

Prepayment Risk

Financial Engineering AY 2024-2025

The owner of a mortgage can decide to repay his loan before the contractual maturity, completely or in part, in most cases without suffering any penalty. This might happen for a number of reasons which can go even beyond market driven incentives – i.e. a more favourable general level of interest rates; as a direct consequence, the client behaviour can modify in a material way the future cash flows that the mortgage issuer would expect to receive according to a purely contractual view. Thus, the estimation of such behavioural effects is a key factor in order to guarantee an accurate representation of the future expected cash flows, which in turn is at the base of the interest rate risk management. In [1] a behavioural model for prepayment risk based on a Deep Learning approach is introduced, in which the rate of early repayment on the mortgage portfolio is estimated by means of a Neural Network. The Network is calibrated using the past history of the observed repayment events.

1. Students shall build the Neural Network described in the section 3 and appendix A of [1].
2. The set of features will be composed by the contractual and time features listed in section 3.2.1 of [1], plus the following market features:
 - a. *Full rate on new fixed rate contracts*¹: volume-weighted average of contract rates from fixed rate mortgages originated during the last month;
 - b. *3-month Euribor rate*²: (monthly) average of 3-month Euribor rate fixings during the last month;
 - c. *IRS rate*²: (monthly) average of IRS rate fixings (for the tenors 10, 15, 20, 25, 30 years) during the last month;
 - d. *Difference of current IRS rate versus historical minimum*²: the current (monthly average) IRS rate is compared with the historical minimum reached in the past, but neglecting the history of the last 12 months;
3. Students shall execute the analysis of the forecasting capability of the NN discussed in section 4.2 of [1] on the basis of the provided dataset (comprising only fixed rate mortgages) and of the provided time series of market data.
4. Students shall also discuss the performance of the NN approach versus a simpler logistic regression estimator based on the same explanatory variables (i.e. features).

Realize a library in Python, optional in Matlab.

References:

[1] Roberto Baccaglini, Federico Cozzi, Vittorio Malacchia, and Luca Sitzia *A Neural Network Approach for the Estimation of Mortgage Prepayment Rates*. UniCredit Internal Document (Aprile 2021)

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¹ The time series of this feature should be derived from the dataset of fixed rate mortgages provided, based on the available information on the issue date of the mortgage, the initial outstanding amount and the full rate.

² The time series of this feature is available from the annex *rates_202203.csv*.