Risk Management

Master's Degree in Banking and Financial Regulation

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Índice general

Capítulo 1

Overall risk managment overview

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It is important to quantify every risk and look for ways to mitigate those risks. It is impossible to mitigate those risks or to allocate provisions for them if the risks are not quantified.

What does it mean to buy the risk?

It is to sell protection to the bank in case of default

• **Default risk**

Bankruptcy: Bank is unable to meet a payment obligation = it has run outof cash

Insolvency: Bank's liabilities exceed its assets = it has become over-indebted

→ Rumoured insolvency may lead to a bank run (for fear of depositorsnot to get repaid). Insolvency and bankruptcy are closely linked

Closure or takeover by regulator: Can occur for a variety of reasonsincluding non-financial reasons such as unlawful activity (moneylaundering, market manipulation, fraud, etc...)

Capítulo 2

Introduction to Bank Financial Analysis

Working as a credit risk analyst you need to:

•**Understand the business model of the bank:** How does it make money?

•**Understand how much risk the bank takes:** Are the risk appropiate? Is it well managed?

You have to focus on the key factor and ask yourself: What could cause the bank severe problems?

The risks of a bank can be divided into the following 6 areas:

2.1. Liquidity and funding

It is the single biggest risk of a bank and the most difficult to analyse. It is analysed using the balance sheet, which contains information on liquidity: cash, cash equivalent assets and centrall bank balances. The **biggest problem** with the balance sheet is that it is a **"snapshot picture"**, i.e it is **delayed**, usually several months and it is often **dressed up**.

Instead you should focus on the **ability of a bank to fund itself** and **identification of potential risks.**

Figura 2.1: **Liquidity and funding risk table**

High risk	Low risk
Large share of wholesale funding (e.g. ≥ 50% of total assets)	Large share of retail funding – tends to be more stable
Material maturity mismatch (duration of liabilities ≤ duration of assets)	Duration of assets and liabilities well matched
Material refinancing needs in the coming 12-18 months (e.g. maturing bonds)	Proven market Access: bank recently issued new bonds to the market
Low diversification of funding sources, e.g. heavily reliant on comercial paper issuance	Funding sources are well diversified by type and/or borrower
Low or no credit rating	Good credit rating (at least Investment grade)

2.2. Asset quality

Weak asset quality can lead to insolvency. If a bank gives out loans which are not repaid, they become losses and if these losses exceed the capital of the bank, the bank is insolvent.

The purpose of the analysis is to get clues as to the **balance sheet risks** the bank is taking. **Higher risk assets** are expected to exhibit higher volatility. Higher volatility means **higher likelihood of unexpected losses**.

Key asset components:

- **Inter-bank lending:** Tends to be low risk (short-dated, high quality counterparties)
- **Customer loans:** Usually the highest risk part of the balance sheet – long-dated, illiquid
  1. Track record
  2. Trend in non-performing loans
  3. Trend in loan loss provisions. High or low given the current credit cycle
  4. Strong loan portfolio growth
  5. Material concentrations (borrower, sector, región)
- **Securities portfolio:** Quality varies a lot!
  1. Disclosure often poor. Best sources: Investor presentations
  2. Depending on accounting classification Banks may not have to recognise losses inmmediately
  3. Track record
  4. Trend in impairment provisions

Figura 2.2: **Asset quality risk table**

High risk	Low risk
Strong growth of non-performing loans. High percentage of NPLs (≥7-10%)	Low NPLs would typically indicate prudent lending
Strong growth in loan loss provissions. High share of LLPs relative to net interest income (≥30%)	Low LLPs typically indicate prudent lending
Strong loan portfolio growth. Potentially weak underwriting standards &aggresive growth targets	
Heavy loan losses in the past. Changing the risk culture of a bank is difficult and takes time. So poor track record could hint at future asset quality problems	Sound track record, especially during the financial crisis

2.3. Capitalization

The insolvency ranking determines "How are losses ging to be distributed". The more senior the debt, the sooner it is going to be paid:

- Equity
- Hybrid capital
- Junior debt
- Senior unsecured
- Senior secured

The cushion to absorb losses is given by the equity, the hybrid capital and the junior debt. Equity is the **main cushion** to absorb losses.

Distinguish between

• **Book equity**

1. Accounting item from the balance sheet
2. May include unrealised gains/losses of securities ("revaluation reserve" under IFRS)
3. May include hybrid capital ("equity-like financial instruments")

• **Regulatory equity (or capital)**

1. Capital according to regulatory definition
2. Often excludes certain types of accounting capital = more stringent

• **Banks are required to comply with minimum regulatory capital requirements**

Key ratio: tier-1 capital ratio. Calculated as:

$$T1CR = \frac{\text{Tier-1 capital}}{\text{Risk} - \text{Weighted Assets (RWA)}} \tag{2.1}$$

Figura 2.3: **Capitalization risk table**

High risk	Low risk
Low regulatory capital ratios, relative to both, mínimum requirements and peers. May also undermine market confidence (important for wholesale funded Banks)	Strong capital ratios
Small book equity base. A small bank is less able to diversify away individual risks than a larger bank, so more likely to suffer life-threatening losses	Large capital base
Negative trend in book equity	Steadily growing book equity

2.4. Earnings

Earnings act as a buffer to absorb unexpected losses. If weak could impair capital base.

- **Pre-tax profit or loss**
- **Profitability:** Return on (average) equity
  - → Pre-tax income divided by book equity
  - → Measure of return to shareholders
  - → Pre-crisis: pre-tax ROEs of 25 % and more. Post-crisis: 10-15 % is good
- **Cost-efficiency: Cost-to-income ratio**
  - → Operating costs (excluding Loan loss provisions) divided by operating revenues
  - → "How much does it cost the Bank to generate one $1 of revenues?"
  - → Ratios did not change much pre and post crisis, but significance of ratio is somewhat lower

Don't be fooled – if a Company/Bank reports stellar profitability, it probably is too good to be true!

Figura 2.4: **Earnings risk table**

High risk	Low risk
Poor track record of earnings – losses in consecutive years	Proven track record of earnings across the business cycle. No losses during the financial crisis
Poor operating efficiency. Costs are very high compared to revenues (cost-income ratio ≥ 85%)	Strong operating cost efficiency
Low profitability (as measured by ROE), relative to peers	Solid profitability

2.5. Management

What is the importance of analyzing management quality? Poor Management can cause a variety of problems:

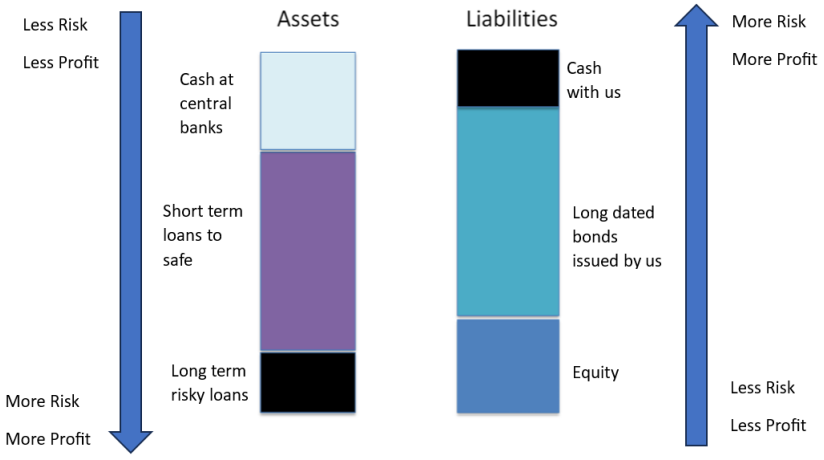
- → Bad strategic decisions
- → Excessive risk appetite; or just a follower...
- → Failure to establish adequate risk control mechanisms
- → Brand damage (e.g. customer scandals)
- → Regulatory fines, in extreme cases loss of licence
- → Poor integration of acquisitions

It is very difficult to assess – much easier in retrospective! Management is measured against its track record or its targets.

2.6. Solvency, Liquidity, Capital

1. How does a bank go bust?
   - Solvency and Capital
   - Liquidity and Illiquidity
2. Putting some numbers to it
   - Metrics and Ratios
   - A "Banks" Balance Sheet
3. Rise of the Treasury Departments

Figura 2.5: **Stylised balance sheet**



The right side of the diagram, the liability side represents the cash given to us, leaving an obligation to others. This money is uded by the bank (us) to lend to others, leaving them with an obligation to pay us.

For example, if the risky assets (colored in black in the asset side) default, the losses are absorved by the capital (= equity). If the risky assets are much bigger than the equity and they default, they wipe out the capital and the bank is insolvent.

Liquidity problems can also arise too. If a lot of depositors ask for their money back ("cash with us") we may draw down on our central bank cash to pay them, but if money market depositors no longer roll loans to us and we cannot sell our assets, we do not have cash to give them so we default on our liabilities. We are iliquid.

RWAs vs CET1 Ratio

The ratio between the capital and the assets it protects weighted for risk:

CRD IV CET1 ratio: Higher ratio, better capitalised firm, less leverage

Liquidity coverage ratio

It is the ratio between the High Quality Liquid Assets (HQLA) and the liquidity stresses it protects against. The higher the ratio the more liquid the firm is.

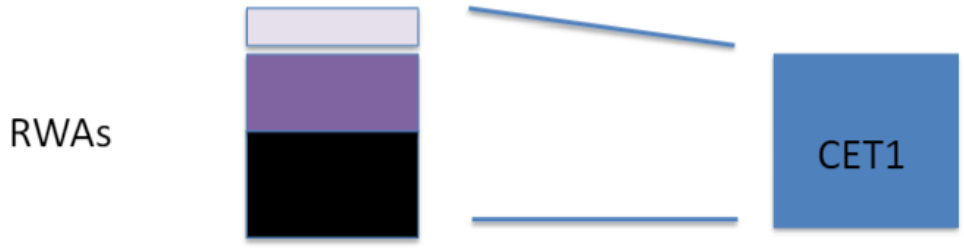
There are tiers of High Quality Liquid Assets. Our liquidity pool is predominantly level 1:

→ Cash at core central Banks

→ Highly rated governments bonds

→ SSAs, multilateral development Banks, covered bonds

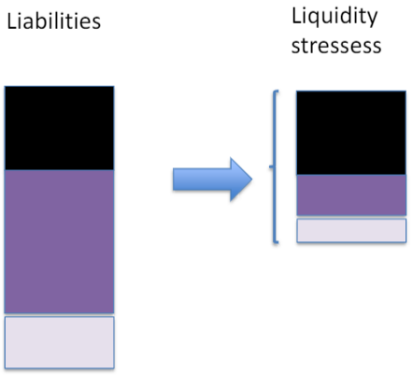
Figura 2.6: **RWA CET1 ratio**



Liquidity Stresses

Cash outflows come from the liabilities side of the balance sheet:

- Current account outflows
- Money markets deposits outflows
- Unable to finance in repo market
- Collateral outflows on derivatives
- Down grade triggers
- ... and more ...



How does a bank go bust?

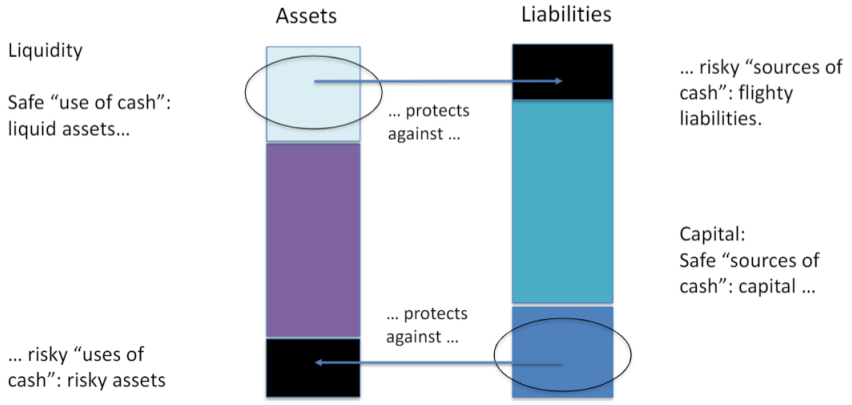
Rumours of losses (solvency) lead to wholesale markets withdrawing funding (liquidity) e.g. Northern Rock

Securities being marked down (solvency) leads to greater financing requirements where those securities are used as repo collateral (liquidity) e.g. Bear Stearns, Lehman

In practice both happen together.

To avoid solvency and liquidity problems banks are required to "set aside" capital to support possible future losses on the asset side.

Figura 2.7: **Stylised balance sheet**



How do we measure this capital?

1. Capital and solvency: How much capital do we have to support possible losses on our assets?

→ BCBS 270 Leverage Ratio (leveraged balance sheet)

→ CRD IV CET1 Ratio (RWAs & "capital ratios")

→ Total Loss Absorbing Capital (TLAC)

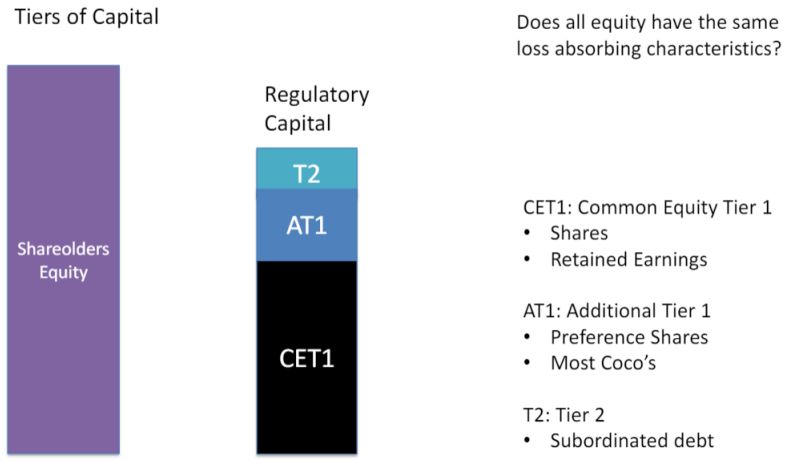
2. Liquidity and illiquidity: How much liquid assets do we have to support possible cash outflows?

→ Liquidity Coverage Ratio

→ Liquidity Risk Appetite

→ PRA Individual Liquidity Adequacy (ILG)

→ Stable Funding Ratio



Capítulo 3

Enterprise Risk Management (ERM)

Enterprise Risk Management is a process, effected by an entity's board of directors, management and other personnel, applied in strategy setting and across the enterprise, designed to identify potential events that may affect the entity, and manage risks to be within its risk appetite, to provide reasonable assurance regarding the achievement of entity objectives.

A good ERM framework is always **proactive** (never reactive), flexible and is implementabel at any level of the organization.

3.1. The COSO Framework

The COSO ERM framework defines essential components, suggests a common language, and provides clear direction and guidance for enterprise risk management. Management considers how individual risks interrelate.

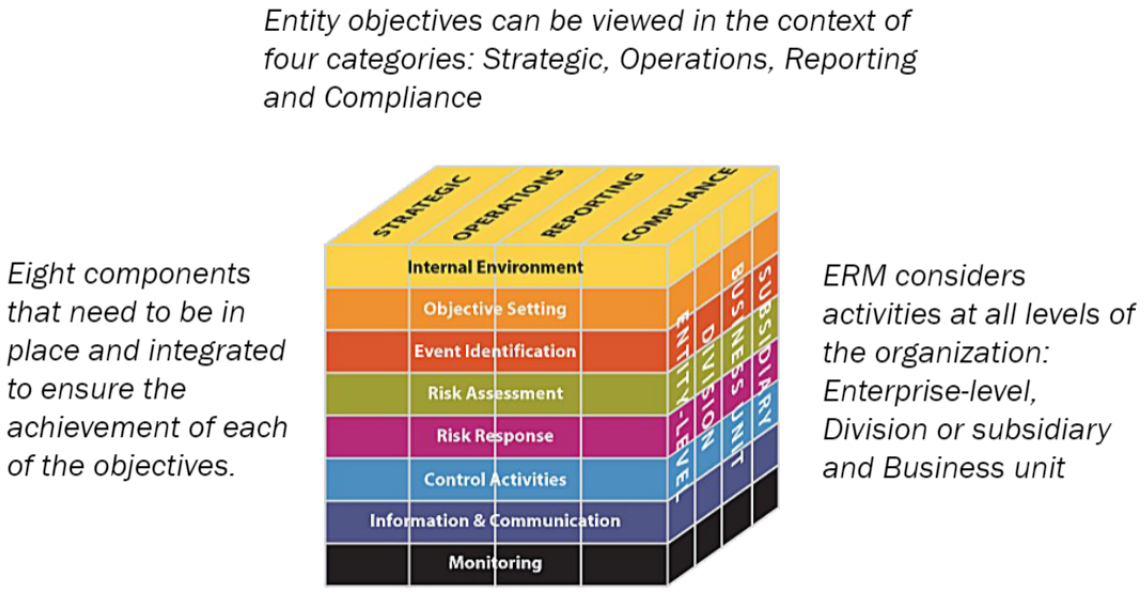


Figura 3.1: The COSO Framework

3.1.1. Internal Environment

Establishes a philosophy regarding risk management. It recognizes that unexpected as well as expected events may occur.

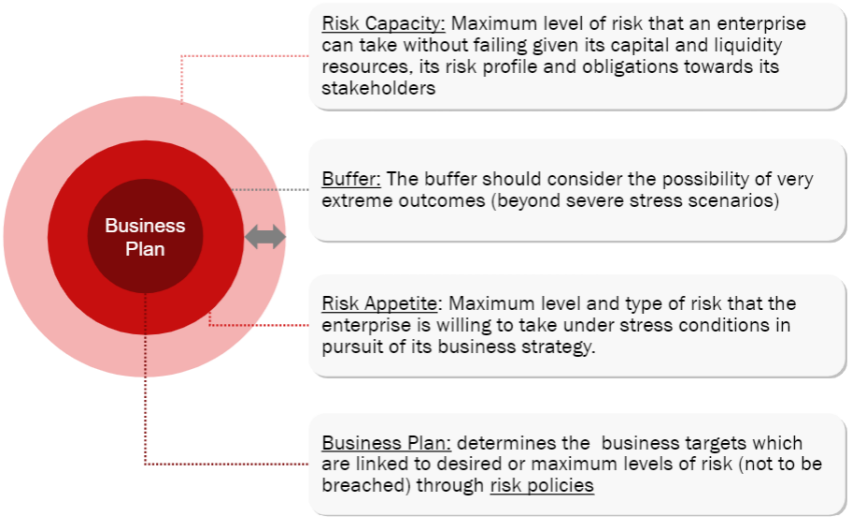
Establishes the entity's **risk culture** which is the way in which its management and personnel collectively perceive and respond to risk.

3.1.2. Objective Setting

Is applied when management considers risks strategy in the setting of objectives.

Forms the **Risk Appetite** of the entity which is the amount of risk — on a broad level — an entity is willing to accept in pursuit of value.

Ensures that the **Risk tolerance**, the acceptable level of variation around objectives, is aligned with risk appetite.



3.1.3. Event Identification

Differentiates risks and opportunities:

→ Events that may have a negative impact represent risks.

→ Events that may have a positive impact represent natural offsets (opportunities),which management channels back to strategy setting

Involves identifying those incidents, occurring internally or externally, that could affect strategy and achievement of objectives. Addresses how internal and external factors combine and interact to influence the risk profile.

3.1.4. Risk assessment

Allows an entity to understand the extent to which potential events might impact objectives

→ Assesses risks from two perspectives: Likelihood and Impact

→ Employs a combination of both qualitative and quantitative riskassessment methodologies.

→ Is used to assess risks and is normally also used to measure the relatedobjectives.

→ Assesses risk on both an inherent and a residual basis

The risk assessment process is composed of many steps:

Define Risk Criteria

Defines what factors are going to be taken into account when measuring the risk: Impact, likelyhood, vulnerability of the entity to that risk or speed at which the risk event manifests itself

Risk Measurement

Uses both **qualitative** and **qualitative** measures to assess the risk.

→ **Qualitative measures** are the most common. They are relatively quick and easily understood by a large number ofemployees who may not be trained insophisticated quantification techniques. However the information they can give is limited in terms of differentiation, aggregability and they might be imprecise

→ **Quantitative measures** permit cost-benefit analysis of riskcresponse options and they are more precise. However they can be time consuming and costly and interpretability can be hard when using complex models.

Risk interaction between the different risk factors is also measured using a risk interaction matrix.

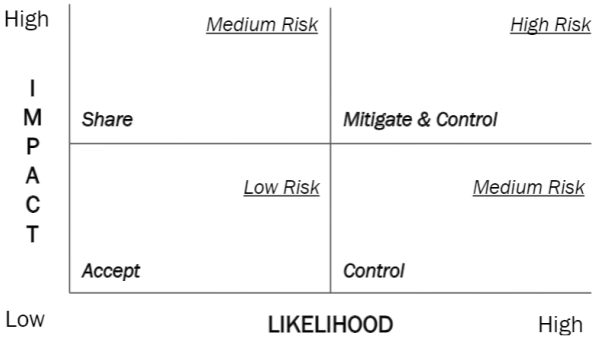
Risk prioritization is also important. Usually risks are classified in a matrix depending on the **impact** and **likelyhood** of such risk. The higher both these indicators are the more priority to tackle the risk.

3.1.5. Risk Response

Selects and executes response based on evaluation of the portfolio of risks and responses. Options available:

- Accept = monitor
- Avoid = eliminate (get out of situation)
- Reduce = institute controls
- Share = partner with someone (e.g. insurance)

Usually this response is based on previous steps, for example where the risk is classified in the impact vs likelyhood matrix.



