Regulatory Capital Requirements – Overview

Why economic capital is not enough...

March 13, 2023

Agenda

Section 1

The role and the importance of the Regulator

Financial regulation – The Regulator

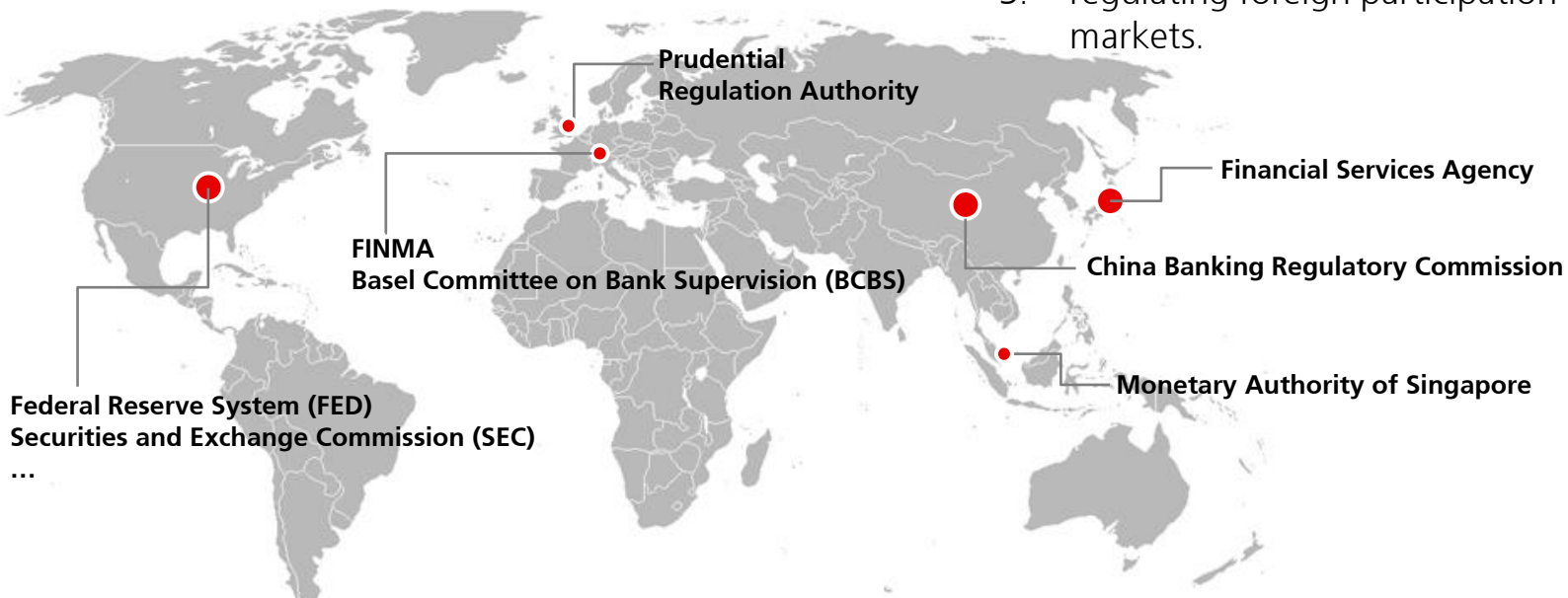
Facts:

Financial regulation is a form of regulation or supervision, which subjects financial institutions to certain requirements, restrictions and guidelines, aiming to maintain the integrity of the financial system. This may be handled by either a government or non-government organization.

