Credit Risk

Lecture 5 – Risk modeling and bank steering

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1. Credit risk models to fulfill regulatory requirements and prevent the bank from failure
2. Reevaluating the profitability of activities taking credit risk into account
3. Lessons from the field

Objectives of the lecture

Teaching objectives

At the end of this lecture, you will:

- Understand the role and differences of **provisions and capital requirements** for banks;
- Know the **model-origin of the credit risk capital requirements** in details;
- Have a clear view of the **different profitability indicators** of business lines, their limits and how to appreciate them with regards to other indicators.
- get familiar through a practical example (thanks to our friend Denis Alexandre)

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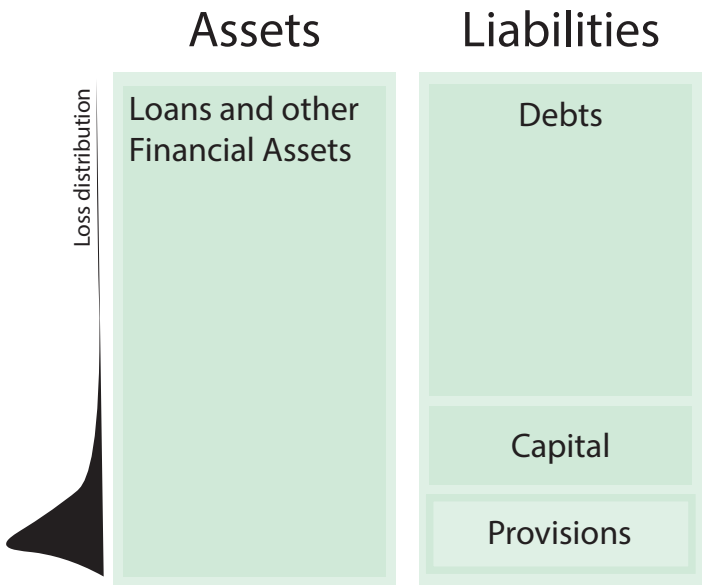
Provisioning/Impairement and capital

In order to protect the economy, banks must set aside provisions and capital to be resilient in case of turmoil. The guidelines for credit risk impairement are defined within IFRS 9 framework (implemented in 2018, January 1st). The level of provisioning depends on the deterioration of the quality of the underlying loan and shall cover the expected loss (1 year time horzion or full maturity).



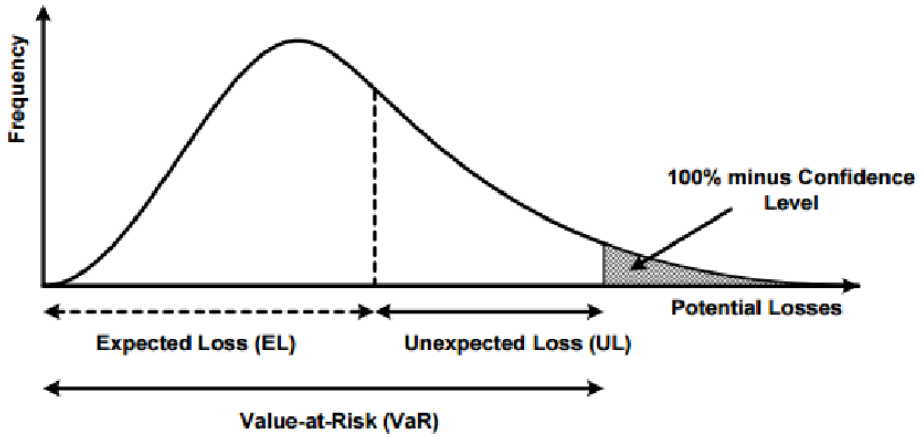
- Société Générale
- BNPP
- CASA
- JPM
- GS
- MS

Expected and Unexpected

The loss distribution of a bank is often split in two parts: the expected loss, from 0 to the average loss, and the unexpected loss above the average up to a percentile

Expected Loss and Unexpected Loss

- **Expected Loss (EL)**: the average loss, that is the normal cost of doing business covered by provisioning and pricing policies;
- **Unexpected Loss (UL)**: potential unexpected loss for wich capital should be held.