3.1.6. Control Activities

Policies and procedures that help ensure that the risk responses, as well as other entity directives, are carried out. Occur throughout the organization, at all levels and in all functions.

3.1.7. Information & Comunication

Management identifies, captures, and communicates pertinent information in a form andtimeframe that enables people to carry out their responsibilities.

Communication occurs in a broader sense, flowing down, across, and up the organization.

3.1.8. Monitoring

Effectiveness of the other ERM components is monitored through:

- Ongoing monitoring activities
- Separate evaluations

- A combination of the two

Collect and display information (Key Risk Indicators and dashboards)

Perform analysis

- Risks are being properly addressed
- Controls are working to mitigate risks

Capítulo 4

Credit Risk Management

22/09/2023

Credit Risk: the risk of financial loss arising from the default or credit quality deterioration of acustomer.

A default shall be considered to have occurred with regard to a particular obligor when either or both ofthe following have taken place:

(a) the institution considers that the obligor is unlikely to pay its credit obligations to the institution, theparent undertaking or any of its subsidiaries in full, without recourse by the institution to actions such asrealising security;

(b) the obligor is past due more than 90 days on any material credit obligation to the institution, theparent undertaking or any of its subsidiaries.

Key concepts

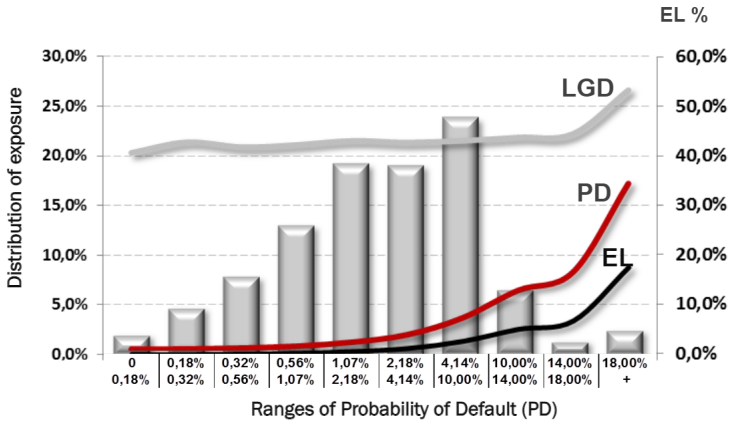
Probability of Default (PD) is the likelihood of an obligor to default over a particulartime horizon.

Loss Given Default (LGD): is the percentage of the asset/loan which the bank expectsto lose if an obligor goes into default.

Expected Loss (EL): is the amount that the bank expects to lose as a consequence of a customer default. It is covered with provisions. Calculated as EL = PD x LGD

Total Loss: maximum loss that the bank could incur as a consequence of a customer default.

Unexpected Loss: is the difference between expected loss and Total Loss. The Risk management objective is to minimise the unexpected loss. This is covered with capital.



4.1. Credit Risk Cycle

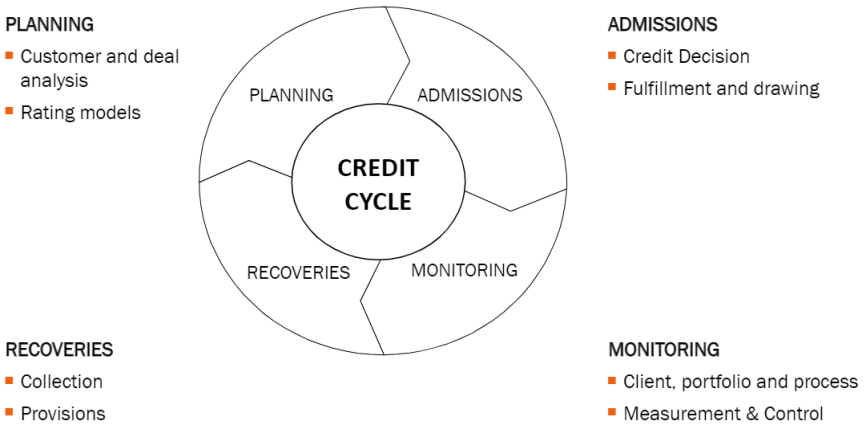


Figura 4.1: Credit risk cycle

4.1.1. Planning

1.- Customer Analysis

Is a forward looking assessment that focuses on the credit quality of the customer. It takes into account both financial data (P&L, cash flow, key ratios) and non-financial data (management, sector, business plan).

2.- Rating and Scoring models

They assign a PD to each customer. They are used to classify loans into homogenous groups for purposes of credit risk. Rating and scoring mdels should be integrated into the daily management of risk

- risk policies and decision making
- monitoring of credit portfolios
- capital calculation (RORAC)

Three main types of models:

- Scoring
- Manual Rating (expert model)
- Automatic Rating (statistical model)

These models are reviewed at least once a year. They need to incorporate newly available financial information about the customer, market, sector...

3.- Customer limits

The level of risk that the Bank is prepared to take with a client/group. It is normally defined in terms of Capital at Risk and set as a notional amount with limits depending on the type of business.

It should be an efficient combination of business plan and risk appetite.

- Delegation of powers to authorise transactions which fit in this limit from the Credit Committees to the risk analyst.
- Aimed at facilitating all the recurring financing products of the company's business, excluding possible non-typical financing and products of special sophistication such as derivatives which are not aimed at hedging
- Requires constant monitoring of the portfolio

- Normally used with companies with good credit rating
- Using equivalence tables (capital consumption by rating and maturity)

4.- Pricing

Pricing frameworks should take into account profitability and risk perspectives.

For retail and business banking customers the pricing should be more portfolio and product based, whereas for mid-corps and corporates should be transaction specific.

Banks should reflect in loan pricing all relevant costs including:

→ The cost of capital (considering both regulatory and economic capital)

→ The cost of funding, which should match the key features of the loan (e.g. duration)

→ Operating and administrative costs

→ Credit risk costs

4.1.2. Admissions

Risk Segmentation

Segmentation allows risk to be classified on the basis of certain criteria for its efficient management. Objectives:

- To analyse the risk in different ways according to type
- To assess returns and risks of the entity better
- Decision-making based on more adequate information

Analysis and Decision

The CEO delegates his authority to the CRO and Risk Comittee.

The Risk Framework in every bank sets out the main committees which are involved in the management, control and oversight of risk. It includes a description of roles and responsibilities and a clear articulation of the Authority Structure.

Approval levels	Limits	Volume sanctioned
Executive Committee	No Limit	1%
Central Risk Committee	€150 million	4%
Territorial Risk Committee	€50 million	20%
Risk Analyst	Variable	75%

Decisions can be appealed, normally in a higher level of approval authority.

The Risk assessment and business case are summarised in the "Credit Paper". The document is produced by the Risk analyst and reviewed by the Front Office.

4.1.3. Monitoring

Constant process of permanent observation, which makes it possible to detect incidents in advance that might arise in patterns for risk, transactions, clients and portfolios, with a view to taking action to mitigate or resolve them.

Four basic principles in monitoring:

1.- Proactiveness

2.- Anticipation

3.- Efficiently leveraging work already done

4.- Value added (comparative and transversal vision of clients by comparing them to sector average or peer groups)

The scope of monitoring includes clients, portfolios and processes.

Clients monitoring

All clients should be monitored either by the analyst that has them in his portfolio (high value clients) or by automated systems.

The intensity of monitoring depends on the characteristics of the client and the risk associated with them. Three basic tools:

- Early warning signals
- Rating updates
- Reviews (ordinary and special)
- Watchlist

What is an alert?

Alert signals may be defined as those circumstances or events that can potentially modify aclient's credit worthiness, either for better or for worse. This alerts should be analysed and, if necessary, scaled amd propagate it along the organization to take action.

Figura 4.2: Examples of alerts

Watchlist

A client appearing on the Watchlist list is one being individually monitored more closely than a normal one. An action is set to follow in relation to them (e.g. Reduce exposure) and measures to be taken are defined.

LEVEL	DEFINITION	ACTIONS
High	Terminate relationship (indicating date if possible)	Cancel the whole risk
Medium	The desire is to continue to do business but at a lower exposure level	Reduce short term risk Reduce long term risk
Low	Concern is mild. Further new information is awaited or some event.	Do not increase risks Pay normal attention

Portfolio monitoring

Aggregate view of risk factors (descriptive, qualitative, sector and management) related to the performance of a portfolio with the aim of detecting trends and changing risk appetite. Portfolios are defined by clusters of customers with the same risk behaviour, sector or vintage.

Significant portfolios (those that represent $> 10\,\%$ of exposure) should be monitored at least on a monthly basis.

Portfolio analysis requires the following steps:

1.- Observing trends

2.- Identifying homogeneous portfolios

3.- Focusing on clients (special reviews)

4.- Establishing policies and actions

5.- Feedback

And the key tools are:

- Databases
- Management dashboards: Contains key indicators such as NPLs, exposure, watchlist, rating, sectors, profitability...
- Sector analysis
- Scenario analysis

Process monitoring

Monitoring of the internal processes that come into play in the credit risk cycle to ensure it is homogeneous, effective and efficient, and identification of areas for improvement. The processes can be defined as the risk machinery. Process monitoring seeks to ensure that all the parts are fit for purpose.

Leading banks are deploying **analytics** tools can ensure consistency and automated monitoring. Data analytics enhances early warnings, automated controls and forward looking monitoring (forecasting and nowcasting)

4.1.4. Recoveries

NPL customers (90 days past due) or customers that we consider that are unlikely to pay their debt are transferred to the Collections and Recoveries area.

Provisions raised if applicable based on specific factors relevant to the customer and/or portfolio.

The recovery process aims to:

- Protect the Bank's position
- Restructure cases and return them to an upto date position if possible
- Recover the debt either by sale of assets orthrough litigation

High value/exposure loans are usually assessed on a case-by-case basis

Forbereance

Forbearance occurs when a counterparty is experiencing financial difficulty in meeting its financial commitments, leading to the lender granting concessions or modifications that it would otherwise not consider under normal market conditions.

Examples of potential concessions: extending the loan term, granting grace periods, reducing the interest rate, postponing principal or interest and easing of covenants.

Capítulo 5

Credit Risk Modelling. Stress testing under IFRS9

04/10/2023

Rocío Falcones

Definitions

→ **Expected loss (EL)** is the value of a possible loss times the probability of thatloss occurring

Expected Loss (EL) = Probability of Default (PD) × Loss Given Default (LGD) × Exposure at Default (EAD)

→ **Probability of default (PD)** is "probability of default of a borrower"

→ **Loss given default (LGD)**: Magnitude of likely loss on the exposure, expressed as a percentage of the exposure.

LGD = 1 - ($\frac{Recoveries}{D_{T,T+1}}$))

Where:

$D_{T,T+1}$: Loan amount that went from current or less than 90 days past due to more than 90 days past due during the time period from "T" to "T+1"

→ **Exposure at default (EAD):** amount to which the bank was exposed to the borrower at the time of default, measured in currency.

→ **Credit conversion factor (CCF):** converts the amount of a free credit line and other off-balance-sheet transactions (with the exception of derivatives) to an EAD amount. It is used to calculate the exposure at default.

CCF Factor = $\frac{\Delta Utilization_{t,t-1}}{Utilization_t}$

EAD = Current Drawn + (CCF factor * Current Undrawn)

For the calculation of the recover and the LGD you have to take into account many factors, sometimes even looking two years ahead because this whole process take time.

First you calculate the undrawn amount as the *Credit line - Drawn amount*.

Then the *LGD(%)* as $1 - Recovery(\%)$ which gives you the percetnage the bank will lose if a default occurs.

LGD probability = $\frac{LGD_{amount}}{DEFAULT_{amount}}$

$EAD = \text{Max}\{Drawn\ amount, Drawn\ amount + CCF \times Undrawn\ amount\}$

	C	D	E	F	G	H	I	J	K	L	M	N	O
Segment	**Balance Amount (Drawn amount)**	**Credit Line**	**CCF (t-12m)**	**Undrawn Amount**	**Default?**	**Recovery**	**PD**	**Default**	**LGD (1-H)**	**LGD (€)**	**EAD MAX(C,C+(E*F))**	**EL (PD*LGD*EAD)**	**EL%**
Credit Line	€ 1,000	€ 1,500	15%	€ 500	1	70%	100%	€ 1,000	30%	€ 300	€ 1,075	€ 323	30.0%
Credit Line	€ 900	€ 1,000	10%	€ 100	0	65%	0%	€ -	35%	€ -	€ -	€ -	0.0%
Cards	€ 500	€ 2,000	-10%	€ -	0	20%	0%	€ -	80%	€ -	€ -	€ -	0.0%
Cards	€ 1,200	€ 2,000	0	€ 800	0	15%	0%	€ -	85%	€ -	€ -	€ -	0.0%
Credit Line	€ 1,100	€ 2,000	8%	€ 900	0	56%	0%	€ -	44%	€ -	€ -	€ -	0.0%
Cards	€ 800	€ 2,000	12%	€ 1,200	1	18%	100%	€ 800	82%	€ 656	€ 944	€ 774	82.0%
Credit Line	€ 300	€ 1,000	-5%	€ 700	1	73%	100%	€ 300	27%	€ 81	€ 300	€ 81	27.0%
Cards	€ 700	€ 1,000	-15%	€ 300	0	21%	0%	€ -	79%	€ -	€ -	€ -	0.0%
Credit Line	€ 2,000	€ 3,000	30%	€ 1,000	0	65%	0%	€ -	35%	€ -	€ -	€ -	0.0%
Credit Line	€ 1,200	€ 3,000	12%	€ 1,800	0	70%	0%	€ -	30%	€ -	€ -	€ -	0.0%
Weigthed Average													
Credit Lines	€ 6,500	€ 11,500		€ 5,000			20%	€ 1,300	29%	€ 381	€ 1,375	€ 81	5.9%
Cards	€ 3,200	€ 7,000		€ 2,300			25%	€ 800	82%	€ 656	€ 944	€ 194	20.5%
Total	**€ 9,700**	**€ 18,500**		**€ 7,300**			**22%**	**€ 2,100**	**49%**	**€ 1,037**	**€ 2,319**	**€ 274**	**11.8%**
Simple Average													
Credit Lines	€ 6,500	€ 11,500		€ 5,000			33%		34%		€ 1,375	€ 153.54	11.2%
Cards	€ 3,200	€ 7,000		€ 2,300			25%		82%		€ 944	€ 192	20.4%
Total	**€ 9,700**	**€ 18,500**		€ 7,300			**30%**		**53%**		**€ 2,319**	**€ 346**	**14.9%**

We can then calculate the *Expected Loss (EL)* as $PD \times LGD \times EAD$. And finally the percentage expected loss is $EL(\%) = \frac{EL}{EAD}$

• **Weighted vs simple average**

If you have a large corporate portfolio it is better to go for a simple average because one big loan can affect severely the PD of the other loans in the portfolio

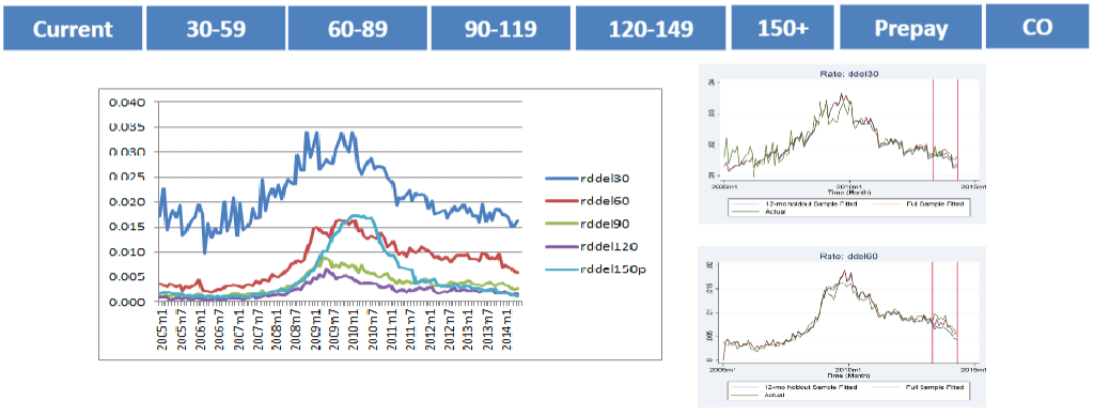
5.1. Credit Risk modelling techniques

Regression is the most common model technique, to calculate dependent variable (PD, LGD, EAD) based on independent internal drivers (LTV, collateral, age, industry) and/or macro drivers (GDP, Unemployment)

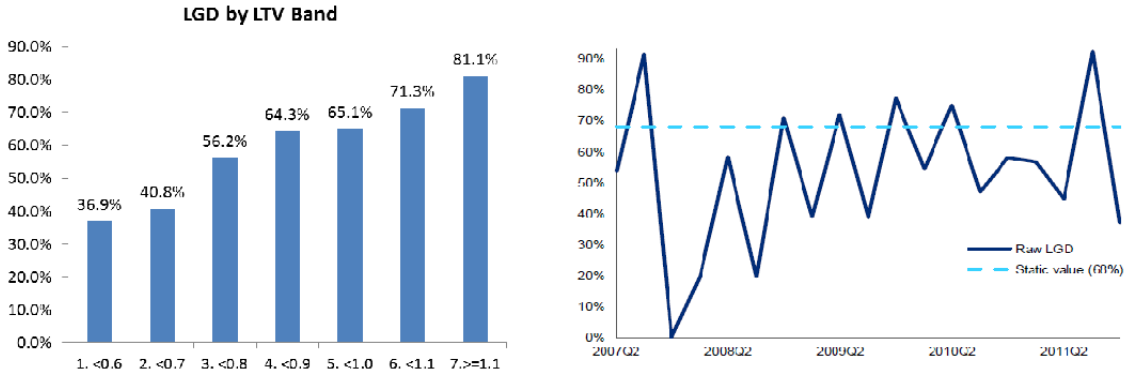
$$LN(\frac{PD_t}{1-PD_t}) = \beta_0 + \beta_1 x_t^1 + ... + \beta_n x_t^k \quad \Longrightarrow \quad PD_t = \frac{1}{1+e^{-(\beta_0+\beta_1 x_t^1+...+\beta_n x_t^k)}} \tag{5.1}$$

Transition matrices: Dynamic, granular approach, aligned with industry best practices. Requires a well calibrated risk rating system.

Vintage modeling: Generally provides a good response to stress conditions. Dynamic as prior state contributes to the current state

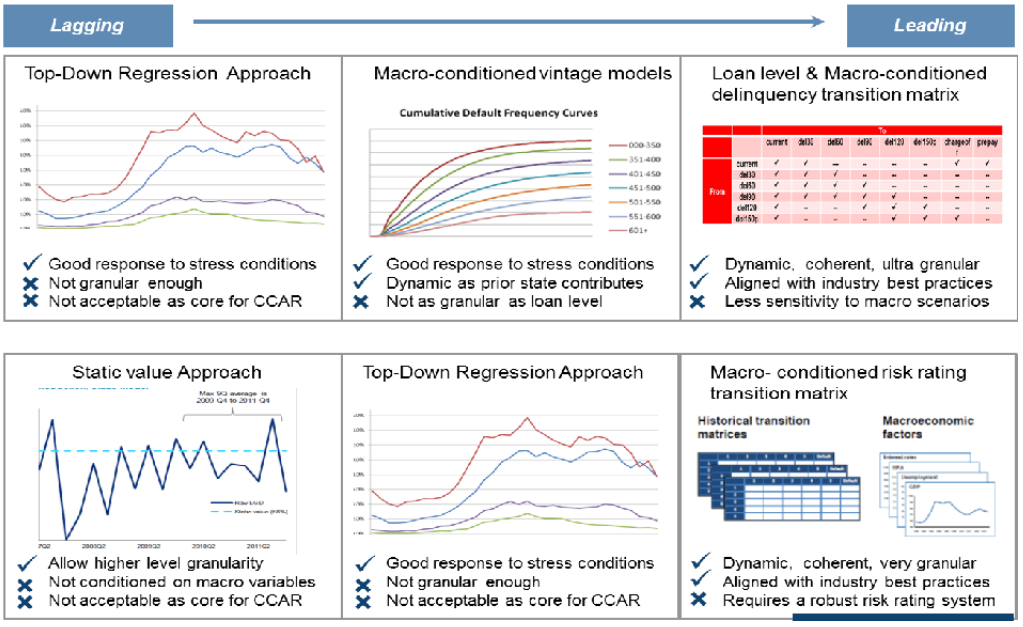


Static value: Can allow for a higher level of granularity/more portfolio-specific PDs/LGDs. Can recognize different buckets.



Scorecard models: They ask the same 10 questions to a lot of people and based on their answers they give them a score. Usually to give a credit score to a new client you use scorecard models.

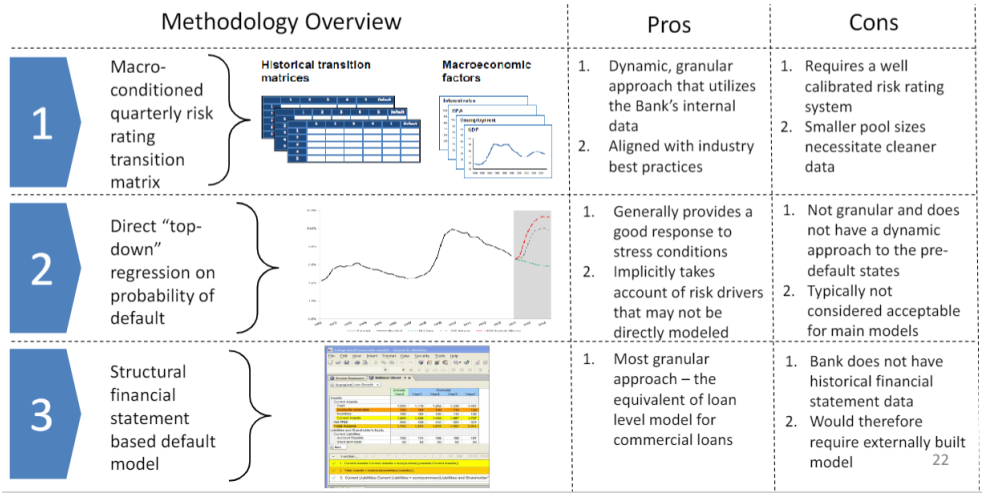
Decision trees: Based on the answers of your questions you are going to be asked different questions.