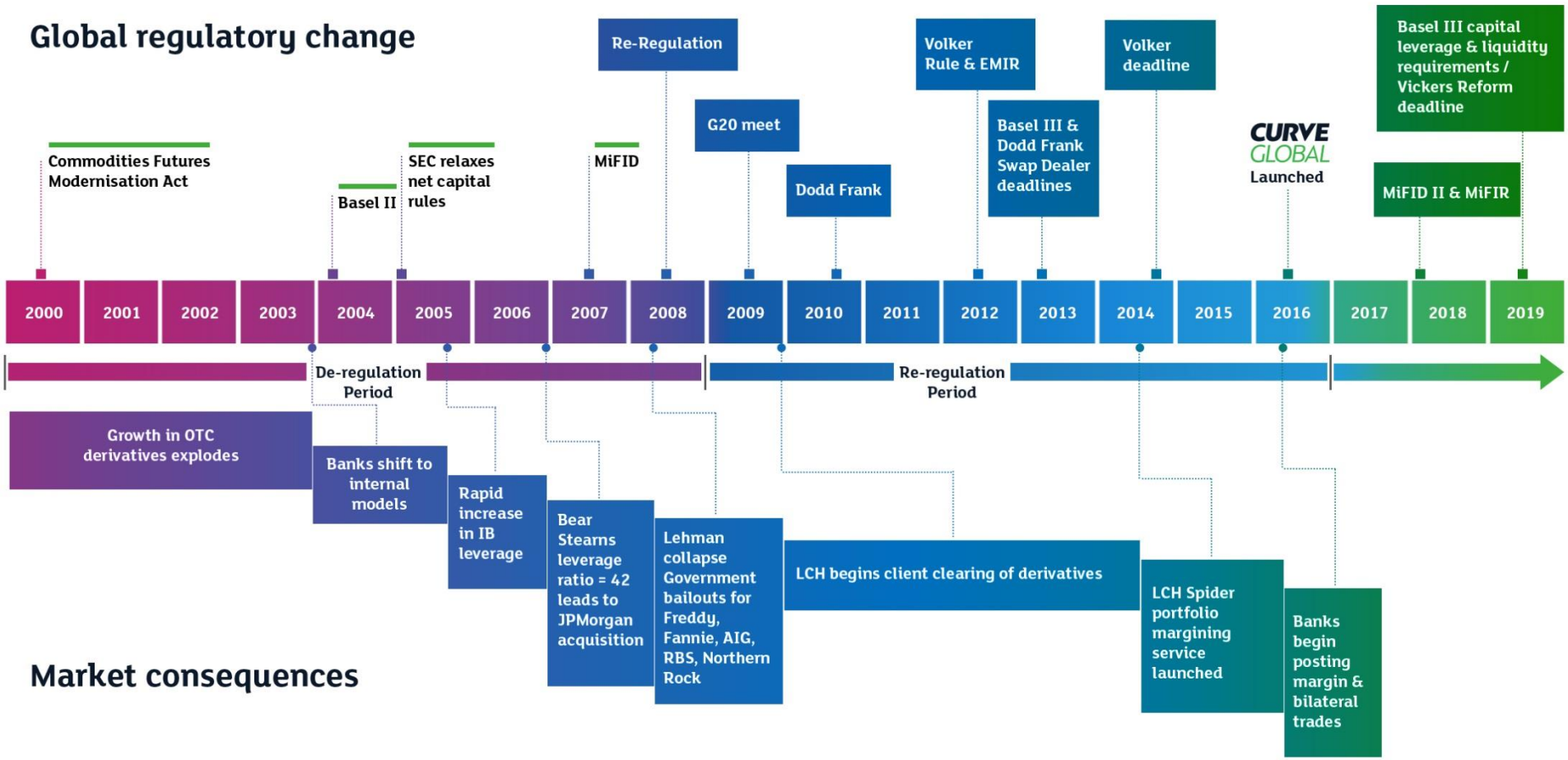
See map below for a few examples of regional regulation bodies.

Goals of the financial regulation:

1. market confidence – to maintain confidence in the financial system.
2. financial stability – contributing to the protection and enhancement of stability of the financial system.
3. consumer protection – securing the appropriate degree of protection for consumers.
4. reduction of financial crime – reducing the extent to which it is possible for a regulated business to be used for a purpose connected with financial crime.
5. regulating foreign participation in the financial markets.



Regulatory Cycles



*Source: London Stock Exchange Group plc. All rights reserved

History

"There are strong reasons for believing that banks left to their own devices would maintain less capital—not more—than would be prudent. The fact is, banks do benefit from implicit and explicit government safety nets. Investing in a bank is perceived as a safe bet. ***Without proper capital regulation, banks can operate in the marketplace with little or no capital.*** *And governments and deposit insurers end up holding the bag, bearing much of the risk and cost of failure. History shows this problem is very real … as we saw with the U.S. banking and S & L crisis in the late 1980s and 1990s. The final bill for inadequate capital regulation can be very heavy. In short, regulators can't leave capital decisions totally to the banks. We wouldn't be doing our jobs or serving the public interest if we did."**

*Source: Remarks By Sheila Bair Chairman, U.S. Federal Deposit Insurance Corporation; 2007 Risk Management and Allocation Conference, Paris, France, June 25, 2007, http://www.fdic.gov/news/news/speeches/archives/2007/chairman/spjun2507.html