Provisions

Provisions are required by accounting rules and are designed to cover expected losses (the ECL: Expected Credit Loss)

- **IASB**: International Accounting Standards Board;
- A liability on **incurred losses** (on **Non Performing Loans**, NPL);
- That is **estimated**;
- and **adjusted** when closing the case.

IFRS9 – New provisioning rules

- A **non procyclical** rule for provisioning;
- A **forward looking**, **Point-In-Time**, provisions on all the loans (**IFRS 9**).

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Basel Accords 1 (1988)

Capital must be set aside to cover unexpected losses since Basel Accords 1 in 1988

Basel Accords 1 (1988)

- Basel Committee on Banking Supervision (BCBS) – 27 countries;
- **Cook ratio** and **standard** and simple computation of regulatory capital:
  - on the **banking book**:

$$\text{Regulatory Capital} = 8\% \times \text{Weights by counterparty type} \times \text{EAD}$$

  - on the **trading book** (since 1996) too.

Weight depends on the **nature** of the counterparty: Sovereign OECD : 0 %; Bank OECD: 20 %; Mortgages: 50 %; Other: 100 %.

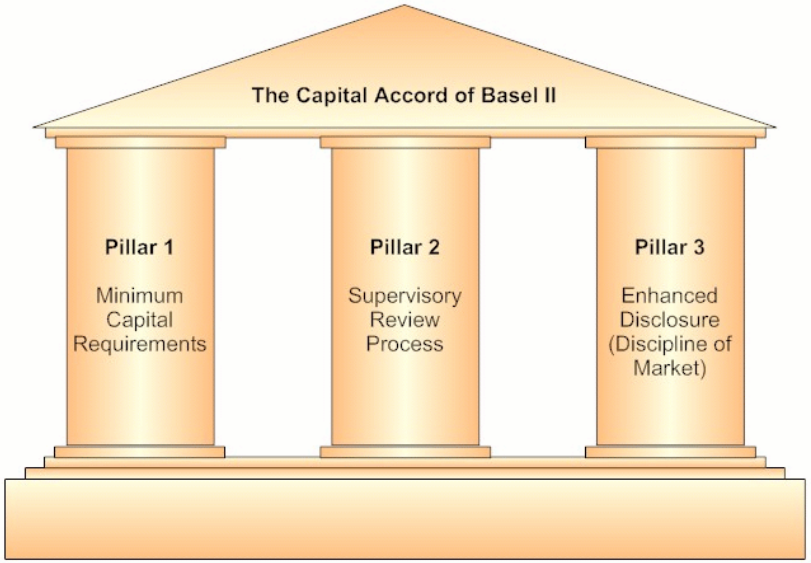
Basel Accords 2 (2006)

Basel Accords 2 were designed to increase the readability for a supervisor of banks activities and risks (i.e. better alignment between risk and capital levels)

Basel Accords 2 (2006)

- **Pillar 1**: Minimal Capital Requirements: capital for credit + market + operational risk;
- **Pillar 2**: Supervisory Review Process;
- **Pillar 3**: Enhanced Disclosure.

Basel 2 is amended after the 2007-2008 financial crisis, enlarging the scope of covered risk (e.g. market risk, credit and market risks).

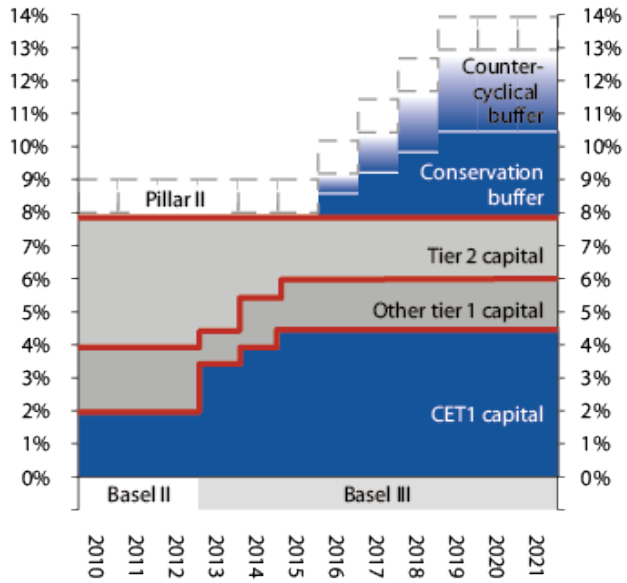


Basel Accords 3 (2014-2019)

