Credit Risk Management

Public Lectures

22-23.04.2024 Masaryk University, Brno

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- Academic Engagement:
  - University of Luxembourg
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- Research:
  - Early Warning Systems in Credit Risk
  - Real Estate Collateral Valuation Models
  - Model Risk Quantification
- Professional:
  - Nordea Bank
  - Banque Internationale a Luxembourg
  - Lloyds Bank
  - CITI
  - BNY Mellon
  - HSBC
  - RBS

Agenda

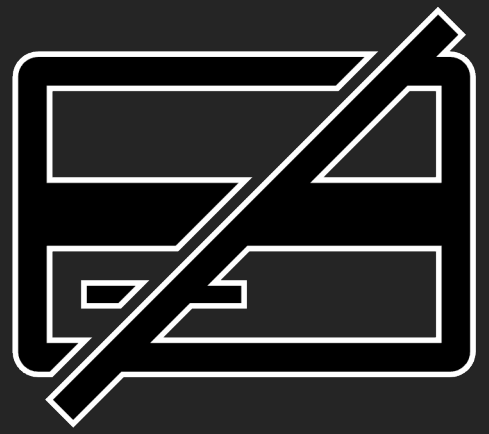
- What is Credit Risk?
- How Credit Risk is managed at financial institution;
- How banks model Credit Risk;
- Focus on Key Risk Indicators (KRIs);
- Focus on model risk;
- Focus on collateral haircuts;

Credit Risk - what is credit risk for a financial institution?

Sources – where can you find credit risk?

Credit Risk can be found in:

- Absent or downgraded ratings or risk profiles of customers, which could also bias the financial ratios
- Some types of customers acceptable or not acceptable to the bank either due to customer profile or specific type of activity
- Any limitations on markets or specific geographies eligible for finance
- Risks concerning short vs. long term lending and any specific maturity limitations
- Preferred type of finance products, e.g. high-risk loans
- Any specific collateral requirements
- Interest rate or currency mismatch and any related hedging requirements
- Industry specific sustainability requirements
- Industry specific climate related and environmental risks



Credit Risk – how would you manage it?

Risk Culture – what do you need to manage credit risk and foster good credit risk culture?

Credit Risk Culture

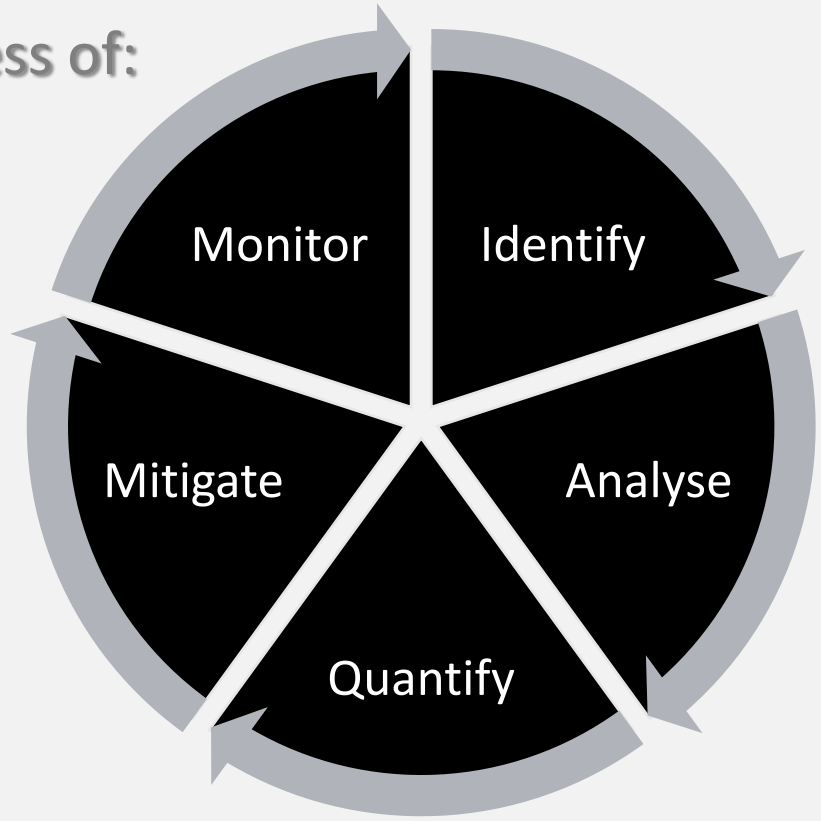
- Institutions should develop a credit risk culture as part of the overall risk culture through policies, communication and staff training, in accordance with the EBA Guidelines on internal governance.

- The credit risk culture should include an adequate ‘tone from the top’ and ensure that credit is granted to borrowers who, to the institution’s best knowledge at the time of granting the credit, will be able to fulfil the terms and conditions of the credit agreement, and is secured, when relevant, by sufficient and appropriate collateral, where relevant, and considering the impact on the institution’s capital position and profitability, and sustainability, and related environmental, social and governance (ESG) factors.

