Credit Risk Management:
A Model Validator's Perspective

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Contents

Part I
Introductory

1 Why we are here and how we get there?

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.

2 What to discuss today?

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?

Part II
Risk types

Risk

- Uncertainty: Multiple future outcomes.

- Risk: Chances of bad outcomes or losses.

3 Market risk

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.

4 Credit risk

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).

5   Operational risk

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.

Part III
Stakeholders of credit risk models

6   First line of defense

Model owner

- Credit risk type owner.

Model user

- Business department.

Model developer

- Modelling department.

7   Second line of defense

Model validator

- Model risk managment department.

- Model validation function.

8 Third line of defense

Auditor

- Auditing department.

9 Other stakeholders

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.

Part IV
Credit risk models

10 Important concepts

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.

11   Credit model types

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.

12   Model development

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.

Part V
Credit risk model validation

13   Data quality checks

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...

14 Regulation compliance

Regulation compliance

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

15 Methodology evaluation

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?

16 Model performance assessment

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.

17 When statistics fails

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.

Part VI
One more thing

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!