Basel Accords 3 is more refined as for capital definitions and is more macro-prudential as it requires liquidity and funding requirements and treats differently systemic banks

Basel Accords 3 (2014-2019)

- **Liquidity Ratios**: Liquidity Coverage Ration (**LCR**) and Net Stable Funding Ratio (**NSFR**);
- **Leverage Ratio** (3 %);
- New definitions of **capital**.



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The Standard Approach for Credit risk

The regulator lets banks several option to fulfill capital requirements: from standard, model-free, approach, to more complex internal models approaches

Rating	$>$ **AA-**	$>$ **A-**	$>$ **BBB-**	$>$ **BB-**	$>$ **B-**	$<$ **B-**	**NR**
Sovereign	0%	20%	50%	100%	100%	150%	100%
Banks	20%	50%	100%	100%	100%	150%	100%
Corporates	20%	20%	100%	100%	150%	150%	100%

Weighted Assets

$$\text{RWA} = \text{Weights} \times \text{EAD}$$

Not just based on the **nature** of the relation but on its **grade** too.

The Internal Rating Based – IRB

Credit RWA, even with more advanced approaches, require the use of the regulator model, as the bank only has parameters PD, LGD, and EAD at its hands

The Internal Rating-Based Approach

- IRB **Fondation**: modeling of PD only;
- IRB **Advanced**: modeling of PD, LGD and EAD.

$$\text{RWA} = f(\text{PD}, \text{LGD}, \text{EAD})$$

IRB Approach – The formula

The IRB Approach is an estimation of the unexpected loss on a loan based on a modified version of the Vasicek model

IRB Approach – The formula

Using the IRB Approach, the **Risk-Weighted Assets formula** is:

$$RWA = LGD \times \left(\Phi \left(\frac{\Phi^{-1}(PD) + \sqrt{\rho}\Phi^{-1}(0.999)}{\sqrt{1-\rho}} \right) - PD \right) \times MA \times SF \times MCR \times EAD$$

- The Maturity Adjustment, $MA = \frac{1+(M-2.5)\times b}{1-1.5\times b}$ with $b = (0.11852 - 0.05478 \times \log(PD))^2$;
- The Scaling Factor, $SF = 1.06$;
- The Minimal Capital Requirements, $MCR = 12.5$.

Notebook

IRB Approach – The correlation parameter

The correlation parameter

The **correlation parameter** depends on the type of the countractor:

Type	**Value for ρ**
Large Corporates Institutions	$0.24\text{-}0.12\times\frac{1-e^{-50\times PD}}{1-e^{-50}}$
SME with turn over <5 MEUR	$0.20\text{-}0.12\times\frac{1-e^{-50\times PD}}{1-e^{-50}}$
SME	$0.24\text{-}0.12\times\frac{1-e^{-50\times PD}}{1-e^{-50}}-0.04\times\left(1-\frac{T-5}{45}\right)$
Residential Mortgages	0.15
Revolving	0.04
Other retail exposure	$0.16\text{-}0.13\times\frac{1-e^{-35\times PD}}{1-e^{-35}}$

During the tutorial, we will interpret this formula and understand in details its link with the Vasicek model.

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Economic Capital and stress testing

As regulatory capital is arbitrary, banks also calculate economic capital to have their own vision of their resilience

Economic Capital

- Regulatory capital does not take into account **correlation risk**, **concentration risk** and has other limits;
- Thus, banks have their **own internal models to steer their activity**.