Credit Risk Management

What is Credit Risk management?

- It is a continuous process of:
  - Identifying risk
  - Analysing risk
  - Modelling risk
  - Mitigating risk
  - Monitoring risk
  - Predicting risk



Credit risk appetite, strategy and credit risk limits

The credit risk appetite should be implemented with the support of appropriate credit risk metrics and limits. These metrics and limits should cover key aspects of the credit risk appetite, as well as client segments, currency, collateral types and credit risk mitigation instruments.

CASE STUDY

Desing of Key Risk Indicators for Shadow Banking Entities

Shadow banking entities are undertakings that carry out one or more credit intermediation activities and that are not excluded undertakings. Credit intermediation activities are defined by the regulator as “bank-like activities involving maturity transformation, liquidity transformation, leverage, credit risk transfer or similar activities”, and certain activities specified in the Capital Requirements Directive IV (CRD IV).

Your task is to design Key Risk Indicators (KRIs) for dealing with such entities.

Learning Objectives:

- Interpretation of Regulations;
- Design of KRIs.

Credit Risk Management: KRI Design

- In accordance with internal policies at many financial institutions - **Key Risk Indicators** Corporate Policy, Lines of Business can use granular metrics commensurate with their operational models, risk environments and regulator expectations. These metrics are not subject to the requirements of the KRI policy however Business Chief Risk Officers or designees will use judgment to ensure appropriate metrics deemed to warrant Risk oversight are selected, monitored and documented in an efficient manner.

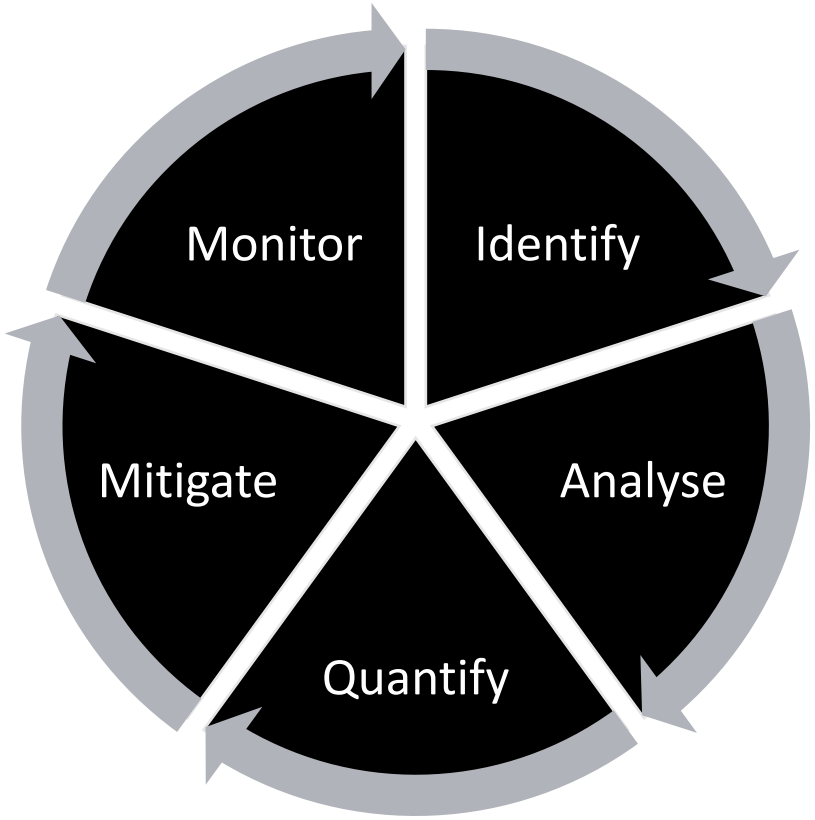
- KRIs are not to be confused with routine management statistics or general performance indicators that are reported or tracked by Business or Portfolio Management. The standards represent predetermined and agreed upon acceptable target values (i.e., thresholds) for each indicator.

- A key risk indicator (KRI) is a metric for measuring the likelihood that the combined probability of an event and its consequences will exceed the organization's risk appetite and have a profoundly negative impact on an organization's ability to be successful.

https://www.eba.europa.eu/sites/default/documents/files/documents/10180/1310259/f7e7ce6b-7075-44b5-9547-5534c8c39a37/EBA-GL-2015-20%20Final%20report%20on%20GL%20on%20Shadow%20Banking%20Entities.pdf

