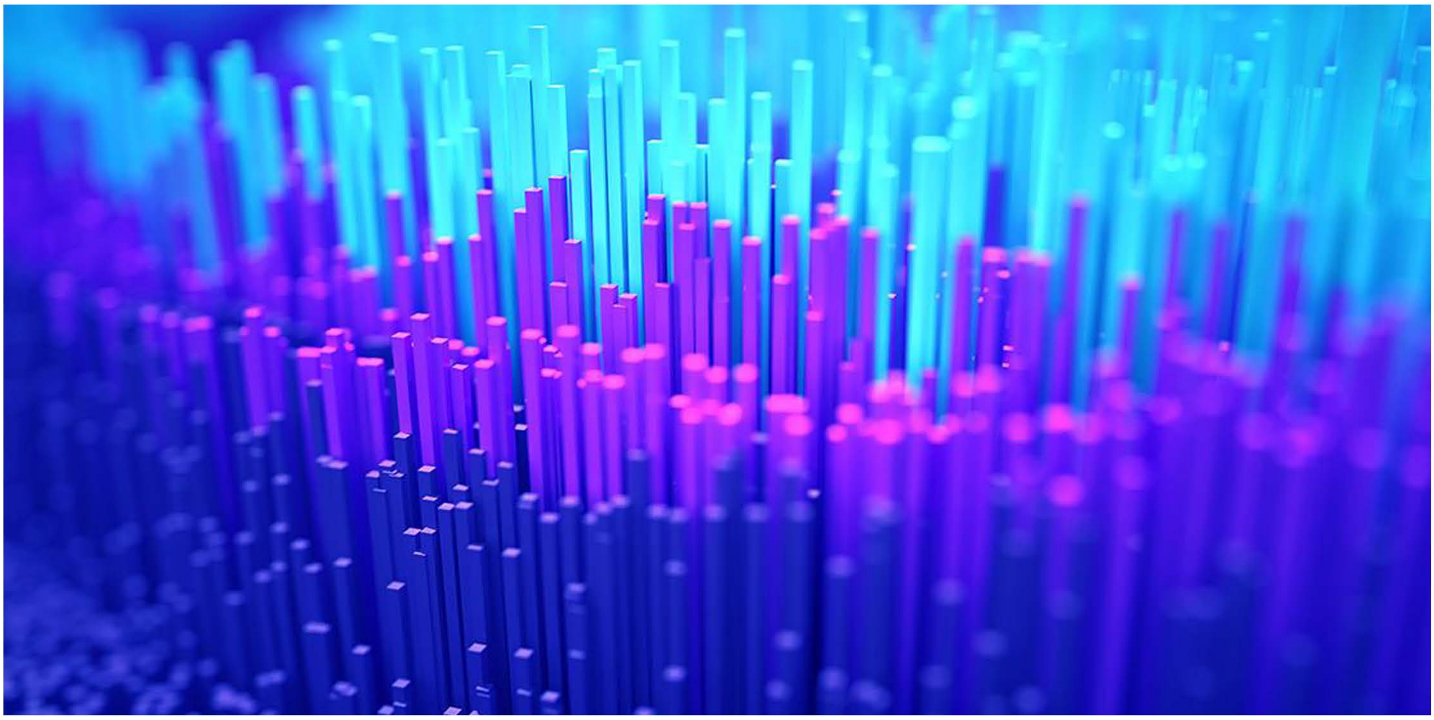
MOODY'S
ANALYTICS

DOCUMENTATION: NOVEMBER 2019

Portfolio Analyser

Integrated Stress Testing & Impairment Solution



Portfolio Analyzer is a robust impairment solution for forecasting probabilities of default (PD), loss given default (LGD), and prepayments for all retail credit lending portfolios originating in Western European countries. The solution leverages retail credit data from the European Data Warehouse and Moody's Analytics highly regarded economic forecasts to produce predictive measurements of loan behavior. Key applications:

- Estimate PDs, LGDs and prepayments under stressed scenarios.
- Assess future credit loss, capital estimates, and VaR contribution.
- Analyze loans and future originations, vintages and credit scores.
- Devise pricing and screening borrowers' risk levels at origination.
- Detect deterioration early with robust monitoring features.