Section 2

Regulatory Capital vs Economic Capital

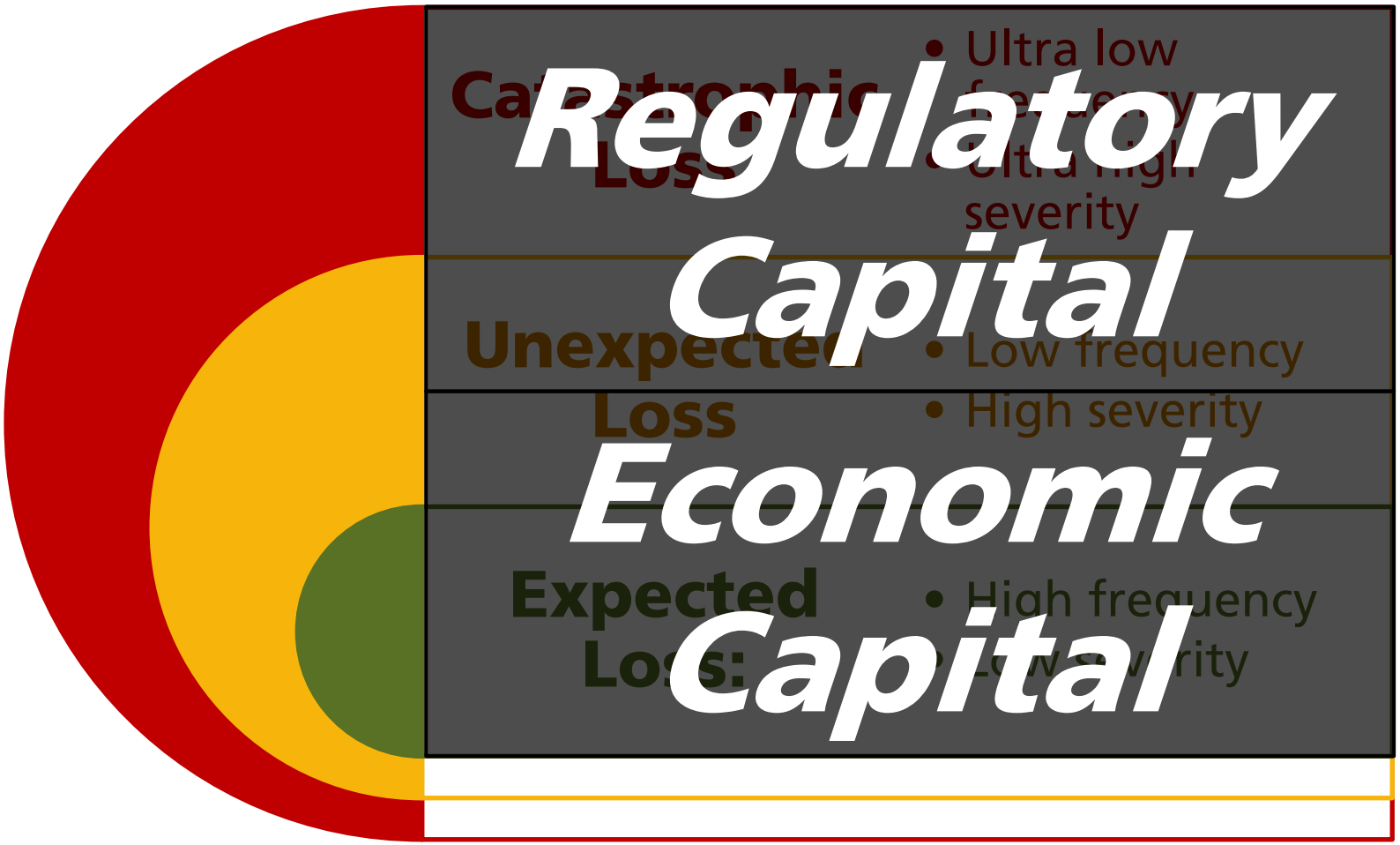
Economic capital (EC)

- Represents the **amount of capital** that the entity needs to have in place (maintain reasonable balance sheet in terms of fair value) **to stay solvent** (knowing time horizon and confidence level);
- Can be understood as a **capital buffer** for bank with capacity to **absorb expected and some unexpected losses** (knowing time horizon and confidence level; i.e. calculated as Value At Risk (VAR));
- Can be calculated both at **single risk level or aggregated one** (can reflect the risk of the current portfolio / exposure / project and assures that decisions are taken based on risk-adjusted basis);
- Economic capital can be seen as a **tool** developed and implemented by individual entity **for internal risk management purpose**;
- It allows banks to **assess profitability** of risk-taking activities, efficiently **allocate capital** across the banks divisions and cover the economic effects of investments decisions.

Regulatory Capital (RC)

- Is the **mandatory minimal amount of capital** to be kept by banks (e.g. Basel II's Pillar 1 minimum capital requirement);
- Usually established at **aggregated risk level** (e.g Basel II is minimum capital requirement for whole entity as $\sum$ of capital for credit, operational and market risk) so **cannot be directly assigned to portfolio, exposure or project level** to facilitate risk-based decisions;
- RC can **significantly deviate from the actual / desirable capital levels** (determined by sophisticated risk-based capital methodology). It might be **due to company specific circumstances or Point-in-Time risk calculation**.
- The purpose of RC is to **keep bank up and running even in catastrophic situation**;
- In general **RC>>EC** but in some circumstances relying solely on regulatory capital **may lead to significantly undercapitalized or overcapitalized companies**;

Why Economic capital is not enough?



