PRODUCTS & SERVICES

CONTENTS

We are an independent consulting company that implements projects for financial institutions in the area of credit, market and operational risk management. Our team of specialists in mathematics, statistics, programming and finance bring a wide range of knowledge and experience, creative approach, and proven solutions.

QC HISTORY

2002

Beginning
QC is established as specialized credit risk consulting division of Medianresearch, a.s.

2009

Independent company
QC spins-off from Medianreserach and becomes an independent risk consulting company

2010

International expansion
QC acquires first international clients in Slovakia, Austria, Hungary and Romania

2021

Stabilized team
QC team expands to 10 consultants across managerial and analytical positions

2024

Revenue milestone
QC surpasses €1 million revenue threshold

QC TODAY

10 countries

1 million EUR annual revenue

15 employees

15+ years on the market

100+ projects

* Czech Republic, Slovak Republic, Belgium, Bulgaria, Austria, Slovenia, Hungary, Romania, Germany and Poland

OUR CLIENTS

International banks

novakbm otp group

Raiffeisen BANK

ERSTE Group

INTESA SANPAOLO

KBC

otpbank

UniCredit Bank

Czech banks

MONETA MONEY BANK

UniCredit Bank

ČSOB

wüstenrot

Equa bank

Fio banka

ČESKÁ spořitelna

PPF Banka

TRINITY BANK

Partners

CREATIVE DOCK

trask

Grant Thornton

pwc

Corporates

akcenta forex and payments

CEZ GROUP

ExxonMobil

MODELING

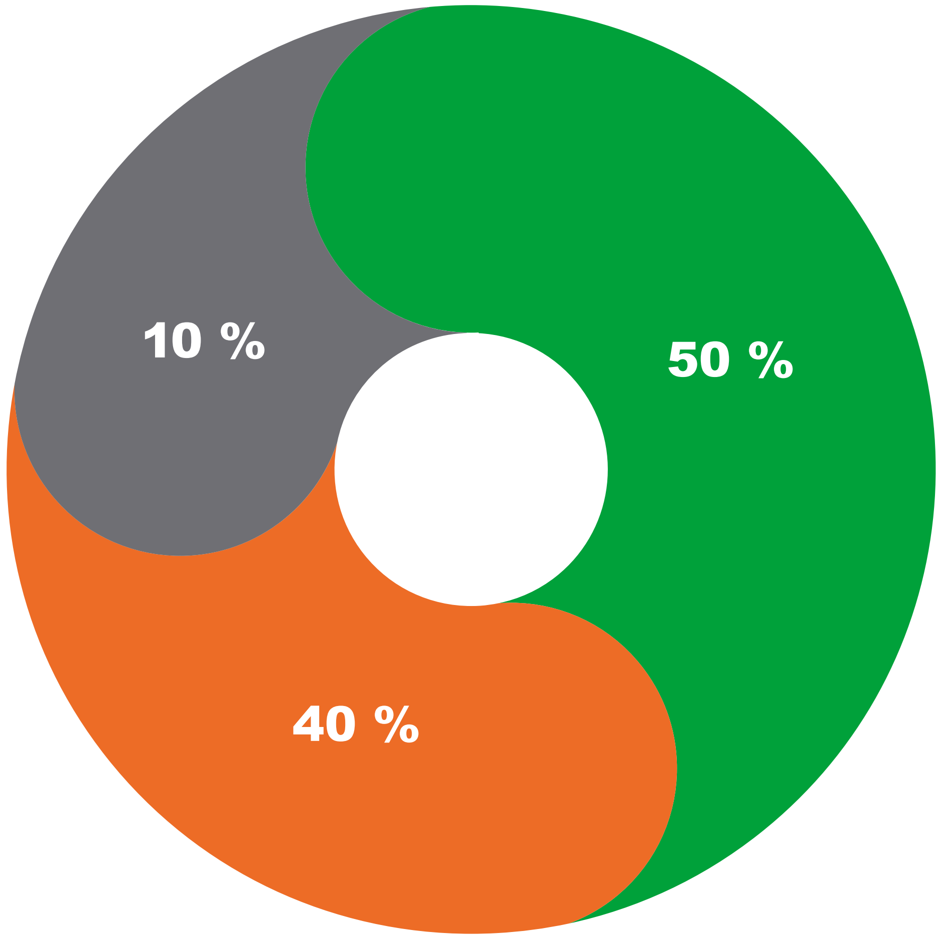
Our experts possess wide experience with the development of credit, market and operational risk models. We deliver projects from standardized tasks such as the development of underwriting PD scorecards, regulatory IRB, IFRS9 and IRRBB modelling to specialized and niche problems such as macroeconomic scenario generation, development and testing of MoC methodologies, nowcasting models using high frequency and Google trends data, or Bayesian models. Thanks to our wide working experience and deep academic background, we are able to provide innovative modelling methodologies compliant with regulatory requirements.

VALIDATION

We value 'practical' approach to model validation focusing on the key and most material problems from not only regulatory, but also business perspective. In other words, while meeting the regulatory requirements is a must, we concurrently aim to provide maximum value for our validation clients. We have also experience with building, reviewing and enhancing regulatory as well as non-regulatory validation frameworks. QC is an owner of ECB approved validation methodology.

AUDIT

QC provides support in internal audit departments in their assessment of credit, market and treasury risk models. Thanks to our partnership with Big 4 companies, we regularly participate on external credit risk and treasury audits of major Czech as well as European banks.



CONTENTS

PARTNERS


Jiří Witzany
CEO, CFO | Partner


Pavel Charamza
HR Director | Partner


Petr Veselý
Research | Partner

MANAGERS & EXPERTS


Michal Kuchta
Director


Martin Cigán
Manager


Milan Fičura
Director | Research

ANALYTICAL TEAM


Nikolai Pravdin
Senior Consultant


Petra Tomanová
Senior Consultant


Alexander Mačejovský
Senior Consultant


Vladimír Turek
Consultant


Masood Tadi
Consultant


Kamila Dolejšová
Consultant


Jakub Smorada
Consultant


Karolína Jindrová
Consultant

PEOPLE

Jiří Witzany

CEO, CFO | Partner

Jiří is an expert in credit risk, financial derivatives, and market risk modeling. He brings extensive management and consulting experience from several prominent Czech banks, with a particular emphasis on portfolio and credit risk management.

He previously worked at Komerční banka, where he built a modern market risk management system. Concurently, he oversaw the implementation of the Trema dealing system, the middle office function, and the management information system for financial markets trading. He became the director of credit risk management, primarily responsible for the development of scoring functions, credit risk reporting and data management, Basel II implementation, and real estate valuation.

He is a professor of finance at the Faculty of Finance and Accounting of the University of Economics and the director of the postgraduate program in financial engineering. He imparts his expertise on financial matters at the Faculty of Mathematics and Physics at Charles University. He lectured at both the Pennsylvania State University and the University of California.

Jiří completed his mathematics studies at the Faculty of Mathematics and Physics at Charles University and received his PhD from the Pennsylvania State University.

Pavel Charamza

HR Director | Partner

Pavel possesses strong analytical and mathematical skills, along with expertise in credit risk assessment and scoring. His work experience includes fraud prevention, underwriting and collection processes, media analysis, stochastic optimization, and big data applications in banking. He has extensive international top management experience.

Formerly, he was responsible for developing credit risk models at Komerční banka. He significantly helped Komerční banka become a leader in applying scoring functions and generally in credit risk management system among domestic banks. He spent 8 years as a member of the Board of Directors at Mediaresearch, where he was responsible for development and analyses. He founded and managed the CRA System – a quantitative risk management division of Mediaresearch. He also worked as the Chief Risk Officer of Home Credit China, and then as the Group Chief Risk Officer of Home Credit International.

Pavel has been teaching at the Department of Probability and Mathematical Statistics at Charles University for over two decades. Currently, he delivers lectures on sampling theory at the same department and teaches credit risk topics at the University of Economics.

He graduated from the Faculty of Mathematics and Physics at Charles University where he received his PhD.

Petr Veselý

Research | Partner

Petr has extensive experience in credit risk and mathematical modeling. He focuses on scoring function development, early warning systems, risk premiums, loan loss provisioning, and Basel regulation.

Previously, he has collaborated with a number of bank institutions, especially in the areas of portfolio and credit risk management.

His work experience includes the position of Head of the Department of Scoring and Portfolio Management at Komerční banka. He held positions as the Head of the Department of Portfolio Management at eBanka and as the Head of the Department of Credit Portfolio Management at Raiffeisenbank. Finally, he was Head of the Department of Portfolio Management and Reporting at Sberbank CZ.

He studied at Charles University, particularly at the Faculty of Mathematics and Physics, where he successfully completed his PhD in probability theory.

PEOPLE

Michal Kuchta
Director

Michal is a modelling and regulatory expert with over eight years' working experience with leading European banks. His primary focus is on credit risk modelling and validation (both IFRS 9 and A-IRB), market risk modelling (IRRBB), macroeconomic forecasting and model governance – the definition of internal processes, set up and revision of monitoring and validation frameworks. As a director, Michal is responsible for the development of QCs analytical team and company strategy.

His main working experience include development of multiple IFRS9 and A-IRB models, development and implementation of validation and monitoring frameworks, addressing ECB IMI obligations and findings, development of MoC framework, validation team lead covering annual validation for regulatory purposes, A-IRB and IFRS9 models, and external audit of IFRS9 models of major European banks.

He previously worked as an International Economist, Macroeconomic forecaster, and Risk Modeller at Moody's Analytics, headline provider of macroeconomic expertise, and as a Manager at PwC.

He received a master's degree in economics and a master's degree in financial engineering with a minor in data engineering. Currently, he is also a PhD candidate in economics and finance.

Milan Fičura
Director | Research

Milan is a research director at Quantitative Consulting with over 11 years of experience in advanced credit (IFRS9, A-IRB) and market risk (IRRBB) modelling and model validation. As a research director, Milan focuses on the development of advanced modelling approaches, development of innovative and pioneering methodologies and provides methodological support on wide range of QC projects.

His main working experience includes leading multi-year validation projects covering bank-wide risks (IFRS9, underwriting scorecards, ICAAP, ILAAP, IRRBB, CSRBB), development of multiple IRRBB models, development of MoC framework, addressing ECB IMI findings and obligations, valuation of complex derivatives, and the development of models for asset pricing and portfolio management.

Milan received a master's degree in financial engineering and has a Ph.D. in Finance. He also lectures on portfolio management, computational finance, derivatives valuation and credit risk modelling at the Prague University of Economics and Business

Martin Cigán
Manager

Petr has extensive experience in credit risk and mathematical modeling. He focuses on scoring function development, early warning systems, risk premiums, loan loss provisioning, and Basel regulation.

Previously, he has collaborated with a number of bank institutions, especially in the areas of portfolio and credit risk management.

His work experience includes the position of Head of the Department of Scoring and Portfolio Management at Komerční banka. He held positions as the Head of the Department of Portfolio Management at eBanka and as the Head of the Department of Credit Portfolio Management at Raiffeisenbank. Finally, he was Head of the Department of Portfolio Management and Reporting at Sberbank CZ.

He studied at Charles University, particularly at the Faculty of Mathematics and Physics, where he successfully completed his PhD in probability theory.

CONTENTS

List of Topics

1. ***Data quality***
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3. ***Internal rating based approach***
4. ***IFRS9 – ECL***
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   ii. *Operational risk*
   iii. *Credit concentration risk*
   iv. *Interest rate risk of the banking book (IRRBB)*
   v. *Credit spread risk of the banking book (CSRBB)*
7. ***Nowcasting***
8. ***Automation solutions***
9. ***Model monitoring***
10. ***Underwriting process***
11. ***Seminars & workshops***

DATA QUALITY FRAMEWORK

INTRODUCTION

High quality data is the core for any further work.
After data are collected, list of tests should be performed to evaluate:

- ✓ what is the **quality of the data**,
- ✓ what are the **most serious drawbacks**, and
- ✓ Whether data can be **further used** for modelling, validation, monitoring, or reporting.

WHY SHOULD WE CARE?