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Introduction

The Challenge: Obtaining trusted measures of loan risk relative to credit and economic trends

Risk managers often find it difficult to accurately quantify future loan portfolio performance based on customer data and estimates of future external factors alone. This often stems from a lack of comparable credit data relative to the countries they operate in and their ability to effectively quantify the impact of the future economic events. As a result, reliability in projects becomes problematic among internal stakeholders, regulators and shareholders. Having credible models that account for industry trends and varying economic paths is critical.

Portfolio Analyzer (PA) provides clients with a rigorous modeling framework based on unique data, sound assumptions and validated results, to generate credible outcomes under different stressed scenarios. Our solution provides a transparent and consistent framework to meet organization-specific needs.

We model probability of default (PD), prepayment probability (PP), and loss-given default (LGD). We build the LGD model using a level regression, whilst conducting PD and PP modelling by using hazard rate models based on time-to-event data. All three models are integrated into a multiperiod analysis to determine cash flows and credit losses in a portfolio of loans. To assess whether there was significant increase in credit risk, we compare the account's lifetime probability of default at reporting date versus the lifetime probability of default at origination, adjusted for loan age, using an optimal threshold based on discriminatory analysis. We obtain the forecast of impairments, both at portfolio and account level, by stressing transition rates upon the conditional PD term structure, and by accounting for attrition rates.

PA utilizes Moody's rich databases of retail and SME loans sourced from European DataWarehouse (EDW), to build robust econometric models and forecast impairments. PA analyzes loan portfolios by first generating trajectories of economic scenarios at a quarterly frequency over a specified horizon. Next, for each loan in the portfolio, loan-level models calculate monthly default and prepayment probabilities over the target horizon as a function of loan-specific and economy-wide factors. Given these probabilities, the software then simulates default events, prepayment events, and loss-given default events to aggregate simulated losses across all loans in the portfolio for each trajectory. Simulated losses are themselves aggregated across all trajectories to produce an estimate of portfolio-level loss distribution. Historical economic data used for simulations are updated quarterly. Users may construct their own macro-economic forecasts of stress scenarios, or use forecasts provided by Moody's Analytics (MA) to conduct credit-risk analysis. Finally, IFRS 9 Expected Credit Losses (ECL) are computed applying a quantitative stage allocation rule for assessment of significant increase of credit risk (SICR). Moreover, forecasting impairments under stressed scenarios is possible to evaluate further.

Additional Features

» Customizable model parameters and risk buckets

» Fully documented and transparent methodology

» Flexible and secure data entry/updating and exporting

» Detailed model validation documents

» Access to economists and risk practitioners

Figure 1 - PA Integrated Impairment Solution

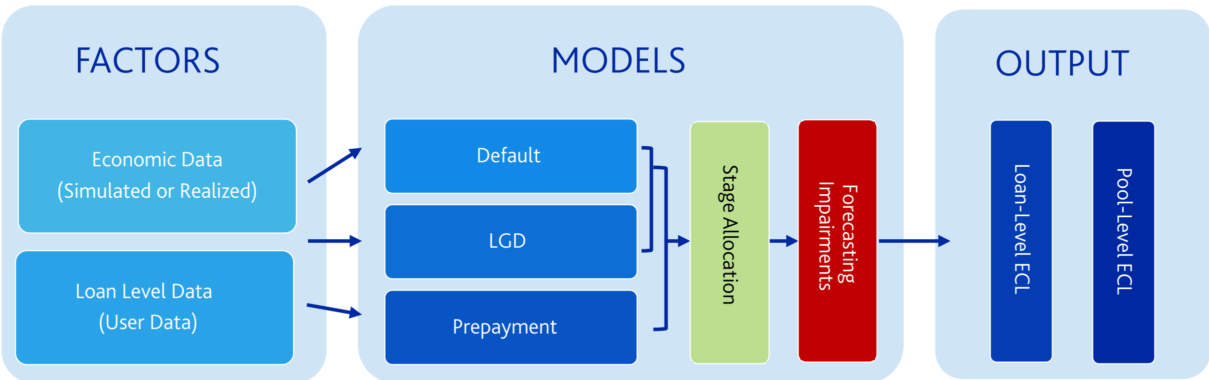


Figure 2 - Number of Active Loans – CMR (Consumer Loans)

