Prediction and modelling of mortgage prepayment risk

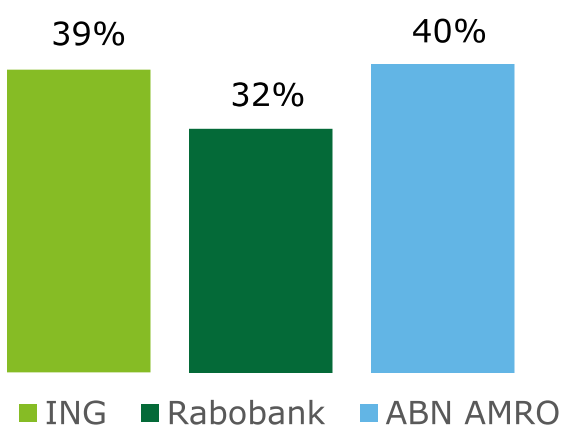
Case study Deloitte

Introduction

Mortgages play an important role in a bank's business model

Mortgages on the balance sheet

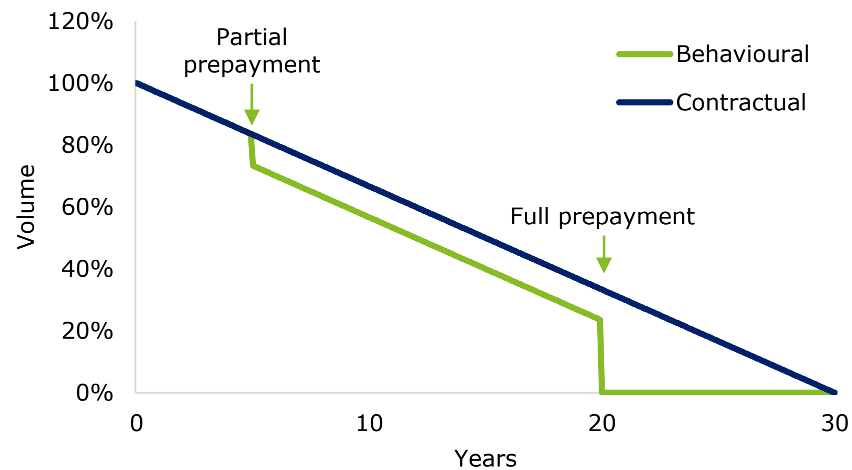
- A mortgage is a loan taken out to buy or refinance a house, the house serves as collateral for the loan;
- A large part of a bank's balance sheet consists of mortgage loans.



Source: 2019 Annual Reports

Prepayments

- The mortgage holder typically has the option to prepay (part of) the remaining mortgage debt;
- There exist different types of prepayment events, a selection:
    - **Partial prepayment:** part of the outstanding loan amount is repaid;
    - **Full prepayment due to:**
        - Relocation: the loan is fully repaid due to relocation;
        - Refinancing: the loan is internally or externally refinanced.



Introduction

What is prepayment risk and what triggers it?

Prepayment risk

Low interest rates & booming housing market	Prepayment trigger	Less interest rate gain / risk for lender	Prepayment risk quantification
• Housing market is booming; • Central bank quotes low interest rates.	• Low interest rates triggers mortgage holders to pay off their mortgage.	• Interest income decreases and volatility of income increases when prepayments occur.	• To prevent loss caused by prepayments it is useful to quantify the risk of prepayments and take this into account in risk management.

- In case of a relocation a mortgage holder generally has two options:
  - A **full prepayment** of the existing mortgage, and taking a new mortgage on the new house;
  - **Take-along** the existing mortgage to the new house, and finance any additional debt with a new mortgage.

- The prepayment option is especially attractive for the mortgage holder in a **decreasing interest rate environment**, since the mortgage holder is then able to get a lower interest rate on a new mortgage;

- The take-along option is especially attractive for the mortgage holder in an **increasing interest rate environment**, since the mortgage holder is then able to keep the current lower interest rate.

Prepayment risk is the risk that a mortgage loan will be paid off in a different speed than initially expected, which can e.g. be caused by the prepayment or take-along option.

Prepayment risk is to a large extent driven by the **interest rate incentive:**

Interest rate incentive = contractual rate – market rate

Prepayment drivers

Prepayments are sensitive to customer, contract and macro economic indicators

Customer

- Characteristics real estate
  - Type of building (apartment, house)
  - Location
- Characteristics creditor
  - Age
  - Family situation
  - Income per mortgage sum
  - Delayed payment

Contract

- Original/current principal
- Original/current loan-to-value
- Loan age
- Fixed interest term
- Current interest
- Prepayment fee

Macro-economic

- Risk-free interest
- Mortgage rates
- Housing price levels/variation
- Unemployment rate
- Consumer trust
- Inflation
- Saving behaviour

Research Question

Do the current models still provide accurate estimations of mortgage prepayments in the current economy of low/negative interest rates?

Main goal

The goal is twofold:

1. Predict the prepayment risk of mortgages in a booming housing market with extremely low interest rates based on historical data;
2. Find a way to include the take-along option.

IT usage

Tasks

- Analyse the given data set;
- Select the features that are important for prepayment risk;
- Derive some descriptive statistics, such that the first findings on prepayments can be discussed;
- Select suitable multinomial logit model for forecasting prepayment risk;
- Backtest the results using a test set;
- Find reasons why mortgage holders still prepay, even with a negative interest rate incentive;
- Quantify the remaining prepayment probability considering the take-along option, using public data;
- Conclude about the performance of the model in a report and presentation.

Data

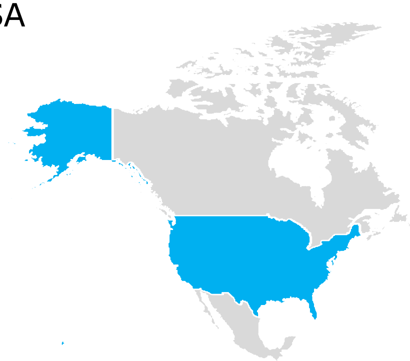
A subset of the Freddie Mac dataset is used which contains information about mortgages in the whole of the USA

Freddie Mac

Freddie Mac is the Federal Home Loan Mortgage Corporation, it is a governmental institution in the USA that offers financial services with a focus on mortgages.

Content of the data set

- The data set from Freddie Mac is an open source single family loan-level dataset
- It covers mortgage information of the whole of the USA



- We will provide a subset of the data

Open source versus private

- Mortgage information is often not public in the Netherlands due to competitive reasons;
- In the USA mortgages are often shifted to the balance sheet of governance entities.

Organisation of the data set

- 2 Excel sheets: the origination data file and the monthly performance data file;
- Origination data file contains all the information about the start of the mortgage;
- The monthly performance file gives an update about the mortgage status and performance every month.

Goals

The goal is to filter out those features that are of importance for prepayment risk.

Thank you.

Questions?