5.2. Commercial models for stress testing

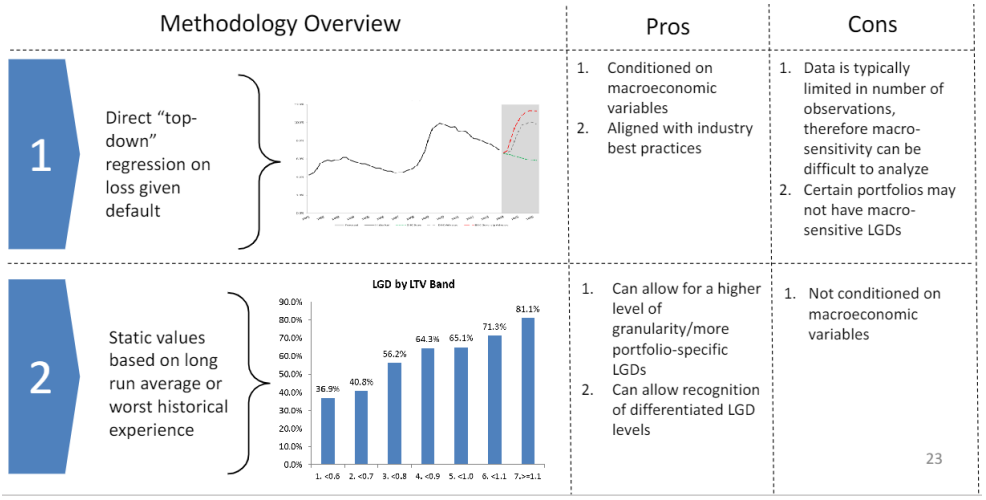
5.2.1. Potential methodologies - PD

Depending on the problem and the type of data you have available you will choose one methodology or the other.



5.2.2. Potential methodologies - LGD

Because of the nature of the LGD, the bank has less data to work with because it only has the data of the defaulted individuals. That's why the methodologies used to estimate LGD are very different from the ones used for PD.



5.3. Detailed analysis of IFRS9 main modeling concepts

Under IAS 39 the banks provisioned "too little and too late". There were only two scenarios to compute expected loss, a non defaulted individual and a already defaulted individual.

So with IAS 39 we had:

$$\text{(Non Default) EL} = \text{PD}_{12m} \times \text{LGD} \times \text{EAD} \tag{5.2}$$
$$\text{(Default) EL} = 1 \times \text{LGD} \times \text{EAD} \tag{5.3}$$

And under IFRS 9 we have three stages:

$$\text{S}_1 = \text{PD}_{12m} \times \text{LGD} \times \text{EAD} \tag{5.4}$$
$$\text{S}_2 = \text{PD}_{lifetime} \times \text{LGD} \times \text{EAD} \tag{5.5}$$
$$\text{S}_3 = 1 \times \text{LGD} \times \text{EAD} \tag{5.6}$$

where

$PD_{12m} = \frac{\text{Default}_{t,t+12}}{\text{Balance}_t}$

5.4. Flows of exposure

The deterioration/cure of exposure is the transition of the assets between one stage and another. To compute the flows of exposure between $Stage_i(S_i)$ and $Stage_j(S_j)$; $\quad i, j \in \{1, 2, 3\}$ we use the following formula:

$$\textit{Exposure FLow from } S_i \textit{ to } S_j = ExpS_i(t-1) \times TR_{i,j}(t) \tag{5.7}$$

where:

- $ExpS_i(t-1)$ is the exposure in *Stage* i at time $(t-1)$
- $TR_{i,j}(t)$ is the transition rate from *Stage* i to *Stage* j in the time interval $[t, t+1]$

5.5. Gross impairment flow

The next step is to compute all the Gross Impairment Flows from stage i to stage j, $(GIF_{i,j})$ for all the combinations of $i, j \in \{1, 2, 3\}$. We compute this using the following formula:

$$GIF_{i,j} = ExpFlow_{i,j} \times PD_j \times LGD_{i,j} \tag{5.8}$$

*Observation: The PD in stage 1 can be estimated using the transition rate from stage 1 to 3 $(TR_{1,3})$ as this are the proportion of assets from stage one that are going to be defaulted at time $t+1$. We can then rewrite equation 5.8 as follows:

$$GIF_{i,1} = ExpFlow_{i,1} \times TR_{1,3} \times LGD_{i,1} \tag{5.9}$$

GIF are interpreted as the provisions that arise from the movement to a different stage.

5.6. Provisions

Finally we can compute the provisions needed in each stage S_i:

$$Prov\ Stock\ S_i(t) = Prov\ Stock\ S_i(t-1) + \sum_{j \neq i} RoP_{i,j} - \sum_{j=1}^{3} GIF_{j,i} \tag{5.10}$$

where:

• $\mathbf{RoP}_{i,j}$ is the release of provisions from *Stage i* to *Stage j*

RoP are interpreted as those provisions correspondent to the exposure leaving a stage.

5.7. New entries

Lastly we have to take into account new entries of assets into the portfolio.

• **New Exposures/Prepayments** = Total *Exposure(t-1) × EAD Growth rate (t)*

• **Gross Imp Flow of New Entries** = *New Exposures/Prepayments* × $TR_{1,3}$*(t+1)* × $LGD_{1,3}(t+1)$

• **Release of Provisions of Prepayments** = *New Exposures/Prepayments* × $S_1Cov(t-1)$

where $\boldsymbol{Cov} = \frac{Provisions}{EAD}$

The transitions from defaulted to non defaulted is is the same number under IAS 39 as under IFRS 9. The only thing that changes is impairment and provisions.

The final impairment in stage 1 is S1 = S1→S1 + S2→S1 + S3→S1 - (S1→S2 + S1→S3)

Also for S1→S1 we need to take into account that the scenario could have changed so we need to compute $Prov_t - Prov_{t-1}$

5.8. Credit and climate stress testing

A bank stress test is an analysis conducted under hypothetical scenarios designed to determine whether a bank has enough capital to withstand a negative economic shock. These scenarios include unfavorable situations, such as a deep recession or a financial market crash.

5.8.1. Capital depletion and capital flexibility

Capital depletion measures how many basis points the total capital of the bank falls under a stresst scenario.

Capital flexibility measures the distance left to the minimum threshhold. In other words it is the difference between the capital left in the bank after the depletion and the minimum capital required.

5.8.2. ECB Climate Risk stress test

CR ST 2022 will test bank capabilities to evaluate climate risk in three modules:

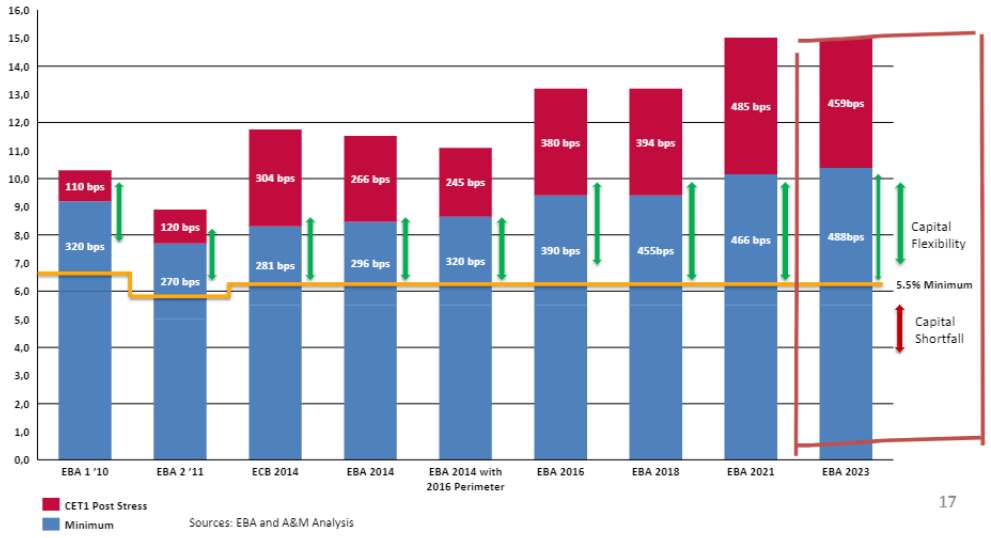
Questionnaire:

- Goal: qualitative assessment of climate risk stress testing framework
- 11 areas including general use, governance and RAF, integration with strategy, methodology, scenarios, data, ICAAP, future plans, internal audit, parent company and bottom-up projections

Climate Metrics Benchmarking:

- Goal: benchmark banks' income reliance to transition risk sectors and financed GHG emissions
- Metric 1: Gross Interest and Fee Income from NFCs to cover 80 % of income / max 5 countries

Figura 5.1: Capital depletion and capital flexibility in an EBA stress test



- Metric 2: Scope 1, 2 & 3 Emissions, Revenue and Loans for top 15 per sector non-SME corporates

Bottom up Stress Test:

- Bottom-up stress test projections for subset of banks under transition and physical risk scenarios
- 4 individual tests with different scope, metrics and horizons:
  - 2 transition risk tests (one short term covering credit and market and one long term covering credit)
  - 2 physical risk tests, one Drought & heat and one flood. They are short-term (1 year horizon).
- and qualitative assessment for operational and reputational risk

5.9. Main findings of the cimate stress test exercise

5.9.1. Module 2

Banks have heavily use proxies to complete key data points for Scope 1, 2 and 3 emissions and EPCs, with major dispersion per counterparty and per sector. Proxies accounted for more than 80 % of scope 3 data.

5.9.2. Module 3

Transition Risk

Manageable projected loan losses due to benign macro scenarios, limited exposure coverage and limitations in data/modeling capabilities.

€70Bn losses from short-term exercises (3-y disorderly transition + 2 physical risk scenarios) underestimate risk. Disorderly scenario projects losses 73bps higher than baseline.

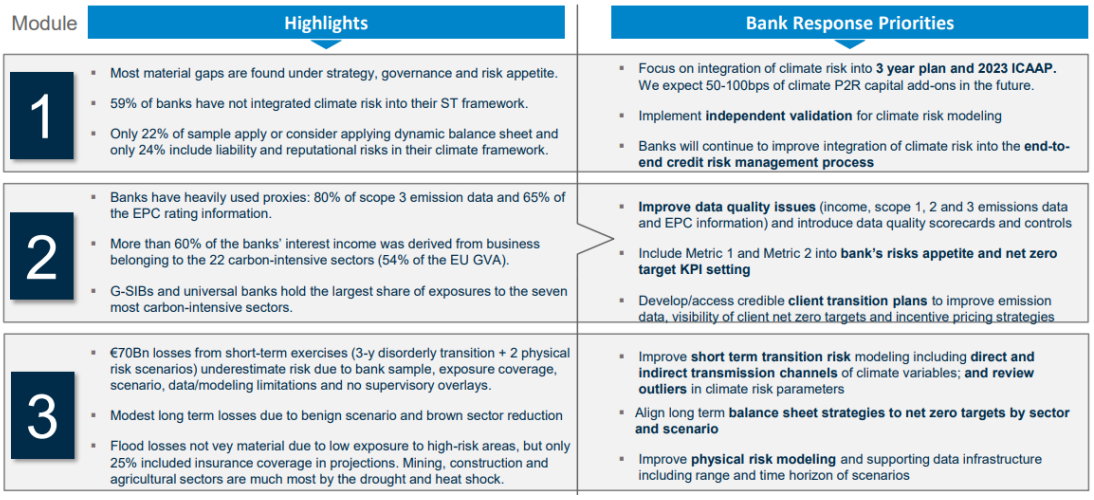
Modest losses are a result of mild scenarios and projected reduction in exposures to brown sectors. Weaknesses in bank's data and modeling capabilities affect the accuracy of these results.

Physical Risk

Impacts of drought & heat and flood scenarios are very idiosyncratic depending on industry concentrations and location of real estate collateral.

Banks with material footprint in mining, construction or agricultural activities, are highly impacted by the drought and heat scenario. Most banks did not incorporate insurance coverage or public natural disaster relief schemes into their projections, which may lead to an overestimation of the total losses.

Figura 5.2: Highlights of Climate Risk Stress Test



Capítulo 6

Market Risk Management

05/10/2023

Gilbert Mateu

6.1. Identify, Measure and Follow up the risk

A Probabilistic view but Uncertainty $\neq$ Risk

Risk = Unexpected volatility, or volatility of the results.

Expected losses must be assumed as costs and loaded on the product price.

Assess the impact of various risk mitigation actions

A dynamic perspective: This approach is critical. Escenarios "What if" (Stress Tests) Challenges that go beyond the technical aspects

6.2. Risk management is everyone's responsability

• **Board of directors:** They are the ones that set the risk appetite of the bank and set the risk framework that everyone needs to follow

• **Front office:** They need to respect the risk framework and the limits on the risk they are allowed to take. They need to cooperate with the back office to register all of the trades and the risks that are taken.

• **Back office (Operations):** They need to make sure that every operation of the bank is in place and in the systems of the bank.

• **Middle office:** They are the risk department and they are in charge of monitoring the risk. They have to be completely independent from the front office. They need to make sure that the pricing and the decisions of the front office are correct.

6.3. Types of risks and sources of market risk

• **Market risk:** It is the risk of losses due to movements in financial market prices

• **Credit risk:** It is the risk of losses due to the fact that counterparties may be unwilling or unable (e.g. country risk) to fulfill their contractual obligations

• **Operational risk:** It is the risk of loss resulting from failed or inadequate internal processes, systems and people, (any risk which is not market risk neither credit risk)

6.3.1. Sources of market risk

Interest Rate Risk

- Yield curve risk: it is the risk of experiencing a shift in market interest rates associated with investing in a fixed income instrument. The risk is associated with either a parallel shift or a flattening or steepening of the yield curve (which is a result of changing yields among comparable bonds with different maturities).
- Credit spread risk : the credit or yield spread is the difference in yield between two bonds. Non-Treasury bonds are generally evaluated based on the difference between their yield and the yield on the Treasury bond of comparable maturity. Credit spread risk reflects the fact that yield spreads are not fixed. Because bond yields are always in motion, so too are spreads. The direction of the yield spread can increase, or "widen", which means that the yield difference between two bonds or sectors is increasing. When spreads narrow, it means the yield difference is decreasing.

Foreign Exchange Risk or Currency Risk: is the financial risk that exists when a financial transaction is denominated in a currency other than that of the base currency of the company.

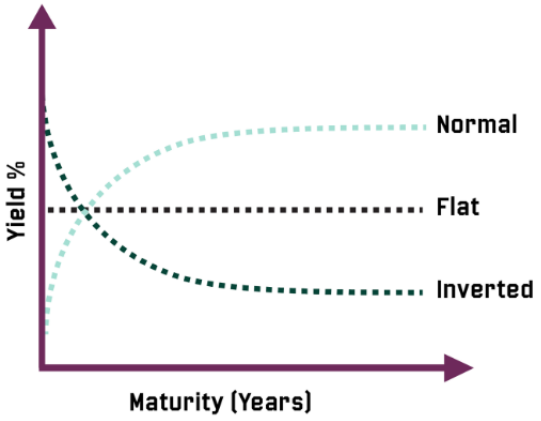
Equity Risk: is the financial risk involved in holding equity in a particular investment.

Commodity Risk: refers to the uncertainties of future market values and of the size of the future income, caused by the fluctuation in the prices of commodities.

Other Risks

- Volatility Risk: It refers to assets that incorporate certain options and whose price depends, among other factors, on volatility. Related with bonds, Volatility risk involves bonds with embedded options. Expected volatility or "vol.^{ef}fects the option price within a callable or puttable bond. Greater expected yield volatility yields a greater increase in the value of the option.
- Correlation Risk: financial correlations measure the relationship between the changes of two or more financial variables in time. It is a very significant risk in the hedging process of a position or a portfolio analysis.

6.3.2. Yield curve



Positive or Normal yield curve

An upward-sloping yield curve indicates that long-term rates exceed short-term rates. It is hoped that the longer the period of time during which the investor renounces liquidity, the higher the price he receives for giving up liquidity. In addition, if the term is longer, there is more uncertainty to be paid, and therefore it entitles to higher compensation (interest rate).

Flat yield curve

A flat yield curve indicates no change in interest rates for different maturities.

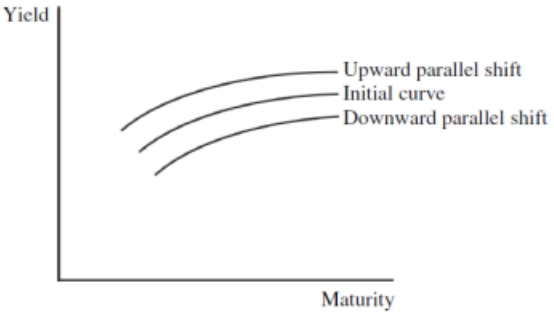
Negative or Inverted yield curve

A downward-sloping yield curve indicates that short-term rates exceed long-term rates. An inverted yield curve occurs when the market expects a fall in interest rates.

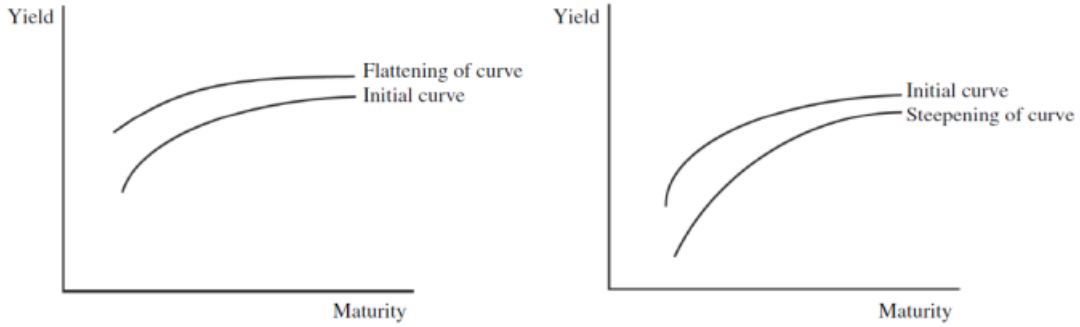
The most liquid assets in the yield curve are futures so market makers want to hedge their position against paralel shifts with futures. Instantly after making an operation you hedge it with a 10-year bond.

6.3.3. Yield curve shifts

Parallel and non-parallel shifts (twists)



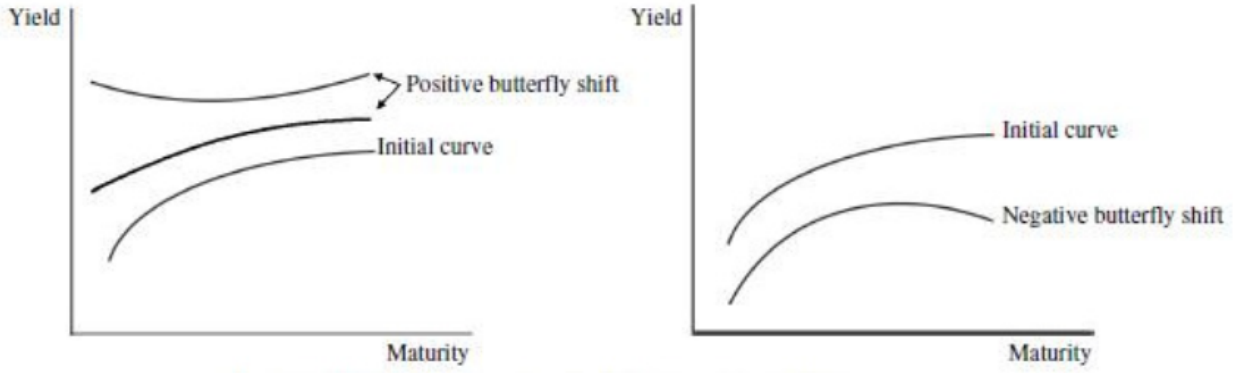
(a) Parallel shifts



(b) Nonparallel shifts: Twists (steepening and flattening)

Butterfly shifts

- Changes in the humped shape of the yield curve



6.4. Volatility

Volatility is a measure for variation of price of a financial instrument over time. Standard deviation measures the dispersion of the observations (returns) in a distribution around the mean value.

Historic volatility is derived from time series of past market prices.

An **implied volatility** is derived from the market price of a market traded derivative (in particular an option).

The symbol σ is used for volatility, and corresponds to standard deviation of daily percentage changes in the values for the reference period, which should not be confused with the similarly named variance, which is instead the square of the volatility, σ^2

Usually historical volatility predicts better future volatility than implied volatility because people tend to "overreact", or to think that when things are going good they are going to stay that way forever.

Volatility does not measure the direction of price changes, merely their dispersion. The higher the volatility, the higher the risk.

6.5. Correlation

In general, financial instruments are not independent of each other. The **correlation** measures the degree to which two variables are linearly related.