Statement	Metric	Limit/Thershold
Interconnectedness: appropriate mitigation techniques are in place to address potential risks stemming from the uncertainty about interconnectedness of the shadow banking entities. (14.a)	Each Legal Entity (or relevant Line of Business) has a clear policy/procedure on mitigating the risk of uncertainty about interconnectedness of SBEs	Techniques 100% documented
Institutions should set an aggregate limit to their exposures to shadow banking entities relative to their eligible capital (17)	Aggregate Limit as % of Eligible Capital	x% of the Eligible Capital
When setting individual limits for shadow banking entities, as part of their internal assessment process, the institutions should take into account information available about the portfolio of the shadow banking entity, in particular non-performing loans (19c)	% of non-performing loans in the shadow banking portfolio	0%

Credit Risk Management is conducted through the 3 Lines of Defence model. All lines are coordinating tasks to set up the governance framework. The objective followed in credit risk policies and procedures should be to promote a proactive approach to monitoring credit quality, identifying deteriorating credit early and managing the overall credit quality and associated risk profile of the portfolio, including through new credit-granting.



First Line of Defence

- Credit Risk Modelling Team
- Credit Risk Data Management Team
- Model Implementation Team
- Model Risk Manager (Credit Risk Unit)

Second Line of Defence

- Model Validation (Independent Model Validation Unit)

Third Line of Defence

- Internal Audit

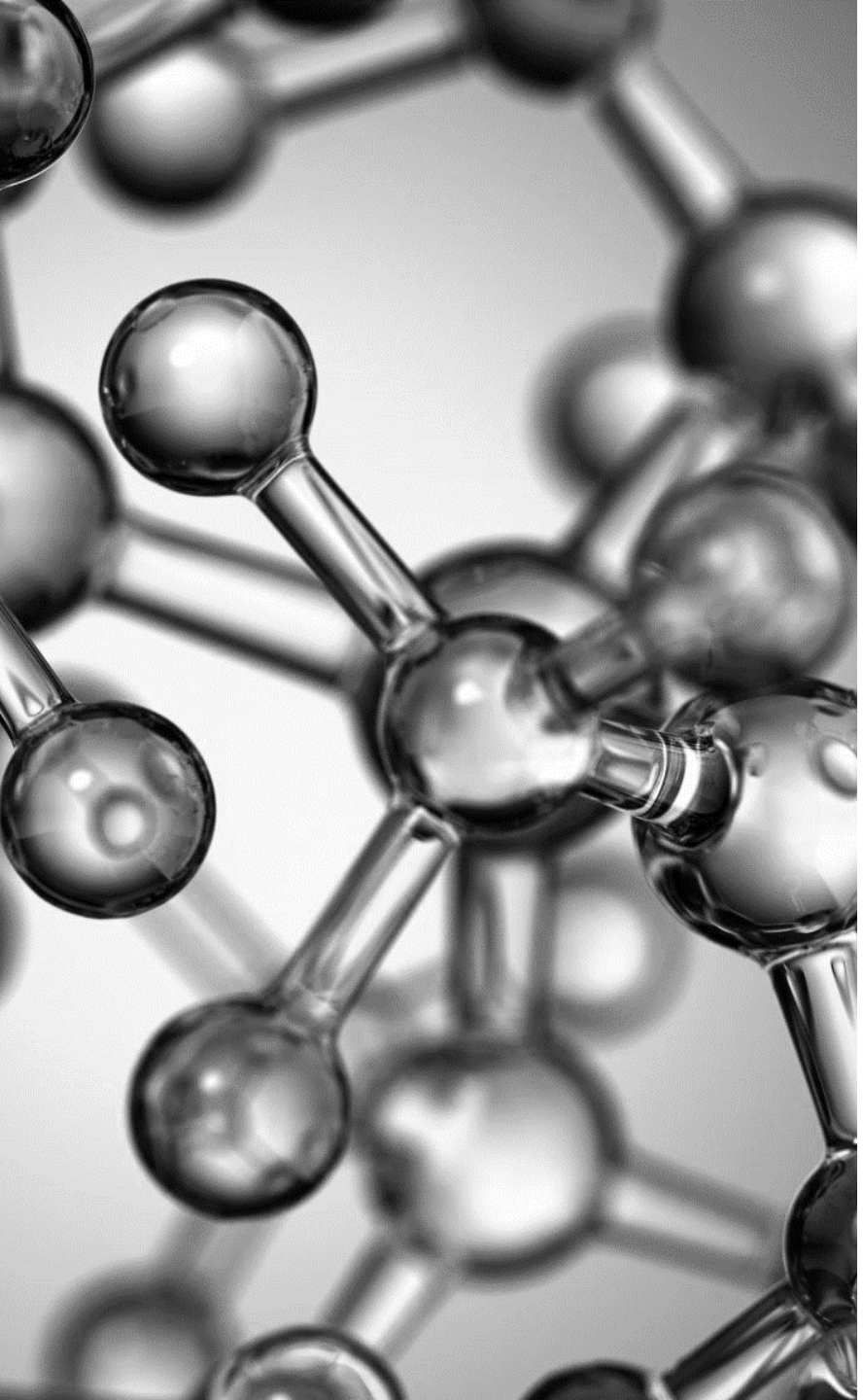
Credit Risk quantification - what credit risk models do you know?