Poor data quality → **The best ever** model development → **Poor model**

IRB BANK?

ECB guidelines require IRB banks to follow data quality framework and perform data quality checks, which goal is to assure a high quality of the modelling data. Well-developed framework can also provide regular quality report.

NON-IRB BANK?

Non-IRB banks can get the **advantage of high-quality** IRB standard framework which can be used as a general guideline for setting their own data quality framework, thresholds and list of tests.

REGULATIONS:

- ECB Supervisory Data Quality Framework, Tools and Products (ECB, 2017)
- ECB guide to internal models, Risk-type-specific chapters (ECB, 2019)
- Targeted Review of Internal Models (TRIM) - Documentation request and list of mandatory data quality tests (ECB, 2018)

DATA QUALITY DIMENSIONS

Quality of the data is measured via **8 dimensions** which can reveal potential problems that could lead to biased and inaccurate reports, models etc. Therefore, the best practise is to set quantitative thresholds and evaluate the results (i) for each DQ check separately, and (ii) for all checks together to be able to assess the quality jointly.

1. COMPLETENESS — The values are present in any attributes that require them.
2. ACCURACY — The data are substantively error-free.
3. CONSISTENCY — Data values agree across different data sources.
4. VALIDITY — Data strictly follow classification system, contain valid values.
5. UNIQUENESS — The data are free from duplications.
6. TIMELINESS — The data values are up to date.
7. AVAILABILITY — The data are made available to the relevant stakeholders.
8. TRACEABILITY — The history, processing and location can be traced back.

AUTOMATION SOLUTIONS – DATA QUALITY TOOL

INTRODUCTION

Our Data Quality tool implements QC Data Quality Framework across dimensions of Completeness, Accuracy, Validity, Timeliness, and Uniqueness.

Based on input parameters, it performs **17 data quality checks**, summarizes their outcomes, and export the results in ready-to-report format.

It empowers its users to implement checks based purely on **logical relations** within the data without the need to code and gives opportunity for building a robust set of business specifications which the data are expected to adhere to.

TOOL OUTPUT

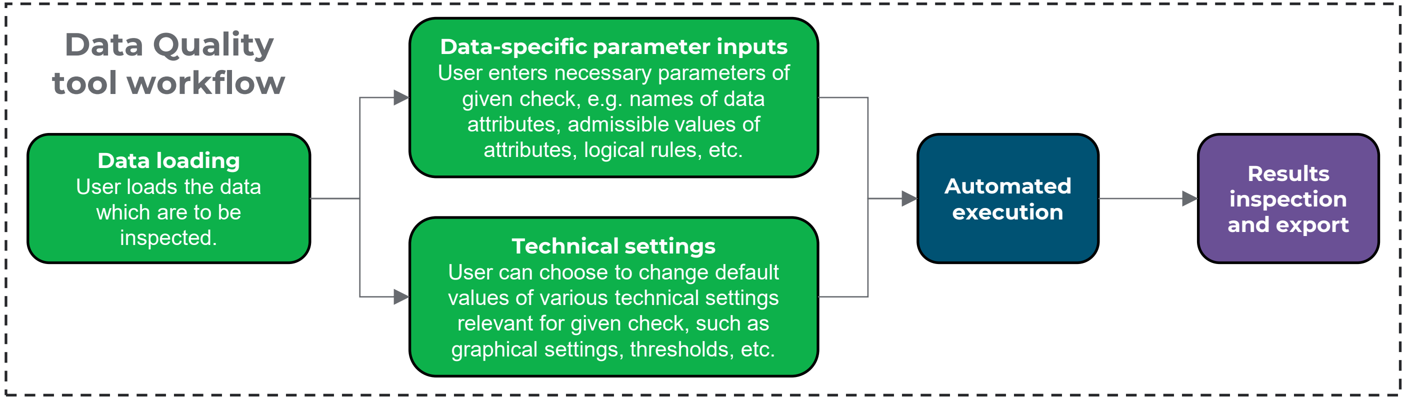
Tool provides **Pass/Fail flags** of individual observations.
Outcomes are aggregated into number and exposure weighted **sums and percentages**.
Results can be **grouped** across selected dimensions, which can provide crucial insight into data behaviour.

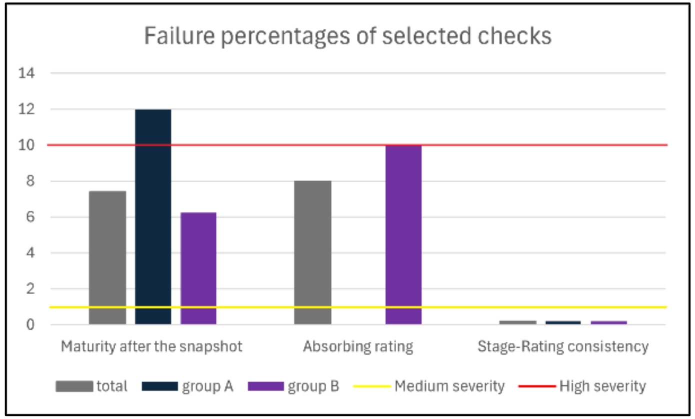
WHY SHOULD WE CARE?

Our data quality tool offers **quick, easy to manage**, and yet **robust** way to gain **overview** of client's data, discover potential issues, and point to their likely sources.

Tool can test relations between data attributes which user enters as purely logical expressions.

Rule Name	Logical Rule
Maturity after the snapshot	[in_default = False] -> [mat_date >= obs_date]
Stage-Rating consistency	[stage = 3] <-> [rating >= 10]
Absorbing rating	[Lag(rating) = 99] -> [rating = 99]
Applied absorbing rating	[abs_rating_applies = True] -> [[Lag(rating) = 99] -> [rating = 99]]



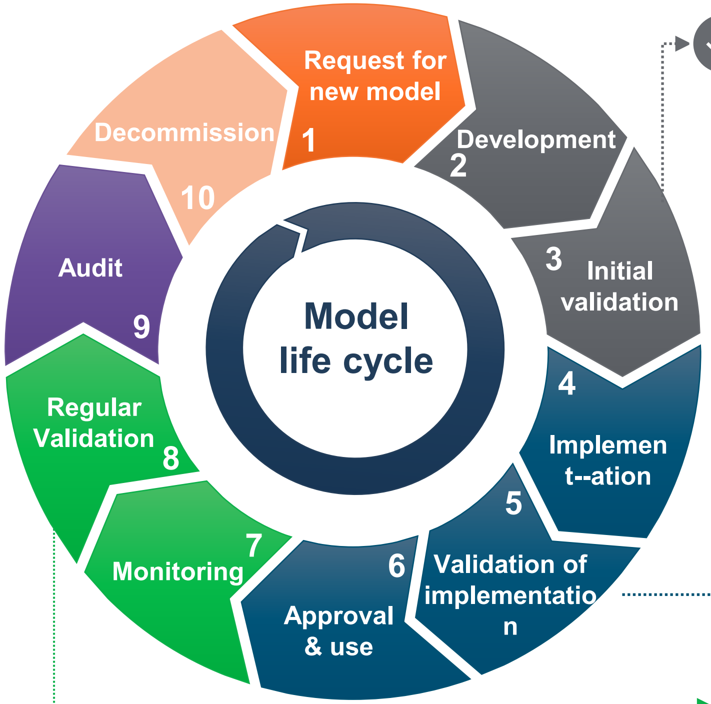


INTRODUCTION
Model validation refers to the specific set of activities aiming to ensure the conceptual and methodological model **soundness**, its **fit for purpose** and **satisfactory performance** over time.
Contrary to audit, validation findings may contain not only what needs to be done, but also how it should be done.

Second line of defence
Validation verifies models and reviews the documentation produced by the development team, **guaranteeing that the first line** of defence is **working according to the specifications.**

Validation independence
A sufficient level of **Validation unit's independency** from related underwriting or modelling processes allows to **avoid a conflict of interests**.

Regulatory requirement
For IRB banks validation of internal models is among **mandatory requirements set by the regulator**.



Relevant regulations:
- ECB guide to internal models – Credit risk (2024)
- EBA/REP/2023/29 – Supervisory handbook on the validation of rating systems under the IRB approach (2023)
- EBA/GL/2022/14 – Guidelines on the management of IRRBB and CRRBB (2022)

Initial validation
- Performed when a **new model is developed** or after **material changes** to existing model.
- Assesses a **wider set of model's characteristics,** allowing for a more comprehensive assessment.
- Provides a valuation of model's **initial state**, serving as a **baseline** for on-going validations and monitoring.

Implementation validation
- Performed during implementation phase, **before** concerned model is **put into operation**.
- Fucuses on a **technical correctness** and **operational efficiency** of a model implementation in the actual computer code.
- Ensures that implemented model are **in line the documented model** methodology.

Regular validation
- Performed regularly at a **specified frequency** or because of a monitoring warning signal.
- Focuses on model's **current performance** compared to its initial state and previous validation results.
- Allows to manage **inherent model risk** and to **timely intervene** in case of a significant model's performance deterioration.

INITIAL & IMPLEMENTATION VALIDATION

INITIAL VALIDATION
is an essential first step of validation cycle for any model, as it allows not only for a **complex assessment** of the model before its implementation but also **determines a baseline** for future valuations of model's performance.
It acts as an **additional layer of defence**, allowing to efficiently measure and manage **residual model risk** – the risk coming from imperfections of the modelling process that **cannot be removed** but **only mitigated** by internal control functions – by **revealing modelling deficiencies** or errors and **providing a proposal for corrective actions** before model's implementation into Bank's internal processes.

IMPLEMENTATION VALIDATION
is a follow-up of initial validation, as it allows to assess **correctness of the implementation** of a model **into an actual computer code** with respect to the documented model methodology.
Unlike initial or regular validations, it rather makes focus on **risks related to IT environment** in which models are implemented, ensuring its **integrity and robustness**.
As such, implementation validation may be required not only when implementing a newly developed model but also in case of **material IT-related changes** (e.g., update of implementation software) or **changes in a range of model application**.

QC's standard validation methodology addresses all aspects of model risk:

Model governance
- Assignment of **roles & responsibilities**
- Mitigation plan for **findings**
- Formulation and assignment of **tasks**
- Documentation **versioning**

Data appropriateness
- **Data sources** assessment
- **Data quality** assessment
- **Representativeness** analysis

Qualitative assessment
- Model **fit for purpose**
- **Conceptual** model soundness
- **Methodological** soundness
- Quality of **documentation and codes**

Quantitative assessment
- **Benchmarking / Challenger** model
- Model **testing** and **back-testing**
- Model **performance**
- **Materiality** of issues and deficiencies

Initial validation objectives
- **To assess methodological soundness and robustness of a model.**
- **To challenge modelling assumptions and limitations.**
- **To check the quality and representativeness of modelling data.**

Implementation validation objectives
- **To assess technical correctness of implementation codes.**
- **To assess operational efficiency of calculation processes.**
- **To ensure that the implementation of the models is successful and error-free.**

QC experience:
- **Major Belgian banking group**
  - Initial validation of A-IRB and IFRS9 models for Czech and Belgian portfolios
- **Major Czech Bank**
  - Validation of application and behavioral PD models for retail, mortgages SME and corporate portfolios
- **Major Slovenian bank**
  - Development of custom-fit validation methodology
  - 8+ years of initial validation of all internal models

REGULAR VALIDATION (CREDIT RISK)

REGULAR VALIDATION of internal models is a **mandatory requirements set by the regulator** for **IRB banks:**

"The on-going validation aims at ensuring the adequate model performance and appropriateness of the model for IRB purposes on an on-going basis." (EBA/REP/2023/29)

Although it is not mandatory for non-IRB banks, regular validation remains a useful tool for management of **inherent model risk** – the risk embedded in the model (or portfolio) that **cannot be removed** but **only mitigated** by internal control functions.

Regular validation objectives

To test the performance of the model on newly available recent data.

To assess the validity of methodological assumptions and modelling choices.

To check the impact of internal, market or legal changes on the portfolio and model.

