



Enhancing ALM: how to evolve behavioural models using Machine Learning Techniques

Behavioural models use available consumer data to estimate future behaviour in specific scenarios. **A common assumption is to predict agents' choices assuming their rationality.**

Unfortunately, the empirical evidence and recent development of behavioural economics, show how **customers' behaviour falls outside of what can be considered fact-based or rational.** For example, when market rates increase, banks should expect a greater number of prepayments on floating rate mortgages, but according to empirical evidence this is not always the case.

What are the main reasons behind this phenomenon? **Prepayment models** can help Banks to understand the main factors guiding customer behaviour in their loan portfolio.

Another example is about deposits, well known to be instruments without defined maturity and repricing rule. **Behavioural model on Non-Maturing Deposits (NMDs)** are generally calibrated on historical data in order to identify a behavioural maturity and a repricing rule based on the elasticity of the customer rate with respect to a market pivot rate.

The recent pandemic crisis has increased the interest in such models, as it has had a significant impact on customers' behaviour. Taking into account the behavioural **component it is possible to implement new and more flexible models, improving the reliability of metrics and the risk management process.**

In this context the use of **Machine Learning techniques** can improve the predictive power of the models, compared to the behavioural model framework currently adopted by Banks.

“Artificial Intelligence (AI) in the banking sector, provides great opportunities to enhance customer experience, democratize financial services, improve cybersecurity and consumer protection and strengthen risk management.”

European Banking Authority

Prepayment model nowadays

Within the banking industry behavioural models are broadly used in order to model the prepayment rate. Banks with mortgage portfolios face the risk of an early prepayment of these mortgages and a high historical prepayment rates generally lead to a more volatile mortgage portfolios' duration.

Behavioural modelling helps identifying the expected cash flows profile and volatility. In this regards Banks can optimise their investment and funding strategies, decreasing the hedging cost (with a positive impact on liquidity management).

Different models are used by financial institutions, the two mostly adopted are the Cox Proportional Hazard (PH) and the Logistic regression models. Both of them explain the time to event (mortgages prepayment) as a function of different explanatory factors:

- **Refinancing factors**, such as market interest rate in comparison with the mortgage rate;
- **Macroeconomic factors**, such as GDP growth rate or unemployment rate;
- **Customer specific factors**, such as age of the mortgage holder or socio-economic status.

Being able to map all the relevant features which could affect the mortgage prepayment is the main challenge in reaching acceptable results: Machine Learning constitutes a key success factor in addressing this challenge.

Non-maturing products model nowadays

Non-maturing deposits (NMDs) are liabilities that are characterized by two key features:

- Absence of contractual maturity,
- Interest rates set by the bank.

It is crucial for banks to model the trend of customers' deposits, in order to anticipate the impacts on liquidity and interest rate risk management.

The factors affecting NMDs can be classified into three main categories:

- **Market factors**, in particular the interest rate term structure;
- **Macroeconomic factors**, such as GDP growth rate or unemployment rate;
- **Behavioural factors**, that connect the reaction of the customer to changes in the economic environment.

All the above factors are combined by adopting two different types of model usually developed by banks:

- **An interest rate model**, that expresses the interest rates paid by customers on the deposits as a function of the market interest rates. Usually, a strong autocorrelation between deposits rates and market rates exists, causing poor performance relying on traditional econometric techniques;
- **A deposit volume model**, namely a model that defines a behavioural cashflow profile for sight deposits according to a set of explanatory variables which may contain customers information and macro-economic factors.

In the current low interest-rate environment, the modelling of NMDs has attracted attention from banks and supervisory authorities. In fact, traditional models are not able to include assumptions regarding negative interest rates. The calibration of a market rate model with such assumptions is fundamental to obtain reliable estimates.