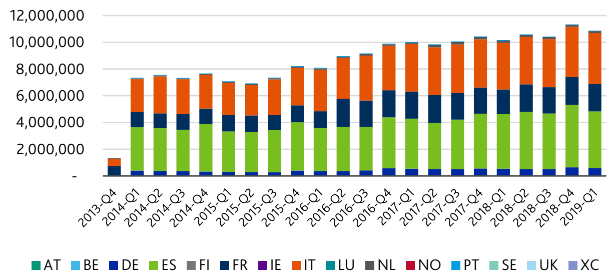


Figure 3 - Number of Active Loans – LES (Leasing)

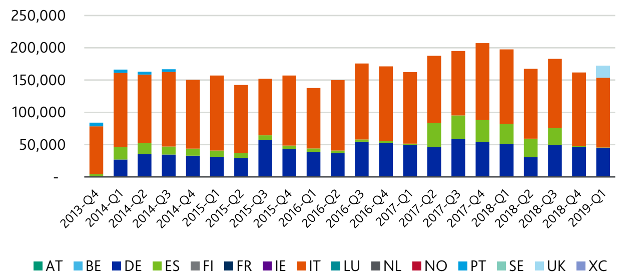


Figure 4 - Number of Active Loans - CRE (Credit Cards)

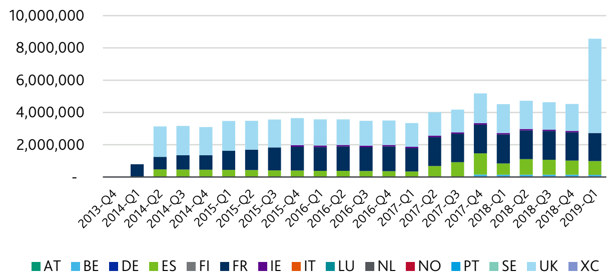


Figure 5 - Number of Active Loans – Auto

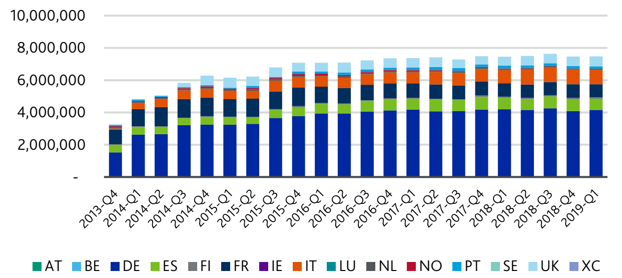


Figure 6 - Number of Active Loans – SME

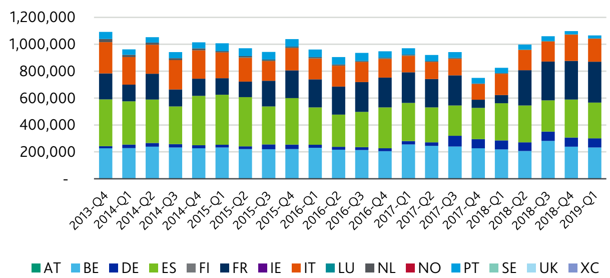
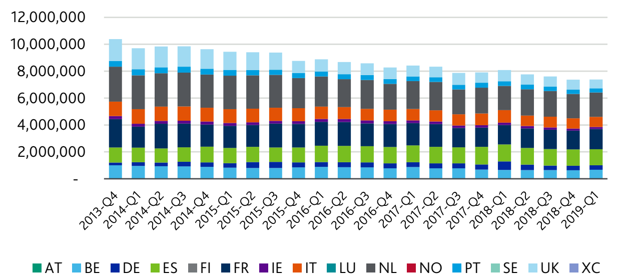
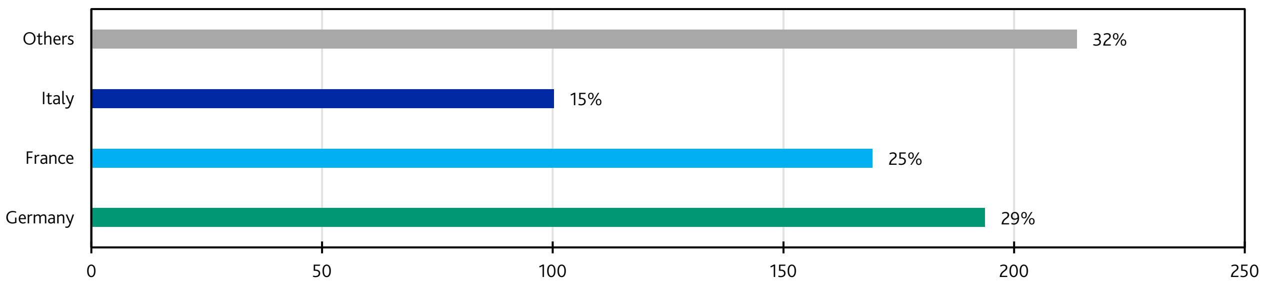