Every validation framework should comply with the set of **additional regulatory requirements:**

1. Validation unit **should be independent** from underwriting and model development.
2. Regular validation to be performed **at least on annual frequency**.
3. Applied validation procedures and test are **in line with those prescribed by the regulator** for a relevant model type.
4. Validation results are **reported** directly to the **senior management**.
5. All validation findings and recommendations **are addressed in a timely manner**.

QC's standard validation methodology addresses all aspects of model risk:

Model governance
- Assignment of **roles & responsibilities**
- Mitigation of validation **findings**
- Timely completion of **tasks**
- **Versioning** and description of changes

Data appropriateness
- **Data quality** assessment
- **Representativeness** analysis
- **Evolution** of portfolio

Qualitative assessment
- **Conceptual** model soundness
- **Industry & macroeconomic** outlook
- Materiality of **recent changes**

Quantitative assessment
- **Benchmarking / Challenger** model
- **Back-testing** and **stability** analysis
- Model **performance**
- **Materiality** of issues and deficiencies

QC experience:
- **Major Belgian banking group**
  - 25+ Annual validations of A-IRB PD, LGD and EAD models for regulatory purposes
- **Major Slovak Bank**
  - Implementation of annual validation for LGD models
  - Annual validation of PD and LGD model for regulatory purposes
- **Major Slovenian bank**
  - Development of custom-fit validation methodology
  - 8+ years of regular validation of all internal models

REGULAR VALIDATION (IRRBB & CSRBB)

REGULAR VALIDATION of internal models is a **mandatory requirements set by the regulator** for **banks using internal IRRBB and CSRBB models:**

“Upon approval, the model should be subject to ongoing review, process verification and validation at a frequency that is consistent with the level of model risk.” (EBA GL - IRRBB, 2022)

Regular validation objectives

- **To test the performance of the model on newly available recent data.**
- **To assess the validity of methodological assumptions and modelling choices.**
- **To check the impact of internal, market or legal changes on the portfolio and model.**

Every validation framework should comply with the set of **additional regulatory requirements:**

1. Validation unit **is independent** from the model development to prevent the conflict of interest.
2. Validation is performed at a **frequency** that is consistent with **the level of approved model risk**, but **at least annually** as considered by ECB.
3. Validation results are reported to the management body, and **all validation conclusions, findings and recommendations are addressed** in a timely manner.

While **minimum requirements** on the extensiveness of validation procedures follow the **principle of proportionality,** regulatory specifies **five core elements** that should always be included into institution’s validation framework of internal **IRRBB** models:

CORE ELEMENT:	OBJECTIVE:	APPLICABLE SOLUTION:
Evaluation of conceptual & methodological soundness	To revaluate model soundness in case of material portfolio changes or a significant deterioration of model performance.	Qualitative assessment based on the comparison with the benchmark and challenging of modelling assumptions.
Ongoing model monitoring	To verify the sufficiency of monitoring process, and to assess the monitoring results.	Verification of the completeness and frequency of monitoring reports, occurrences of warning signals and corresponding follow-up processes.
Outcomes analysis	To compare model’s predictions against the reality, and to assess its performance stability in time.	Back-testing of key internal parameters; Qualitative assessment of outcomes’ reasonability and credibility.
Assessment of experts’ input	To verify the validity of any expert opinions and judgements that were used in internal models.	Qualitative re-assessment of expert inputs in cooperation with responsible experts, and impact assessment in case of changes.
Validation of diversification assumptions	To verify if diversification assumptions made during the model development still hold.	Analysis of the portfolio’s evolution and representativity, including material changes in relevant products.

QC experience:

- **Major Slovenian bank**
  - Development of annual validation methodology for IRRBB and CSRBB models
  - 8+ years of regular validation of IRRBB and CSRBB models
- **Major Czech bank**
  - Internal audit of IRRBB models

INTERNAL RATINGS BASED APPROACH

INTRODUCTION

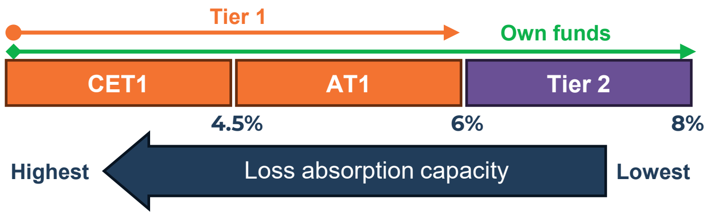
Banks calculate minimum capital requirements using the Standardized Approach (SA) or the Internal Ratings-Based Approach (IRB). Unlike SA, IRB uses precise internal estimates of Probability of Default (PD), Loss Given Default (LGD), and Credit Conversion Factor (CCF).

MINIMUM CAPITAL REQUIREMENT

Under Pillar I, banks must hold own funds of at least 8% of risk-weighted assets (RWA), meeting defined quality standards as follows:

- **Tier 1 capital** ≥ 6% of RWA
  Highest-quality going-concern capital for absorbing losses, comprising Common Equity Tier 1 (CET1) of at least 4.5% of RWA plus Additional Tier 1 (AT1).
- **Tier 2 capital**
  Supplementary gone-concern capital for absorbing losses, such as subordinated debt with lower loss-absorption capacity.

Own funds = Tier 1 + Tier 2 ≥ 8% of RWA



STANDARDIZED VS IRB APPROACH

	SA	IRB	
		Foundation IRB	Advanced IRB
Typical Bank	Small	Large & mid-sized	Large & mid-sized
Rating	External	Internal	Internal
Risk Weight	Uses external ratings. **Due diligence is carried out to assess risk of each exposure** and assign appropriate risk weight.	Uses regulatory capital requirement function with: • **Internal PD** • **Regulatory LGD** • **Regulatory CCF**	Uses regulatory capital requirement function with: • **Internal PD** • **Internal LGD** • **Internal CCF**
Required data	Low	Moderate	High

RISK-WEIGHTED ASSETS

Once the models are developed, parameters calibrated, and conservatism applied, the regulatory capital requirement K is calculated:

$$K = \underbrace{\left\{ \underbrace{LGD \times N\left(\frac{N^{-1}(PD) + \sqrt{R} \times N^{-1}(0.999)}{\sqrt{1-R}}\right)}_{VaR^{99.9\%}_{1-year}} - \underbrace{PD \times LGD}_{Expected\ loss} \right\}}_{Unexpected\ loss} \times MA$$

where R is asset correlation, and MA is maturity adjustment. Then, the RWA under the IRB is:

$$RWA_{IRB} = K \times 12.5 \times \mathrm{EAD}$$

Finally, output floor is applied as the following comparison with the RWA under SA:

$$RWA = max(72.5\% \times RWA_{SA}, RWA_{IRB})$$

Regulations & standards:

- BCBS 2004 - International Convergence of Capital Measurement and Capital Standards
- BCBS 2011 - Global Regulatory Framework
- BCBS 2013 - Principles for Effective Risk Data Aggregation and Risk Reporting
- BCBS 2019 - Finalising post-crisis reforms
- CRR (EU 575/2013) – Prudential Requirements
- EBA/GL/2016/07 - GL on Default Definition
- EBA/GL/2017/16 – GL on PD and LGD estimation
- EBA/GL/2019/03 - GL on Downturn LGD Estimation
- ECB 2024 - Guide to Internal Models

QC experience:

- **Major Belgian banking group**
  - Development of PD, LGD and EAD models
  - Initial and regular validation of IRB models
  - Addressing ECB obligations, supporting IMI
- **Major Slovak bank**
  - Annual validation of PD and LGD models
- **Major Czech bank**
  - Development of IRB methodology

INTERNAL RATINGS BASED APPROACH – OUR SERVICES

OUR IRB MODEL SERVICES INCLUDE:

1. DATA PREPARATION: We leverage our extensive knowledge with data and regulatorions to tackle the most demanding portfolios of our clients while maintaining high standards required by the regulator.

2. MODELLING: We specialize in building advanced models to estimate PD, LGD, and EAD, ensuring a clear and accurate picture of credit risk across your portfolio, as required under the Foundation or the Advanced IRB.

3. MARGIN OF CONSERVATISM CALCULATION: Our unique approach ensures the correct level of the margin is applied compliant to the regulations.

4. MODEL VALIDATION AND MONITORING: Ongoing validation and performance monitoring are essential for IRB model integrity. We provide continuous monitoring and recalibration services to keep your models compliant and accurate over time, meeting the ongoing validation standards.

5. REGULATORY COMPLIANCE & APPROVAL SUPPORT: Our team assists in preparing your models for regulator approval, ensuring all documentation, testing, and validation comply with the stringent standards set out by the Basel framework and local regulatory bodies.

6. METHODOLOGY DEVELOPMENT: We develop custom methodologies or support customers in their development process for all the steps afore.

7. SUPPORT AND TRAINING: We offer supporting services in periods of increased workloads and trainings for your teams.

IFRS 9 – ECL

INTRODUCTION

According to IFRS 9, banks must recognize a loss allowance for expected credit losses (ECL) on applicable financial instruments, with ECL described as:

- **Unbiased** → no conservatism
- **Forward-looking** → macroeconomic dependency
- **Probability-weighted** → optimistic, baseline and pessimistic scenarios
- **Discounted** → at the effective interest rate (EIR) to the reporting date

THREE-STAGE APPROACH

To calculate ECL, we identify each product's stage, which reflects its credit quality since recognition and specifies how ECL is calculated:

- **Lifetime ECL** – Credit-impaired instruments or instruments with significant increase in credit risk (SICR).
- **12M ECL** – Recognized non-credit-impaired instruments or instruments without a SICR.

	Stage 1	Stage 2	Stage 3
Asset Quality	Performing	Under-performing	Non-performing
Status	Initial recognition or no SICR	SICR	Objective evidence of impairment
Impairment	12M ECL	Lifetime ECL	

IFRS 9 vs BASEL

IFRS 9

- Ensures instruments reflect their true value.
- Incorporates macroeconomic factors as predictors.

BASEL (IRB)

- Ensures banks hold sufficient regulatory capital to absorb unexpected losses.
- Reveals potential capital reallocation by comparing loss provisions with Expected Loss.

	BASEL	IFRS 9
Philosophy	Based on **rules**	Based on **principles**
Estimation perspective	**Through the Cycle (TTC)**	**Point in Time (PiT)**
Bias	**Additional conservatism** (MoC, floors, caps)	**Unbiased**
PD/EAD horizon	**12M** horizon	**Beyond 12M** horizon
EAD/LGD Cost Coverage	**Direct** and **Indirect** costs	Only **Direct** costs
Discounting	**Discounted to default date**, usually with annualized 3M EURIBOR + 5% fixed add-on	**Discounted to reporting date** with EIR

OUR SERVICES & CONTRIBUTION

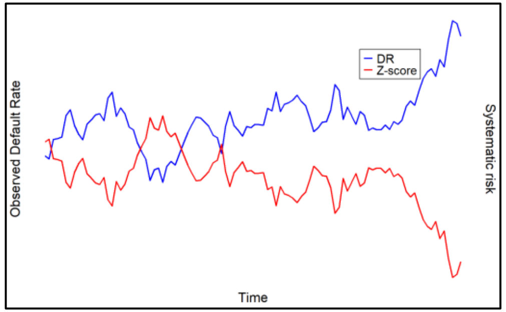
- **Data readiness & governance**
  Establishing data pipelines, quality controls, and governance structures for reliable ECL estimation.
- **Economic scenario construction**
  Designing base, upside and downside scenarios of macroeconomic variables.
- **Model design**
  Developing forward-looking models for PD, LGD, and EAD.
- **Model backtesting**
  Assessing model predictions against realized defaults and losses to ensure reliability.
- **Model validation**
  Conducting initial, implementation, and regular validation.