6.6. Value at Risk (VaR)

Definition: VaR is a risk measure that estimates the maximum loss with a given confidence level, which may occur in the market positions of a portfolio for a given time horizon. For example: calculating the VaR of a portfolio with a confidence level of 99 % and a time horizon of one day.

6.6.1. Delta Normal Method

When measuring the risk of a position, you have to know what are the risk factors affecting our position. Let's define n as the number of contracts of a financial asset whose price depends on the risk factor S. The value of our position at time 1 is approximated by:

$$V_1(S_1) = V_0(S_0) + \delta \cdot (\Delta S); \qquad \text{where: } \delta = \frac{dV}{dS} \tag{6.1}$$

Therefore, the VaR of this position will depend on the variation of the risk factor (or underlying) and the delta of the position:

$$\Delta V = \delta \cdot (\Delta S) \tag{6.2}$$

$$VaR_c = \delta \cdot (S_0 \cdot z_c \cdot \sigma) \tag{6.3}$$

Being Zc the percentile of the distribution for a confidence level of c.

1.- Example of a 1 Asset portfolio

Consider a portfolio invested on a unique asset, for an amount of 25 M €. The annual volatility of the portfolio is 30 %. Consider 252 trading days during the year.

a) What is the 1 day VaR, with a confidence level of 95 %? What about 99 %?

$\text{VaR}_{95\,\%}(1 \text{ day}) = 25 \cdot \frac{30\,\%}{\sqrt{252}} \cdot 1,645 = 777{,}190$; where 1,645 is $Z_{95\,\%}$ of the normal distribution $N(0,1)$

$\text{VaR}_{99\,\%}(1 \text{ day}) = 25 \cdot \frac{30\,\%}{\sqrt{252}} \cdot 2,326 = 1{,}098{,}932$; where 2,326 is $Z_{99\,\%}$ of the normal distribution $N(0,1)$

b) What is the 1 week VaR for 95 % and 99 % confidence levels?

$\text{VaR}_{95\,\%}(1 \text{ week}) = 25 \cdot \frac{30\,\%}{\sqrt{52}} \cdot 1,645 = 1{,}710{,}904$

$\text{VaR}_{99\,\%}(1 \text{ week}) = 25 \cdot \frac{30\,\%}{\sqrt{52}} \cdot 2,326 = 2{,}419{,}186$

*There are 52 trading weeks

1.- Example of a 2 Asset portfolio

Consider a portfolio invested in two assets, Asset 1 and Asset 2, each of them for an amount of 12,5 M. €. Asset 1 volatility is 35 %. Asset 2 volatility is 28 %. The correlation between both assets is 0,2.

a) What is 1 day VaR, with a confidence level of 95 %?

→ First we need to compute the variance of the portfolio which is given by the following formula:

$$\sigma_p^2 = \sum_{i=1}^{n}\sum_{j=1}^{n}\rho_{ij}\omega_i\omega_j\sigma_i\sigma_j = \sum_{i=1}^{n}\omega_i^2\sigma_i^2 + 2\sum_{i=1}^{n}\sum_{j<i}^{n}\rho_{ij}\omega_i\omega_j\sigma_i\sigma_j \underset{\rho_{ij}=\frac{\sigma_{ij}}{\sigma_i\sigma_j}}{\Longrightarrow} \sigma_p^2 = \sum_{i=1}^{n}\omega_i^2\sigma_i^2 + 2\sum_{i=1}^{n}\sum_{j<i}^{n}\omega_i\omega_j\sigma_{ij} \quad (6.4)$$

Were:

- σ_p^2 is the variance of the portfolio p
- σ_i is the standard deviation of asset i
- ω_i is the proportion of the value of asset i relative to the total value of portfolio p
- σ_{ij} is the covariance between asset i and asset j
- ρ_{ij} is the correlation between asset i and asset j
- n is the number of assets in the portfolio

Using equation 6.4 for two assets we can compute the variance:

$\sigma_p^2 = (0,5^2 \cdot 0,28^2) + (0,5^2 \cdot 0,35^2) + 2 \cdot (0,2 \cdot 0,5 \cdot 0,28 \cdot 0,5 \cdot 0,35) = 0,060025$

Now the volatility of the portfolio σ_p is:

$\sigma_p = \sqrt{\sigma_p^2} = \sqrt{0,060025} = 0,245$

And finally:

$\text{VaR}_{95\,\%}(1 \text{ day}) = 25 \text{ M} \cdot 1{,}645 \cdot \frac{0{,}245}{\sqrt{252}} = 634.704{,}72$

6.6.2. Historical simulation

Historical simulation is a relatively simple approach to calculating value at risk that avoids some of the drawbacks of the variance-covariance approach. In particular, it avoids the assumption that returns on the assets in a portfolio are normally distributed: it captures the abnormality of asset returns if it is present in the historical data.

Instead, it uses actual historical returns on the portfolios assets to construct a distribution of potential future portfolio profits and losses, from which the VaR can be read. This approach requires minimal analytics. All it needs is a sample of the historic returns on the different instruments in the portfolio whose value at risk we wish to calculate.

There are 4 basic steps:

1.- Colect data

Identify the different assets in theportfolio and collect historical data ontheir returns over a set observation-period (for example, t days)

2.- Generate scenarios

For each asset in the portfolio andeach t in the observation period, generate scenarios by calculating the return (percentage change) on each ofthe assets. The percentage price changes for each asset in the portfolio are calculated asfollows:

$r_{i,t} = \frac{S_{i,t} - S_{i,t-1}}{S_{i,t-1}}$

where:

$r_{i,t}$ is the return on asset i at time t

$S_{i,t}$ is the price on asset i at time t

3.- Simulate portfolio returns

Simulate portfolio return by applying this historical return information to it. Suppose, for example, there are t observations from period 0 to period T. Then, the return on a portfolio consisting of n assets can be expressed as follows:

$R_t^p = \sum_{i=1}^{n} \omega_i \cdot r_{i,t}$

Each scenario gives rise to a portfolio return R_t^p. If you have 100 scenarios then 100 simulations of the portfolio return can be generated from R_1^p to R_{100}^p

4.- Reorder results

After generating the scenarios and calculating the portfolio value for each scenario, the results are reordered by the magnitude of the change in the value of the portfolio.

If there are 1000 scenarios and the VaR at the 95 % confidence level is needed, then we would expect the actual loss to exceed the VaR in 5 % of cases (50), so the 51^{st} worst value (highest loss) on the reordered list is the required VaR.

6.6.3. Monte Carlo simulation

Monte Carlo simulation is a more flexible method than the other two methods. It involves simulating the random price behaviour of financial assets in a portfolio using the power of a computer. Each simulation gives a possible value for the portfolio at the end of the relevant time period. After a sufficient number of simulations have been performed, the simulated distribution of portfolio values (from which the VaR estimate is inferred) should converge to the portfolio's unknown true distribution. Although this method is the most flexible, it also happens to be the most computer intensive, as the simulation may have to be replicated a substantial number of times to get the required level of accuracy.

This process is used when you have products with convexity (the graph of the price vs the interest rate). Some of this intruments are options or zero coupon bond.

VaR has some advantages and drawbacks but it is not enough, we need backtesting and stresstesting

6.7. Back testing & Stress testing

Backtesting analysis compares routinely real daily profits and losses with measures of risk generated by VaR models. It measures how many times the actual results exceed VaR confidence bands: it counts how many times each day loss exceeds the VaR of the previous day (N).

	Variance - Covariance	Historical	Monte Carlo
Portfolio Valuation	Delta approximation (linear)	Full	Full Aproximation
Assumed Distribution of Returns	Normal distribution	Actual	Flexible (usually the normal distribution)
Requirement for Cashflow Mapping	Yes	No	No
Suitability for Options	No (unless holding period is short and portfolio has moderate options content)	Yes	Yes
Computation and Implementations	Relatively easy to compute and implement	Easy to compute and implement	Can be costly and slow depending on the number of simulation runs required
Accuracy of VaR Estimate	Depends on validity of normality assumption and degree of portfolio optionnality	Good, provided the historical data is a reliable guide to future market behavior	Generally the most reliable method provided sufficient simulation runs are carried out.

We must determine the number of exceptions N from which we conclude that reality is not statistically compatible with the model. Most of the statistic tests define a level of Type 1 error of 5 %, and then minimize the Type 2 error (in other words, they maximise its power = 1 - Type 2 Error)

The stress testing is a complementary and essential tool for measuring risks that aim to measure changes in the value of a portfolio when measurements based on "normal" cases would be misleading.

It is necessary to complement VaR measurements with simulations of crisis

- Objective ones: historical ones
- Subjective ones: hypothetical scenarios, when no historical stress event is suitable for the portfolio in question or risk managers want to stress test new or different combinations of risk factors
- A single-factor Stress testing (sensitivity)
- Multiple-factor Stress testing (scenario analysis)

Capítulo 7

Operational risk

7.1. Definition by Basel

The risk of loss resulting from inadequate or failed internal processes, people and systems or from external events

• The definition includes legal risk but excludes strategic (business) and reputational risk.

• Specificity: an operational risk is a consequence of doing business, the banks do not take OpRisk on a voluntary basis because you don't receive any gain for this type of risk, exclusively losses.

• A distinction between:

  ◦ Operations risk relate to the activities carried out by the back office or "Operations" area of the bank: processing, confirmation, settlement, reconciliation.

  ◦ Operational Risk is a much broader concept incorporating not just Operations risk but also many other possible risk events.

7.1.1. Broad categories of OpRisk

Internal Fraud

Losses due to acts of a type intended to defraud, misappropriate property or circumvent regulations, the law or company policy, excluding diversity - discrimination events, which involves at least one internal party

- Unauthorized activities: intentional misreporting or mis- marking of positions (e.g. rogue trading).
- Theft and fraud : Fraud , Employee theft (extortion, embezzlement, robbery),

External Fraud

Losses due to acts of a type intended to defraud, misappropriate property or circumvent the law, by a third party.

- Theft and fraud : robbery, forgery, cheque kiting,
- Systems Security: damage from computer hacking or theft of information.

Employment practices and workplace safety

Losses arising from acts inconsistent with employment, health or safety laws or agreements, from payment of personal injury claims, or from diversity / discrimination events

Clients, Products and business practices

Losses arising from an unintentional or negligent failure to meet a professional obligation to specific clients (including fiduciary and suitability requirements), or from the nature or design of a product.

Damage to physical assets

Losses arising from loss or damage to physical assets from natural disaster or other events.

- Disasters and other events

Business disruption and system failures

Losses arising from disruption of business or system failures

- Systems : Hardware failure, Software failure

Execution, Delivery and process management

Losses from failed transaction processing or process management, from relations with trade counterparties and vendors.

- Transaction Capture, Execution & Maintenance
- Monitoring and Reporting
- Customer Intake and Documentation
- Customer / Client Account Management

7.2. Identification of Legal Risk

A bank should ensure that agreements and contracts are legally enforceable for each aspect of its activities in all relevant jurisdictions.

Approaches

- BIA: Basic Indicator Approach
  - Minimum for all banks

- TSA: The Standardized Approach
  - Minimum for large banks

- AMA: Advances Measurement Approach
  - Minimum for international active banks

BIA	TSA	AMA
$K_{BIA} = GI \cdot \alpha$	$K_{TSA} = \sum_{i=1}^{8} GI_i \cdot \beta_i$	$K_{AMA} = \sum_{i=1}^{8} \sum_{j=1}^{7} [\gamma_{(i,j)} \cdot EI_{(i,j)} \cdot PE_{(i,j)} \cdot LGE_{(i,j)}]$
• GI = average annual Gross Income last 3 years • α = 15%	• Banks activities mapped to 8 business lines framework • GI = average annual Gross Income last 3 years • $12\% < \beta_i < 18\%$	• i is the business line and j is the risk type • EI = Exposure Indicator • PE = Probability of loss Event • LGE = Loss Given Event
• Minimum for all banks	• Minimum for large banks	• Minimum for international active banks

	β coefficient
Corporate finance	18%
Trading and sales	18%
Retail banking	12%
Commercial banking	15%
Payment and Settlement	18%
Agency services	15%
Asset Management	12%
Retail brokerage	12%

Figura 7.1: Economic capital for the three approaches to operational risk

7.3. Two kind of complementary approaches to tackle Operational Risk:

Quantitative approach

- LDA: Loss Distribution Approach
  - Based in Internal Data + External Data

- Challenges:
  - good quality data
  - in sufficient quantities,
  - for frequency and severity of losses
  - Losses are categorised as:
  - Actual losses: losses already expensed by the organisation

- SBA: Scenario Based Approach
  - Internal Data
  - Expert Judgement
  - External Data

Scenario analysis is a **process:**

✓ undertaken by a bank's risk management experts and experienced business line managers

✓ to identify risk events, assess historical internal/external events, and analyse internal risk controls.

- Qualitative Approach

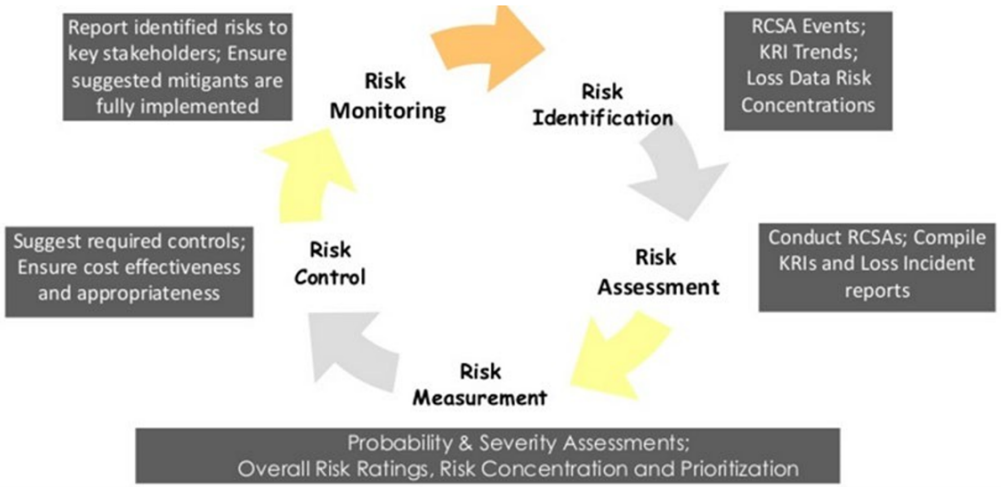
- RSCA: Risk Control Self Assessment

  → process should capture prevalent and likely risks in a business function and suggest required controls.

- KRI: Key Risk Indicators

  → parameters used to identify changes in the risk profile of business activities and processes. They give early warnings of problems or highlights current failures.

7.4. OpRisk Management Process Flow



Capítulo 8

Duration

Duration of an asset, also called **Macaulay Duration**, is a measure of the weighted average time it takes for the cash flows from a bond to repay its initial investment. It takes into account both the interest payments and the return of principal at maturity. Macaulay duration is expressed in years and helps investors assess the interest rate risk associated with a bond. It provides a way to estimate how sensitive the bond's price is to changes in interest rates.the time that will take the investor to gain back the initial investment.

Duration is a weighted average of every cash flow, weighted by the price of the asset.

The formula for the duration is the following:

$$Mac\ Cauley\ Duration = \frac{\sum_{t=1}^{n} t \cdot \frac{CF_{it}}{(1+r)^t}}{P} = \sum_{t=1}^{n} t \cdot \frac{\frac{CF_{it}}{(1+r)^t}}{P} \tag{8.1}$$

where P is the present value of the asset and is computed as:

$$P = \sum_{i=1}^{T} \frac{CF_i}{(1+r)^i} \tag{8.2}$$

Where:

- CF_i is the cashflow at time i
- r is the interest rate

Macaulay Duration can also be defined as

$$Macaulay\ Duration = \frac{\frac{dP}{P}}{\frac{dr}{1+r}}$$

This formula is obtained by differienciating the price with respect to the interest ratio:

$$P = \sum_{i=1}^{T} \frac{CF_i}{(1+r)^i} \Rightarrow \frac{dP}{dr} = -\frac{1}{1+r} \sum_{i=1}^{T} \frac{CF_i}{(1+r)^i} = \frac{1}{1+r} \cdot Duration \cdot P \Rightarrow Duration = \frac{\frac{dP}{P}}{\frac{dr}{1+r}} \tag{8.3}$$

Whe can also define the ***Basis Point Value (BPV)*** as:

$$BPV = \frac{dP}{d(1+r)} = \frac{dP}{dr} \tag{8.4}$$

8.1. Modified Duration

Modified duration is another measure of interest rate risk for bonds. It is a modified version of Macaulay duration and is expressed as a percentage. Modified duration indicates the percentage change in the bond's price for a 1 % change in interest rates. It is a useful metric for investors who want to assess the potential impact of interest rate fluctuations on the value of their bond holdings.

$$\textit{Modified Duration} = \frac{\frac{dP}{P}}{dr} = \frac{\textit{Macaulay Duration}}{dr} \tag{8.5}$$

The duration is the interest rate elasticity of the price: for a bond it measures the degree of change of the price when the interest rate corresponding to that bond (TIR) changes. It gives the percentage price change with respect to the percentage change in TIR:

$$\Delta P = \textit{Modified Duration} \cdot \Delta r \tag{8.6}$$

Summary

Concept of Duration: 3 Different meanings.

- Time of a portfolio when Reinvestment Risk = Price Risk. Tool for hedging
- Weighted average time of cash flows at repricing.
- Price sensitivity to IR changes.

Properties of Duration: Maturity (for fixed rate, repricing for floating), market Interest Rate, coupon:

- The lower the coupon the higher the Duration.
- The bigger the maturity (or repricing date for floating) the higher the Duration.
- The lower the market interest rate the bigger the Duration.

Capítulo 9

Credit Rate metrics

21/10/2023

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Programs from the ECB to buy sovereign and corporate debt:

TPI PSPP CSPP SMP

Ratings are very important for companies. From rating AAA to BBB- the cost of financing increases very slowly as the rating downgrades. However, the cost of financing increases exponentially after a company falls bellow the "investment category grade" which is BBB-, especially during crisis.

There is also a transition matrix which tells you the probability that a company is going to move from one rating category to another.

Initial	Rating at year end								
Rating	Aaa	Aa	A	Baa	Ba	B	Caa	Ca-C	Default
Aaa	91.37	7.59	0.85	0.17	0.02	0.00	0.00	0.00	0.00
Aa	1.29	90.84	6.85	0.73	0.19	0.04	0.00	0.00	0.07
A	0.09	3.10	90.23	5.62	0.74	0.11	0.02	0.01	0.08
Baa	0.05	0.34	4.94	87.79	5.54	0.84	0.17	0.02	0.32
Ba	0.01	0.09	0.54	6.62	82.76	7.80	0.63	0.06	1.49
B	0.01	0.06	0.20	0.73	7.10	81.24	5.64	0.57	4.45
Caa	0.00	0.03	0.04	0.24	1.04	9.59	71.50	3.97	13.58
Ca-C	0.00	0.00	0.14	0.00	0.55	3.76	8.41	64.19	22.96
Default	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00

9.1. Altman's Z-Score and default probabilities

Using discriminant analysis, Altman attempted to predict defaults from five accounting ratios.

$Z = \beta_1 \cdot Working\ Capital + \beta_1 \cdot Retained\ Earnings + \beta_1 \cdot EBIT + \beta_1 \cdot Market\ Value\ of\ Equity + \beta_1 \cdot Sales$

Where each β_i is computed using a logistic regression. The value of the Z score gives you an estimation of the PD of a company:

- If $Z \geq 3$, the firm is unlikely to default.
- If $2.7 \geq Z < 3.0$, we should be "on alert".
- If $1.8 \geq Z < 2.7$, there is a good chance of default.
- If $Z \leq 1.8$, the probability of a financial embarrassment is very high.

9.2. Default probabilities from Equity Prices

• If VT < D ⇒ it is rational for the company to default on debt at time T ⇒ value of equity is 0.

• If VT > D ⇒ company should make debt repayment at T ⇒ value of equity= ⇒ VT - D.

• According to Mertons model: *ET = max(VT - D, 0)*

• The equity of a company is a call option on the value of the assets with a strike price equal to the repayment required on the debt (D).

We can compute the value of the Equity today using the Black-Scholes formula:

$$E_0 = V_0 N(d_1) - De^{-rT} N(d_2) \tag{9.1}$$

where:

- $$d_1 = \frac{ln(\frac{V_0}{D}) + (r + \frac{\sigma V^2}{2})T}{\sigma_v \sqrt{T}} \tag{9.2}$$

- $$d_2 = d_1 - \sigma_v \sqrt{T} \tag{9.3}$$

The firm defaults if the option is not exercised and it happens with probability: $(N(-d2))$

To obtain this probability we need V_0 and σ_V, which are not directly observable. From Ito's lemma:

$$\sigma_E E_0 = \frac{\partial E}{\partial V} \sigma_V V_0 \tag{9.4}$$

$\frac{\partial E}{\partial V}$ is the delta of the equity $N(d1)$ and so

9.3. Bond Spreads

A very useful indicator of systemic risk is the TED spread (the difference between EURIBOR and US bonds)

The bond spread is the difference between the bond yield minus the yield of a risk-free bond with the same maturity and characteristics.

• Potential risk-free yields are obtained from:

– Sovereign bonds

– Swap rate.

The bond spred is calculated as: $Spread_{5y} = Yield_{5y} - RiskFree_{5y}$

The problem is that the Risk Free rate is very hard to measure and you don't have data for a yield for a bond with the maturity you like (in this case 5 years) every day.

The cds has to be very close to the bond spreads because they are pricing the same thing.