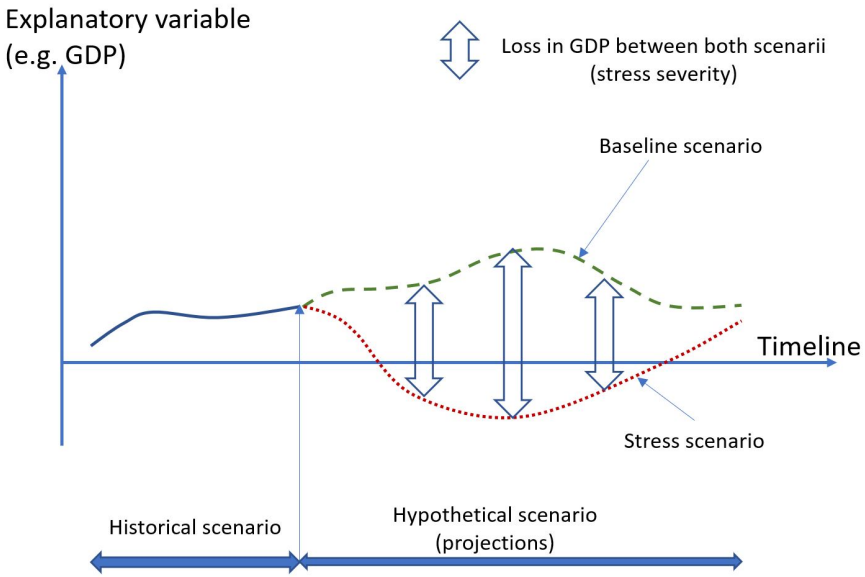
They thus compute a so called **economic capital**. Economic capital is however -as a adverse risk measure- replaced by stress testing that gets a better buy-in.

Economic Capital and stress testing

The objective of stress testing is to forecast the financial and solvability trajectory of the bank along two scenarios: a baseline scenario and a stress scenario. We offen refer to 'global stress tests'. There are complete by specific stress tests that focus on a reduced number of risk factors or reduced perimeter (e.g. impact of oil prices decrease on corporate portfolio)

Stress testing

- Global stress test allow to ensure that the minimal capital requirement and/or financial KPI are fullfi lled during a **remote crisis scenario**. There are also used by regulators (e.g. EBA)
- **The correlation between the different risks lies within the description of the scenario**, enabling the aggregation of risks.



Conclusion

Credit risk models to fulfill regulatory requirements and prevent banks failures

- **Provisions** are **accounting requirements** dedicated to cover **expected losses** of the bank;
- **Capital requirements** are buffers designed to prevent banks from failure in case of **unexpected losses**;
- **Basel Accords** are at the origin of the current capital requirements framework and is based, for the most advanced approach, on the **Vasicek model**.

▶ Quiz

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Return On Equity – ROE

The ROE is a basic profitability indicator, that fail to grasp specificities of the banking sector

Return On Equity – ROE

The **Return On Equity** of a Business Line is:

$$\text{ROE} = \frac{\text{Net Income of the BL}}{\text{Regulatory Capital allocated to the BL}}$$