Regulations & standards:

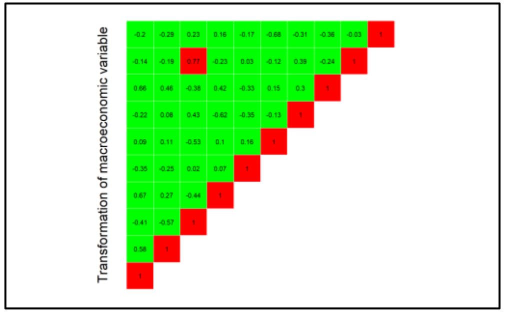
- BCBS 2015 - Credit risk and accounting for ECL Guidance
- EU 2016/2067 -Commision Regulation
- EBA/GL/2017/06 - GL on credit risk management and accounting for ECL
- EBA/GL/2018/01 – IFRS 9 transitional measures
- IFRS 9 2025 - Financial Instruments

IFRS 9 – ECL – CASE STUDY

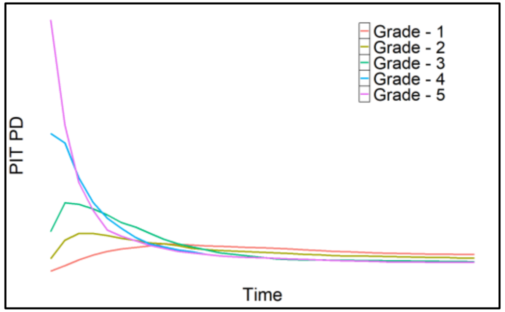
1. DATA PREPARATION:
TTC migration matrix is computed and Basel PDs (without MoC) are used as the TTC PDs. Systematic risk Z is derived as inversion of observed DR, based on the Merton model. Other parameters, such as asset correlation or the measure of PIT-ness incorporated in TTC PDs, are also calculated.



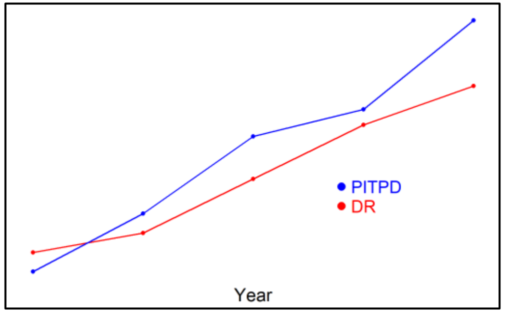
2. SELECTION OF VARIABLES
After selecting macroeconomic variables (MEVs) based on business rationale, we apply transformations on them (e.g., moving average, first difference). Then, we test their characteristics and use correlation matrix to identify combinations suitable for candidate models.



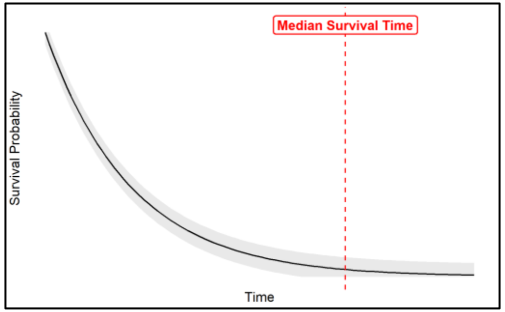
3. PIT PD CALCULATION
We begin by calculationg PIT PDs for each candidate model using MEV-based forecasts. We then, evaluate each model's predictive accuracy alongside its business rationale and select the one that delivers the strongest overal performance.



4. LGD & EAD:
LGD is determined as best estimate of Basel LGD excluding MoC. For instalment loans, EAD is calculated from prepayment schedules, and for revolving products, a predefined CCF and behavioural maturity based on Kaplan-Meier median survival time are used.



5. FINAL ECL AND BACKTESTING:
Finally, ECL is calculated and the model is backtested accross all stages. Furthermore, independent test are performed on model parameters for comprehensive evaluation. For example, PIT PD is computed on historical data and compared with the corresponding DR.



QC experience:

- **Major Belgian banking group**
  - Development of ECL models for SME portfolio
  - Initial validation of ECL model for Belgian mortgages
  - Annual validation of Czech mortgages, SME and retail SME portfolios
- **Major Bulgarian bank**
  - Development of 4 ECL models for Corporate, SME and retail portfolios
- **Big 4 company**
  - External audit support of major Dutch banks.

INTRODUCTION

Solvency Stress Test evaluates a bank's ability to withstand financial shocks arising from adverse scenarios that impact capital. Under Pillar II, the following stress tests (ST) are required:

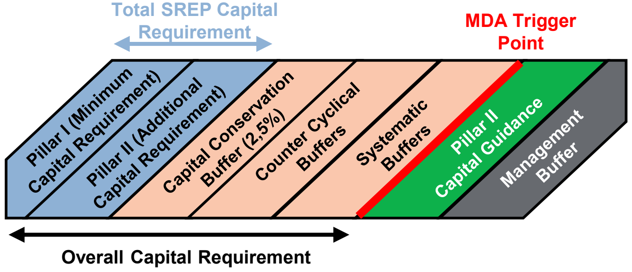
- **Comprehensive Assessment (Internal)**
- **Supervisory**
- **EU-wide**
- **Macroprudential**

CAPITAL REQUIREMENT - INTERNAL ST

ST checks if the bank holds enough capital under given scenario. The pass limit, which varies by scenario, is determined by:

- **Overall Capital requirement**
- **Pillar II Capital Guidance**
- **Management Buffer**

If capital drops below the Maximum Distributable Amount (MDA) Trigger Point, bank faces restrictions on payouts, such as bonuses or dividends.



RISK TYPES – INTERNAL ST

- Credit risk
- Market risk
- Profitability risk
- Operational risk
- Reputation risk
- Liquidity risk
- Non-Performing Exposure (NPE) Strategy risk

SCENARIO TYPES – INTERNAL ST

For each scenario type, the bank has to choose a balance sheet assumption:

- **Static**: Business plan is not followed after a severe crisis.
- **Dynamic**: Business plan is followed after small or no economic downturn.

Scenario	Description
Baseline	**Expected** economic and financial **development**.
Slow-down	**Slower economic growth** compared to business plan.
Aggravated	**Economic recession**, impacting all risks simultaneously.
Reverse Stress Testing	**Reverse-engineered scenario**, where SREP capital requirement is not met.
Adverse NPE strategy impact	**Negative effects on NPE reduction plan** by failing cure of certain NPEs and increasing LGD of NPEs.

OUR SERVICES & CONTRIBUTION

- **Scenario development**
  Design of plausible scenarios based on economic variables.
- **Sensitivity analysis**
  Assessing the degree of vulnerability to various risks and their impacts.
- **Impact assessment**
  Application of advanced statistical models to quantify effects on given portfolios and RWA.
- **Operational risk identification**
  Identifying and quantifying fraud, system failures, cyberattacks, and other operational risks.
- **Regulatory Compliance**
  Ensuring stress testing aligns with regulatory guidelines and requirements.
- **Validation**
  Conducting initial, implementation, and regular validation.

REGULATIONS & STANDARDS:

- CRD (2013/36/EU) - Capital requirement directive
- CRR (575/2013) - Capital requirement regulations
- EBA/GL/2016/10 - GLs on ICAAP/ILAAP information collected for SREP
- EBA/GL/2018/04 - GLs on institutions' ST
- EBA/GL/2022/03 - SREP GLs
- ECB 2017 - Multi-year plan on SSM Guides ICAAP/ILAAP

ICAAP

INTRODUCTION

ICAAP is an abbreviation for **I**nternal **C**apital **A**dequacy **A**ssessment **P**rocess which is a key component of the regulatory framework for financial institutions, particularly in the banking sector. Its main purpose is to ensure that a bank or financial institution has **sufficient capital to cover its risks, both in normal and adverse conditions.**
While **Pillar 1** covers the minimum capital requirements (CR) of the **fundamental part of credit, market and operational risks**, **Pillar 2** supported by ICAAP considers also **other types of risk** which can lead to an increase of CR.

WHY SHOULD WE CARE

Correct understanding, managing and measuring the risks **mitigate** the possibility of leading the institution into **financial problems**. **ICAAP is obligatory** and incorrect performance or omitting some risk types can lead to penalties and increase of CR.

QC CONTRIBUTION

QC has many years of experience in risk management in Czech and European banks where we have provided consultations, developed and validated various models along with appropriate monitoring and stress testing processes.

RISKS UNDER PILLAR 2 AND ICAAP

RISKS COVERED BY PILLAR 1 & 2

Credit risk: Probability of a financial loss resulting from a borrower's failure to repay a loan.

- Counterparty risk
- Concentration risk
- Residual risk
- Migration risk
- FX lending risk
- Real estate risk
- Default risk

Market risk: Probability of a financial loss resulting from behaviour of financial markets.

- Credit spread risk
- CVA/DVA risk
- Foreign exchange risk
- Position risk

Operational risk: The risk of loss due to inadequate or failed internal processes and people, or from external events.

- Compliance risk
- Conduct risk
- Data quality risk
- Fraud risk
- Project risk
- Reputational risk

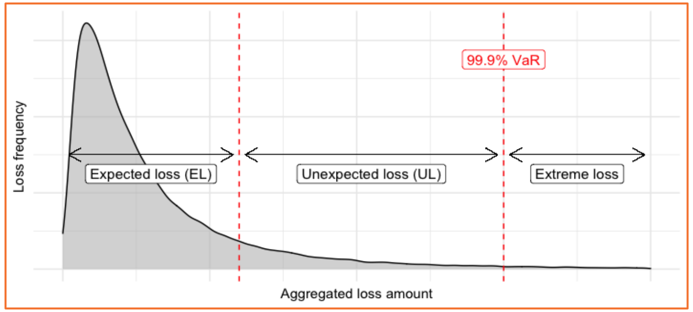
Other risks under Pillar 2 and ICAAP:

Business risk: The risk of loss due to management decisions, change in consumer demand, overall economy or regulations.

Liquidity risk: The risk of loss due to inability to meet cash and collateral obligations.

Interest rate risk: The risk of loss due to interest rate fluctuations and therefore possibility of a change in the asset's value.

Model risk: The risk of loss due to insufficiently developed model and incorrect usage, implementation or interpretation.



REGULATIONS:

- ECB Guide to the ICAAP (2018)
- EBA Capital requirement regulations – CRR (575/2013)
- EBA Capital requirement directive – CRD (2013/36/EU)
- EBA Guidelines on ICAAP and ILAAP information collected for SREP purposes (EBA/GL/2016/10)

ICAAP: OPERATIONAL RISK

INTRODUCTION

Operational risk (OpRisk) is one of the key risks to manage, measure and mitigate. It can be comprehended as ***"risk of loss resulting from inadequate or failed internal processes, people and systems** or from external events,"* (BCBS) and includes legal risk.

7 LOSS TYPE EVENTS

Based on **EBA internal risk taxonomy** on OpRisk, operational losses are divided into **7 categories** which are modelled separately if the data quality allows it. The total annual loss is then calculated as the **sum of losses from each event type.**

1. Internal fraud
2. External fraud
3. Employment practices and workplace safety
4. Clients, products & business practices
5. Damage to physical assets
6. Business disruption and technology system failures
7. Execution, delivery & process management

PILLAR 1 $OpRisk\ capital = BIC \times ILM$

Originally, the **minimum capital requirements** under Pillar 1 could be calculated with one of the three methods:

- Basic indicator approach (BIA)
- Standardized approach (TSA/ASA)
- Advanced measurement approach (AMA)

In accordance with the final **Basel III** package (published in 2010) and **Basel IV** package (published in 2017), these methods are being replaced with a new **standardised approach (SAOR)** which can be summarized as:

- BIC is the Business Indicator Component, which is calculated by multiplying the business indicator (BI) by a set of regulatory determined marginal coefficients (α_i),
- ILM is the Internal Loss Multiplier, which is a scaling factor that is based on a bank's average historical losses and the BIC.

Bucket	BI range	α_i
1	≤ 1	12%
2	1 < BI ≤ 30	15%
3	> 30	18%

PILLAR 2 AND ICAAP

The minimum capital requirement is challenged and **complemented if needed** to assure that the institution possess sufficient capital under all market situations supported by Internal Capital Adequacy Assessment Process (**ICAAP**).

ICAAP allows **more flexibility** in determining the appropriate capital requirement for operational risk. Banks are required to assess the actual operational risks they face, based on their **own internal models, historical loss data, risk scenarios, and stress tests –** last two are the key tools in ICAAP for estimating how much additional capital may be required in the event of a severe operational risk event.