Capítulo 10

Rating

10.1. Introduction

Credit ratings are opinions of the likelihood of full and timely payments of debt obligations in the future "probability of defaul"). They address the possibility that a financial obligation of a corporate will not be honored as promised. Rating is key to access fixed income capital markets. Disintermediation process (bonds and TLBs versus banking facilities)

Capital markets: fixed income vs equity. CFOs require an "equilibrium"

Accounting versus Rating criteria. "Cash is king". Rating adjustments.

Different issuers: corporates, financial Institutions, public sector, projects and structured finance.

Credit Rating Benefits VS Costs

Benefits

- Wider and more stable access to capital markets
- Management of borrowing costs
- Counterparty Risk: helping banks to support lending and trading decisions
- Enhances management of strategic options, leading to better decision making.

Costs

- Cost in securing public credit ratings:
  - On-going rating fees associated with monitored ratings
  - Disclosure required by agencies (although information may be kept confidential)
  - Potential for a ratings outcome below expectations
- Ability to support stable ratings in the medium term

10.1.1. Rating process overview

→ **Financial information:** Historical accounts, CAPEX, information on liabilities, Treasury and financial policy...

→ **Business model:** Evolution of business units, market share, key market drivers...

→ **Group organisation, strategy and market context:** Group structure, corporate strategy, regulatory environment...

10.1.2. General Principles for Assessing Environmental, Social and Governance Risks

ESG refers to a broad range of qualitative and quantitative considerations that relate to the sustainability of an organization and to the broader impact on society, investments and activities. ESG considerations often have more potential credit risk than credit benefit. As a result, in some cases may be incorporated in the scorecard as a downward notching factor.

Ratings capture ESG considerations with material credit implications for sectors and debt issuers (e,g. pollution emissions standards may be an important credit issue for an auto manufacturing sector)

Environmental factors: carbon transition, physical climate risks, water management, waste and pollution, natural capital

Social factors: customer relations, human capital, demographic and societal trends, health and safety, responsible production

Governance factors: financial strategy and risk management, management credibility and track record, organizational structure, compliance and reporting, board structure and policies

Main issues in ESG rating:

- Lack of market standardization (too many providers with different methodologies)
- In addition, many issuers are placing ESG instruments into the markets (green, social and sustainability) when there is a use of process in place for a specific project or have ESG frameworks linked to KPIs (ESG frameworks). All require a Second Party Opinion (SPO)

Key products offered by ESG providers:

- Second Party Opinion (SPO): An assessment of an issuer's green, social or sustainability bond framework which captures the alignment to leading standards and the contribution of the issuance to the Sustainable Development Goals.
- ESG linked finance/framework
- Sustainability rating

Issuers versus instruments ratings

Usually large corporates like to mix their sources of financing between fixed income markets (bond issuance) and bank debt.

Usually when a company wants to adquire another company, let's say company A, it uses a SPV (Special Pupose Vehicle). The balance sheet of this SPV has the equity of the company A as the only asset in its balance sheet and in the liability side it has its own equity and debt. Usually this debt is made of three things:

TLAs: Also referred to as a Term A Loan or a senior term loan. LA tranches typically amortize, with the borrower having to repay an amount of the TLA each year equal to between 5.0 % and 20.0 % of the initial principal amount of the loan. The amount of the amortization payment generally increases during the term of the loan.

TLBs: Also referred to as a Term B Loan or an institutional term loan because they are made by institutional investors. TLBs typically mature within six to seven years and have a small repayment schedule (usually about 1.0 % of the principal amount of the loan per year, payable quarterly) during the term of the loan, with the remainder due on the maturity date.

Bonds: Regular corporate bonds.

The risk of a product is correlated with the rating of the company that issues it but i doesn't have to be the same. For example if a BBB company issues a collateralized bond, this instrument will probably have a higer rating such as A or AA, depending on the collateral.

The risk of the instrument can also be below the rating of the company that issues it. For example hybrid instruments are ususally rated two notches below. Two main reasons:

1. It is a perpetuity
2. Because the management of the company may cancel or differ they payment of coupons

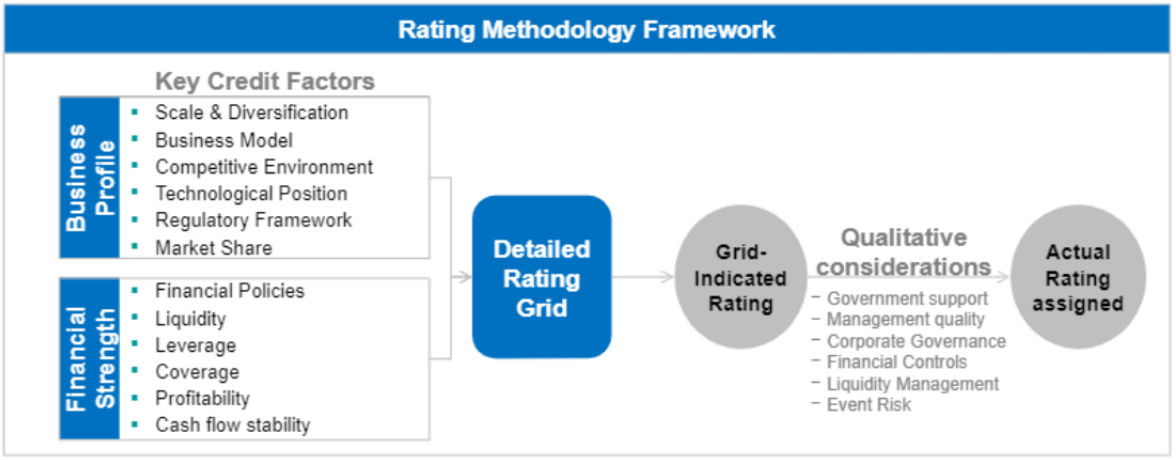
10.1.3. Moody's methodology

1.- Moody's credit **analysis focuses on the fundamental factors and key business drivers** relevant to an issuer's long-term and short-term risk profile.

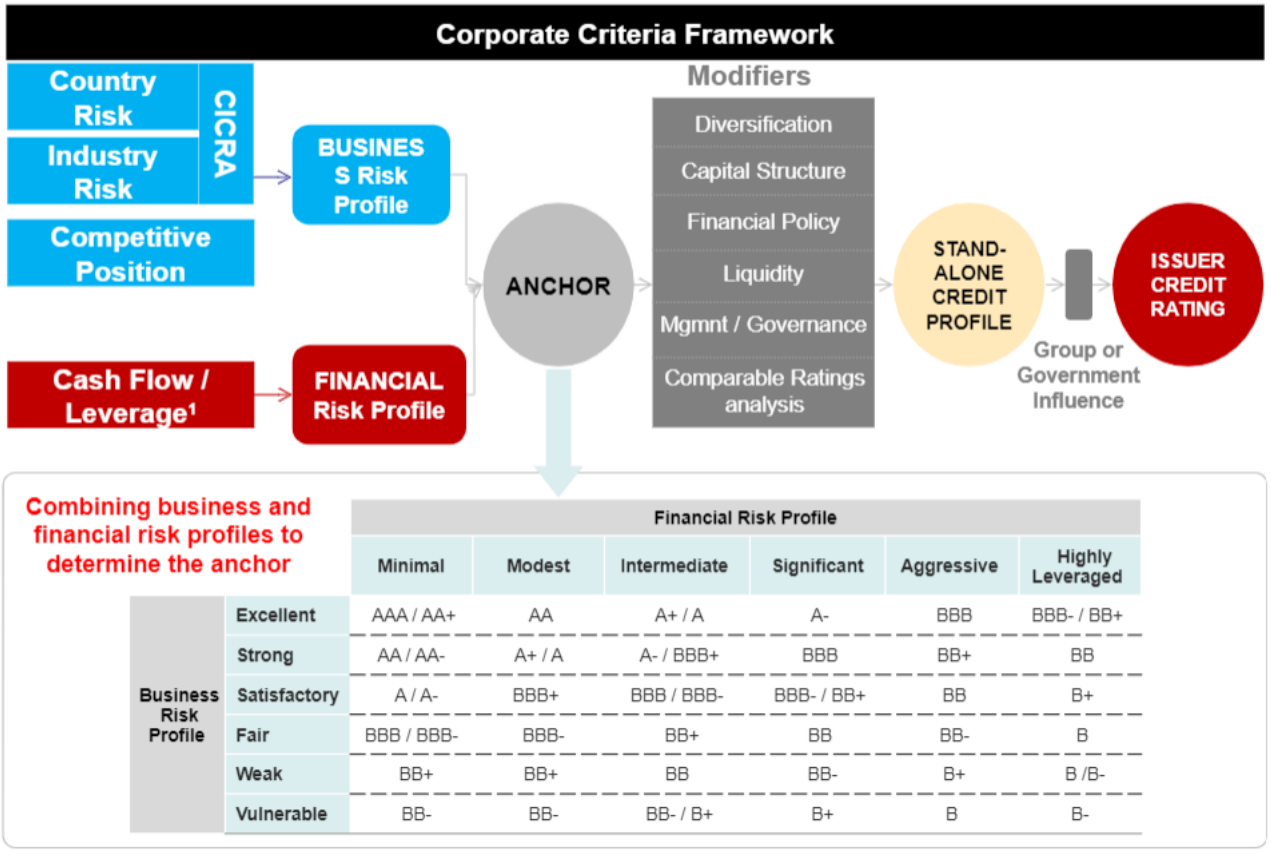
2.- Several **analytical principles** guide the process, including, **focus on the long term and emphasis on stability and predictability of cash flow.**

3-. Moody's utilises **specific rating methodologies to assess credit risk across different sectors**. Specific risk factors likely to be weighed in a given rating will vary considerably by sector.

4.- Each sector rating methodology includes a **detailed rating grid to provide guidance on how key qualitative and quantitative risk factors are likely to affect rating outcomes.**



10.1.4. S&P methodology



Combining business and financial risk profiles to determine the anchor

Business Risk Profile	Financial Risk Profile: Minimal	Modest	Intermediate	Significant	Aggressive	Highly Leveraged
Excellent	AAA / AA+	AA	A+ / A	A-	BBB	BBB- / BB+
Strong	AA / AA-	A+ / A	A- / BBB+	BBB	BB+	BB
Satisfactory	A / A-	BBB+	BBB / BBB-	BBB- / BB+	BB	B+
Fair	BBB / BBB-	BBB-	BB+	BB	BB-	B
Weak	BB+	BB+	BB	BB-	B+	B /B-
Vulnerable	BB-	BB-	BB- / B+	B+	B	B-

Capítulo 11

Liquidity risk

11.1. Balance sheet structural risks

Risks that arise from the structure of the balance sheet and the financial characteristics of the instruments that compose it, i.e. the repricing of the interest rates references, maturities and other related characteristics. They are classified into:

Interest rate risk: Risk of changes in market interest rates affecting the financial position of the entity in terms of Net Interest Margin (short term) and Economic value (long term).

- Base risk
- Curve risk
- Repricing risk
- Operational risk

Exchange rate risk: Risk of variations in currency exchange rates that may negatively impact the financial position of the entity.

Liquidity risk: Risk of incurring losses due to events that affect the capacity to meet the resources with borrowing obligations.

- Funds Liquidity risk: The risk that your funding sources stop providing liquidity
- Market Liquidity risk: The risk that the market is not liquid enough to sell your assets at a fair value in case of necessity.

There are two aspects from a macro perspective that lead to this lack of liquidity:

- Channeling savings towards investment: Institutions contribute to channel private savings in credit for investments
- Maturity Transformation: The bank assumes the risk of breach in the investment horizon

11.2. Liquidity Risk on the Bank balance

Originated by the maturity transformation function in the banking industry, liquidity risk arises in a bank balance due to the divergence between **L/T investment** (loans and FI portfolios) and **S/T funding**, including an **important component** of funding with **indefinite maturity as well as contingent liabilities.**

11.3. Liquidity Risk in the Financial Sector

The main features of this entity Liquidity Balance, wich will determine the metrics and limits are:

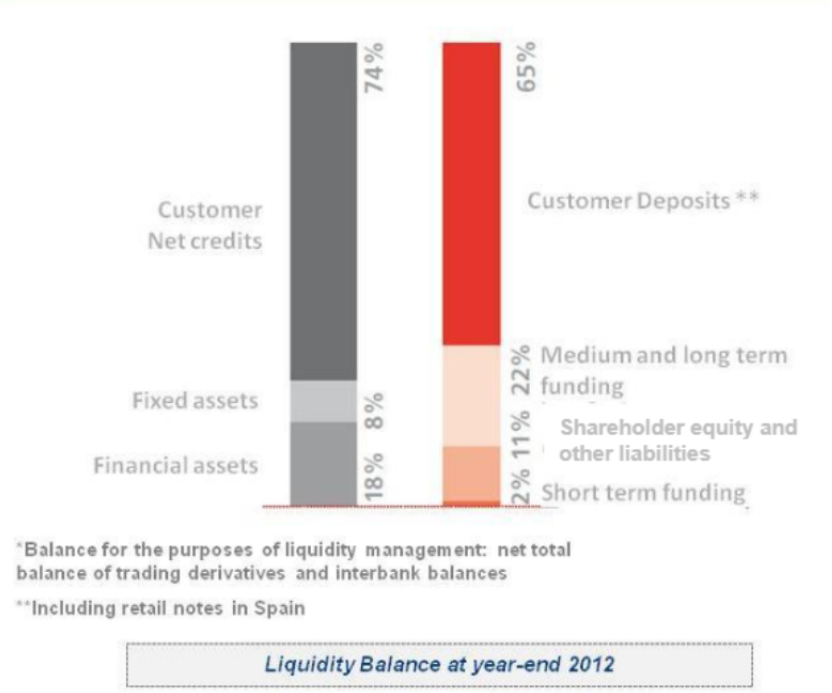


Figura 11.1: **Liquidity balance.** This balance sheet is pretty good in terms of liquidity: Even though it could be better (the customer net credits could be a little bit lower and match the customer deposits. A mismatch of a 15 % difference can start raising concerns) the bank has very little short term funding. On top it has a lot of equity and a lot of deposits from customers or retail (which are more stable than short term funding from banks).

- ✓ High share of customer deposits on a retail balance
- ✓ Diversified wholesale funding with focus on the medium and long term and with low weight in the short term

11.4. Impact of structural risk

11.4.1. Fundamental concepts of liquidity Risk

Risk Dimension

- Structural Liquidity Component (endogenous): It arises because of mismatches (in value and date) of cash inflows and outflows due to financial institutions´ operative.
- Market Liquidity Component (exogenous): It is caused by the losses a financial institution might suffer when clearing its financial assets, as a consequence of market conditions
- Capital Liquidity

Risk Source

- Systemic Crisis: Factors that affect the financial sector as a whole o Idiosyncratic Crisis: Factors that specifically affect the entity
- Diagnosis Procedures
- Perceived Liquidity vs. Solvency
  - **Liquidity** indicates the **capacity to allocate** a determined amount of **cash** for a given moment in time, in order to **cover short term liabilities**.

- **Solvency refers** to a financial institution **global capacity to face its liabilities and other obligations**, but not necessarily to its capacity to pay in cash in the short term (as liquidity does).

Mitigation

- Liquidity Buffer
- Diversification
- Liquidity Contingency Planning

11.4.2. Key areas of impact

Structural risks have an impact on the main business drivers and has to be taken into consideration. Impacts on P&L, capital, liquidity and concentration are different depending on the type or risk being evaluated.

Tabla 11.1: Relative impacts that liquidity risks have on each of these drivers (columns).

	P&L	**Capital**	**Liquidity**	**Concentration**
Liquidity	High/medium (1)	Low (2)	High (3)	Medium (4)

✓1. The impact of liquidity risk on the P & L statement is directly related to the firm's capacity of obtaining funds at a reasonable cost. Differentials applied to own issuances (i.e. if you have to place an issuance to cover a liquidity problem or you need to do it in short period of time, it may carry an interesting spread) and costs associated to the use of buffers of liquid assets translate into a reduction of profit.

✓2. Liquidity cannot be used as a mitigation for capital and vice versa. It is relevant to highlight that lately, there have been liquidity stress scenarios that can affect entities with solid capital reserves.

✓3. From its own definition, liquidity risk affects the bank liquidity. It is precisely this risk which is trying to be controlled.

✓4.Liquidity risk has impacts on concentration, from a funding perspective and when considering a liquid asset portfolio. From a liquid asset perspective, if we have a portfolio highly concentrated in one asset type (i.e. Spanish government bonds) and a crisis or major event happen, the liquidity buffer automatically will diminish its value. From a funding perspective, if we get the majority of funding from 5 or 10 counterparties, the bank can be in a problem if one or two counterparties run away.

11.5. Measurement of Liquidity Risk

11.5.1. Introduction

The Boards are concerned of Structural risk management and the tools that the risk methodologies bring to them to control it. **Best market practices** define **quantitative and qualitative elements to control risks**, which also serve as a performance management tool as the business strategy is being implemented.

11.5.2. Qualitative Analysis

Structural risk evaluation considers the following analysis dimensions and axis:

The qualitative analysis studies all analysis axis mentioned in figure 11.2, and for each sub-axis it is evaluated the current status of the entity. This allows to understand a detailed situation of the entity regarding the liquidity risk approach.

11.5.3. Quantitative Analysis

To **measure structural risk**, a series of metrics are used that take into consideration **two possible approaches**:

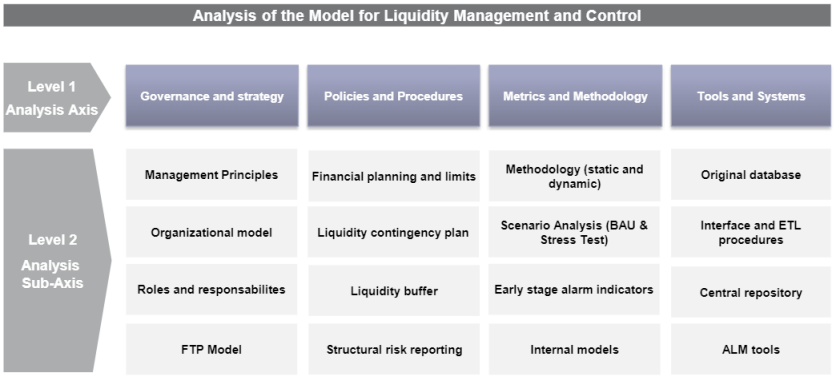


Figura 11.2: Structural risk evaluation

Static Approach

✓ Captures a static snapshot of the balance sheet for a given moment without manipulating any variables related to time analysis.

✓ Implies assuming the balance sheet maturity of all items:

- Not considering new contracts/renewals
- Enabling changes in the market conditions at the time of the analysis

Dynamic Approach

✓ Takes into consideration **P&L projections**, with changes in various factors in a timely basis

✓ Uses projections of business **growth and funding**, based on the bank's strategic plan

✓ This approach implies the **continuity of business:**

- It takes into consideration new business and renewal of contracts
- P&L simulations include scenarios with different variations on conditions, of the market and the balance sheet

→ BAU scenario (business as usual)

→ Stressed scenario: They need to reflect crisis of various magnitudes.

- Mild stress scenario
- Moderate stress scenario
- Severe stress scenario

11.5.4. Common metrics

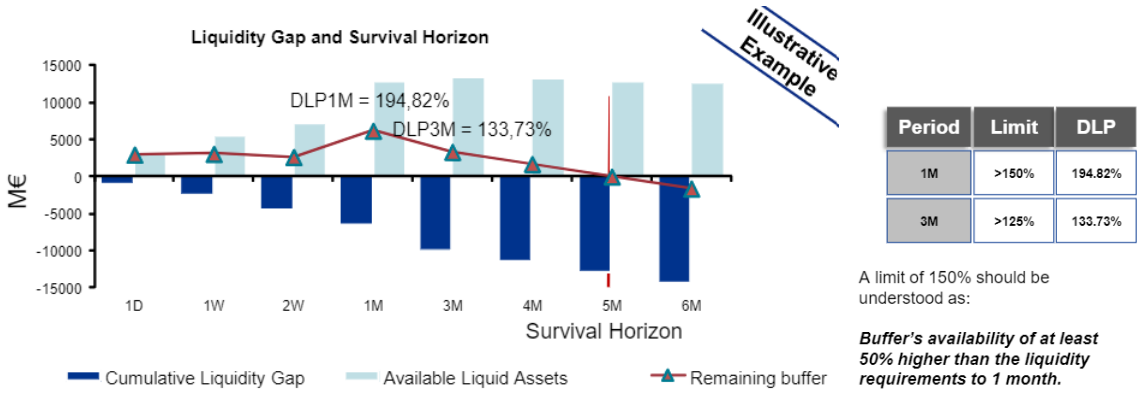
Survival Horizon

- Survival horizon is defined as the time at which the entity would be able to **survive without resorting to capital markets** in a scenario of stress (with a determined magnitude and length). To achieve this survival, the horizon is calculated **assuming that the financial institution uses its cash reserves.**

Dynamic Liquidity Profile (DLP) – Limits System

- Given a **stress scenario** to consider, with its corresponding composition of the liquidity buffer, the Entity may have a survival horizon above the limit. The question that the limit on the DLP tries to answer is **"how many liquid assets are available in the predicted limit for survival horizon".**

Loan to Deposit ratio (LTD)



- Loan to deposit ratio (LTD): Measures the reliance on wholesale funding by calculating the ratio between thegranted loans and all retail deposits

$$LTD = \frac{Total\ Loans}{Total\ Deposits} \tag{11.1}$$

The features are:

✓ It can be applied from a vision of commercial liability: retail customers and institutional clients

✓ Provides information about the interdependence between retail and wholesale business

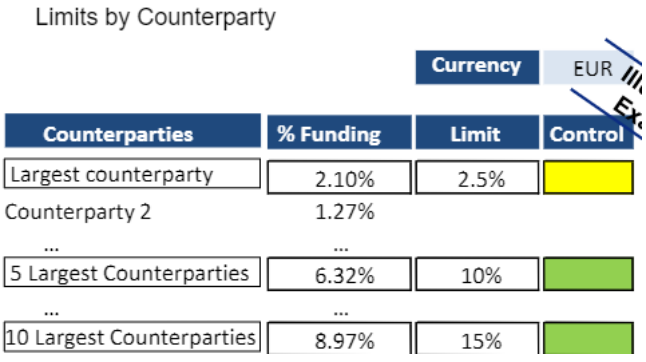
✓ Too high ratio implies increased vulnerability to systemic crises affecting the volumes and costs of access to wholesale funding

Traditionally, LTD has been in the Spanish financial institutions above 100 % this means that credit activity has been financed by funding wholesale markets. However, the deleveraging process in recent years has lowered the ratio to levels even below 100 %.