Models in Regulatory Framework for Credit Risk

- Basel II:
  - Credit Risk measurement approach:

Standardised	FIRB (Foundation)	AIRB (advanced)

• Use of regulatory prescribed weights for exposure classes;
• Over-reliance on agency ratings;
• Some flexibility on the choice of risk weight assignment.
	• Use of own models for Probability of Default (PD) – subject to the regulatory approval;
	• Use of regulatory prescribed LGD models (e.g. regulatory floors).
		• Use of own models for:
		  • PD
		  • LGD
		  • EAD
		• Credit risk models are subject to regulatory review.



Input → Processes → Output

Input

Assumptions

Data

Scenarios

Expert Judgment

Process

Methodology

Implementation

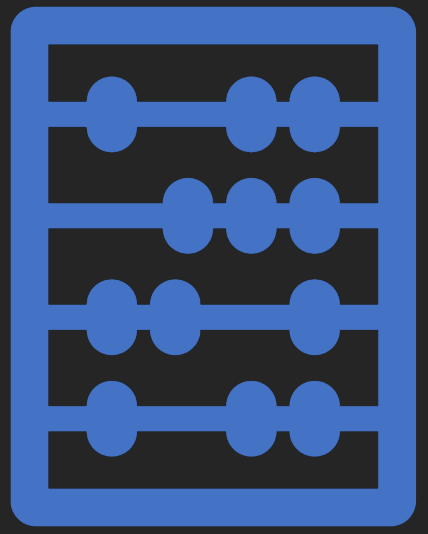
Calculation Engine

Aggregation

Output

Quantitative Estimates

Forecasts

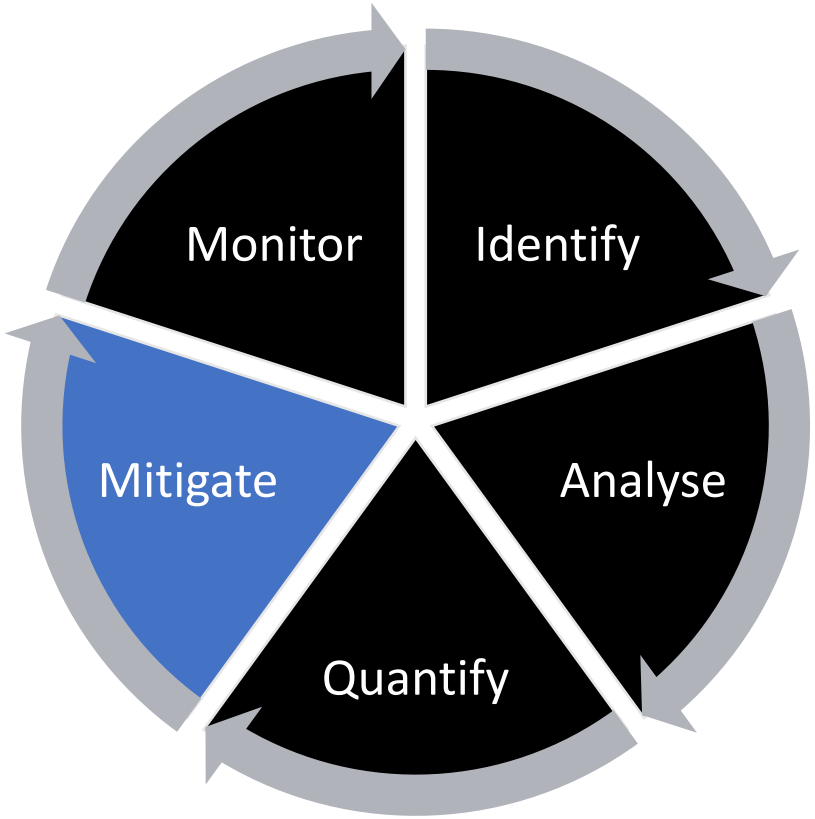


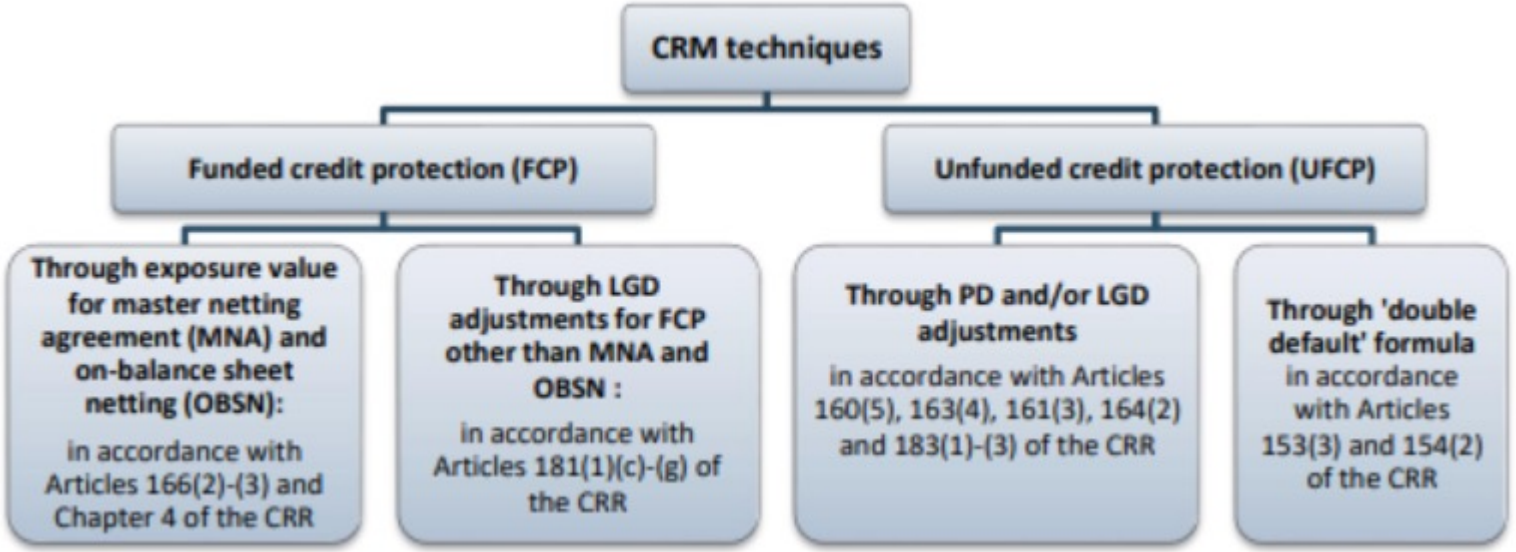
Model risk – what are the sources of this type of risk? Where can you find it?

‘**model risk**’ means the loss an institution may incur as a consequence of decisions that could be principally based on the output of internal models, due to errors in the development, implementation or use of such models, including the following:

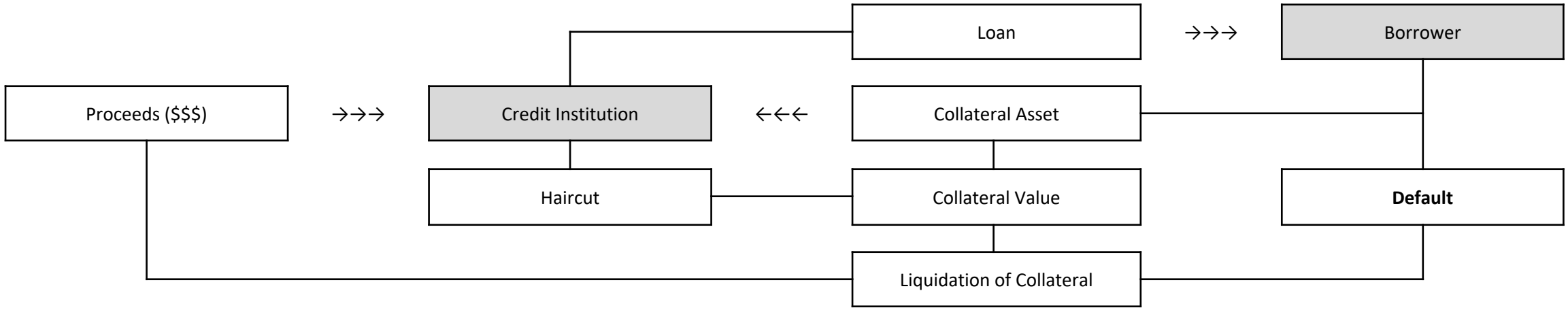
- (a) the improper set-up of a selected internal model and its characteristics;
- (b) the inadequate verification of a selected internal model’s suitability for the financial instrument to be evaluated or for the product to be priced, or of the selected internal model’s suitability for the applicable market conditions;
- (c) errors in the implementation of a selected internal model;
- (d) incorrect mark-to-market valuations and risk measurement as a result of a mistake when booking a trade into the trading system;
- (e) the use of a selected internal model or of its outputs for a purpose for which that model was not intended or designed, including manipulation of the modelling parameters;
- (f) the untimely and ineffective monitoring of model performance to assess whether the selected internal model remains fit for purpose;

EBA Guidelines on credit risk mitigation for institutions applying the IRB approach with own estimates of LGDs





The collateral is only utilised by a bank in a case of bankruptcy of the obligor. Figure below shows that a bank assesses the value of the collateralised asset and applies a haircut that reduces the asset value. This would mean that a collateralised asset valued at EUR 100 would be worth less upon the application of a haircut (e.g. EUR 80 if the haircut is 20%). The challenge faced by banks is to find an appropriate value for a given type of collateral that should be sensitive to the changing macro conditions and balanced between being conservative enough to deliver a minimum level of credit risk protection and being least detrimental to the borrowers.