Regulations:

- ECB Guide to the ICAAP (2018)
- EBA Capital requirement regulations – CRR (575/2013)
- EBA Capital requirement directive – CRD (2013/36/EU)
- EBA Guidelines on ICAAP and ILAAP information collected for SREP purposes (EBA/GL/2016/10)
- BCBS Operational Risk – Supervisory Guidelines for the AMA (2011, BCBS196)
- EBA-RTS-2015-02 RTS on AMA assessment

ICAAP: OPERATIONAL RISK – CASE STUDY

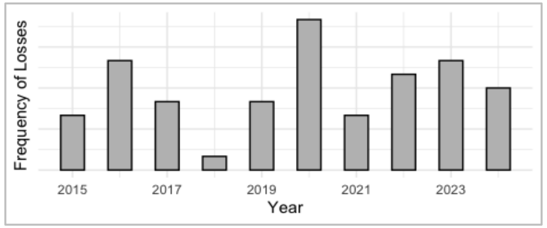
QC APPROACH FOR ICAAP

Among other approaches, widely used advanced method is **Loss distribution approach** (LDA) which is suitable for institutions with **high quality historical data** and sufficient frequency of observed losses. This approach is based on **simulation** of annual losses laying stress on fitting severity distribution of rare but high-severity losses.

1. DATA PREPARATION

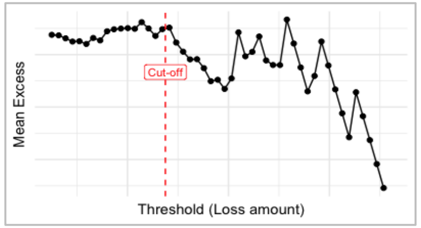
Data collection
- Recommended at least 5 years of historical data including a whole economic cycle.

Descriptive statistics
- Data inspection for each loss type.
- Based on data quality and number of events, each loss type is modelled separately or in buckets.

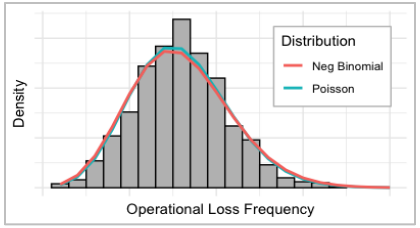


2. MODEL DEVELOPMENT

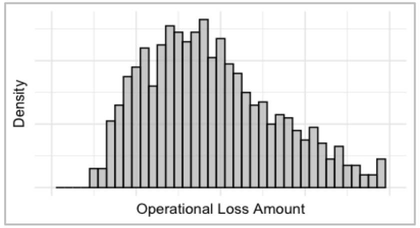
Severity distribution cut-off
- Separation of low severity losses with higher frequency (LSHF) and high severity with lower frequency (HSLF).
- Method: mean excess plot.



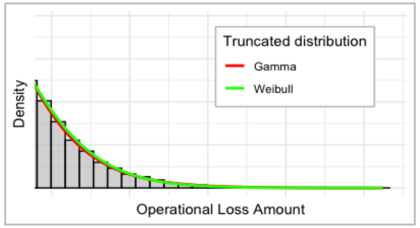
Frequency distribution fitting
- Finding distribution for both LSHF and HSLF.
- Fitting: Neg. Binomial, Poisson, …
- Criteria: AIC, BIC.



LSHF severity distribution fitting
- Empirical distribution (if enough observations are available) or
- Fitting: Log-normal, Pareto, Gamma...
- Criteria: AIC, BIC, Anderson-Darling test.



HSLF severity distribution fitting
- Heavy tail distributions (Tr. Weibull, Tr. Gamma, GDP, Tr. Log-normal, …).
- Criteria: AIC, BIC, Anderson-Darling Upper tail test.

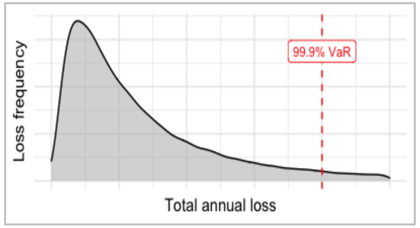


3. SIMULATION

Monte Carlo simulation
- Simulate annual total loss:
  1. Generate annual frequency under and above threshold.
  2. Generate loss amounts under and above threshold.
  3. Calculate total annual loss.
  4. Iterate at least 1M times.

4. CR ESTIMATION

Capital requirement estimation
- Calculation of 99.9 % quantile from the simulated total annual losses - Value at Risk (VaR) → estimated CR for OpRisk



QC experience:
- **Major Slovenian bank**
  - Development of challenger models
  - Initial and regular validation
  - Development and implementation of monitoring methodology

ICAAP: CREDIT CONCENTRATION RISK

INTRODUCTION

Credit concentration risk (CCR) is risk of loss resulting from an excessive concentration of exposure. EBA/GL/2022/03 stipulates that the risk of the institution incurring significant credit losses due to a concentration of exposures to a:

- **small group of borrowers**
- set of borrowers with **similar default behaviour**
- **highly correlated financial assets**

must be assessed.

CCR CATEGORIES

Based on the **EBA guidelines**, the assessment should consider following concentration categories:

1	**Single-Name**: Groups of connected counterparties
2	**Sectoral**: Same economic sector
3	**Geographical**: Same geographic region
4	**Product**: Same product
5	**Collateral & Guarantee**: High amounts of collaterals and guarantees

PILLAR 2

CCR is required to be assessed within the **Pillar 2** framework under the **Capital Requirements Directive** (2013/36/EU). Institutions are expected to identify, measure, and manage concentration risk as part of their **Internal Capital Adequacy Assessment Process** (ICAAP) in line with the EBA Guidelines on ICAAP.

According to EBA/GL/2022/03: „... **competent authorities can use different measures and indicators**, the most common being the Herfindahl-Hirschman Index (HHI) ..., which may then be included in more or less complex methodologies to estimate the additional credit risk impact„.

$$HHI = \sum_{i=1}^{n} s_i^2$$

s_i = share of exposure to entity i in total exposure

n = number of exposures.

Another common measure for assessing CCR is the Gini coefficient, which quantifies the inequality of exposure distribution across a portfolio.

MONITORING

Besides developing model capturing precise concentration of exposure, monitoring of the concentration risk is methodologically more complex. Separating credit-default losses from concentration losses is especially difficult. Therefore, an effective monitoring framework should include:

- **Early warning signals**
- **Follow-up actions**
- **Quantitative analysis of results**
- **Qualitative analysis of results**

Regulations and standards:

- BCBS 2006 – Supervisory Framework for CR
- CRD (2013/36/EU) - Capital requirement directive
- CRR (575/2013) - Capital requirement regulations
- EBA/GL/2016/10 - GL on ICAAP and ILAAP Information Collected for SREP Purposes
- EBA/GL/2020/03 - GL on Internal Models for CR
- ECB 2018 - Guide to the ICAAP

QC experience:

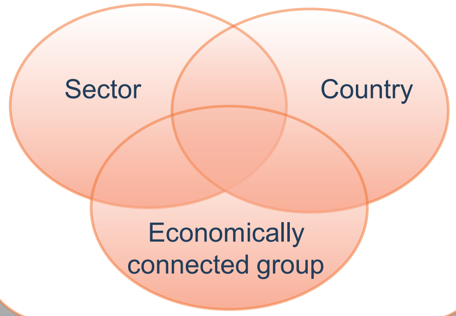
- **Medium Czech bank**
  - Development of methodology and model
  - Model implementation support
- **Major Slovenian bank**
  - Development of challenger models
  - Initial and regular validation
  - Development and implementation of monitoring methodology

ICAAP: CREDIT CONCENTRATION RISK – CASE STUDY

Capturing Concentration Risk

- The *Herfindahl-Hirschman Index* (HHI) or *Gini coefficient* are a commonly used measure of market concentration; however, it does not account for:
  - (i) **forward-looking risk information** and
  - (ii) **correlations** among connected groups of clients.
- The **QC approach** incorporates both of these aspects of concentration risk. We offer various methods for correlation estimation, tailored to the specific portfolio at hand.

Client Relationships Based on Types of Economic Connections



Simulated Losses

- The 12-month credit losses from multiple simulation runs are calculated while accounting for concentration risk.

Simulated Migrations

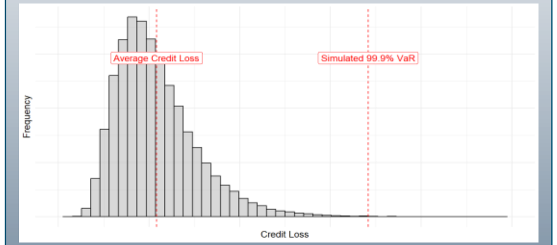
- In particular, for highly concentrated portfolios, rating migrations should be simulated.
- The QC approach builds on the *CreditMetrics* framework.

Simulated Defaults

- For more diversified portfolios, it may be sufficient to focus on simulating defaults, or even on the PD of a leader within economically connected groups of clients.

Simulated Economic Capital

- Using the 12-month losses from all simulation runs, the simulated economic capital is calculated as the difference between the empirical 99.9th percentile (VaR) and the average loss.



Economic Capital under the ASRF model

- The Asymptotic Single Risk Factor (ASRF) model is a credit risk model that assumes an infinitely granular portfolio where default dependence is driven by a single systematic risk factor.
- Economic Capital under ASRF model is calculated as the difference between the Value at Risk (VaR) at the 99.9th percentile derived from the ASRF model and the expected loss.

$$EC_{99,9}^{ASRF} = VaR_{99,9}^{ASRF} - EL^{ASRF}$$

Additional Capital Requirement

- The capital requirement arising from concentration risk is calculated as the difference between the simulated economic capital, which accounts for concentration risk, and the economic capital derived from the ASRF model.

$$EC_{99,9}^{simulated} - EC_{99,9}^{ASRF}$$

ICAAP: INTEREST RATE RISK IN THE BANKING BOOK (IRRBB)

INTRODUCTION

IRRBB refers to the risk arising from the **adverse movements in interest rates**, which affect **prices, values, earnings and costs** of interest rate-sensitive items **in the banking book** - posing a significant threat to a bank's **current capital base and future earnings**. *"IRRBB is an important risk for all banks that must be specifically identified, measured, monitored and controlled." (Basel, 2016)*

Moreover, the **rise of IRs** in recent years led to **increased regulator's concern**, such that European Banking Authority published **an update to their regulatory standards and guidelines** for IRRBB.

"Institutions should measure their exposure to IRRBB in terms of potential changes to both the economic value and net interest income measures plus market value changes" (EBA, 2022).
To comply with new regulatory requirements and to **avoid potential instability**, IRRBB must be sufficiently **hedged and/or covered** with respect to the bank's **current risk appetite**, and its capital adequacy should be considered in a bank's ICAAP.

<table>
<tr><th>Simplified Approach</th><th>Standardized Approach</th><th>Internal Approach</th></tr>
<tr><td colspan="2">Regulatory methodology is taken over.</td><td>Internal methodology is developed.*</td></tr>
<tr><td colspan="2">Six prescribed IR shock scenarios are prescribed.</td><td>Bank's own IR shock scenarios are tested.</td></tr>
<tr><td>All parameters are prescribed by the regulator.</td><td colspan="2">Parameters for products with behavioral component need to be estimated internally.</td></tr>
<tr><td>Applicable only for small and non-complex institutions.</td><td colspan="2">Applicable for all institutions.</td></tr>
</table>

***Internal Measurement Systems (IMS)**

If decided to use **Internal approach**, following requirements should also be fulfilled to obtain regulator's approval:

- IMS should cover **all material components** (gap risk, basis risk and option risk), and capture **all risk dimensions** of IR-sensitive instruments.
- IMS should be frequently **calibrated**, **back-tested** and **reviewed**.

