies

##### U.S. Implementation of the Basel Accords:

[Basel III Implementation](#)

[Basel II Advanced approaches implementation](#)

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[Basel I Revisions \(Basel IA\)](#)

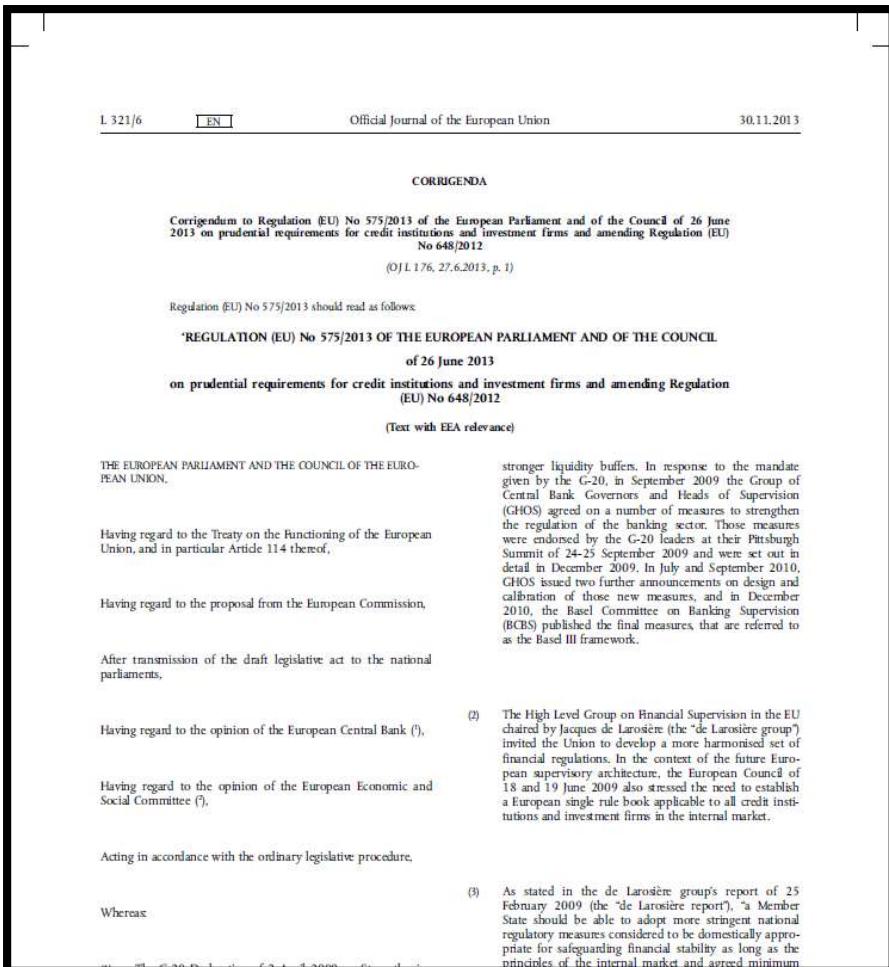
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Source: <https://regmedia.co.uk/2015/10/26/european-parliament.jpg?x=1200&y=794>

# Capital Requirements Regulation (575/2013)



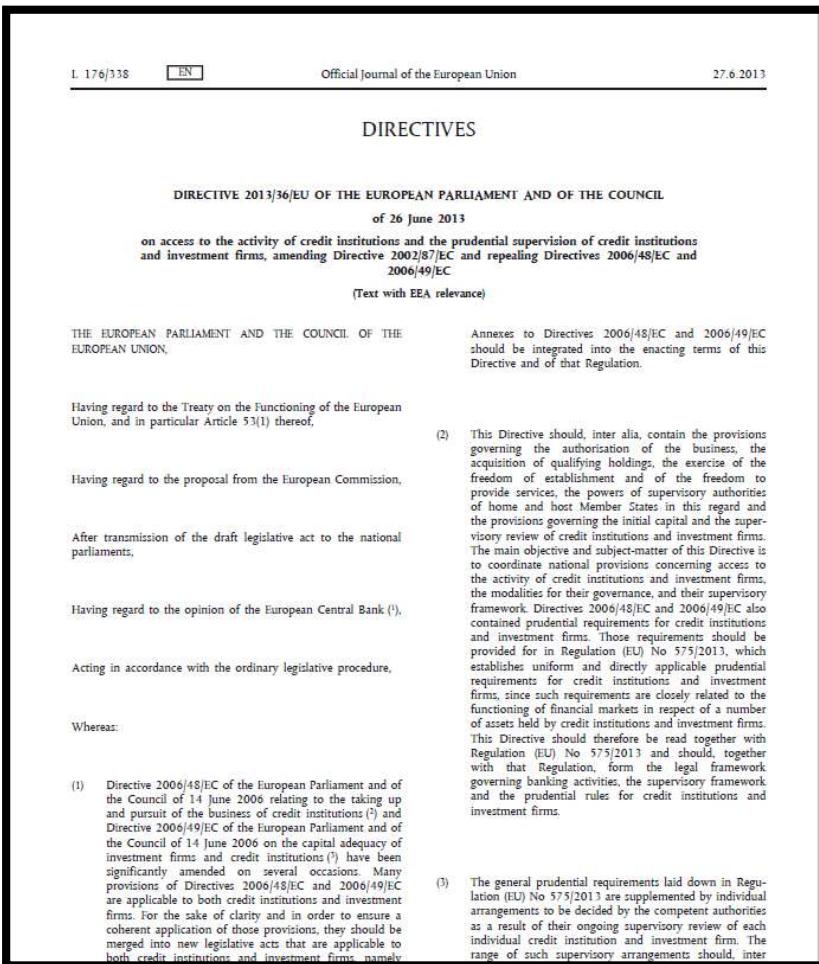
## Capital Requirements Regulation (2013): *Official Journal of the European Union.*

Regulation (EU) No 575/2013 of the European Parliament and of the Council of 26 June 2013 on prudential requirements for credit institutions and investment firms and amending Regulation (EU) No 648/2012 Text with EEA relevance.

Source: <http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex:32013R0575>

CRR (Pilar 1)

# Capital Requirements Directive (2013/36/EU)



**Directive 2013/36/EU of the European Parliament and of the Council of 26 June 2013 on access to the activity of credit institutions and the prudential supervision of credit institutions and investment firms, amending Directive 2002/87/EC and repealing Directives 2006/48/EC and 2006/49/EC Text with EEA relevance**

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**CRD IV (Pilar 2)**