Loss: expected / unexpected / catastrophic

Expected Loss (EL):

the cost of doing business, covered within the pricing (charged to the client) and provisions calculations

Calculation:

EL[% of Exposure] = PD * LGD

Unexpected Loss (UL):

losses above expected levels, time and severity is impossible to know in advance, covered by sufficient company's capital

Calculation:

RWAs / Risk Scenarios / VaR

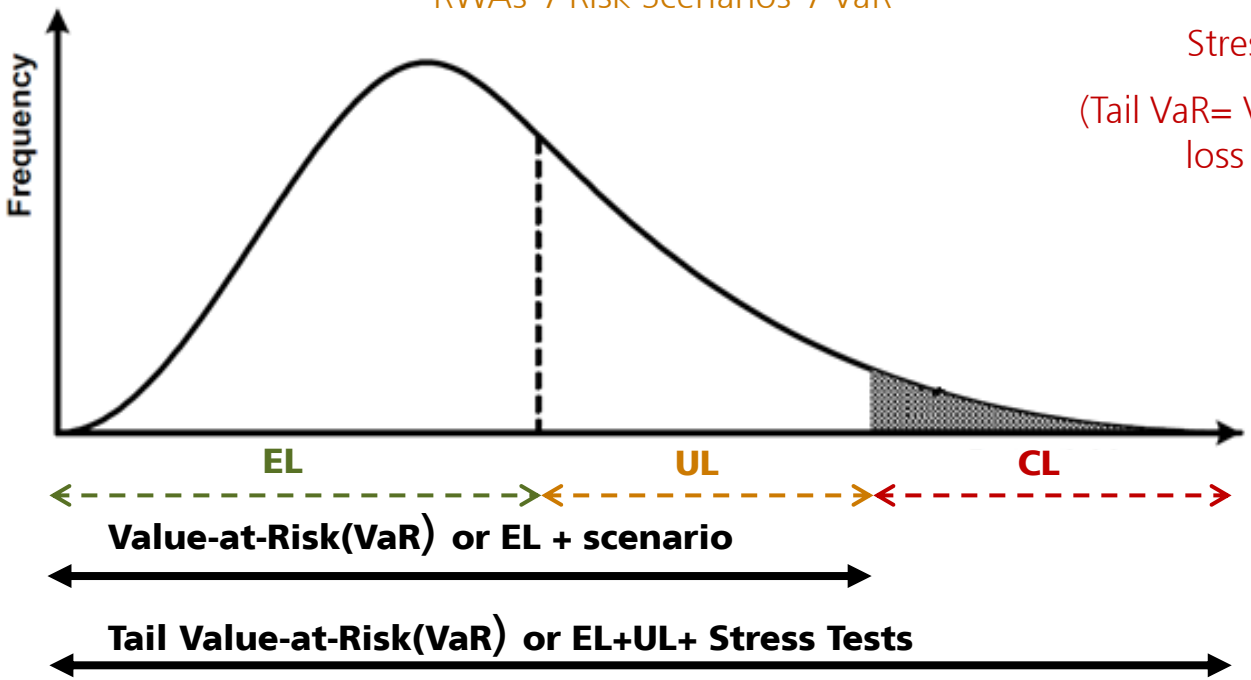
Catastrophic Loss (CL):

extremely rare events, sometimes even never observed, can be thought as "nuclear", at least partially covered by company's capital

Calculation:

Stress Testing / TVaR

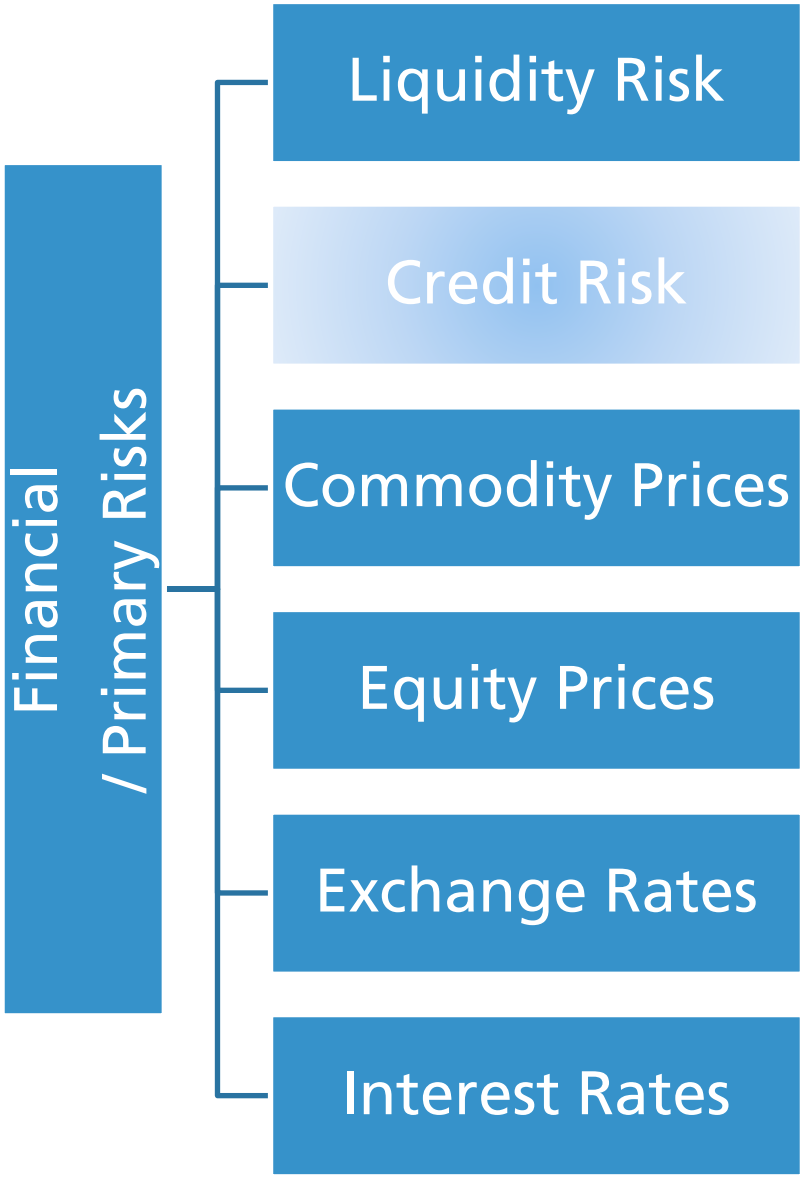
(Tail VaR= VaR + expected average loss in excess of VaR)