Figure 7 - Number of Active Loans – RMB (Residential Mortgages)



*XC = Others

Figure 8 - Consumer Finance Balance By Country - Current (as of July 2018, in billions of euro)



Impairment Models

The models hosted in PA incorporate loan and geographical characteristics. We control for macroeconomic factors and the fluctuations in both the province-specific and national level.

We make use of a multiperiod setting. Specifically, when analyzing credit risk throughout a loan's lifecycle, the resulting expected loss depends not only on the state of the economy at the loan's origination and maturity dates, but also on the precise path of included macroeconomic variables for the duration of the respective loan timespan. Correlation between fluctuations of considered macroeconomic variables and correlation between default probabilities of different borrowers is implicitly determined through their dependence on common underlying factors.

A loan may exit a portfolio before its maturity is due through either default or prepayment. We model both events by using hazard rate models based on time-to-event data. Hazard rate models produce estimates of loan-survival duration, which we then transform to obtain default (prepayment) probability. In this setting, all loans are assumed to have the potential to prepay or default over a sufficiently long horizon.

With time-to-event data, the use of survival analysis can produce estimates of the conditional probability that a loan prepays or defaults in the ensuing time interval, provided the loan will have "survived" until, but not including, that interval. Specifically, we use panel logit models (Cameron & Trivedi 2005). We build the LGD model using a level regression.

Optimal Variable Selection

The criteria for selection of explanatory factors are:

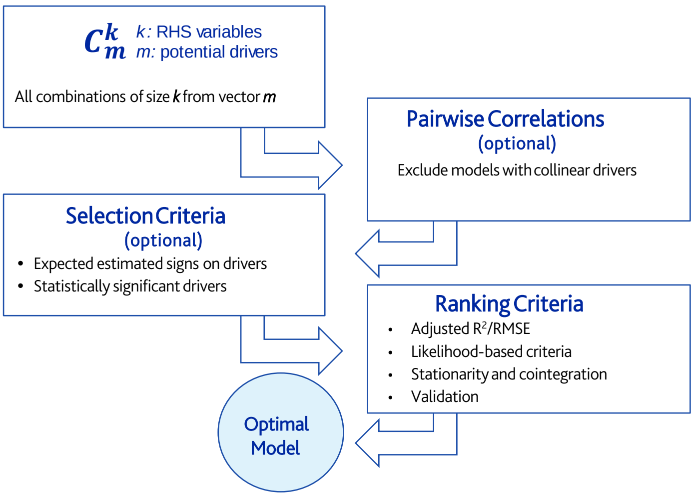
» Common Sense/Economic Theory. An economic rationale ought to be present.

» Practical Implementation. A factor should be readily available. The loan originator must be able to calculate the factor based on data she/he maintains and can easily access, and can be defined unambiguously. The loan originator must be able to calculate the factor in an analogous manner and/or based on simple rules.

» Statistical Robustness. A covariate should demonstrate coefficient values, the direction and magnitude of which are consistent with economic reasoning and exhibit (relatively) low correlation with other covariates included in the model.