Concentration ratios - Limits System

Under the principle of autonomy in cash to each of the relevant currency, a concentration limits system for funding must provide term limits, type of instrument and counterparty.

Assigned limits should be similar for each of the currencies in which the Entity operates.



For analysis of the liquidity buffer using concentration measures that allow to monitor the composition and degree of diversification in terms of a set of key features is highly recommended.

The main features of the liquidity buffer concentration analysis are the **type of asset, the term and the counterparty.**

$$\frac{Volume\ by\ asset\ type}{Liquidity\ Buffer} \tag{11.2}$$

$$\frac{Assets\ volume\ by\ term}{Liquidity\ Buffer} \tag{11.3}$$

$$\frac{Assets\ volume\ by\ counterparty}{Liquidity\ Buffer} \tag{11.4}$$

11.6. Appendix: Other Metrics

The Static Liquidity Gap is calculated by temporally distributing the cash flows generated by the balance sheet along the time in order to calculate the gap between cash inflows and outflows in different time horizons.

$$GAP_{SIMPLE,i} = CF(Assets)_i - CF(Liabilities)_i \tag{11.5}$$

$$GAP_{ACCUMULATED,i} = \sum_{t=1}^{t=i}(CF(Assets)_i - CF(Liabilities)_i) \tag{11.6}$$

The liquidity gap can be in single or cumulative terms:

- **Simple Gap:** is calculated as the difference between the asset cash flows and liability cash flows for each maturity.
- **Cumulative Gap:** Projected net cash flows (for a given period of time), calculated as the difference between the assets and the liabilities cash flows. It provides information about the requirements (negative gap) or excesses (positive gap) of liquidity in the considered period.

Capítulo 12

Interest rate risk in the banking book (IRRBB)

03/11/2023

Inmaculada Gómez

Definition: IRRBB refers to the current or prospective risk to a bank´s capital and to its earnings, arising from the impact of adverse movements in interest rates on its banking book.

1. IRRBB is a structural risk, which arises when market "risk-free" interest rates change and there is a mistmatching in the terms and conditions at which Banking Book IR sensitive assets and liabilities reprice.
2. All Interest Rate Instruments are affected, regardless of the accounting valuation (both instrumets at amortized cost and at fair value)
3. Separate Regulatory Treatment for IR positions in the Trading book (Pilar I risk) vs IR Positions in the Banking Book (Pillar II).

Two types:

General interest rate risk (in scope of IRRBB): is the risk arising from the general movement of interest rates (benchmark risk-free rates)

Credit Spread risk in the banking Book (CSRBB): is the risk arising from changes in market premiums - over the risk free rate.

The banks don't have Pillar I requirements for assets alocated in the banking book of the bank. The assets in the trading book of the bank will have Pillar I requirements that account for the market risk.

12.1. Sources of the IRRBB

12.1.1. Gap risk (or yield curve risk)

Risk resulting from the differences in the timing of the repricing ofIR sensitive assets and liabilities, capturing the effect of changes to the general level of risk-freemarket interest rates occurring consistently across the yield curve (parallel risk) or differentlyacross the term structure (non-parallel risk).

I) Parallel Gap Risk: Risk arising under parallel shifts of the term structure of IR. Example: Liabilities reprice before than assets.Parallel upward IR movements damages the Net Interest Income and the EV.

II) Non Parallel Gap Risk (yield curve risk): Risk arising from non parallel shifts of the IR term structure:Steepening IR changes damages the EV

12.1.2. Basis risk

Risk arising from the fact that different instruments in the balance sheet, even ifperfectly matched in terms of repricing maturity, reprice differently due to other reasons suchas the existence of different "risk-free" reference rates.

Two main sources of Basis risk:

I) External Reference rate Basis Risk: risk arising from the fact that assets and liabilities, even if perfectly matched in terms of repricing maturity, may still reprice differently because they linked to different external rate indexes: (ie Libor vs policy rate) Example: Floating rate mortgages linked to Central Bank rates funded by floating debt securities linked toLibor (UK): risk arising when the spread between Central Bank rate and Libor changes.

II) Tenor basis risk: deals of positions, despite repricing on the same date, and being linked to the same benchmarkrate (e.g. euribor rate), still reprice differently due to the fact, when they reprice, they do so for different period ortenors. Since 2008 (after Liquidity crisis) there are different reference rate curves for interbank posititions within a givencurrency: OIS Curve, 1 Month Curve, 3 Month Curve, 6 Month Curve, 1 Year Curve. Example: Floating mortgages linked to 1Y Euribor funded by debt securities linked to Euribor 3 months. Basisrisk arisen if the basis (spread between 1 Year -3 months) decreases

12.1.3. Option risk

Non-linear risk arising from automatic and behavioural options (embedded or explicit), where the institution or their customers can alter the applicable interest rate or the timing of the repricing cash flows.

Two main type of option risk:

I) Behavioural Interest rate Options: IR Options with exercise driven both by financial factors and customer behaviour. Example:

- **Retail Fixed rate Loans with prepaymnet risk:** Losses under downward IR scenarios. Penalties by early prepayment do not compensate the loss of early prepayment and reinvestment at lower rate
- **Retail Term deposits with risk of early redemption:** Losses under upward IR sceanrios. Penalties to depositors by early redemptiom (loss of accrued IR) do not compensate the loss ofearly redemption and refunding at higher rates.
- **Floating rate Loans with prepayments risk:** Incentive to prepay if the contractual spread of existing loans higher than spreads of new floating rateloans. Also in very low IR scenarios there is a an incentive to prepay to migrate to fixed rate at lower rates

II) Automatic Interest rate Option: IR Options with exercise only driven by financial factors (floors, caps, swaptions). Example: Floating rate mortgage with embedded bought floor.

- **Embedded Automatic Interest Rate Options:**
- **Explicit Automatic Interest Rate Options:** floors, caps, swaptions receiver, swaptions payer. (Bought orSold).

Scope and variables for computing the IRRBB effect:

- IR changes do not have short-term effect in earnings or in Regulatory capital for amortized cost (AC) instruments.

- For controlling the IRR on long-term earnings, there is a need of evaluating in the present the IR changes effect also on AC instruments in the BB.

	Asset	Liability
Bought	- **Floating rate mortgage / or floating rate debt securities portfolio with floors bought.** - Fixed rate IR Debt securities with prepaymnt option for the bank (Embedded Swaption Payer bought)	- Floating rate debt securities issued with caps bought. - Fixed rate Debt securities issued with prepayment option for the bank (Embedded Swaption receiver bought)
Sold	- Floating rate mortgage / or floating rate debt securities portfolio with **caps sold** - Fixed rate IR assets with prepayment option for the issuer (Embedded Swaption Receiver Sold).	- **Customer deposits not passing negative rate to customers (sold 0% floors)** - Floating rate debt securities issued with Floors sold. - Fixed rate Debt securities issued with prepayment option for the investor (Embdedded Swaption Payer sold) .

- Economic Value: Variable that allows to compute in the present the IR effects on long-term earnings, considering total IR positions in the BB, regardless its accounting record.

IR changes affect:

- Price effect: calculated discounting value to the observed IR of future cash flows of IR assets and liabilities in the BB through the metric: ECONOMIC VALUE. It does not affect the AC instruments in the short term but it is important to consider long term effects.

- Reinvestment/ Refunding effect: which is the future reinvestment / refund of IR sensitive assets and liabilities sensitive that reprice. The analysis is focused around NET INTEREST INCOME.

Perspectives for IRRBB measurement:

- **Short term earnings:** (NII + price effect of IR instruments at FV), short term focus (1-3 years), simpler measurement

- **Economic Value:** long-term approach, more complete approach: controls the repricing schemes of all assets and liabilities, not just short-term ones, more complex measurement (highly dependent on hypothesis)

Two methods for calculating Economic Value:

- Constant Balance Sheet assumption: Instruments that mature are reinvested/refunded to the extent necessary to fund the remaining balance sheet.

- Run-off assumption: Only valuating existing positions until amortization. These two methods are equivalent at the end.

Difference between IR price effect on the EV and the effect on the long-term NII explained by a residual term: “opportunity cost”, that consists of two components:

- Net BB asset-liability in fixed rate instruments funded by “Equity” component: Example: fixed IR assets funded by equity. Price risk is the opportunity cost of interest income locked at fixed rates and not benefiting from IR increases.

- Difference in interest rates earned in assets and liabilities: Price risk of valuating net margin under rising IR.

12.1.4. Examples of balance sheet IR structures

12.2. Price effect and reinvestment effect of the IRRBB

IR changes affect:

1. **Price Effect:** Discounting value to the observed IR of future cash flows of IR assets and liabilities in the BB. ECONOMIC VALUE
2. **Reinvestment or Refunding Effect:** Future reinvestment / refund of IR sensitiveassets and liabilities sensitive that reprice NET INTEREST INCOME

RISK	ASSET	LIABILITY
No General IRRBB	- 1 Year Floating rate mortgage with residual maturity of 1 Year.	- 1 year Term deposit
Parallel repricing risk (upward movement)	- 5 Years Fixed rate Loan.	- 1 year Term deposit
Behavioral IR Option (Risk of loan prepayment under downward IR scenarios) or (Risk of term deposit early redemption under upward IR scenarios)	- 5 Years Fixed rate Loan.	- 5 Year Term deposit
Automatic IR Option (Risk of portfolio prepayment under downward IR scenarios and **Behavioural Risk of term deposit early redemption** under upward IR scenarios)	- 5 Years Fixed rate Debt Security (with prepayment option for the issuer).	- 5 Year Term deposit

RISK	ASSET	LIABILITY
Parallel and non Repricing risk **CSRBB**	- 10 Years Fixed Rate debt securities	- 1 year Term deposit
No Parallel General IRRBB but **CSRBB**	- 10 Years Fixed Rate debt securities (hedged with IRS)	- 1 year Term deposit
Non Parallel repricing risk (flatenning upward movement) and **Basis Risk**	- Floating rate mortgage (linked 1 Year Euribor)	- 3 month debt securities issued

Definition of Reinvestment Risk and Price Risk

- **Reinvestment Risk:** This risk arises when the coupons or interest payments received from the fixed-rate instrument need to be reinvested at prevailing market rates. If interest rates have fallen since the instrument was purchased, the investor may have to reinvest the coupons at lower rates, leading to lower overall returns.
- **Price Risk:** This risk is associated with changes in interest rates affecting the market value of the fixed-rate instrument. When interest rates rise, the value of existing fixed-rate instruments tends to decrease.

On a going concern view, the IRRBB impact only will materialize on future Net InterestIncome (NII) through the reinvestment/refunding effect. Except for:

- the price effect of instruments registered at fair value.
- the Price effect of instruments registered at amortized cost only reflected incase the Bank needs to sell the instrument.

12.2.1. Different accounting registration of Reinvestment/Refunding effect and Price effect

1) Price effect

- Only immediate registration in part of Banking Book instruments: IR instruments at Fair Value
- In the large mass of assets and liabilities of the Banking Book sensitive to the rates (at amortized cost) price effect does not manifest itself (unless instruments are sold)

2) Reinvestment/refunding effect

- Changes in market interest rates affect future reinvestments / refinancing of assets and liabilities that are repriced, regardless of the accounting portfolio in which they are classified.

- Gradual registration, year by year on the net interest income, as repricing of interest rates occurs (short and medium/long term effects)

The evaluation of the reinvestment/refunding IRR effect on long-term NII is made through the price effect on the EV metric. The evaluation of the price effect on all IR instruments in the BB (EV metric), regardless of whether they are not booked at fair value, allows to measure (in the present) the reinvestment/refunding effect of interest risk on the long-term net interest income (NII).

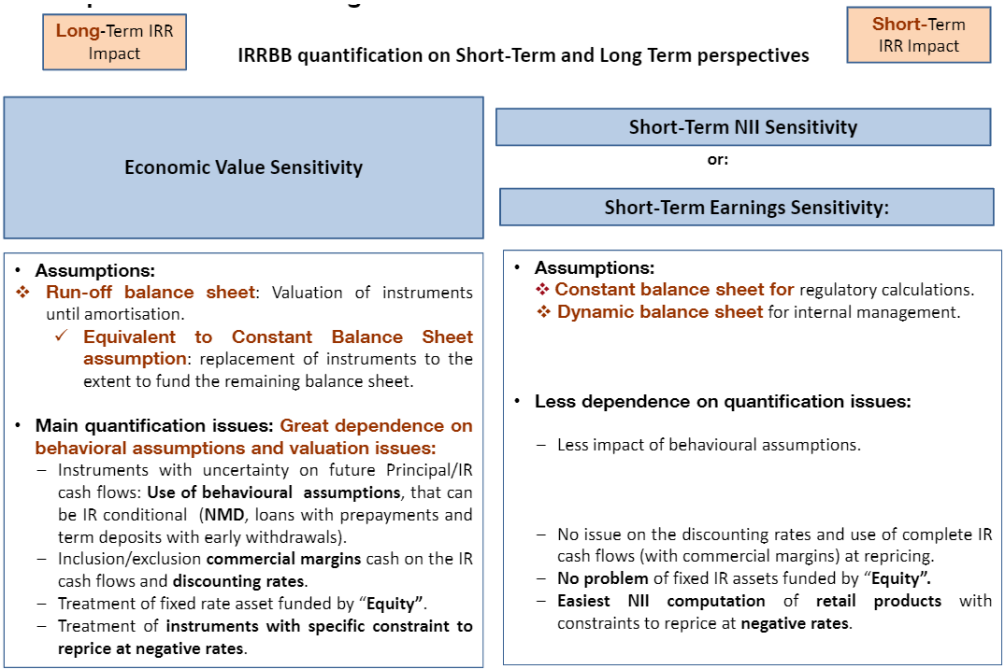


Figura 12.1: Two approaches to measure IRRBB. The two approaches are complementary.

12.3. Duration and Reappreciation Gap

Have clear how to calculate the duration gap and 1 year reappreciation gap departing from the repricing cash flows of a balance sheet: first part of example in pags 48-51 on this presentation.

Calculating the duration gap and the one-year repricing gap from the repricing cash flows of a balance sheet involves analyzing the maturity and repricing characteristics of assets and liabilities. Here's a step-by-step guide:

12.3.1. Duration Gap Calculation:

1. Define Time Buckets:

Group assets and liabilities into time buckets based on their repricing periods (e.g., within 1 year, 1-5 years, $>$ 5 years).

2. Calculate the Present Value of Cash Flows:

For each time bucket, calculate the present value of cash flows for assets and liabilities. This involves discounting future cash flows at current market interest rates.

3. Calculate the Weighted Average Time to Repricing:

Multiply the present value of each time bucket's cash flows by the time to repricing (duration) and sum across all buckets for both assets and liabilities.

4. Calculate the Duration Gap:

Subtract the weighted average duration of liabilities from the weighted average duration of assets.

$$Duration\ Gap = \sum(PV\ of\ assets \times Duration\ of\ assets) - \sum(PV\ of\ liabilities \times Duration\ of\ liabilities) \quad (12.1)$$

• Repricing Gap Calculation:

1.- Identify Repricing Cash Flows: Group assets and liabilities based on their repricing periods (e.g., < 1 year, 1-5 years, > 5 years).

2.- Calculate Repricing Amounts: Calculate the total amount of assets and liabilities repricing within each time bucket.

3.- Compute 1-Year Repricing Gap: Subtract the total amount of liabilities repricing within one year from the total amount of assets repricing within one year.

4.- 1-Year Repricing Gap = Total amount of assets repricing in 1 year-Total amount of liabilities repricing in 1 year

These calculations provide insights into the interest rate sensitivity and the maturity/repricing structure of the balance sheet. The duration gap measures the sensitivity of the economic value of equity to interest rate changes, while the 1-Year Repricing Gap specifically assesses the gap within a one-year time horizon.

Please note that this is a simplified explanation, and actual calculations might involve further complexities, such as incorporating present values, considering different interest rate scenarios, and adjusting for optionality embedded in certain instruments. Consulting financial experts or utilizing specialized software can enhance accuracy and efficiency in performing these calculations.

Look how to deal with the IRRBB measurement on the EVE metric under negative IR rates when having instruments nor repricing at negative rates

Interest Rate Risk in the Banking Book (IRRBB) and its measurement using the Economic Value of Equity (EVE) metric becomes particularly challenging in an environment of negative interest rates, especially when certain instruments do not reprice at negative rates. Here's how you might approach this scenario:

• Understanding Risk Exposure: Identify instruments that do not reprice at negative rates, such as fixed-rate loans or deposits with floors. Assess the extent of exposure to these instruments in your portfolio.

• Adjusting Assumptions: In cases where repricing at negative rates isn't possible due to contractual terms or floors, consider adjusting the assumptions used in the EVE model. You may need to model the behavior of these instruments more conservatively by assuming a floor of zero or a higher positive rate instead of using negative rates.

• Scenario Analysis: Conduct scenario analysis to gauge the impact of different interest rate scenarios, including further negative rate movements. Stress testing your portfolio against various interest rate environments helps in understanding potential vulnerabilities.

• Hedging Strategies: Explore hedging strategies to mitigate the risk arising from instruments that do not reprice at negative rates. This might involve using interest rate derivatives or other financial instruments to manage the risk exposure effectively.

• Review Risk Limits and Policies: Regularly review risk limits and policies in light of the changing interest rate environment. Ensure that risk tolerance levels are aligned with the actual risk exposure and update them as necessary.

• Communication and Reporting: Effective communication and transparent reporting are crucial. Provide clear explanations in risk reports about the assumptions made and the adjustments performed due to the limitations of repricing at negative rates.

• Regulatory Compliance: Ensure compliance with regulatory guidelines and requirements regarding IRRBB measurement under negative interest rates. Stay updated with regulatory developments that might affect risk management practices.

• Continuous Monitoring and Review: Monitor the EVE metric continuously and review the models and assumptions regularly. This helps in identifying emerging risks and making necessary adjustments in a timely manner. Remember, the treatment of instruments that do not reprice at negative rates in the EVE metric requires careful consideration, proper documentation of assumptions, and a proactive approach to manage and mitigate associated risks. Consulting with experienced risk management professionals and regulators can also provide valuable insights and guidance in dealing with this complex issue.

• Regulatory Compliance: Ensure compliance with regulatory guidelines and requirements regarding IRRBB measurement under negative interest rates. Stay updated with regulatory developments that might affect risk management practices.

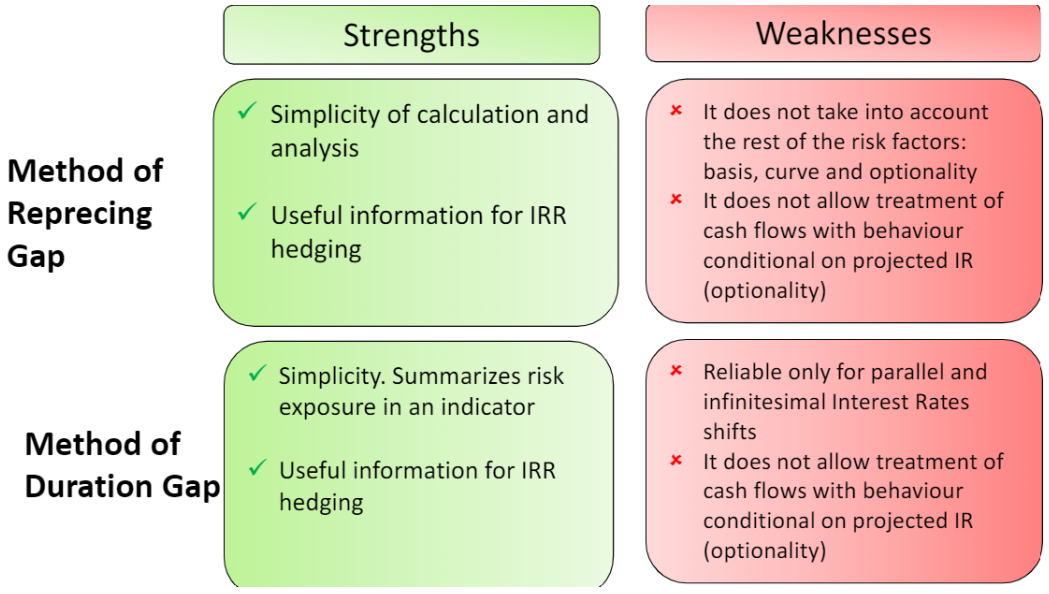
• Continuous Monitoring and Review: Monitor the EVE metric continuously and review the models and assumptions regularly. This helps in identifying emerging risks and making necessary adjustments in a timely manner.

