Credit Risk Management: A Model Validator's Perspective

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ABN AMRO Bank, Credit Risk Model Validation

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Who am I?

- Yuhao Zhu.
- Credit Risk Model Validator at ABN AMRO Bank.
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- Graduated from Erasmus University Rotterdam.

What do I do?

- Validating credit risk models, e.g., PD, LGD, and EAD.
- Assessing data quality, methodologies, model performance, and regulation compliance.
- Maintaining the validation standards for quantitative analyses and statistical tests.
- Developing the Python package of statistical tools and pipelines for model validation.

Why this topic?

- ABN AMRO has around 175 billions of mortgages.
- What if borrowers stop paying back loans?
- Credit risk is very important concern for banks.
- Model validation is an important part of credit risk management.

Content

- We look at different risk types in banks.
- We look at different stakeholders in credit risk management.
- We look at different stages in model validation.

What to expect?

- What do I expect for daily work in model validation?
- What are basic skills and tools needed for credit risk model validation.
- Wo I want to find a job in credit risk management?

Risk

- Uncertainty: Multiple future outcomes.
- Risk: Chances of bad outcomes or losses.

Definition

- Market risk: risk of losses in positions due to movements in market prices.

Products

- Stocks.
- Forwards and futures.
- Options (European, American, Asian, and Bermudan).
- Swaps.

Quantification of risk

- Standard deviation
- Value at Risk (VaR).
- Expected shortful (ES).

Pricing tools

- Binomial tree.
- BSM model. $C(S) = N(d_1)S - N(d_2)Ke^{-rT}$.
- Simulation.

Definition

- Credit risk: risk of default on a debt due to borrower failing to make required payments.

Products

- Mortgage loans.
- Credit cards.
- Bonds.

Quantification of risk

- Probability of risk (PD).
- Loss given default (LGD).
- Exposure at default (EAD).

Definition

- Operational risk: risk of loss resulting from inadequate or failed internal processes, people and systems or from external events. This definition includes legal risk, but excludes strategic and reputational risk.

Types

- Internal Fraud, external Fraud, clients, products, and business practice.
- Model risk.

Model risk

- Model risk: risk of losses due to decisions resulted from incorrect models.

Model owner

- Credit risk type owner.

Model user

- Business department.

Model developer

- Modelling department.

Model validator

- Model risk managment department.
- Model validation function.

Auditor

- Auditing department.

Other stakeholders

- Regulators.
- Executive board.
- Shareholders.
- Clients.

Stakeholder management

- Model validation is not only about assessing models.
- It is also concerned with stakeholder management.
- Active communication with stakeholders during validation.
- Procedures, policies and independence of model validation function.

Credit risk parameters

- Probability of Default.
- Exposure at Default.
- Loss Given Default.
- Expected loss.
- Unexpected loss.

PD

- The probability that the obligor defaults within the one-year period.
- A structural approach of understanding PD (BSM model).

Unexpected loss

- Why we care about unexpected loss?
- Economic and regulatory perspectives.
- Relationship between UL, EL and VaR.

RWA

- Risk-weightd assets (RWA).
- Function of PD, LGD, and EAD.
- To calculate regulatory capital.
- Advanced internal rating-based approach.

Risk parameters

- PD model.
- LGD model (Cure rate, LGN, LGC).
- EAD model.

PL and NPL

- Program lending.
- Non-program lending.

Low-default portfolio

- Normal portfolio.
- Low-default portfolio.

Rating system

- Rating system: pool similar clients together and assign the same risk parameter.
- Grades or pools.
- Model development phase and risk quantification phase.

Assumption for PD model

- We have a lot of independent and identical clients.
- Each of the has the same probability to go default.

Statistical notations

- Bernoulli trials D with the probability p.
- Binomial distribution for $\sum D$.
- Normal distribution when $N \to \infty$.

Logistic regression

- Dependent variable: 1 or 0.
- Independent variable: Clients' characteristics, macroeconomic variables, delinquency.
- Logit regression.
- $P(D = 1) = y = \frac{1}{1+e^{-X\beta}}$.
- Pros and cons.

Machine learning

- Decision tree.
- Bagging or boosting.
- LASSO.
- Pros and cons.

Risk quantification

- Rank clients according to predicted PDs, $\hat{y}$.
- Pool clients with similar characteristics together.
- For each pool, the estimated PD is estimated from long-run averages of one-year realized default rates.

Data quality checks

- Data is essential for risk models.
- Model cannot be good if data is bad.
- Data quality checks are important in model validation.
- Dimensions: completeness, accuracy, validity, uniqueness, timeliness, traceability...

Regulation compliance

- Risk management in banking sector is highly regulated.
- CRR (Capital Requirement Regulation).
- Other regulations and policies: RTS, EBA guideline, etc.

Methodology evaluation

- Check assumptions of models, e.g., 6 assumptions for OLS.
- Check risk drivers (variables) selection.
- Check treatment and transformation of variables.
- Check the use of machine learning for some steps.
- What are the tests and tools for the checks?

Model performance assessment

- Discriminatory power.
- Calibration accuracy.
- Population stability.

Discriminatory power

- How predicted values differentiate "goods" and "bads".
- For example:
- Predicted PD: [0.1, 0.2, 0.3, 0.4, 0.5, 0.6, 0.7, 0.8, 0.9, 1.0]
- Realized defaults: [0, 0, 0, 0, 0, 1, 0, 1, 1, 1].
- It is ordinal rather than cardinal.
- Useful in mornitoring clients.

Test DP

- Cumulative accuracy ratio (Gini coefficient) for PD models.
- Receiver operating characteristic (AUC) for PD models.
- Kendall's tau family (Gamma concordance, Somers' D) for LGD and EAD models.
- Correlation (value or rank).
- Some examples.

Calibration accuracy

- How accurate the predicted values are?
- For example:
- Predicted PD for a certain pool: $\hat{p} = 1\%$.
- Realized: 3 out of 100 clients default.
- It cardinal rather than ordinal.
- Useful in assessing the parameters for a group of similar clients.

Test CA

- Binomial test for PD and cure rate models.
- t-test for LGD and EAD models.
- Some examples.

Stability of the rating system

- Whether the rating system is stable?
- We look at how clients move across grades or pools.
- Population stability Index (PSI) and KS.
- Migration matrix and its stability.

Other aspects

- Overriding.
- Benchmarking.
- Representative of risk drivers.

Usage of statistical tests

- Know the null hypothesis of the statistical tests.
- Check the underlying assumptions.
- Find the statistics.
- Get the confidence interval.
- Pay attention to asymptotical assumptions and sample sizes.

Make expert judgement

- Depending on the nature of the model, choose the best statistical tests.
- Deviate from standards in special cases and write down reasons.
- Make expert judgement when quantitative methods fail.

If ...

- If you are interested in working in credit risk modelling or model validation.
- What skills do you need to have?
- Plan in advance!

Quantitative skills

- Statistics: risk is about probability, random variables, etc.
- Financial economics: The nature of risk. Prices are outcomes of individual behaviors.
- Econometrics: Very often used for reduced forms. (Credit risk)
- Stochastic calculas: Take prices as given and make arbitrage. (Market risk)
- Machine learning: Nice to have.

Programming skills

- A genearl programming language, e.g., Python.
- A data-oriented language, e.g., SAS.
- One is enough. More does not mean good!

Certificates

- FRM: Very specific. Highly related to daily practice in risk management.
- CFA: A broacher range of topics.
- Choice: Take FRM if you are determined in working in risk management.

Thank you

- Thank you for your attention!