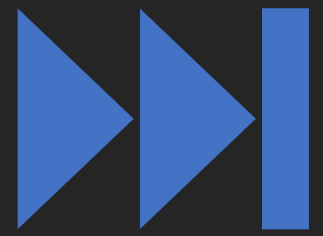


Collateral – what is the appropriate value of the haircut? What drives the haircut?

What we learnt so far….

- How to read and interpret regulations…
- How to design KRIs…
- What risk is inherited in credit risk models…
- How credit risk is managed….

Seminar Case Studies



- Data Quality Checks
- Credit Concentration Risk
- Default Consistency (Cyclicality)
- Backtesting

Data Quality

Data Quality – how important is data quality?
What data quality gaps do you know?

Dimension	Explanation
Completeness	Values must be present in the attributes that require them. Is defined as the availability of the required information. Completeness checks are carried out to detect missing information.
Timeliness	Data values are up to date.
Validity	Data are founded on an adequate and rigorous classification system.
Availability / Accessibility	Data are made available to the relevant parties.
Consistency	A given set of data can be matched across different data sources of the institution.
Accuracy	Data is substantively error-free. Is interpreted as the absence of mistakes and exact correspondence of the reported values with the underlying concept for each data point. Accuracy is ensured by a set of validation rules that have to be respected by the reported data.
Uniqueness	Aggregate data are free from any duplication from filters or other transformations of the source data.
Traceability	The history, processing and location of the data under consideration can be easily traced.
Representativeness	Historical data are representative of current portfolio.

Data Quality – Spotlight on Completeness

- **Completeness** is defined as the data property which covers the way how the data is identified, defined and present against the following aspects:

SCOPE

- Scope of the historical data equal to the model scope and corresponding data requirements
- All primary keys are present in the dataset
- All relevant ID fields are in the dataset
- All relevant date and timestamp columns are in the dataset
- All potentially relevant risk drivers are present in the dataset
- Variables functional forms are in line with requirements

DATA SOURCES

- Complete set of systems and data sources used
- Presence of legacy systems, historical systems migration or changed processes
- Data reconciliation between different sources providing the same data based on the functional specification
- Performed at primary keys level with the focus on completeness of the base dataset (where all relevant facilities and snapshots should be present)

HISTORICAL WINDOW

- The length of the underlying historical observation period used shall be at least five years for at least one source. If the available observation spans a longer period for any source, and these data are relevant, this longer period shall be used

Data Quality – Spotlight on Completeness

- **Completeness** is defined as the data property which covers the way how the data is identified, defined and present against the following aspects:

MISSING VALUES

- No missing values are allowed for primary inputs and mandatory fields
- Variables with share of uninformative missing values above 5% should not be used in the model development unless well justified
- Added value of external variables has to be assessed on a case-by-case basis, as share of missing values can be significant

MISSING SNAPSHOTS

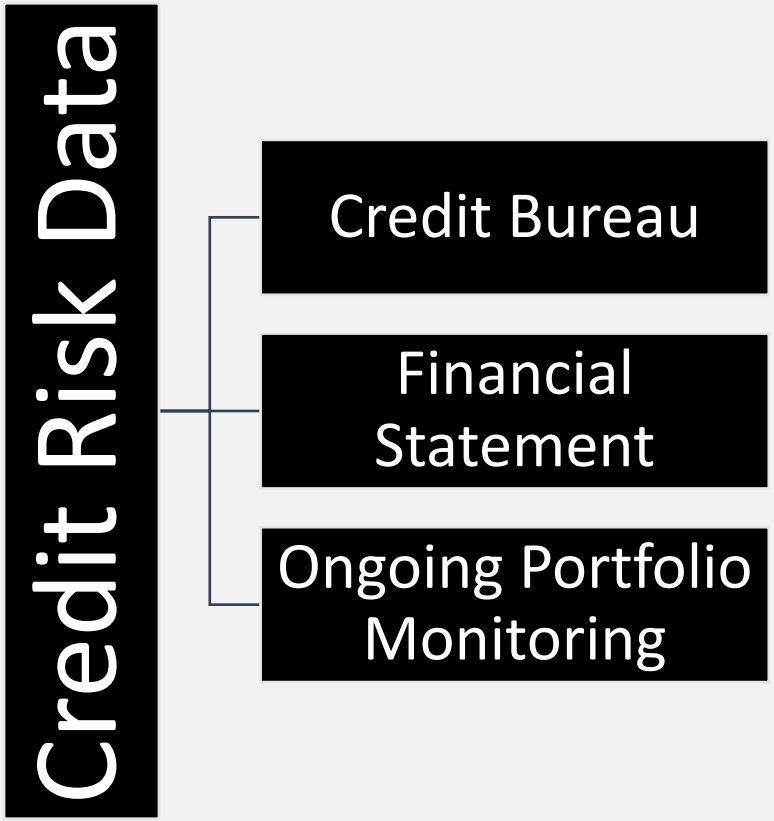
- Number of snapshots between the first snapshot date and the last snapshot date for a facility must be equal to number of unique records for that facility
- Difference between the initial and ultimate snapshot must be checked against documented data request