After we opt-out factors that do not satisfy the required criteria, we feed the remaining potential drivers into Moody's Optimal Variable Selection (OVS) Algorithm. This algorithm filters and narrows down the set of candidate models. The final model is then chosen according to OVS' quantitative ranking criteria and expert judgment.

Figure 9 - Optimal Variable Selection Algorithm



As part of the validation process, all models were tested to verify that they exhibit appropriate predictive capability and contain no material bias.

Stage Allocation and Forecasting Impairments

Stage allocation can be quantitatively assessed using a metric that shows the change in credit risk since initial recognition. To decide whether an account migrated from Stage 1 to Stage 2, we use a quantitative approach that consists of comparing the account's lifetime probability of default (PD) at the reporting date versus the lifetime PD at origination (adjusted by the months on book at reporting date) and identifying whether an account suffered significant increase in credit risk (SICR) using a lifetime PD threshold.

$$Lifetime\ PD\ threshold = logit(Adjusted\ lifetime\ PD\ at\ origination) + optimal\ buffer$$

The optimal buffer maximizes the chances of allocating bad accounts (with expected default in the next 12 months) into Stage 2 and good accounts (no default) into Stage 1. The optimal buffer shows the deviation between the lifetime PD at reporting date and the adjusted lifetime PD at origination, to be treated as an account with SICR.

The buffer which results from the optimization procedure is the same across different levels of lifetime PDs in the *logit* space. However, when measured in levels, the buffer has the property of decreasing as lifetime PDs increases. With such an approach, low PDs are expected to have a greater buffer as the associated instruments are less risky in absolute terms. In contrast, the buffer (in absolute terms) will be smaller for higher PDs, so that even a small increase results in an allocation to Stage 2. The figure below presents the decision tree used for allocation of accounts to a specific Stage.

Figure 10 - Optimal buffer selection

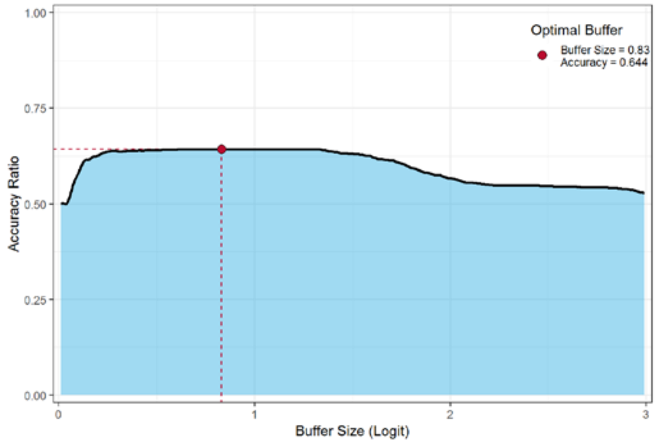
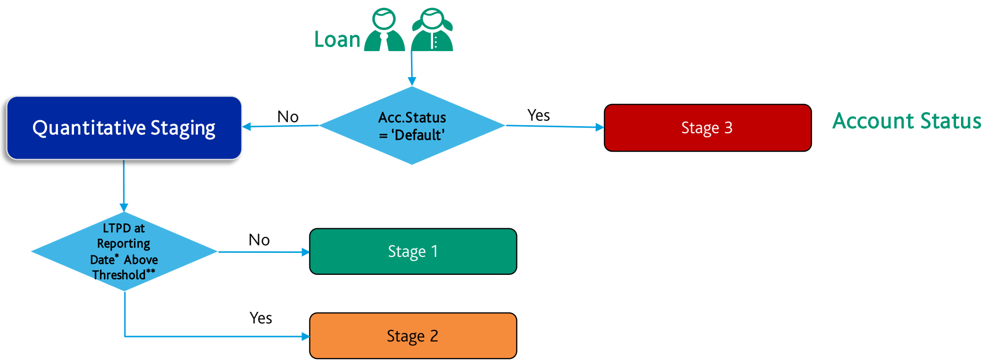