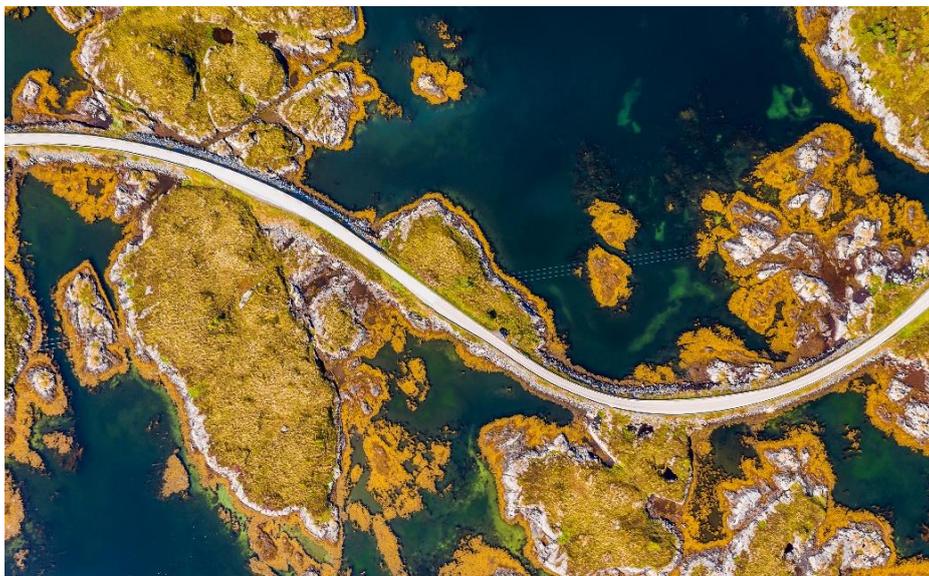
How Machine Learning can help...

Machine learning techniques are becoming popular in the finance and banking industry. The combined adoption of Machine Learning and behavioural models makes it possible to optimize the banking management process, providing benefits to:

- **Risk management process**, improving the quality and granularity of models and the robustness of results;
- **Treasury**, reducing the costs of funding and hedging due to reliable behavioural components included in the cash flows modelling;
- **Finance**, creating a more stable and reliable funding strategy. Machine Learning techniques allow the allocation of funding sources to proper clusters based on customers behavioural patterns.

Machine learning overcomes conventional techniques in the following areas:

- **Big data analysis.** Relying on traditional models, when huge amount of data need to be processed, usually leads the analysis to a trial and error process. This is time-consuming and practically hardly feasible with heterogeneous and big datasets. When we deal with **scenarios analysis for behavioural models**, we need techniques able to reduce computational time and complexity. For example, mortgages dataset are usually very significant in terms of dimension, making the use of Machine Learning more suitable for the creation of reliable prepayment models.
- **Customers' segmentation.** One of the most important tasks is to determine if a big dataset can be divided into smaller clusters, so that in each cluster different explanatory variables and behaviours could be observed. Classification algorithms are a powerful tool to address this task.
- **Classification and clustering** is crucial in behavioural models, as it allows customers segmentation leading to more granular and reliable estimates.



- **Non-linear relations.** A frequent assumption is to consider target and potential explanatory variables as linearly dependent. Indeed this is not always true, especially in prepayment and NMDs modelling. The relation between such variables is generally non-linear, this causes poor performance if we rely on traditional regression techniques. Neural Networks and more in general Deep Learning solve this issue, discovering highly non-linear relations.

... always being careful, Machine Learning is not a magic rule

In order to create reliable models, reliable datasets are needed. The data collection process is fundamental to produce sound behavioural models, safeguarding both statistical properties and economic interpretation.

“The growing use of Big Data and Advance Analytics (BD&AA), including Machine Learning, across the industry will rapidly evolve in the next few years. “

European Banking Authority

“A ‘data-driven’ approach is emerging across the financial sector, affecting institutions’ business strategies, risks and operations with respective changes in the mindset and culture still in progress.”

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How Deloitte can help?

Deloitte Financial Risk Management team leverages on most recent developments in Machine Learning to support in implementing advanced interest rate risk and liquidity risk management framework. In line with the current and upcoming regulatory prescriptions, Deloitte relies on hands-on experience in supporting clients to:

- **Model development and validation leveraging on Machine Learning techniques**
Create Machine Learning behavioural models jointly with more traditional techniques, combining goodness of fit with simplicity and interpretability;
- **Enhance the current liquidity and interest rate risk management** framework based on the evidence provided by the new behavioural models.

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