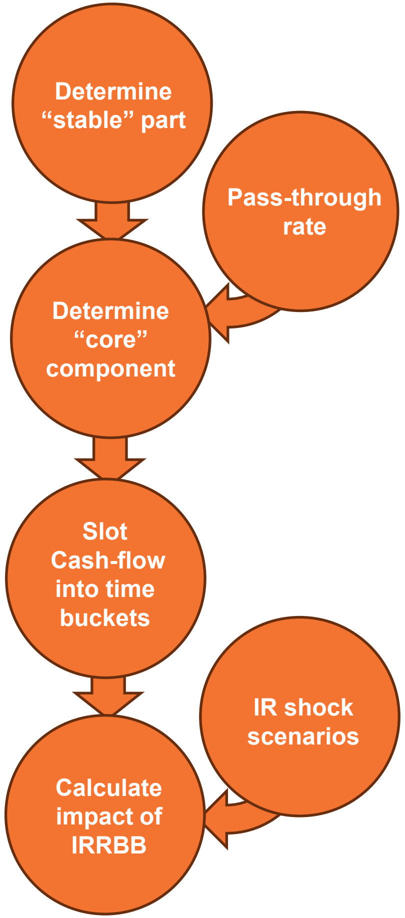
Regulation references:

- The Basel Framework
- BCBS Interest rate risk in the banking book (2016)
- Capital Requirement Directive

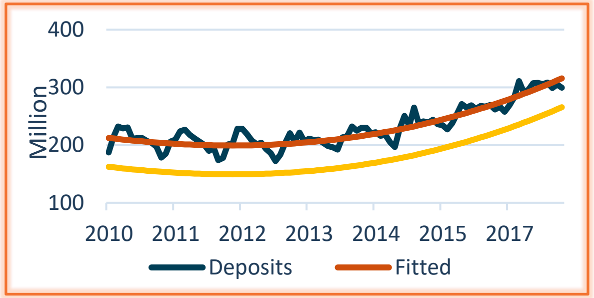
New EBA standards:

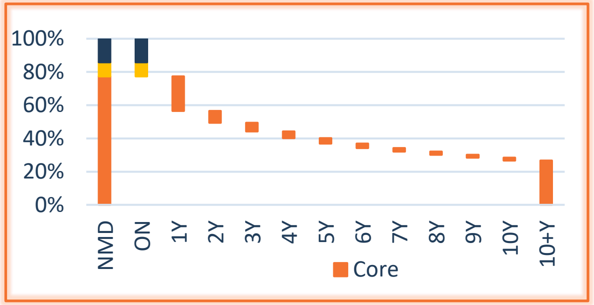
- EBA/GL/2022/14 – Guidelines on IRRBB and CSRBB
- EBA/RTS/2022/09 – RTS on IRRBB standardized methodologies
- EBA/RTS/2022/10 – RTS on IRRBB Supervisory Outlier Tests

ICAAP: IRRBB – NON-MATURITY DEPOSITS – CASE STUDY



	Objective	*QC solution*	*Result*
Stable part	*To systematically estimate sufficiently conservative level of "stable" part of non-maturity deposits – "that is found to remain undrawn with a high degree of likelihood". (BCBS IRRBB, 2016)*	*The model was fitted such that it copies the evolution of Bank's total deposits, making "stable" part less volatile in time, while preventing the decrease of total NMDs below the estimated "stable" level.*	*The estimated level of "stable" deposits increased by XX%, while no breaches were observed, meaning that a sufficient level of conservatism can be achieved even after the increase of "stable" part.*
Pass-through rate	*To determine how "change of the market interest rate is assigned to the deposit to enable the institution to maintain the same level of stable deposits at the current level of interest rates". (EBA RTS, 2022)*	*The sensitivity to all relevant benchmark rates was analyzed, while incorporating a separate treatment for periods of rates' increase/decrease, near-zero and negative IRs.*	*The accuracy of the model increased by XX%, leading to more accurate determination of "core" part of NMDs.*
Slotting Cash-flow	*Since NMDs have no specified maturity, their time of exit needs to be approximated, and "their notional repricing cash flows slotted into the time buckets up to their corresponding maturity dates." (BCBS IRRBB, 2016)*	*Survival analysis was applied to determine probability of individual accounts exiting the portfolio in specified time horizon.*	*The average duration of NMDs increased by XX%, increasing the predicted positive Cash-flow and decreasing the negative impact of IRRBB.*





QC experience:

- **Medium Czech bank**
  - Development of internal model
  - Development of standardized model
- **Medium Czech bank**
  - Iinitial validation of IRRBB model
- **Small Czech bank**
  - Internal Audit of IRRBB model

ICAAP: CREDIT SPREAD RISK OF THE BANKING BOOK (CSRBB)

INTRODUCTION

Credit Spread Risk in the Banking Book (**CSRBB**) is the **risk of loss from changes in credit and liquidity spreads** on credit-risky instruments that are not explained by IRRBB or the ICAAP credit/jump-to-default and credit migrating risk. It applies to all performing assets, liabilities, derivatives, and off-balance sheet items sensitive to credit spread changes (ΔCS), regardless of their accounting treatment.

SCOPE UNDER PILLAR II

- **Policy Option 1**
  Captures changes in market credit and liquidity spreads.
- **Policy Option 2**
  Covers idiosyncratic risk beyond market credit/liquidity spreads.

<table>
<tr><th></th><th>Option 1</th><th>Option 2</th></tr>
<tr><td>Idiosyncratic Credit Spread</td><td>Credit risk</td><td rowspan="3">CSRBB</td></tr>
<tr><td>Market Liquidity Spread</td><td rowspan="2">CSRBB</td></tr>
<tr><td>Market Credit Spread</td></tr>
<tr><td>Market Duration Spread</td><td rowspan="2">IRRBB</td><td rowspan="2">IRRBB</td></tr>
<tr><td>Risk-free Interest Rate</td></tr>
</table>

PILLAR II & ICAAP

Under Pillar II, bank must address CSRBB not covered under Pillar I. CSRBB exposures are assessed, monitored, and controlled under:

ΔEVE – Economic Loss (**> 1 year**)

- Based on **discounted** expected CFs from assets, liabilities, and off-balance-sheet instruments, regardless of their accounting treatment.

ΔNII + ΔMV – Accounting Loss (**< 1 year**)

- Based on **projected** CFs such as Net Interest Income and market value of fair-valued instruments

A practical way to integrate CSRBB into ICAAP capital calculations is to determine ΔEVE, ΔNII and $\Delta FVOCI$ separately, and then set the overall capital requirement (CR) as the minimum of these outcomes.

$$CR = \min(\Delta EVE, \Delta FVOCI, \Delta NII, \Delta NII + \Delta FVOCI, 0)$$

where $\Delta FVOCI$ stands for the change in Fair Value through Other Comprehensive Income, computed in the same way as ΔEVE, but only for instruments measured at fair value.

QC APPROACH

Smaller & mid-sized banks (Simple portfolio)

- Requires regular recalibration due to portfolio changes.
- Avoids modelling the correlation structure among instruments' credit spread changes (ΔCS) by averaging each instrument's ΔCS time series into a single portfolio ΔCS series, using its basis point value as a weight. Then, a Monte Carlo (MC) simulation of the portfolio ΔCS is performed, and VaR is calculated.

Large banks (Complex portfolio)

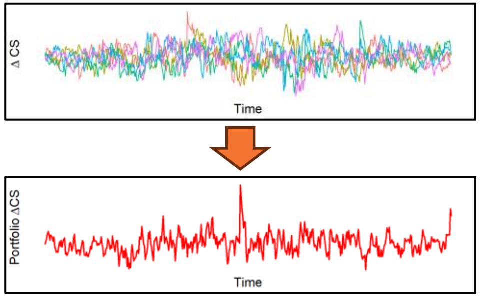
- Demands greater development effort, while offering better level of precision.
- Utilizes all time series of each instrument's ΔCS and their correlation structure (alternatively, PCA can be applied). Then, an MC simulation is performed for each instrument's ΔCS, and VaR is subsequently calculated.

Regulations:

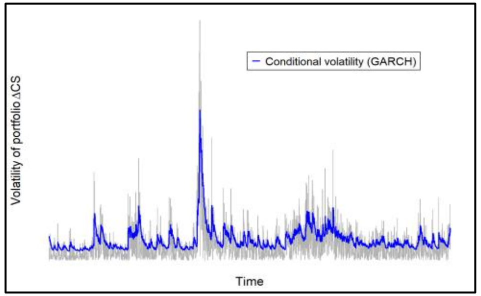
- BCBS 2016 - IRRBB
- ECB 2018 - Guide to the ICAAP
- EBA/GL/2022/14 - GL on IRRBB and CSRBB
- EBA/GL/2018/02 - GL on interest rate risk in non-trading book

ICAAP: CSRBB – CASE STUDY

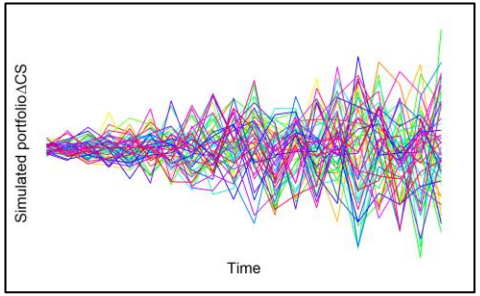
1. DATA PREPARATION:
We exclude the idiosyncratic risk component of each individual instrument and then compute a weighted average time series of portfolio credit spread changes (ΔCS), using each instrument's basis-point value as the weight.



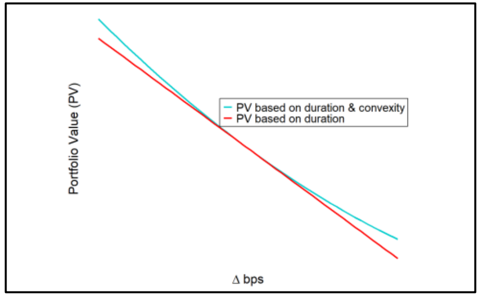
2. MODEL SELECTION PROCESS:
We specify potential candidate models, perform diagnostic tests on them, and select the optimal model based on the lowest AIC among those passing these tests.



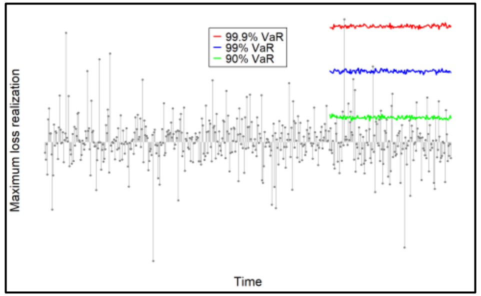
3. SIMULATION OF PORTFOLIO CREDIT SPREAD CHANGES:
We generate Monte Carlo simulation paths of portfolio ΔCS using either TTC approach (with unditional lon-run averages and burn-in period) or PiT approach.



4. RISK QUANTIFICATION:
Using the simulated portfolio ΔCS in conjunction with portfolio duration and, if material, convexity, the maximum cumulative losses are estimated over the specified horizon. VaR is then calculated as the appropriate quantile of these losses.



5. MODEL BACKTESTING:
The adequacy of the VaR model is tested using the Binomial test, the dependency of maximal loss realizations exceeding VaR is assessed through Christoffersen's test. Finally model stability is also evaluated across various time periods.



QC experience:

- **Major Slovenian bank**
  - Development of challenger models
  - Initial and regular validation
  - Development and implementation of monitoring methodology

AUTOMATION SOLUTIONS

INTRODUCTION
Automation refers to systems, processes, or technologies that perform tasks without the need for continuous human intervention. Multiple processes concerning credit risk can be readily automated with our know-how, including but not limited to modelling, monitoring, and report creation.

WHY SHOULD WE CARE?
Automation can greatly boost efficiency and reliability of the affected operations, leading to **significant workload reduction** thanks to reductions of production time, human error, and technical skills requirements.

OUR APPROACH
We prioritize **dependability, flexibility**, and **ease of use**. Our solutions are refined in close collaboration with clients to ensure alignment with their specific business objectives and preferences. Architecture of our solutions maximizes **simplicity of updating** them with new components and functionalities.

OUR PRODUCTS
Our codes adhere to widely recognized **coding style standards,** are packaged as **installable libraries,** and are accompanied by **detailed guidelines**.