Section 3

How to measure the regulatory capital for banks?

The Sources of Risk for Banks – Primary Risks



New regulatory capital requirements

Facts:

1. One of the most dramatic changes to the banking industry since the last financial crisis is the rollout of new capital requirements for banks.
2. Today, banks are required to hold higher amounts of capital, dictated by a **"complex" formula**.
3. This capital protects the bank from (unexpected) losses and ultimately protects taxpayers from potential expensive bailouts.

How to determine that capital level?

- The simplest approach would be to require all banks to maintain a maximum leverage ratio, something like the assets-to-shareholder equity ratio.
- This concept would be
  - simple
  - everyone could understand it, and
  - there would be no question which banks were overly leveraged.

First idea – Leverage ratio

Leverage ratio = Equity / Assets

Leverage ratio Bank A = Leverage ratio Bank B

Asset composition:

50% Treasuries, 25% highly rated loans, 15% in branches and buildings, and 10% in cash

→ conservative assets structure

Asset composition:

50% in subprime loans, 29% in risky derivatives, 20% in branches, and 1% in cash.

→ risky assets structure

Using the assets-to-shareholder equity approach is not correctly reflecting the assets compositions and the risks involved **→ the leverage ratio does not describe the full picture**

→ main idea: re-scale the bank's assets by considering the underlying risk (see next page)

Second idea – risk based approach

Capital Adequacy Ratio (CAR) := Equity / RWAs

CAR Bank A >> CAR Bank B

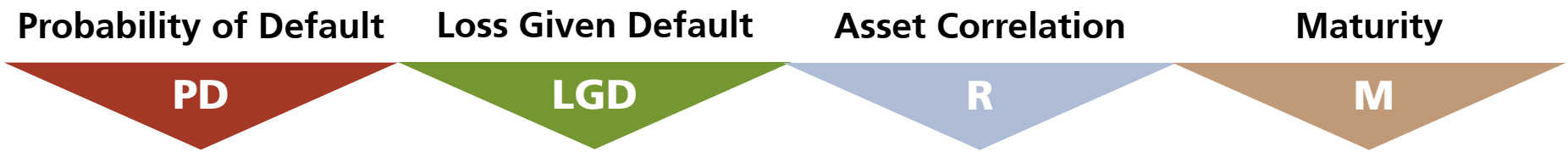
where RWAs stands for **R**isk **W**eights **A**sset**s**.

Regulators require Banks to hold a minimum CAR.

How to derive adequate risk weights? Which are the risk factors that should determine the risk weights?

Risk metrics and the "complex" formula

- From the previous page, risk weights seem to be the key figure in order to correctly scale the Bank's asset side by considering its exposure to risk.
- From an intuitive point of view, at least the following risk metrics should influence the risk weights:



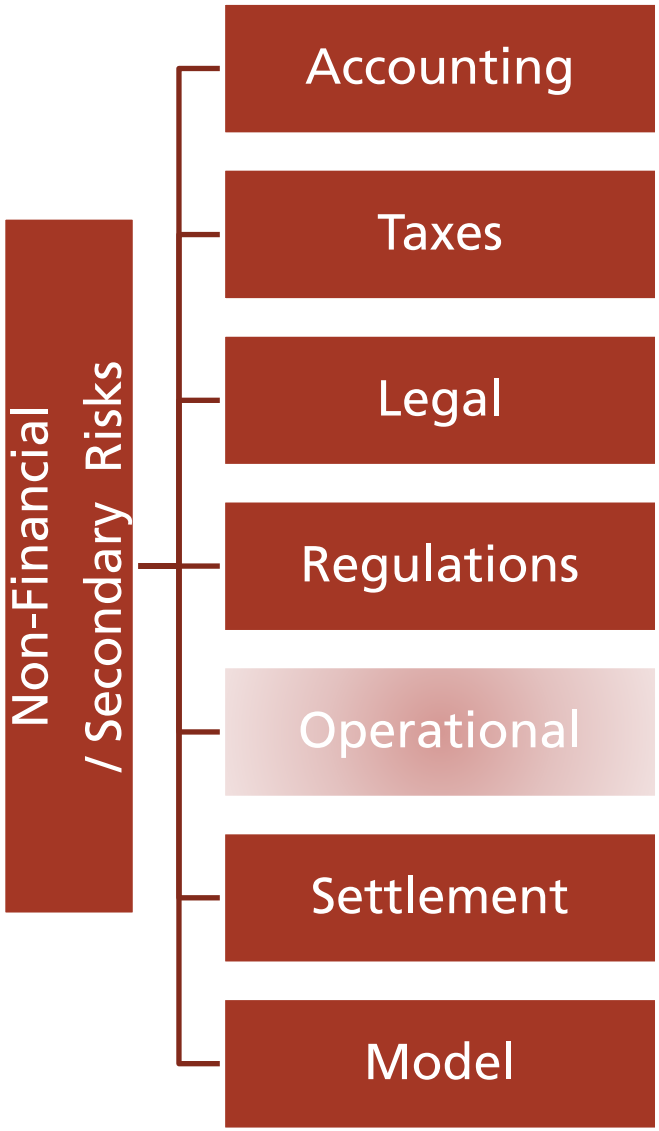
The Basel Committee has derived following mathematical formula for the risk weights:

$$RW = \left(LGD \cdot N\left(\frac{1}{\sqrt{1-R}} \cdot G(PD) + \sqrt{\frac{R}{1-R}} \cdot G(0.999) \right) - LGD \cdot PD \right) \cdot 12{,}5 \cdot 1{,}06$$

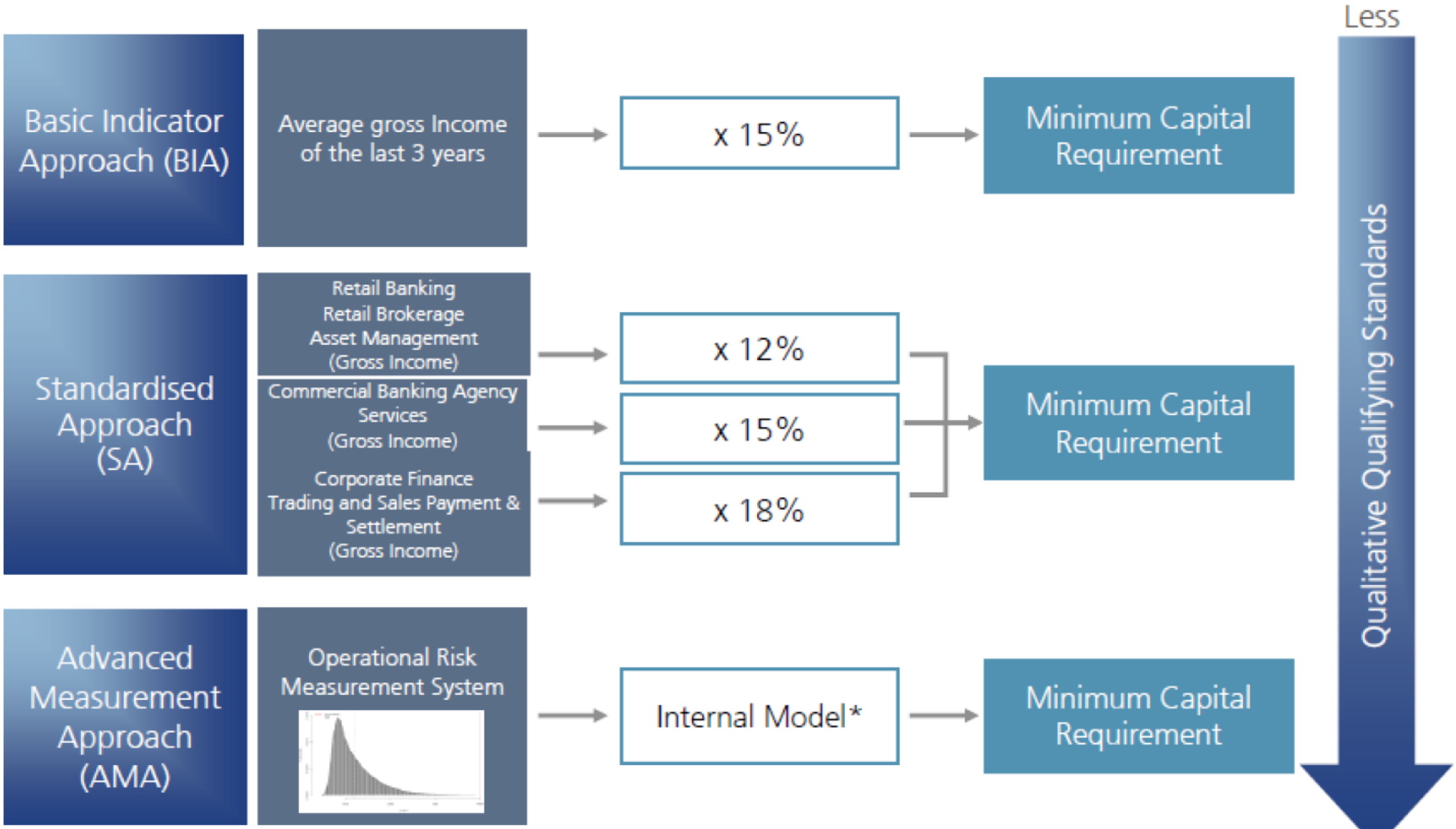
where:

- N(x) is the cumulative distribution function of the normal distribution
- G(x) is the inverse of N
- R is a certain correlation factor that depends on PD.

The Sources of Risk for Banks – Secondary Risks



Three levels of shopistication – Operational Risk Example



* UBS uses an internal measurement approach to measure regulatory capital for Operational Risks

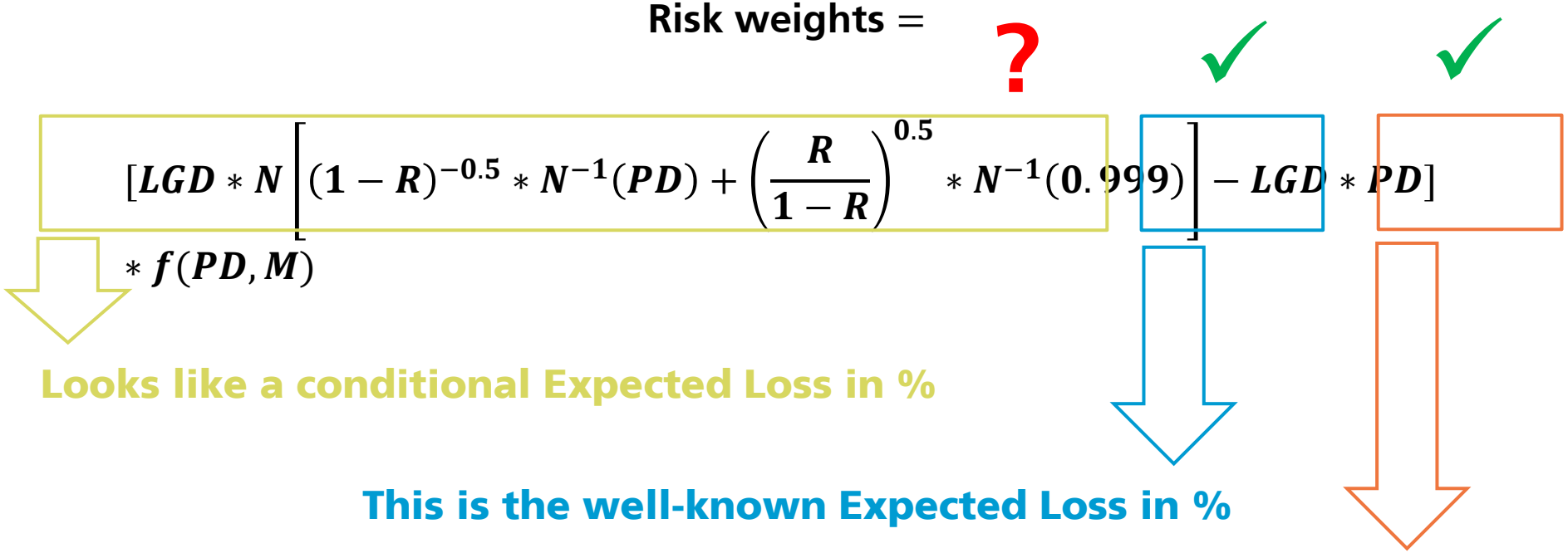
Source: UBS internal material

Section 4 (optional)

Derivation of the Formula for RWAs – corporate loans example

Economic Foundations of the Risk Weight Formula

Risk weights =



Summarizing:

The risk weights formula describes the unexpected loss in %; this is derived as the difference between the conditional EL and the EL. A scaling factor is needed because long-term credits are riskier than short-term credits. As a consequence, the capital requirement should increase with maturity.

Structural models – option analogy

Structular models :

originated to **understand** the economics of a company's **liabilities** and build on the insights of **option pricing theory**.

Assets A_t	Debt $D(t,T)$
	Zero-coupon bond • maturity T • face value K
	Equity S_t

$$D(T,T) = \begin{cases} K & \text{if} \quad A_T \geq K \\ A_T & \text{if} \quad A_T < K \end{cases} = \min[K, A_T]$$

$$\Leftrightarrow$$

$$D(T,T) = K - \begin{cases} 0 & \text{if} \quad A_T \geq K \\ K - A_T & \text{if} \quad A_T < K \end{cases} = K - \max[K - A_T, 0]$$

Owning the **company's debt is economically equivalent** to owning a **riskless bond** that pays K$ with certainty @ T, **and** simultaneously **shorting a European PUT** option on the assets with strike price K and maturity @T.

$$S_T = \begin{cases} A_T - K & \text{if} \quad A_T \geq K \\ 0 & \text{if} \quad A_T < K \end{cases} = \max[A_T - K, 0]$$

Holding the **company's equity is economically equivalent** to **owning a European CALL** option on the company's assets.