Remember, the treatment of instruments that do not reprice at negative rates in the EVE metric requires careful consideration, proper documentation of assumptions, and a proactive approach to manage and mitigate associated risks. Consulting with experienced risk management professionals and regulators can also provide valuable insights and guidance in dealing with this complex issue.

12.4. Methodologies for IRRBB measurement

12.4.1. Repreciation gap vs Duration gap for NII and EV

Repreciation gap for NII



12.4.2. NII: Linear Approximation vs Full Reevaluation

Linear approximation for NII is similar to full reevaluation with parallel IR shift and unconditional IR cashflows.

Linear approximation for NII is not adequate under non parallel IR shifts. This is solved using Partial Repricing GAPS (instead of Total GAP) and applying forward rate shocks (instead of spot IR shocks): Similar to full reval

Example: NII Linear Approximation

1.- Slot the assets and liabilities into time buckets depending on the maturity:

Time buckets	O/N	O/N < t ≤ 1M	1M < t ≤ 3M	9M < t ≤ 12M	Total
Assets	25	25	100	100	250
Liabilities	68				68

2.- Weighted Repricing gap

Time buckets	O/N	O/N < t ≤ 1M	1M < t ≤ 3M	9M < t ≤ 12M	Total
Partial repricing gap (A - L)	-43	25	100	100	183
Time from repricing to horizon	1.00	0.96	0.86	0.13	
Weighted Repricing Gap	-42	24	83	13	77.205

3.- Calculation of NII in upward scenario (+200 bps)

Δ **NII** = *Weighted Repricing Gap* $\cdot$ $\Delta r = 77.205 \cdot 0.2 = 1.544$

Example: NII Full Reevaluation

1.- Slot the assets and liabilities into time buckets depending on the maturity:

Time buckets	O/N	O/N < t ≤ 1M	1M < t ≤ 3M	9M < t ≤ 12M	Total
Assets	25	25	100	100	250
Liabilities	68				68

2.- Calculation of forward rates in upward and base scenario

Time buckets	O/N	O/N < t ≤ 1M	1M < t ≤ 3M	9M < t ≤ 12M	Total
Partial repricing gap (A - L)	-43	25	100	100	183
Time from repricing to horizon	1.00	0.96	0.86	0.13	
FWD in base scenario	0.5 %	0.5 %	0.5 %	0.5 %	
FWD in adverse scenario	2.5 %	2.5 %	2.5 %	2.5 %	

3.- Calculation of NII in upward and base scenario

Time buckets	O/N	O/N < t ≤ 1M	1M < t ≤ 3M	9M < t ≤ 12M	Total
Level of NII in base scenario	-0.21	0.12	0.41	0.06	0.385
Level of NII in adverse scenario	-1.06	0.60	2.07	0.31	1.914

4.- Calculation of Δ NII

Δ **NII** = *Adverse* - *Baseline* = 1.914 - 0.385 = 1.529

Run off assumption is only valid if the instruments can be repriced at market rate at maturity.

Traditional tools: Linear aproximation.

Unconditional is considering that the repricing of the asset happens at the maturity no matter the IR scenario. So the duration is the same independently of the IR scenario. To proper capture the real behaviour you need

to take into account that the duration of the assets is dependant on the IR scenario, i.e the cashflows can change if the IR decrease or increase a lot. The cashflows should be represented conditioned to the interest rate scenario.

12.4.3. Linear approach

Cash Flows of Sensitive IR assets/liabilities and IR derivatives in the Banking Book are allocated topredefined time bands according to their next maturity date (fixed rate instruments) or next repricingdate (floating rate instruments). No consideration of cash flows dependence on Future Interest ratelevel.

Instruments without contractual maturity (sight deposits) and instruments with behavioural IR options(loans with risk of prepayments and term deposits with risk of early redemption) are allocated to thetime bands on the basis of customer behavioural assumptions (not able to consider differentassumptions under different IR scenarios)

When you have non parallel shifts and you want to use linear approximation, you need to multiply the weigthed repricing gap by the forward rates instead of the spot rates. However linear aproximation is not recommended for non parallel movements.

12.5. Main issues in IRRBB quantification

12.5.1. Treatment of non maturity deposits

Non-maturity deposits (NMD's) are deposits paying either no interest or remuneration based on rates that can be varied at the absolute discretion of the institution, and where depositors may withdraw their balances at a short notice or without notice.

Which is the NMD's behavioral?

They can be withdrawn at sight by depositors. However:

- NMD balances (from retail transactional custormers) are very stable.
- Market Interest rate changes are not passed through to their cost at 100 % (high proportion of NMDs are non remunerated also in high IR environtment).

Their behaviour, for Interest rate risk measurement, is like a fixed interest rate Liability. Banks use internalassumptions for dealing NMD as fixed rate liabilities.

- NMD are huge material share of total IR sensitive liabilities.
- NMD weight over the total liability has increased in the low IR environment. (Term deposits migration to NMDs

Treatment of Non Maturity Deposits (NMD): Regulation:

- Evaluation of retail deposits constraint to reprice at negative rates
- Assess migration betwen NMD and other deposits
- Identify "core balances" on NMD
- Not exclusively rely on statistical or quantitative methods

12.5.2. IRBB measurements under negative IR

Conclusion: For capturing on EV the risk on NII, WHEN INSTRUMENTS WITH CONSTRAINTS TO NEGATIVE IR, need to modify normal repricing structure (needed to overcome limitations of EVE-run off assumptions when maturing instruments do not reprice at market rate due to their specific instruments-floors):

- Alternative 1: sold floors

- Alternative 2: increasing time repricing

12.5.3. Treatment of commercial margins cash flows /discounting rates in EV metric:

12.5.4. Treatment of the equity

Using equity to fund fixed rate assets presents a cost of oportunity risk. It is not a risk on the NII but it must also be taken into account.

Duration represents how much the value decresases if the interest rates increase 100 basis points

12.6. Term Structure of Interest Rates

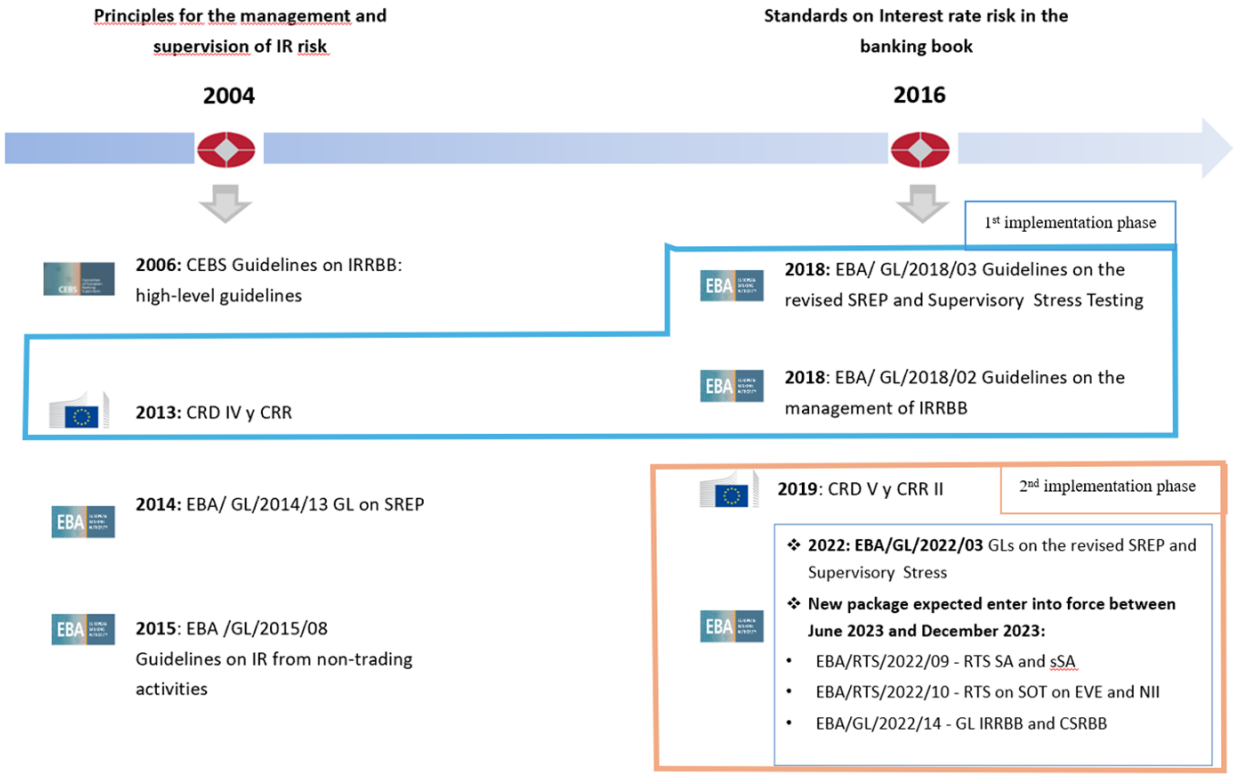
The term structure of interest rates, often referred to as the yield curve, is a graphical representation of the relationship between interest rates (or yields) and the time to maturity of debt securities with similar risk characteristics. In other words, it shows how interest rates vary across different maturities for a specific class of financial instruments, such as bonds.

The key components of the term structure include:

- **Spot Rates:** These are the interest rates applicable to a particular period (usually a single point in time) for a specific maturity. Spot rates represent the current market interest rates for different maturities.
- **Forward Rates:** These are future interest rates that can be implied from the current term structure. Forward rates are the expected future spot rates for a given maturity, and they provide insights into market expectations about interest rate movements.
- **Yield Curve:** The graphical representation of the term structure is known as the yield curve. It plots the yields of fixed-income securities against their maturities. The curve can take various shapes, such as upward-sloping (normal), downward-sloping (inverted), or flat, depending on prevailing economic conditions and expectations.

The term structure od interest rates is not directly observable in the market, you need to compute it with indirect information.

12.7. IRRBB Regulation


Principles for the management and supervision of IR risk
2004
Standards on Interest rate risk in the banking book
2016
1st implementation phase
2006: CEBS Guidelines on IRRBB: high-level guidelines
2013: CRD IV y CRR
2014: EBA/ GL/2014/13 GL on SREP
2015: EBA /GL/2015/08 Guidelines on IR from non-trading activities
2018: EBA/ GL/2018/03 Guidelines on the revised SREP and Supervisory Stress Testing
2018: EBA/ GL/2018/02 Guidelines on the management of IRRBB
2019: CRD V y CRR II
2nd implementation phase
2022: EBA/GL/2022/03 GLs on the revised SREP and Supervisory Stress
New package expected enter into force between June 2023 and December 2023:
EBA/RTS/2022/09 - RTS SA and sSA
EBA/RTS/2022/10 - RTS on SOT on EVE and NII
EBA/GL/2022/14 - GL IRRBB and CSRBB

Capítulo 13

Climate Risk Modelling

04/10/2023

Rocío Falcones

Climate-related financial risks, or climate risks, are the financial risksassociated with climate change.

There are three types of emissions:

Scope 1: emissions resulting directly from a company's operations

Scope 2: upstream emissions from purchased electricity, heating andcooling

Scope 3: all other upstream emissions (excluding scope 2 ones), as well asdownstream emissions from the use or disposal of products and servicessold by the company

13.1. Overview of main climate risks

13.1.1. Physical Risks

Arising from physical climate and weather impacts resulting from climatechange. Includes:

Acute events: Main hazards are:

- Storms and hurricanes
- Droughts
- Heatwaves
- Extreme precipitations and floods
- Wildfires

Chronic events: Gradual, long-term events. Includes:

- Average temperature rise
- Sea level rise
- Changing in precipitation patterns

13.1.2. Transition risks

Arising from economic transformation and any dislocation needed toreduce or eliminate GHG to reach net-zero emissions. Includes:

Policy and legal events:

- Carbon pricing
- Reporting obligations

Technological changes:

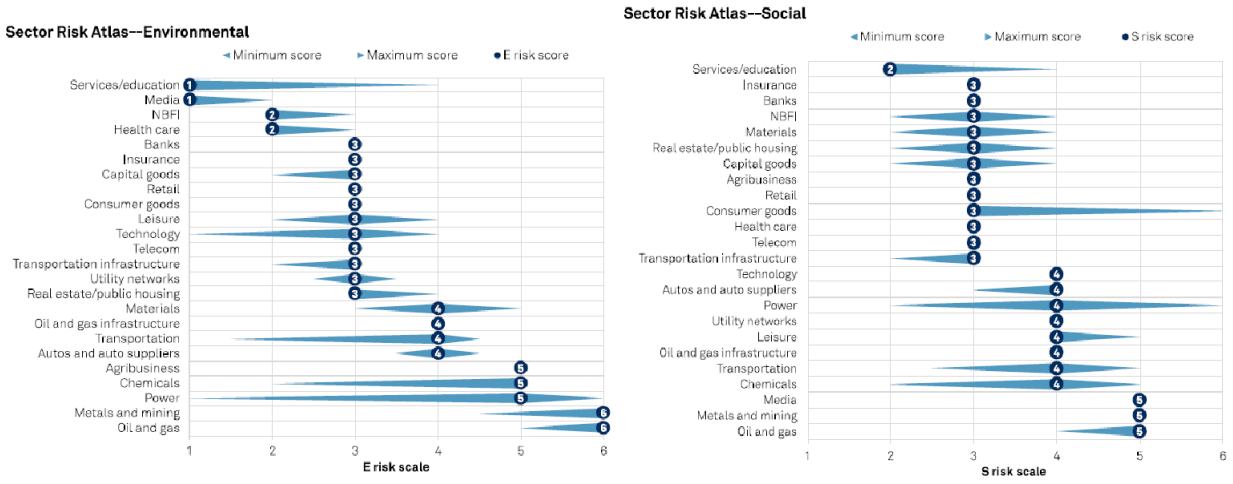
- Substitution of existing products and services with loweremissions options (renewables, energy efficiency, etc.)

Market events:

- Changing consumer behaviour
- Uncertain market
- Increase cost of raw materials

Reputational events:

- Shifts in consumer preferences
- Increase negative feedback from stakeholders
- Stigmatization of sector



13.2. Detailed analysis of main climate risk modeling concepts

The 3 main factors that are taken into account are: **Climate Risk Event/Driver×Exposure×Vulnerability**

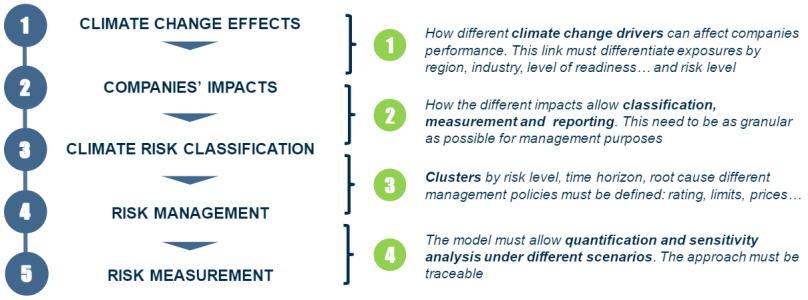
→ **Exposure:** Assets or firms that are in a vulnerable place or setting. Examples are:

- For physical risks: properties or infrastructures in a hazard zone;firms with facilities in hazard areas
- For transition risks: high-emission assets; firms depending onemissions

→ **Vulnerability:** Propensity or predisposition of the asset or firm to sufferadversity from its exposure to hazards.Examples are:

- For physical risks: insurances; contingency plans; adaptiveinfrastructures (e.g. fire breaks)
- For transition risks: viability of transitions plans; ability todecarbonize

13.3. Climate risk modelling diagram



Climate change effect

- Water Scarcity
- Flooding
- Land availability
- Storms, cyclones and hurricanes
- Earthquakes
- Climate change regulation

Companies' impacts

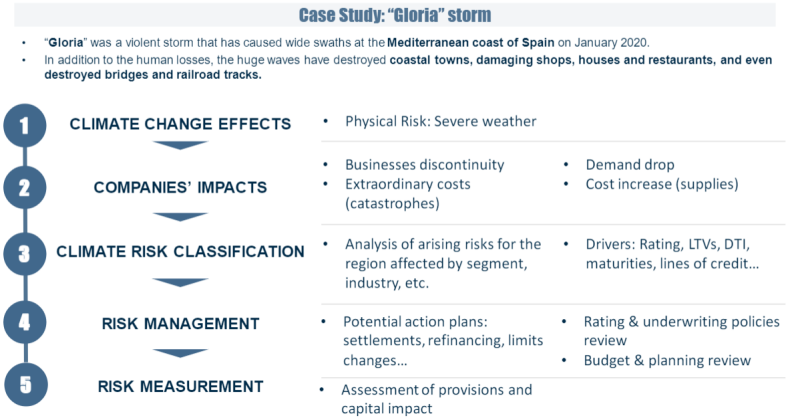
- Cost increase (supplies) and extraordinary costs (catastrophes)
- Productivity decrease
- Businesses discontinuity

Climate risk classification

- Risk taxonomy
- Risk levels
- Risk drivers (region, industry, rating...)
- Time Horizon
- Risk reports

Risk management

- Climate Risk ratings
- Policies
- Green products
- Risk Culture issues & training
- Pricing models



13.4. Example of Transition vs Physical Risk models

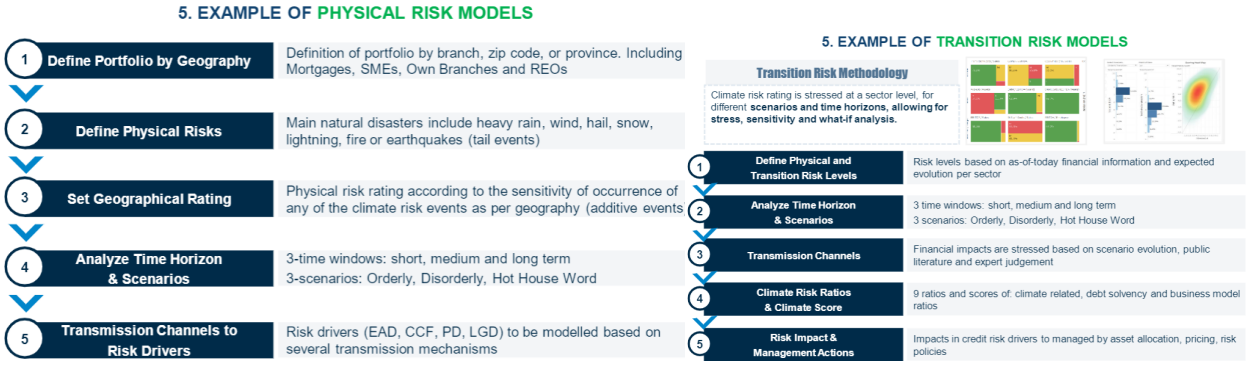


Figura 13.1: Comparison between a physical and a transition risk model.

Capítulo 14

Capital and Regulation according to BIS III

To be able to use the advanced approach you need to have a robust dataset with historical data of PD's and LGD's.

Guarantees:

Standard approach: There can be reclassification. For example if I grant a loan to telefonica and telefonica gives me a government bond as a collateral I can reclassify the PD from 50 % to 0 %

Advanced models: Instead of reclassifying and changing the PD, the collateral is taken into account inside the LGD.

To estimate the PD's you use the downtown period of an economic cycle (usually 2008 in Spain)

The assets in the numerator of the LCR (Liquidity Coverage Ratio) are computed at fair value for this ratio

Capítulo 15

Credit Default Swaps

30/11/2023

Sergio Mayordomo

A CDS is a fixed income derivative instrument, which allows a protection buyer to purchase insurance against a contingent credit event on an underlying reference entity, by paying an annuity premium to the protection seller, generally referred to as the CDS spread, over the life ofthe contract. A "Credit event" is defined as the failure of an entity to meet its debt obligations. Credit default swaps (CDS) were engineered in 1994 by the U.S. bank, JPMorgan Inc., to transfer the credit risk exposure from its balance sheet to protection sellers.

CDS are part of the OTC market and not traded on an organized exchange.

15.1. Cheapest to deliver option

In case of physical delivery, the buyer of protection will deliver the least valuable bond among the defined set of eligible reference obligations and so, he holds a cheapest-to-deliver (CTD) option. These defined set of eligible bonds has been changed many times.

There exist nowadays different types of restructuring clauses that can bedefined in a CDS contract:

- **Full Restructuring (CR):** any restructuring event qualifies as a credit event (and any bond of maturity up to 30 years is deliverable).
- **Modified Restructuring (MR):** any restructuring event (except restructuring of bilateral loans) qualifies as a credit event (the clause limited the deliverable obligations to those with a maturity of 30 months or less after the termination date of the CDS contract).
- **Modified-Modified Restructuring (MMR):** the deliverable obligations are restricted to bonds with maturities of up to 60 months within the CDS contract's remaining maturity for restructured debt, and 30 months for other obligations (MR was perceived as too severe in its limitation of deliverable).
- **No Restructuring (XR):** it does not refer to all restructuring events. Those credit events under restructuring that do not constitute a true loss for the protection buyers, but still might encourage opportunistic behavior on their part, are ruled out.

15.2. International Swaps and Derivatives Association (ISDA)

The CDS Big Bang and CDS Small Bang protocols were approved with the following goals in mind:

1.- Improve the efficiency and transparency of the CDS market.

2.- Standardization of the coupon payments: The fixed couponn payments were defined to be 100 or 500 basis points (US) and 25, 100, 500, 1.000 basis points (EU) and the difference relative to the running par spread would be settled through an upfront payment.