In addition to code solutions, we also offer development of **graphical user interfaces** developed in R or Python which provide a seamless, user-friendly experience and eliminate need of coding.

OUR INSTRUMENTS
python R sas SQL

Automation benefits
- Time saving
- Errors prevention
- Use simplification
- Reduction of skill requirements

QC EXPERIENCE:
- Data Quality tool
- Monitoring reports tool
- IFRS9 PD modelling tool
- Scoring models application
- Unexpected Loss models application

AUTOMATION SOLUTIONS – FUNCTIONALITIES

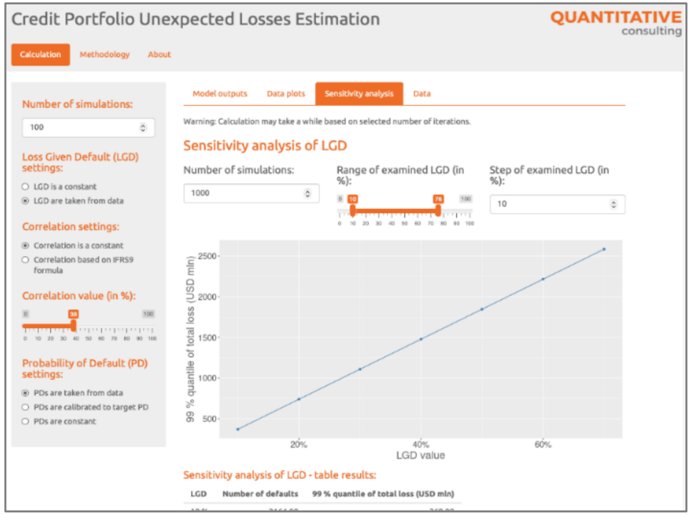
Tool	Code	GUI	Exported outputs	Flexibility: Variables mapping, technical settings	Flexibility: Others	Flexibility: Extensibility	Interoperability of GUI with code environment
Data Quality	SAS or Python	SAS EG or QC Python		✓	Check parameters, logical relations.	Addition of new checks.	✓
IFRS9 PD	Python	QC Python		✓	Methods selection.	Addition/removal/ adjustment of model components and/or associated methods.	✓
Monitoring	R or Python	QC R-Shiny or QC Python	HTML PDF	✓	Model choice, tests parametrization.	Addition of new tests and warning criteria.	✓ *Python GUI only.
Scoring model	R	QC R-Shiny	HTML	✓	Calculation steps parameters, methods selection.	Addition of new binning, model selection, and validation methods.	
Unexpected Loss model						Addition of new Unexpected Loss and sensitivity analysis methodologies.	

AUTOMATION SOLUTIONS – QC EXPERIENCE

CREDIT PORTFOLIO UNEXPECTED LOSSES ESTIMATION APPLICATION

Simple application for calculation of losses resulting from unexpected risk, including sensitivity analysis. It supports both empirical estimation and simulations methods. Includes graphical analysis of the underlying data and the results. Our demo version applies Credit Metrics approach with sensitivity analysis of LGD and correlation values. Client's preferred methods can be added to the implementation at request.

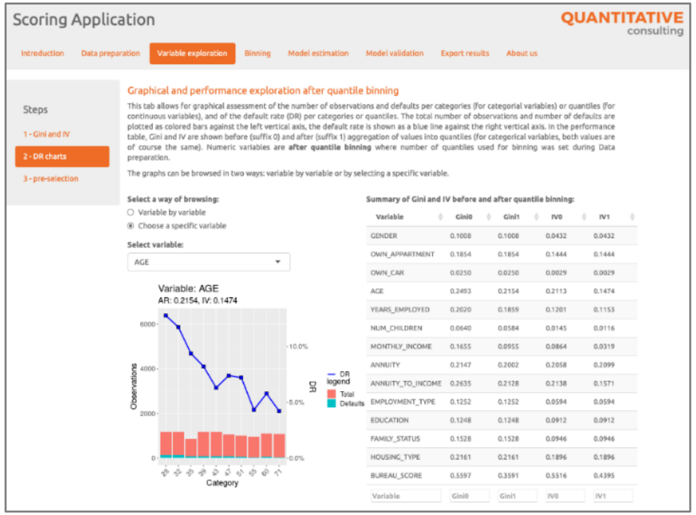
Try demo version at https://quantitative.shinyapps.io/ULEs.



SCORING APPLICATION

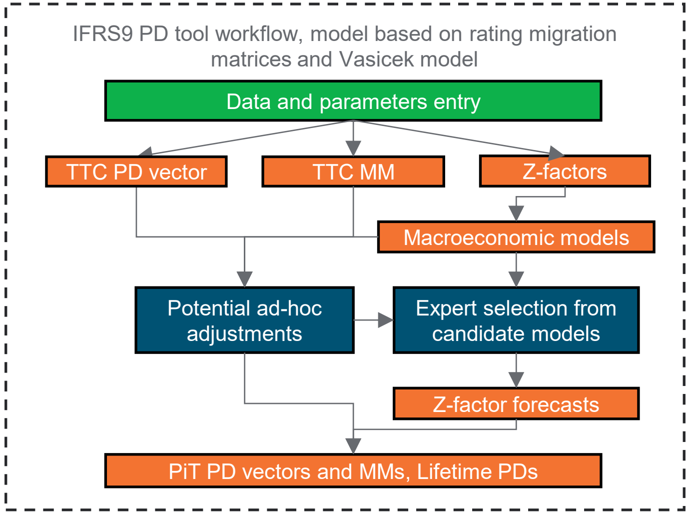
Effective application for automated creation of scoring models from initial univariate data analysis to basic validation of the resulting model. Users have a choice of multiple methods for binning, model selection, and validation with results export. Additional functionalities and mathematical methods can be added at request. Application serves both **modelling and validation teams** for simple and quick development of initial, challenger, and even final scoring models.

Try demo version at https://quantitative.shinyapps.io/Scoring.



IFRS 9 PD modelling tool

Automation of the lifetime PDs estimation, from the micro-level data to the final predictions. Solutions adhere to client's specific internal guidelines and include multiple methodological choices.
The standard implementation is based on pools, migration matrices and Vasicek model, but our infrastructure enables **simple extension** to clients' specific methodological choices.
The tool provides **high granularity** of calculation processes thanks to which modellers can perform ad-hoc adjustments to any of the model's components at the appropriate calculation step.



INTRODUCTION

Nowcasting involves predicting the recent past, present, and immediate future state of economic indicators. It is vital for obtaining timely information on key macroeconomic variables, especially those with low-frequency data.

The COVID-19 pandemic highlighted the limitations of relying solely on official releases from national statistical offices, which often come with significant delays, particularly in times of rapid economic change. Even in normal economic conditions, relying solely on official data has its drawbacks.

WHY SHOULD WE CARE?

Macroeconomic scenarios:
Macroeconomic variables are pivotal for IFRS 9 compliance. However, traditional models, although working with these variables, may produce misleading results if their values are not up-to-date during rapid economic shifts.

Early warning system:
Some high frequency data such as Google Trends or Twitter data might be able to early identify disruptive events which will have an impact on the economic.

Basic approach

Macroeconomic data

Considered models: AR, ARIMA, Bridge equations regression

QC Approach

High frequency data (Google trends, Transactional data, etc.)

Considered models: MIDAS regression, Machine learning

- We use alternative data to **catch the unexpected changes in economic** before classical predictors can register them.

- We use latest modeling approaches to obtain **additional information from data**.
- We carefully select the right model based on available data and customer needs.

Results interpretation

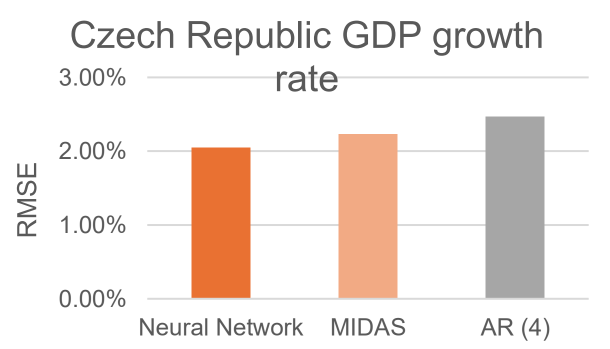
Measurement of the performance

Basic approach:

- Not suitable for usage of high frequency data.
- Does not react well on rapid changes in the economic situation

QC Approach:

- Can handle **data of multiple frequencies**.
- Can effectively **catch disruptive events** in economic.



MODEL MONITORING

INTRODUCTION

Model monitoring concerns tracking of the portfolio characteristics and model performance with the goal of ensuring continuous fulfilment of the model's business and regulatory tasks and timely recognition of potential problems.

WHY SHOULD WE CARE?

Model monitoring belongs among the most fundamental processes connected to use of statistical models in the credit risk. It is a requisite for fulfilment of both internal business needs of clients and of regulatory requirements. Our support in this area can be appreciated by both modelling and validation teams.

OUR SOLUTIONS

QC's practical experience and academic background enable us to **design frameworks** and **offer practical solutions** which will satisfy these needs.

Typical monitoring areas for credit risk models include:

- **Representativeness** – Monitoring of evolution of statistical distribution of portfolio's properties.
- **Stability** – Tracking of compositions of model components.
- **Discriminatory power** – Testing of model's elementary ability to distinguish between good and bad outcomes.
- **Accuracy** – Testing of agreement between model predictions and observed results, usually concerned with precise numeric outcomes.
- **Concentration** – ...of categorical properties.
- **Overrides** – Number of manual overrides.

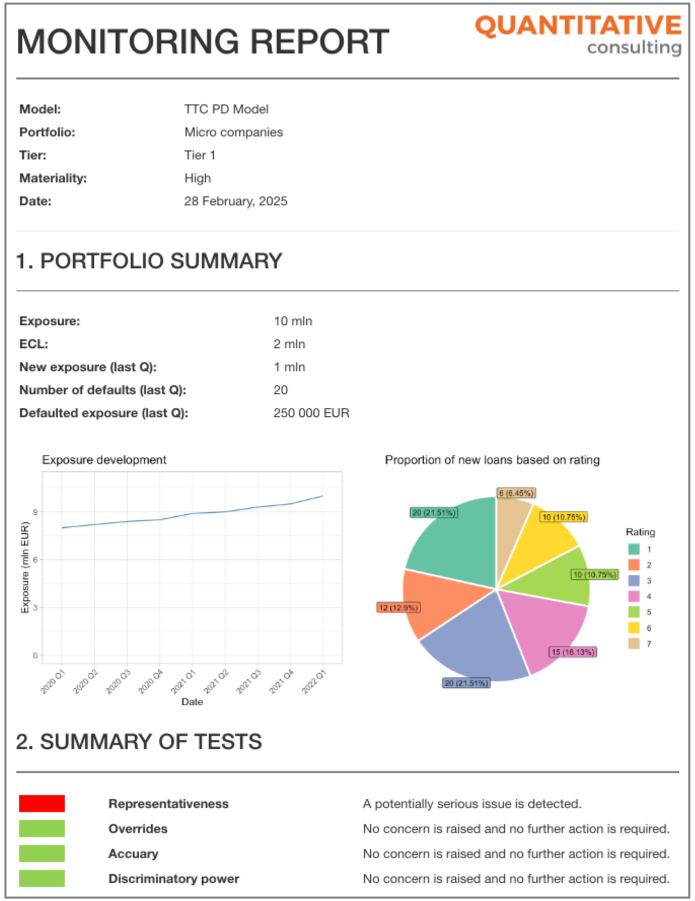
AUTOMATED MONITORING REPORT

We offer application for automated creation of monitoring reports for **PD**, **EaD**, and **LGD models**. The application includes adjustable settings and produces report which contains:

1. Header with proper identifications.
2. Chart and table summaries of the portfolio, tests, and early warning triggers.
3. Test details.