Modelling Assumptions behind RWAs

$$\left[LGD * N\left[(1-R)^{-0.5} * N^{-1}(PD) + \left(\frac{R}{1-R}\right)^{0.5} * N^{-1}(0.999)\right] - LGD * PD\right] * f(PD, M)$$

Where is this coming from? This must be a "kind of" conditional PD…

Recall the one-factor Merton:

- A firm defaults when the value of its assets V_i falls below a certain level given by the default barrier K_i.
- The asset value of a firm is decomposed into a common/systematic factor f and an idiosyncratic noise component ξ:

$$V_i = \sqrt{\mathrm{R}} f + \sqrt{1-R}\xi_i$$

where

- f is a common factor in the economy that affects equally all the companies and is N(0,1) distributed.
- ξ_i is an idiosyncratic factor that only affects company "i" and is also N(0,1) distributed.
- R is the asset correlation, i.e. the correlation between asset value V_i and V_j $\quad \forall\, i \neq j$.

Some mathematics of the RWAs formula

In the one factor model, default occurs when $V_i \leq K_i$. If PD is the default probability, then

$$PD_i = P(V_i \leq K_i) = N(K_i) \rightarrow K_i = N^{-1}(PD_i)$$

Therefore an appropriate default threshold $K_i$can be determined by applying the inverse of the normal distribution to the average PD_i.

Conditional on the common factor $f = y$, it can be shown that:

- the firms' values V_i as well as the defaults are independent,
- the conditional probability of default of firm i reads:

$$PD_i(y) := P(V_i \leq K_i | f = y) = P\left(\sqrt{\mathrm{R}} f + \sqrt{1 - R}\xi_i \leq K_i | f = y\right)$$

$$= \boldsymbol{N}\left((\boldsymbol{1} - \boldsymbol{R})^{\boldsymbol{-0.5}} * \boldsymbol{K_i} - \left(\frac{\boldsymbol{R}}{\boldsymbol{1} - \boldsymbol{R}}\right)^{\boldsymbol{0.5}} * \boldsymbol{y} \right)$$

Final derivation of the RWAs formula

Given that in the RWA formula we are looking for the unexpected loss in a severe / stress market condition, we set the value of the systematic factor at a very conservative value. The Basel Committee sets its value at 0.01%:

$$y = N^{-1}(0.001) = -N^{-1}(0.999)$$

The PD conditional on this conservative value of the systematic factor reads then

$$PD_i\left(-N^{-1}(0.999)\right) = N\left((1-R)^{-0.5} * K_i + \left(\frac{R}{1-R}\right)^{0.5} * N^{-1}(0.999)\right)$$

Recalling that $K_i = N^{-1}(PD_i)$, we get exactly the last component of the RWAs formula previously discussed:

Risk weights =

$$[\boldsymbol{LGD} * \boldsymbol{N}\left[(\boldsymbol{1}-\boldsymbol{R})^{-\boldsymbol{0.5}} * \boldsymbol{N}^{-\boldsymbol{1}}(\boldsymbol{PD}) + \left(\frac{\boldsymbol{R}}{\boldsymbol{1}-\boldsymbol{R}}\right)^{\boldsymbol{0.5}} * \boldsymbol{N}^{-\boldsymbol{1}}(\boldsymbol{0.999})\right] - \boldsymbol{LGD} * \boldsymbol{PD}]$$

$$* \boldsymbol{f}(\boldsymbol{PD}, \boldsymbol{M})$$

Section 5

Concluding remarks

Conclusion

- One of the most dramatic changes to the banking industry since the last financial crisis is the rollout of **new capital requirements for banks**.
- **Regulatory cycles are driven by crises**. Banks without regulations would not keep sufficient capitals.
- **Economic capital** is used in efficient **capital allocation**, whereas **regulatory capital** is a **buffer** for **unexpected and catastrophic losses**.
- Calculation of **VaR** should **always** go in conjunction **with scenario analysis and stress tests**.

- There are several financial ratios that describe how well-capitalized a Bank is, e.g. the **Leverage ratio := Equity / Assets**. This concept does **not sufficiently reflect the riskiness** of the Assets and might give Banks a wrong incentive on how to structure the asset side of their Balance Sheet.
- In order to correctly take the risk of the different assets into account, the Basel Committee requires Banks to have a **Capital Adequacy Ratio (CAR) := Capital / RWAs** above a pre-defined level.
- There is an **analogy between company's balance sheet and options pricing** which can be used in risk modelling:

  Debt = Long Risk Free Bond + Short Put on Assets

  Equity = Long Call on Assets

- **RWAs** can be derived based on the **One-factor Merton Model** (for corporate loans)

Section 7

Q&A