3.- The responsibility for deciding upon the formal trigger of a credit event was fully attributed to the ISDA

In 2014, ISDA proposed the most important changes to the CDS contract:

- A new credit event applicable to financial entities, i.e., governmental intervention to bail out the financial entity
- Senior CDS will be triggered based solely on whether the senior bonds of the entity are restructured
- In regards to asset package delivery: any proceeds (deliverable or non-deliverable) received after a restructuring can now be delivered to settle a financial/sovereign CDS contract, if the original bond was deliverable

15.3. Redenomination Risk

If you have two CDS contracts for spanish sovereign debt that are exactly the same but one of them pays in euros and the other one pays in dollars one of them will be more expensive because of the denomination risk. If the spanish government defaults the euro will probably depreciate so the notional you will get with the CDS will be less valuable. Since this implies more risk (currency risk) the CDS denominated in dollars would be more expensive.

15.4. CDS pricing

An approach to structural pricing frameworks for CDS is given by the reduced-form model which is used to value both the premium leg and the protection leg of a CDS contract.

→ The premium leg is defined as a series of CDS spread payments made until the earlier of the contract maturity or a contingent credit event.

→ The protection leg is the contingent payment made upon occurrence of the credit event.

To estimate the CDS spread, the present values of both legs must be equal at inception in order for the fair CDS spread to be derived.

The bond holder recovers a fraction $1 - w$ of the par value in the event ofdefault.

Setting the premium leg equal to the protection leg yields the CDS premium:

$$S = \frac{E[w \int_o^T \lambda_t e^{(-\int_0^t r_s + \lambda_s ds)} dt]}{E[\int_o^T \lambda_t e^{(-\int_0^t r_s + \lambda_s ds)} dt]} \tag{15.1}$$

Components of CDS spreads

- Expected loss / default probability
- Risk premium
- Counterparty risk
  - → It reduces the value of the insurance promised by the protectionseller.
  - → The economic impact of counterparty risk on CDS spreads can beoffset through the practice of posting collateral in the CDS market
- Liquidity and liquidity risk

- Delivery option implicit in CDS contracts

In sum, CDS spreads are not a pure measure of an entity's default risk.

15.5. Sovereign CDS

During the European sovereign debt crisis speculators were blamed for artificially increasing sovereign borrowing costs by buying naked credit insurance against a contingent government default. A "naked credit default swap" position refers to a situation where an investor or trader holds a credit default swap without owning the underlying asset or bond that the CDS is meant to insure. Now naked CDS on sovereign debt are not allowed unless you can prove it is being used to "proxy hedge" a highly correlated portfolio that you cannot hedge otherwise.

Major diferences from corparate CDS:

- The nature of the credit events that trigger a contingent default insurance payment.
  - → Bankrupcy is typically replaced with repudiation/moratorium for sovereign reference entities.
  - → Sovereign reference entities typically trade with CR.
- Less concentrated trading in the sovereign 5-year contract.
- Currency denomination (USD) given that there is a high risk of currency depreciation, or even redenomination, by the sovereign in the event of default.

15.6. CDS indices

CDS indices provide benchmarks for measuring performance and serve to improve liquidity and transparency. There are two classes of credit derivative indices:

1.) Those that are backed by single-name bond or loan CDS (i.e. iTraxxfamily that covers corporate and sovereign reference entities inEurope and Asia, and the CDX family that covers those in NorthAmerica and in emerging markets).

2.) Synthetic structured indices that are backed by pools of residential orcommercial mortgage-backed securities (MBS).

The two main corporate credit derivative indices are:

- Markit iTraxx Europe Main (iTraxx Europe): 125 European investment-grade reference entities in terms of CDS volume traded.
- Markit CDX North American Investment Grade (CDX.NA.IG): 125 American IG reference entities in terms of volume.

Investors can synthetically invest or hedge different portions of the capital structure of a standardized credit portfolio. This is done by chopping the standardized indices into several so-called tranches.

For example, the tranche corresponding to the attachment and detachment points of respectively 6 % and 9 % will only suffer losses if more than 6 % of the underlying basket defaults, corresponding to at least eight reference names ($125 \times 6\,\% = 8$).

→ iTraxx attachment/detachment points: 0-3, 3-6, 6-9, 9-12, 12-22, 22-100.

→ CDX attachment/detachment points: 0-3, 3-7, 7-10, 10-15, 15-30, 30-100.

15.7. Other uses of CDS

Besides from hedging and speculating, CDS can be used for many more things:

15.7.1. Infer credit risk information

CDS spread is a measure of credit risk. The CDS market tends to lead the bond market in determining the new price of credit risk (discovers the price of risk). However, CDS pricing is affected by many factors and in periods of high risk (mainly counterparty) bonds could reflect information more efficiently.

CDS spreads were considered to be a precise measure of firms' credit quality, widely used by practitioners and by academics. A primary concern is that there is little transparency in the CDS market because transactions in OTC markets are typically bilateral trades.

15.7.2. Capital reliefs

CDS provide banks an additional tool for risk management that is recognized by regulators.

Basel II framework uses a substitution approach in recognizing the risk-mitigating effect of CDS on regulatory capital (the risk of the protection seller substitutes the risk weight of the reference obligation).

When banks buy CDS protection, either through single-name CDS or CDS index, they may reduce their risk-weighted assets and raise their regulatory capital ratios.

However, the use of CDS by banks to improve the appearance of their capital ratios could also have adverse effects:

- It could lead to an incentive to invest in highly risky projects
- and to increase risky lending
- and as a consequence to increase systemic risk

Capítulo 16

CVA and Counterparty Credit Risk

Context

The recent credit deterioration of most retail, mid-sized and financial counterparties has raised the awareness of a non performance risk monitoring and calculation.

Derivatives are instruments that because of their nature (highly leveraged) and composition are very volatile to changes in their risk factors such as credit component.

Methodological Improvements

Non Performance risk, for derivatives, refers to the risk that one of the parties (of a derivative transaction) will be unable to perform under the contractual terms.

Derivative portfolio is, actually, valued discounting cash flows with market curves. These Market Curves do not consider the Credit Component, so a Credit Value Adjustment is needed.

16.1. CVA Components and calculations

$EL = EAD \times PD \times LGD \Longrightarrow EAD$ & LGD are under Credit Value Adj/Debit Value Adj

EAD

EAD = Current Exposure + Potential Future Exposure – Collateral Agreements

- Current Exposure: Discounted Market Value is obtained simply by discounting all the cash flows of the instrument to date
- Potential Future Exposure:
  - With simulation techniques (Monte Carlo) possible values for the exposure are estimated until maturity
  - Different scenarios are simulated using risk factors (rates, correlations, volatility, ratings, spreads)
- Collateral Agreements:
  - Netting agreement can reduce the exposure at default and are especially effective in interbank operations (affect little at corporate). These can also be simulated.
  - Collateral agreements greatly reduced the loss at the time of default but does not completely eliminate the risk. The effect on the liquidity of the company tends to be relevant

PD

- In order to estimate the probability of default, there is information on the market that can be used in the calculation.

- In addition there is information about the historical behavior of the events of default according to the rating of the consideration, i.e: Moody's, S&P,...
- In the case of using internal models, PD Point In Time must be used as a starting point (removing the adjustment to the cycle) and assess possible alternative market.

LGD

- There are market standards about the LGD to apply:
  - 60 % for the standard case (CDS) (recovery rate: 40 %) for accounting, 45 % for regulatory purposes
  - Internal models are based on the discount flows expected in the recovery process

Tabla 16.1: Measurement of Risk factors

	Reference	Type
PD	Through the cycle	
LGD	Downturn (2008)	Forward Looking
CCF	Downturn	Forward Looking

To estimate a proxy of the PD we can do it computing the amount that is defaulting or the number of clients that are defaulting (see Excel "Loss Estimates Example"). Usually they should give roughly the same number. However in this example the proxy PD with the EAD is much higher. This is due to concentration risk most certainly.

16.2. Counterparty Credit Risk Requirements

Standard Approach (SA-CCR)

- Institutions above the thresholds (derivatives MTM $> 10\,\%$ total assets or $>$ 300Mn Eur)
- For less complex portfolios below the SA CCR threshold for which the full SA CCR

Simplified Standard Approach (SA-CCR)

- Institutions above the thresholds (derivatives MTM $< 10\,\%$ total assets or $<$ 300Mn Eur).
- Used by a very limited number of banks with small derivative business (EBA).
- Applicable for simple portfolios or portfolios without excessive independent collateral amounts
- Simplifies parameters used in SA-CCR (e.g., RC = MtM, Deltas = ± 1, duration = E-S, etc.)

Revised Original Exposure Method

- Institutions above the thresholds (derivatives MTM $< 5\,\%$ total assets or $<$ 100Mn Eur).
- Used by a significant number of small banks, for very small and non-significant amounts of derivative exposures.

16.2.1. Standard Approach methodology

SA - CCD $\Longrightarrow$ EAD $= \alpha \cdot$ (RC + Multiplier $\cdot$ AddOn)

Alpha

- $\alpha = 1.4$
- Regulatory scaling factor
- Analogous to the alpha factor in the IMM and the beta factor in the current SM

Replacement Costs

- Current replacement cost

- Calculation depending on whether a netting set is collateralized / uncollateralized
- Consideration of parameters from collateral agreements

Potential Future Exposure Multiplier (SES)

- Takes into account risk-reduced effects of overcollateralization and negative market value
- Reduces the AddOn in these cases

Stressed Capital Add-On (SES)

- Potential future increase in current exposure
- Dependence on the volatility of the business activity

16.2.2. CVA Requirements

Changes have been made to the CVA framework to improve its sensitivity to risk, remove the internal models approach and align with the revised market risk framework.

- **New processes and controls**

The revision of the CVA framework requires entities to consider a series of circumstances, such as the effort at the operational level involved in being able to apply the new standard method, the higher netting of operations or the optimization due to the use of hedges

- **New requirements**

Entities that want to use the SA-CVA method must obtain authorization from the competent supervisory authority and must be able to model exposure, especially credit spreads on less liquid counterparties; and calculate the key risk measure.

- **Increase calculation sophistication**

The revision will have a great impact on the entities methodologies, systems, data and processes. The biggest challenge will be achieving the significant increase in software performance and computing power required to calculate sensitivities for the standard method (SA-CVA).

Basic Approach (BA - CVA)

Default applicable method. There are two alternatives to calculate the BA-CVA:

- Full version: entities that hedge the CVA risk.
- Reduced version: it is obtained from the previous version by eliminating the effect of the hedges.

Standard Approach (SA - CVA)

Differences with respect to BA-CVA:

- Granularity of market risk factors.
- It does not include the risk of default or curvature.
- Use a more conservative methodology.
- Applies a regulatory multiplier of 1.25 to account for higher model risk

CCR

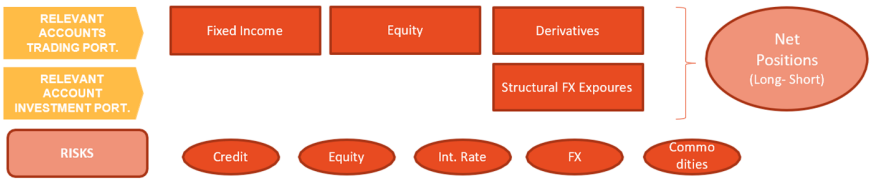
Alternative approach for smaller entities whose aggregate portfolio of derivatives and SFT (securities financing transactions) is less than 100Bi euros. Any bank below the materiality threshold may choose to set its CVA capital equal to 100 % of the bank's capital requirement for CCR.

The following counterparties are excluded from the calculation of CVA capital requirements: non-financial counterparties, intragroup, CCP, pension funds and sovereigns.

16.3. Market Risk

Overview

Market risk is defined as the risk of losses in on and off-balance-sheet positions arising from movements in market prices.



In measuring market risks, a choice between two broad methodologies will be permitted (subject to the approval of the national authorities):

- Standardized Approach (SA): based on % weighting factors on the calculated net positions.
- Internal Models Approach (IMA): Based on VaR, the maximum losses that may occur in the portfolios at a given confidence level (99 %) and a time horizon of 10 days.

Market Risk Capital Requirements are calculated based on:

- One yeat VaR
- One year Market Stress VaR
- Incremental Risk Charge (IRC)
- Comprehensive Risk Measure (CRM)

16.3.1. Standarized Approach

$Capital\ Requirement = 1.3 \cdot CRIRR + 3.5 \cdot CREQ + 1.2 \cdot CRFX + 1.9 \cdot CRComm$

→ EQ = Equity instruments in Trading Book

→ FX = Foreign Exchange and gold

→ Comm = Commodities position w/o gold

→ IR = Interest Rate Instruments & Debt Securities

Total requirements are obtained as sum of the req. for each of these risks (worst - case scenario).

Main criticisms: Arbitrary and Ignores diversification.

16.3.2. Internal Models Approach (Capital Requirements)

$Capital = m + b \cdot VaR + m \cdot SVaR + IRC + max\{CRM, Floor\} + SC$

- VaR is the standard Value-at-Risk measure, based on 99 % 10-day loss
- **m** is a model-based multiplier, m $\geq$ 3
- **b** is an additional factor, depending on VaR backtesting excesses, 0 $\leq$ b $\leq$ 1
- Stressed VaR is VaR calibrated to financial crisis data, (e.g., 2007-2008; m $\geq$ 3)
- IRC is an incremental charge for default and migration risks for non-securitized products (at least weekly computation)
- CRM is an incremental charge for correlation trading portfolios (at least weekly computation)
- Floor is calculated as a times capital charge for specific risk according to the modified standardized measurement method for the correlation book (aka “banking-book charge”)= 8 %

- SC is standardised charge on securitisation exposures (not covered by CRM), comparable to the Banking Book

16.3.3. Internal Models Approach (VaR definition)

VaR Concept

- VaR measures the maximum loss in the portfolio value that may occur as a result of movements in the financial markets for a given confidence level and over a given time.
- Methologies: Historical simulation, Parametric or Monte Carlo simulation

Inputs

- Confidence level = 99
- Time Horizon = 10 days
- Observation Period – At least 1 year
- Revision – At lest every 3 months

Requirements

- Amount: Max (previos day VaR; last 60 days average)
- Backtesting: Number of exceptions análisis (Green, Yellow and Red)
- Plus Factor: Realised P&L should be worse than VaR only 2-3 times per year

VaR, Capital and RWA Link

- Regulator requires 10-day VaR (square root of 10) $\times$ (1-day VaR)
- Capital requirement = 10-day VaR $\times$ multiplier ($>$ 3, bank-specific, fixed by regulator)
- RWA = capital requirement $\times$ 12.5

Pros & Limitations

- Pros: Includes correlation and implies lower Capital Requirements
- Limitations:
  - Crisis y worst case scenario analysis
  - Pro-cyclicality
  - Impact of sudden defaults is not captured

16.3.4. Internal Models Approach (Stressed VaR)

SVaR = VaR "calibrated to historical data from a period of significant financial stres"

Inputs (Similar to VaR)

- Confidence level = 99
- Time Horizon = 10 días
- Observation Period – Relevant to the Firm's portfolio (i.e. 2007/2008)
- Revision – Yearly

16.3.5. Internal Models Approach – IRC/CRM

IRC Concept

- Measures the risk, as well as the potential for indirect losses, due to default and credit migration risk
- P&L impact of rating migration and default

  IRC $\longrightarrow$ Vanilla credit (Bonds and CDS, except CDS for hedging)

CRM Concept

- Captures the risk due to default and credit migration risk, as well as other pricing risks:
  - Correlated defaults
  - Credit spread risk, including gamma and cross-gamma
  - Basis Risk
  - Volatility of implied correlations; etc.
- P&L impact of rating migration and default

  CRM $\longrightarrow$ Correlation trading portfolio (CDOs on corporates and CDS for hedging)

Inputs

- Confidence level = 99
- Time Horizon = 1 year
- Periodicity = Weekly
- Scope = All but securitization products, FX and Sovereign

Computation

- Transition matrix for migration or default
- Migration and defaults are correlated, then translated to PL impacts
- In practice, full revaluation is avoided by using a sensitivity-based approach

16.3.6. Fundamental Review of the Trading Book (FRTB)

1966 –"Overview of the amendment to the capital accord to incorporate market risk". Basel 1.5

- First consideration of market risk for determining regulatory capital
- Prior to this only credit risk was considered

2009 "Revisions to the Basel II market risk framework". Basel 2.5

- As reaction to the finan-cial crisis the committee presents a "Quick Fix".
- Basel 2.5 increases the overall level of capital but does not contain a fundamentally new conceptual design
- Stressed VaR

2010 "A global regulatory framework for more resilient banks and banking systems". Basel 3

- No significant changes for market risk measurement under Basel III framework
- Introduction of capital charges for credit valuation adjustments (CVA)

2012 "Fundamental Review of the Trading Book". Basel 3.5

- The Committee initiates a fundamental review of the trading book regime and capital charges

Main changes

- Full revaluation for some products: This could entail a large-scale change from the current technical and operational landscape and significant computing development .
- P&L quality for backtesting and P&L attribution: Desk-level testing will require significant work from Finance and better Finance/Risk/FO coordination.
- Front Office desks structure: Table structures must conform to FRTB definitions, which will require a major reorganization of FO desks.
- Risk & Capital management: The impact of capital from different businesses will be redistributed with the FRTB and will probably be higher overall.
- Non modellable risk factors: NMRFs are a new and established model that will require a significant data and methodology effort.
- More divulgation: A considerably larger number of reports is likely to be required on a more detailed basis
- Trading and Banking Book boundary: TB/BB regulations require additional controls to be put in place and may affect existing allocations and internal risk transfer practices.

16.3.7. Representative Market Risk Metrics

Value at Risk (VaR): VaR estimates the maximum potential loss of an investment or portfolio over a specified time horizon at a given confidence level. Expected Shortfall (ES): Also known as Conditional VaR, ES measures the average loss in the tail of the distribution beyond the VaR (at extreme).

Stress Testing: This involves evaluating a portfolio's performance under extreme, adverse market conditions that may not be captured by VaR or ES alone. It helps assess the impact of severe market movements on a portfolio.

Beta Coefficient: Beta measures the risk of a security or portfolio relative to the market,. A beta of 1 means the asset moves in line with the market, while a beta > 1 higher volatility, and a beta < 1 lower volatility.

Volatility: Volatility measures the degree of variation of an asset's price over time (abs term). Higher volatility implies greater uncertainty and risk.

Correlation and Covariance: These metrics quantify the relationship between the returns of different assets. Positive correlation implies assets move together, while negative correlation means they move in opposite directions.

Sharpe Ratio: This measures the risk-adjusted return of an investment. It compares the excess return of an investment to its volatility. Higher Sharpe ratios indicate better risk-adjusted performance. Tracking Error: This measures the variability in returns between a portfolio and its benchmark. A higher tracking error implies greater deviation from the benchmark, indicating higher risk.

Liquidity Risk Metrics: Metrics assessing the ease with which an asset can be bought or sold without affecting its price. Higher liquidity reduces the risk of not being able to exit a position.

Option Greeks: Metrics such as Delta, Gamma, Vega, Theta, and Rho help assess the sensitivity of options to changes in various factors like price, time, volatility, and interest rates.

Alpha, measure of performance, is the excess return of an investment relative to the return of a benchmark index.

Capítulo 17

Vocabulary

• **Convertible bond:** A convertible bond is a fixed-income corporate hybrid debt security that yields interest payments, but can be converted into a predetermined number of common stock or equity shares. The conversion from the bond to stock can be done at certain times during the bond's life and is usually at the discretion of the bondholder.

This bond's conversion ratio determines how many shares of stock you can get from converting one bond. For example, a 5:1 ratio means that one bond would convert to five shares of common stock.

The conversion price is the price per share at which a convertible security, such as corporate bonds or preferred shares, can be converted into common stock. The conversion price is set when the conversion ratio is decided for a convertible security.

• **CoCo (Contingent Convertible Bonds):** Hybrid debt securities that convert into common stock if a pre-defined trigger event occurs. CoCos, also known as AT1 bonds, are high-yield, high-risk products.

KEY TAKEAWAYS

→ CoCos have a strike price at which the bond can be converted into stock.

→ They're are used by the banking industry to absorb losses automatically and to satisfy regulatory capital requirements.

→ A bank that's struggling financially does not have to repay the bond, make interest payments, or convert the bond to stock.

→ CoCo investors receive interest payments that are typically much higher than those from traditional bonds.

Cocos are designed to automatically cover bank losses and aid them in satisfying additional Tier 1 (AT1) and Tier 2 (T2) regulatory capital requirements imposed by Basel III.

Contingent convertibles expand on the concept of convertible bonds by modifying the conversion terms. As with the convertible bond, investors receive periodic, fixed-interest payments during the life of the bond. But CoCos automatically create a loss for investors if the issuer's capital drops under a specific level. Reaching these points of, normally, 7 % or 5.125 % of total risk-weighted assets can cause three potential results for investors:

→ A CoCo being converted to common shares

→ A temporary write-down of the CoCo's value

→ A permanent write-down of the CoCo's value

Broadly, the trigger can take several forms, including the price of the underlying shares, the bank's need to meet regulatory capital requirements, or the demand of a managerial or supervisory authority.

• **Loan to Value**: If I have a Loan of 80 and the collaterall is 100 the loan to value is 0.8 or 80 %.

• **Bid-Ask (Markets):** The term "bidrefers to the highest price a buyer will pay to buy a specified number of shares of a stock at any given time. The term .ªskrefers to the lowest price at which a seller will sell the stock. The bid-ask of a market is the difference between these two values. It can be a measure of the liquidity of the market.

• **Private Placement:** It is like a bilateral loan between the issuer and one or two pension funds that can analyse internally the rating of the investment. These are usually small placements (50 million, 100 million...) so it is a market for small companies and it doesn't have much liquidity.