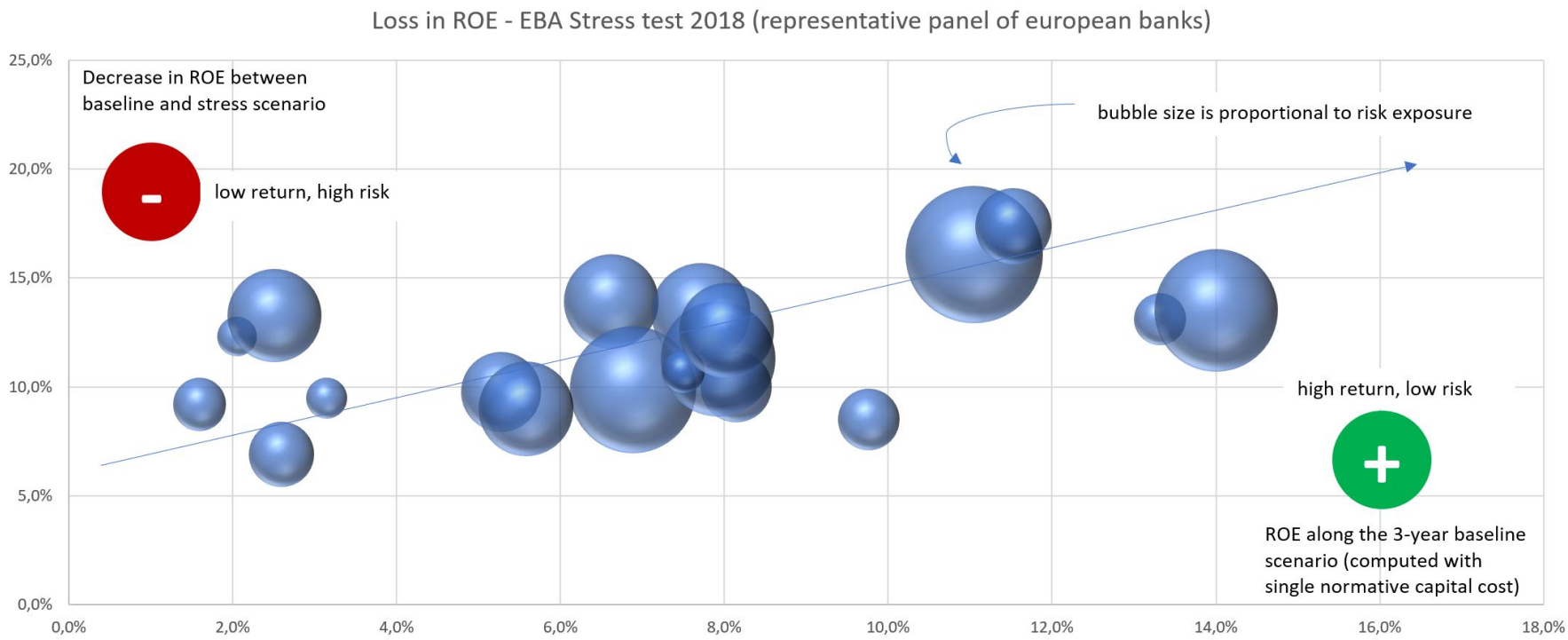
ROE's limits

- **In the numerator**: does **not** take into account the **risk**;
- **In the denominator**: does not take into account the **diversification effect** of the BL and suffers from **arbitrary and discretionary regulations choices**.

As risks are central in the banking sector, they must be taken into account when measuring return.

Return On Equity – ROE

Comparing the ROE sensitivity to stress scenario: the example of EBA stress tests



EBA Website (2018 Stress tests results) and own simplified computations

Risk Adjusted Return On Capital – RAROC

As RAROC accounts for risks it is more appropriate in the banking sector

Risk Adjusted Return On Capital – RAROC

The **Risk Adjusted Return On Capital** of a Business Line is:

$$\text{RAROC} = \frac{\text{Net Income of the BL} - \text{Average loss of the BL}}{\text{Economic Capital allocated to the BL}}$$

RAROC's limits

What should it be compared to?

Hurdle rate and Weighted Average Cost of Capital – WACC

Profitability indicators can be compared to WACC as it is the hurdle rate of a business

Weighted Average Cost of Capital – WACC

The **Weighted Average Cost of Capital** is:

$$\text{WACC} = (r + k_1)T_1 + (r + k_2)T_2 + (r + k_d)D$$

where, T_1/r_1, T_2/r_2 and D/r_D is the proportion / the cost (spread) of Tier 1 capital, Tier 2 Capital and debt in the liabilities of the bank and r the risk free rate.

Hurdle rate and WACC

The WACC is the **hurdle rate** of bank activities, that is, the minimum return necessary to be profitable.

Economic Value Added – EVA

EVA offers an opportunity to measure profitability in absolute

Economic Value Added – EVA

The **Economic Value Added** for a bank is:

$$\text{EVA} = \text{Net Income of the bank} - \text{Average loss of the bank} - \text{WACC} \times \text{Liabilities}$$

Economic Value Added 2 – EVA 2

The **Economic Value Added 2** for a bank is:

$$\text{EVA 2} = \text{Net Income of the bank} - \text{Average loss of the bank} - k \times \text{Economic Capital}$$

where k is the cost of capital, that is: $k = (r + k_1)T_1 + (r + k_2)T_2$.