Figure 11 - Stage allocation decision tree



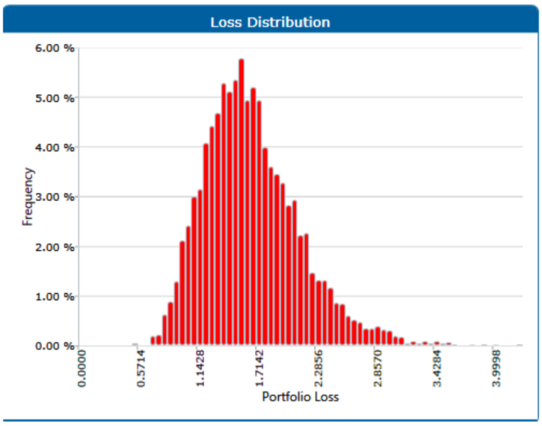
*In logit.
**Threshold = logit(Adjusted lifetime PD at origination) + optimal buffer

The stress-testing exercise also requires forecasting impairments. We follow assumptions adopted by the European Banking Authority and assume a static balance sheet and no cures from Stage 3. We then construct a scenario-conditional transition matrix using historical migration probabilities and IFRS 9 PD account-level projections. Combining this information with quantitative-stage allocation criteria is then used to forecast provisions in each stage using probability-weighted exposures.

Software Capabilities

Analyzing Loss Distribution

In addition to determining expected losses for the entire loan portfolio, it is also useful to consider the loss above or below a specific point on a distribution. In traditional risk management, this is commonly characterized as the *Value at Risk* ("VaR"). Once the loss distribution is available, the VaR can be easily obtained by looking at the quantiles of the loss distribution.

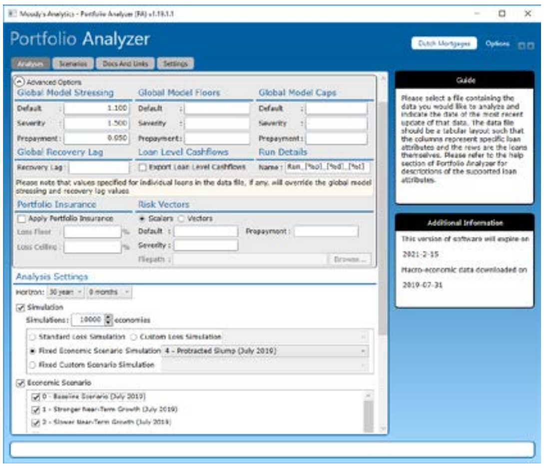


In PA, this distribution is obtained using the Monte-Carlo process, which simulates multiple economic paths of interest rates, unemployment, and home price movements that serve as key inputs in determining the probability of a loan defaulting, prepaying or staying active in any period. PA anchors its simulation of 10,000 (default) economies around the economic scenario in a way that ensures that the mean value of each macro variable at each future point in time is the same as the actual forecasted value of the scenario.

Users can also specify a custom economic assumption as an input to the Monte-Carlo process such that this assumption will become the mean economic path across all generated paths.

Stress Testing a Portfolio of Loans

A key benefit of stress testing is the ability to provide transparency into both model behavior and portfolio risk. PA provides two mechanisms for stress-testing a portfolio of loans:



» The first method implements macroeconomic stress testing by which a specific economic scenario (standard or user-defined) is used as an input to PA and losses and other risk measures under this scenario are calculated. For example, a user may wish to run the "Protracted Slump Scenario" from Moody's Analytics or a customized recession scenario on their loan portfolio.

» The second method involves shocking default rates, prepayment rates and severities directly. For example, a user may wish to double default rates or reduce prepayments by 50%.

The two approaches may be combined. For example, a user may wish to stress the default rates further under a custom macroeconomic stress scenario.

ECL Calculation

PA integrated impairment solution performs a staging and ECL calculation, and provides an output compliant with the IFRS 9 standard.

Expected credit losses (12-month and lifetime) are calculated by summing discounted point-in-time (PiT) expected losses for the next 12 months and until loan maturity, respectively. Final loss allowance is conditioned on the current stage of each account:

$$LossAllowance = \begin{cases} 12m\ ECL,\ if\ Stage=1 \\ Lifetime\ ECL,\ if\ Stage=\{2,3\} \end{cases}$$

We also report, at account level, 12-month and lifetime probabilities of default. All outputs are available for alternative macroeconomic scenarios and for a probability-weighted one.

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