REGULATION REFERENCES:

- EBA/GL/2016/07 – IRB guidelines
- EBA/GL/2023/04 – Guidelines on Model Risk Management
- (EU) No 575/2013 – EBA Capital Requirement Regulation
- 2013/36/EU – EBA Capital Requirement Directive
- The Basel Framework
- IFRS9 Framework


MONITORING REPORT

QUANTITATIVE consulting

Model:	TTC PD Model
Portfolio:	Micro companies
Tier:	Tier 1
Materiality:	High
Date:	28 February, 2025

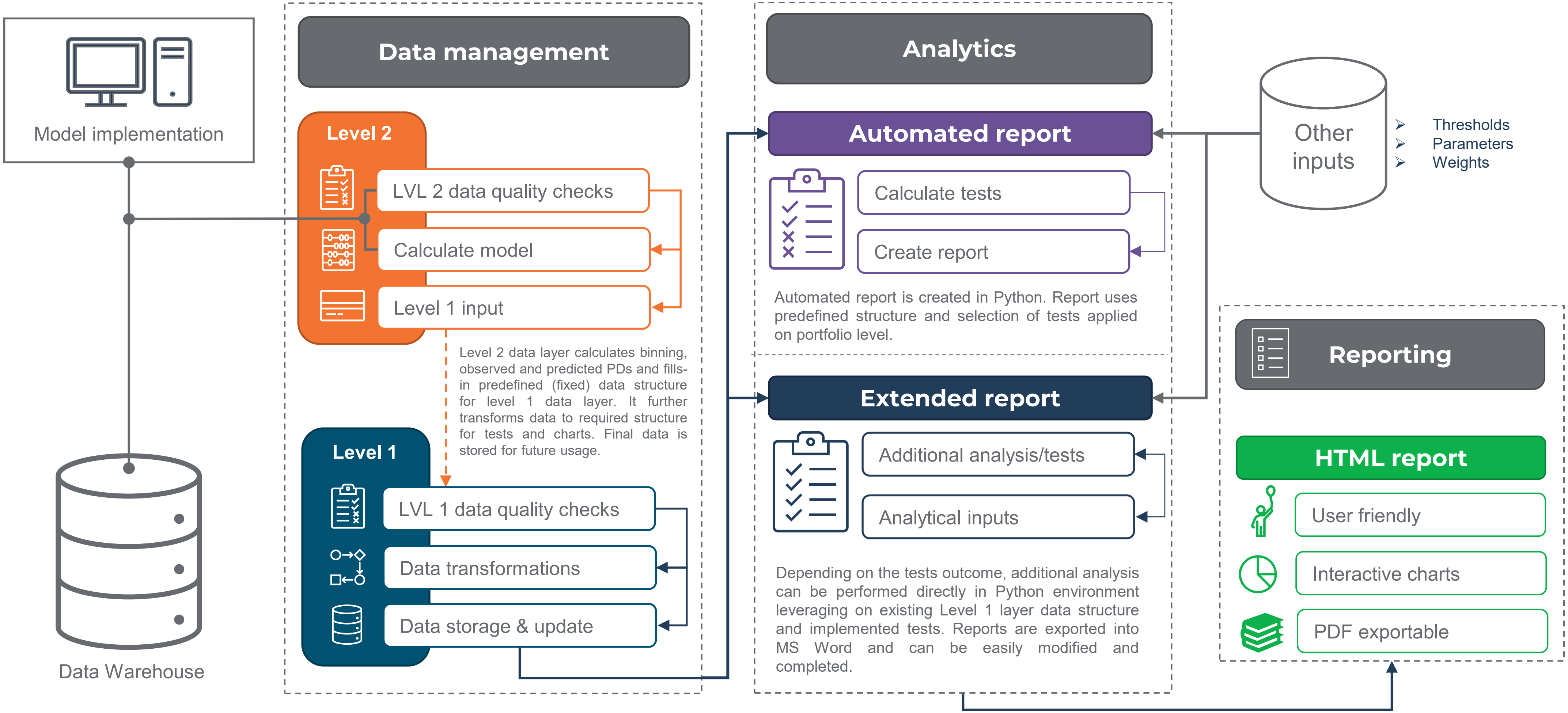
1. PORTFOLIO SUMMARY

Exposure:	10 mln
ECL:	2 mln
New exposure (last Q):	1 mln
Number of defaults (last Q):	20
Defaulted exposure (last Q):	250 000 EUR

2. SUMMARY OF TESTS

	Representativeness	A potentially serious issue is detected.
	Overrides	No concern is raised and no further action is required.
	Accuary	No concern is raised and no further action is required.
	Discriminatory power	No concern is raised and no further action is required.

MODEL MONITORING – PROPOSED ARCHITECTURE



UNDERWRITING PROCESS

INTRODUCTION

Underwriting process refers to sequence of steps lenders use to evaluate the creditworthiness of a borrower's application. The goal of this workflow is to determine whether a credit application should be approved, rejected, or if the lender is willing to offer alternative terms.

TAILORED BY SEGMENT & PRODUCT

Underwriting **varies** considerably **depending on the client segment** as well as **the product type**:

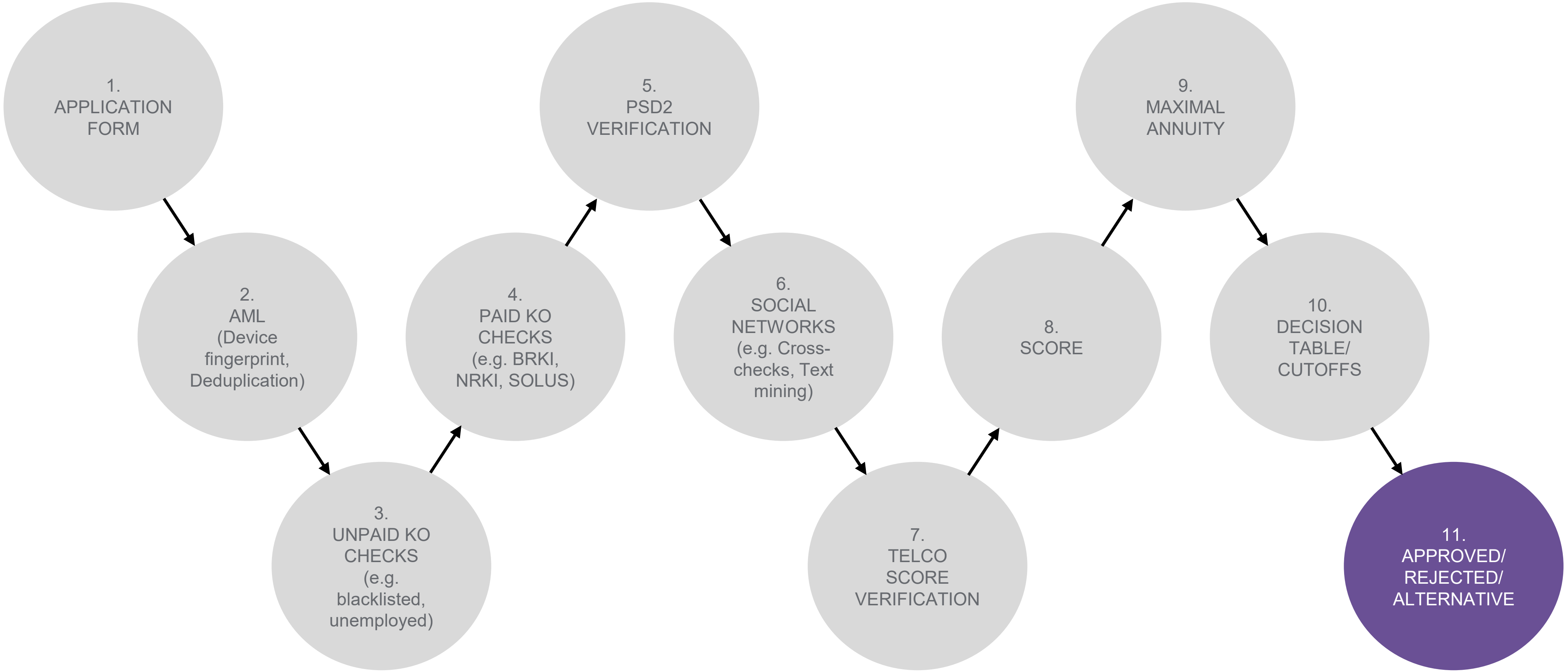
Product / Segment	Mortage	Consumer Loan	Revolving Loan	Investment Loan
Individual	**Partially automated** workflow with collateral assessment.	**Fully automated** workflow with fast decision.	**Fully automated** workflow with fast decision.	
Entrepreneur	**Partially automated** workflow with collateral assessment and review of irregular income streams.		**Partially automated** workflow with periodic review based on CF variability.	**Detailed assessment** of business plan, financial projection and personal liability.
SME			**Partially automated** workflow with periodic review based on operational performance metrics.	**Detailed assessment** of operational strategy, financial forecasts and market position.
Corporate			**Partially automated** workflow with advanced AML and KYC.	**Full due diligence** and multi-level approval.

6 KEY BENEFITS:

- **Automated and Accelerated Workflow** - Streamlined workflow with minimal manual interventions can significantly reduce approval time, improving customer satisfaction and cutting operational costs.
- **Maximizing Approval Rate While Keeping Default Rate Low** - By combining various data inputs, KO checks, and unbiased scorecard, lenders more accurately identify dependable borrowers and ensure greater approvals while maintaining low default levels.
- **Decent AML** - Robust identity verification and suspicious-pattern detection (e.g. Device fingerprint, deduplication) help protect both lenders and borrowers by minimizing the risk of fraud.
- **Better Collection Process** - With direct debit, lenders can reduce delinquencies and simplify the workflow to improve overall collection performance.
- **Champion-Challenger Principle** - Enables the effective comparison of two processes or sets of checks, scoring functions, or cutoffs. Its purpose is to gather insights on the payment behavior of customers who do not undergo the standard process (rejection inference).
- **Reporting and Monitoring** - Dashboards track approval rates, default rates, and other performance metrics, allowing ongoing adjustments to the underwriting process and timely identification of emerging risks.

UNDERWRITING PROCESS – WORKFLOW

CUSTOMER LOAN WORKFLOW ILLUSTRATION:



SEMINARS AND WORKSHOPS

Learn about new topics, broaden your horizon, expand your skills. Seminars and workshops bring new knowledge and offer new opportunities in current employment. Our experienced consultants focus on passing the information in the most comprehensible and intelligible way and can also help with specific questions about your current issues.

Visit **quantitative.cz/seminars** for currently open seminars and workshops or ask for specific topic for your company.

TARGET AUDIENCE

Modelling department, internal audit, risk managers.

STRUCTURE

SEMINAR

Focuses on the **theory** of the current topic. Transfers the knowledge in a form of lectures supplemented by practical examples.

WORKSHOP

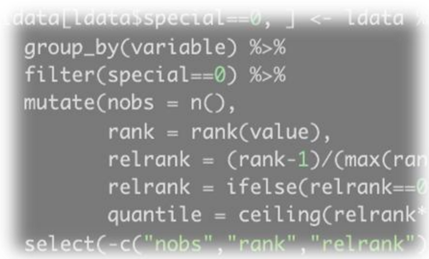
Focuses on **practical skills**. Aims to develop skills using requested data science tools.

SEMINAR + WORKSHOP

Offers **combination** of both. Theoretical lectures are complemented by exercises in the requested data science tools.

TOPIC	S	W	LECTURER
Financial derivatives and counterparty risk	✓		J. Witzany
Stress testing in the context of ICAAP	✓		J. Witzany
IFRS9 modelling	✓	✓	M. Kuchta
Data quality framework	✓	✓	M. Kuchta
Introduction to statistics and machine Learning	✓	✓	J. Witzany
Programming in Python, R, SAS, SQL		✓	M. Cigán
IRRBB modelling and framework	✓		M. Fičura
Model risk governance framework	✓		M. Kuchta
Market risk	✓	✓	M. Fičura
Automated underwriting process	✓	✓	P.Charamza
Data visualization	✓	✓	P. Veselý

(S = seminar, W = workshop)



We quantify, analyze and optimize business processes and bring competitive advantages. We understand your business better using modern machine learning and statistical analysis of your data. We do risk analysis, profit optimization, business scenarios evaluation, penetration and attrition rates analysis using wide possibilities hidden in the data.

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