Title: Adjusting loss reserves for model selection risk

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This article investigates the magnitude of model selection risk in credit risk modeling and its impact on loss reserves. The point-estimate of loss reserves varies with the modeling technique used to model losses. However, even within a specific modeling technique, the set of possible model specifications to choose from can be large. Different model specifications produce different paths for portfolio losses, while loss reserves are typically set based on a single selected model specification or a narrow ensemble of model specifications. The process of model specification selection introduces risk to the loss reserves, which maybe set too low or too high with respect to the required reserves. Such is the case when correlating changes in the Macroeconomic environment to the performance of a portfolio of loans.

Changes in the Macroeconomic environment is one of the main predictors of credit risk of interest to lenders and regulators. The macroeconomic factors that shape the behavior of borrowers are numerous. However, many lenders are forced to develop parsimonious models of default behavior due to sparse default-event rates in their portfolios. Model selection criteria are then applied to select a narrower set of model specifications under which to derive the point-estimate of reserves. This narrower set of model specifications represents a narrower set of macroeconomic predictors employed to drive the loss forecast. This process limits the possible and plausible paths of default behavior and imposes a model selection risk on the point-estimate of the loss reserves.

When measuring the reserve uncertainty resulting from model selection risk, the predictive distribution of possible reserve outcomes is of interest. In this study the uncertainty in reserve outcomes is approximated by calculating the lifetime paths of predicted defaults across sets of model specifications that comply with the stricter of less strict model selection criteria. For each set of model specifications, the standard deviation on the distribution of cumulative lifetime defaults across these specifications is calculated. Reserve risk factors are calculated between percentiles of the distribution of cumulative lifetime defaults and the point estimate of lifetime defaults based on the selected model specification (or ensemble of model specifications). The interest is in using the percentiles of these distributions to guide and adjust the loss reserves.

The sensitivity of the parameters of the distribution to different assumptions used in the process of calculating the distribution is studied. In particular, how do reserve factors depend on (1) the restrictiveness of the model selection criteria used, (2) on the number of model specifications and the in-sample fit quality of the set of model specifications used, (3) on the length of the expected lifecycle of the product, and (4) on the length of the assumed foreseeable future before a mean reversion process is applied to the forecast.

The data used for this study represents portfolios of Commercial and Consumer loan products offered by a mid-size US Bank. The portfolios are relatively small in terms of counts with the larger Commercial portfolios represented by on average 1500 healthy accounts and 3-6 default accounts per quarter, and the larger Consumer portfolios represented by on average 4000 healthy accounts and 18 default accounts per quarter. The historic data available for these portfolios begins 2006-Q4, and the models are calibrated on data for the historic period of 2006-Q4 to 2019-Q4.

The sparse data in these portfolios does not allow the estimation of complex models. For that reason, the models developed for this study are Macro-economic time-series Probability of Default models. Due to multiple quarters with zero defaults in the portfolio, a Binomial fit with a Logistic link function is used to fit the models. The macroeconomic indices are log or logit-transformed depending on their defined range. We do not allow non-stationary transformations for macro-economic predictors that in the long term move in one direction, such as GDP, HPI, and Disposable Income. Such macro-economic indicators are tested for predictive power only in their differenced form. A moving average transform is only allowed for predictors that tend to have a cyclical and bounded time series, such as Unemployment Rate.

Of interest is also the lag in the impact of the macro-economic shocks on the portfolio as well as how prolonged the impact is. For that purpose, Macro-economic indices are also tested for predictive power with a lag of maximum of three quarters and the span over which a difference or a moving average transform is calculated of maximum eight quarters. The latter transform is needed to capture the varying delay in responses to the macroeconomic shock by borrowers with different risk characteristics.

An algorithm then estimates models with all possible combinations of transformed macroeconomic indices. Due to sparse data we target the estimation of parsimonious models with the largest model being a 3-variate model. The algorithm then ranks the models (those that comply with all statistical model-selection criteria and with the requirement for direction of impact of each predictor in the model specification) by AIC. This larger set of models is then reviewed manually and reduced to a narrower set of models that also agree with business logic and expectations. The final selected model for each product, on which the point-estimate of the reserve is calculated, is an ensemble of component model specifications from this latter narrower set of model specifications. The model specifications not used in the ensemble model are used to derive the distributions of cumulative defaults over the lifecycle of each portfolio.