OTHER

- Plot number of obligors / facilities, total portfolio outstanding, default rate, loss

Data Quality – Spotlight on Timeliness

- **Timeliness** refers to whether the information around the different data aspects (e.g. clients, credit agreements, facilities, etc.) is up to date and available at the time of the model's predictions:



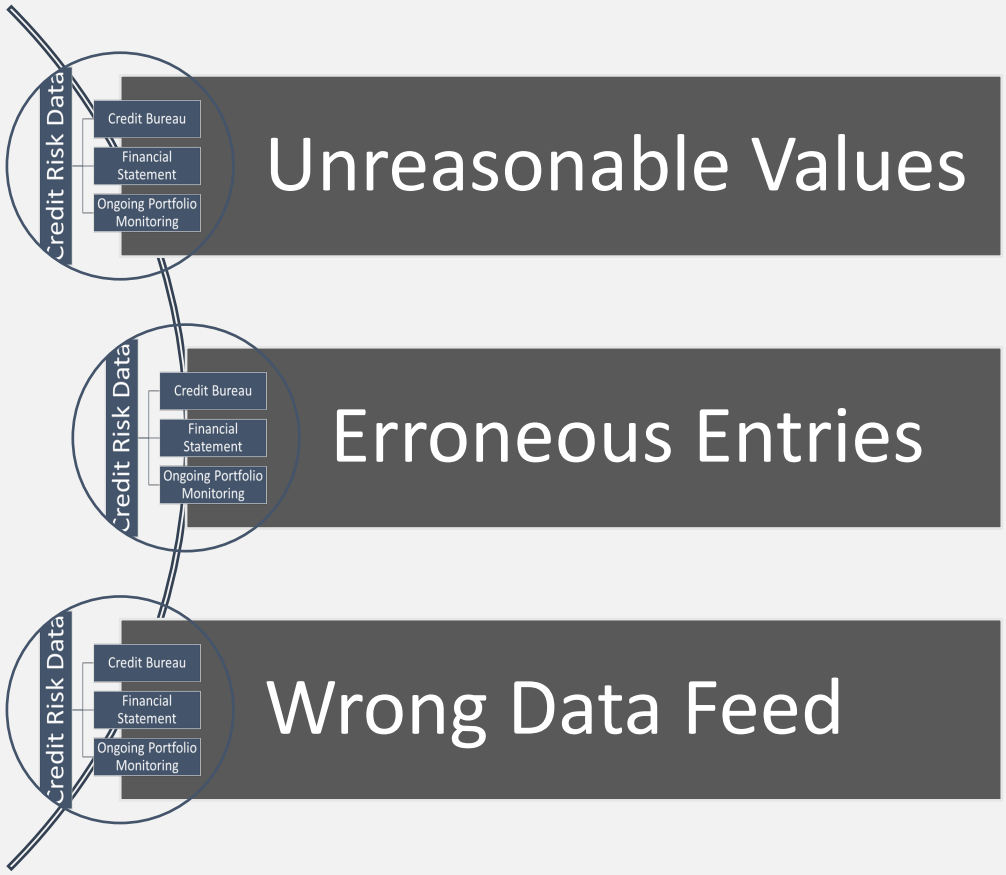
TIMELINESS

- Most recent historical data (given the predefined performance period) is available
- Credit bureau data is no older than 12 months
- Financial information is no older than 12 months
- Internal behavioral information is no older than 1 month

Data Quality – Spotlight on Validity

CASE STUDY

- **Validity** refers to which extent the data is founded on an adequate and rigorous classification system:



Validity

- Field observed data type match with the expected one as defined in the source system, (e.g. variables such as age of obligor or year are expected to be an integer)
- Values observed in the variables are in line with internal policies
- If the observed value is not in line with basic logic, it has to be checked with Business
- If the observed value falls outside predefined range / domain, it has to be checked with Business
- Some fields (especially primary keys such as obligor or facility identifiers) often have a fixed length. Therefore, it is useful to check whether potential duplicates are not a consequence of identifiers truncation.

Data Quality - Spotlight on Consistency

CASE STUDY

- **Consistency**: Evaluate whether:
  - The same data has been used in different model use domains such as capital calculations, business and regulatory reporting or provisions.
  - The data collected from different source systems is consistent (the same primary key can be observed in different data sources used)
  - The related input/output fields retrieved from different sources display consistent values (e.g. a default flag =1)
  - The data is consistent (e.g. in terms of number of defaults, clients, exposures)
    - CASE STUDY: Goodness of Fit (Excel)

$$\chi_c^2 = \sum \frac{(O_i - E_i)^2}{E_i}$$

The subscript "c" is the degrees of freedom (n-1). "O" is your observed value and E is your expected value. It's very rare that you'll want to actually use this formula to find a critical chi-square value by hand. The summation symbol means that you'll have to perform a calculation for every single data item in your data set.