Risk Adjusted Return On Risk Adjusted Capital – RARORAC

These profitability measures require to be tractable to know the cost of capital of the bank: CAPM is an option to estimate that cost

Risk Adjusted Return On Risk Adjusted Capital – RARORAC

The **Risk Adjusted Return On Risk Adjusted Capital** for a bank is:

$$\text{RARORAC} = \text{RAROC} - k$$

Risk Adjusted Return On Risk Adjusted Capital 2 – RARORAC 2

The **Risk Adjusted Return On Risk Adjusted Capital 2** for a bank is:

$$\text{RARORAC 2} = \text{RAROC} - k \times \frac{\text{Allocated Economic Capital}}{\text{Used Economic Capital}}$$

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How to make from the theoretical Cost of capital k, a practical tool?

- How to estimate k, the cost of capital?
- Can we use a unique k for all the business lines?

How to estimate the cost of capital?

Cost of capital of the bank – Using the CAPM

CAPM and cost of capital

The **Capital Asset Pricing Model** [Sharpe, 1964], states that the shareholder's expected return for the firm i ($k = \mathbb{E}(r_i)$) is equal to the risk free rate, plus a market premium multiplied by a factor, β_i:

$$k = \mathbb{E}(r_i) = r_f + \beta_i \times \underbrace{(\mathbb{E}(r_M) - r_f)}_{\text{Market premium}}$$

where $\beta_i = \rho_{i,M} \frac{\sigma_i}{\sigma_M}$, $\rho_{i,M}$ being the correlation between the share of the firm i and the market (M), σ_i and σ_M being the volatility of the share of i and the market, r_f being the risk free rate.

How to estimate the cost of capital using CAPM?

Estimated β on the markets by [Matten, 1996]

Universal Bank	0.97
Investment Banks	1.16
Asset Management	1.21
Retail Bank	1.09
Banking Sector	**1.11**

The cost of capital for banks seems to have declined over the last decades

According to [King, 2009], the cost of capital for banks has declined due (i) the decrease in risk-free rates over this period, and (ii) a decline in the sensitivity of bank stock returns to market risk (the CAPM beta) in all countries except Japan.

How to estimate the cost of capital ?

Gordon-Shapiro formula is an alternative to measure the cost of capital

Gordon-Shapiro formula and cost of capital

The **Gordon-Shapiro equation**, [Gordon, 1959], states that the market capitalization of a firm, P, is equal to the sum of the expected future dividends:

$$P = \sum_{t=1}^{\infty} \frac{D_t}{(1+k)^t} = \sum_{t=1}^{\infty} \frac{D_1(1+g)^t}{(1+k)^t} = \frac{D_1}{k-g}$$

where D_t is the expected dividend distributed in year t by the firm, k is the cost of capital (the discount rate adequate given the risk born by the shareholder) and g is the expected annual dividend growth rate.

Limits of Gordon-Shapiro method?

The estimation is of k, the cost of capital, using the Gordon-Shapiro equation is often too **volatile** as the equity market is, and thus the market capitalization of firms are.

Conclusion

Reevaluating activities rentability taking credit risk into account

- The basic **Return On Equity (ROE)** profitability indicator **lacks to grasp credit risk** in its appreciation of value creation;
- **RAROC and RARORAC** thus offer a more **refined** profitability appreciation;
- These profitability indicators can be compared to the **cost of capital** and the **Weighted Average Cost of Capital (WACC)** which values can be extracted from markets valuations.
- Alternatively, ROE needs to be compared between baseline and stress scenarios.

▶ Quiz

Conclusion

Risk modeling and Bank Steering

- Given their sizes and their risks, **banks are required to set aside provisions and capital** to face expected and unexpected losses;
- **These potential losses and these requirements** must be taken into account to assess **the profitability of a business lines**.

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Bonus

Lessons from the field

In this short video, Denis Alexandre proposes to share with you some practical example on market risk management on credit risk instrument

- Presentation of the skew, as the spread difference between ITRAXX and the sum of its individual components
- How to handle with a market request (link with stress tests)
- Video available here: https://youtu.be/bRzZh9utIfQ

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Proofs of the lecture

Proofs of the lecture

- Proof 1

Proof – Proof 1