Credit Concentration - what is credit concentration risk?

BANK OF ENGLAND
PRUDENTIAL REGULATION AUTHORITY

United Kingdom
North America
South American, Latin America & Caribbean
European (West) Area
Eastern Europe & Central Asia (including Russian Federation)
East Asia & Pacific
South Asia
Middle East & North Africa
Sub-Saharan Africa

Credit concentration risk is the risk of losses arising as a result of concentrations of exposures due to imperfect diversification. This imperfect diversification can arise from the small size of a portfolio or a large number of exposures to specific obligors (single name concentration) or from imperfect diversification with respect to economic sectors or geographical regions.

Agriculture, Forestry and Fishing
Construction

Finance Industry
Real Estate
Manufacturing
Mining and Quarrying
Retail/Wholesale Trade
Business Services & Other
Transport, Utility & Storage

Data Quality – Spotlight on Accuracy

CASE STUDY

- **Accuracy**: the inputs (risk drivers) and outputs (risk parameters):
  - Do not contain errors as descriptive statistics and/or distributions are consistent throughout the modelling period selected and display values expected for the variable;
  - Do not contain large number of unexpected outliers and the existent ones are justified by the business and appropriately documented;
  - Do not contain concentration bias (risk concentration):

$$HHI = \frac{\sum w_i^2}{(\sum w_i)^2}$$

Where w_i denotes the EAD-measured credit concentration risk per defined category *i*. The following measures of the concentration risk are taken

	11.1% < HHI ≤ 24.9%
	24.9% < HHI ≤ 34.5%
	34.5% < HHI ≤ 47.8%
	47.8% < HHI ≤ 77.9%
	77.9% < HHI ≤ 100%

Backtesting Model Performance Tests

Focus on Financial Collateral

Backtesting of Credit Risk Models

Backtesting Process	Validation Focus
Calibration	Assessment of the deviation of the internal model's estimates from the realised observations.
Discrimination	Assessment of the extent to which bad realised observations are assigned low internal model's estimates and the good realised observations are assigned high estimates.
Stability	Assessment of the changes to the population over time that affect the appropriateness of the internal model.

- Backtesting is a model validation process that compares the internal model's estimates with the actual realised observations.
- The purpose of initiating a backtesting exercise is to evaluate the predictive power and performance of a model and how the model performs over time. Backtesting serves to flag model deterioration, when a backtested model starts to underestimate or overestimate risk.
- The backtesting process assesses the following characteristics of the internal models: **calibration**, **discrimination** and **stability**.

- Sensitivity

CASE STUDY

KAPPA COEFFICIENT

You want to apply the Kappa statistic to determine the agreement between the two time series of returns. One series represents the underlying equity in your portfolio of credit collateral, and the other time series is for the risk proxy that is used as an aggregate risk indicator for equity-type collateral (a relative index).

At this point, returns are calculated on the closing prices for both the equity (collateral) and the index (risk proxy used in the model).

You assume that for the Index to be an adequate (sensitive) risk proxy, it must move in unison with the underlying collateral. For example, if an equity price decreases, then the index price should decrease as well on the same day. This would prove that the proxy remains sensitive and accurate, and no unexpected behaviour is recorded.

Data Quality – Spotlight on Accuracy

CASE STUDY

• Kappa Coefficient

The Kappa coefficient is defined by the difference between the observed agreement between the two series of calculated returns and the probability of chance of agreement. Embarking on the formula proposed by Galton (1892), the Kappa coefficient is computed as follows:

$$K = \frac{P_x - P_{chance}}{1 - P_{chance}} = 1 - \frac{1 - P_x}{1 - P_{chance}}$$

Where "P_x" is the relative observed agreement among returns between the equity (collateral) and its proxy (index) and "P_{chance}" is the hypothetical probability of chance agreement obtained from the observed data to calculate the probabilities of each return being assigned to the same category (increase/decrease – expressed as a daily change in closing prices). At this point, the Kappa coefficient measures the agreement in the returns. **However, it does not measure the degree of the variability of the returns**.

A Traffic Lights Approach indicating the level of agreement between the two time series is implemented to interpret the results:

	0.8 ≤ Kappa ≤ 1
	0.6 ≤ Kappa < 0.8
	0.4 ≤ Kappa < 0.6
	0.2 ≤ Kappa < 0.4
	0 ≤ Kappa ≤ 0.2

What we learnt so far….

- Some quant stuff….
- Critical thinking….
- Analytical approach to credit risk…
- Importance of DATA QUALITY!!!!!