Journal of Risk Model Validation **9**(3), 1–29

Research Paper

Stress testing and model validation: application of the Bayesian approach to a credit risk portfolio

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(Received June 8, 2015; revised August 4, 2015; accepted August 4, 2015)

ABSTRACT

Following the recent global financial crisis, regulators have recognized the importance of stress testing, in part due to the impact of model risk, and have implemented supervisory requirements in both the revised Basel framework and the Comprehensive Capital Analysis and Review (CCAR) program. We contribute to the literature by developing a Bayesian-based credit risk stress-testing methodology, which can be implemented by small-to-medium-sized banks, as well as presenting empirical results using data from the recent CCAR implementations. Through the application of a Bayesian model, we can formally incorporate exogenous scenarios and also quantify the uncertainty in model output that results from stochastic model inputs. We contribute to the model validation literature by comparing the proportional model risk buffer measure of the severely adverse cumulative nine-quarter loss estimate – a common way to estimate, being a measure of statistical uncertainty generated by

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Print ISSN 1753-9579 | Online ISSN 1753-9587

a model – obtained from our empirical implementation of the Bayesian to the frequentist model. We find it to be 40% higher in the former than in the latter. As for the model validation exercise, the Bayesian model outperforms the frequentist model statistically significantly, according to the cumulative percentage error metric, by 2% (1.5%) over the entire sample (downturn period).

Keywords: stress testing; model validation; model risk; credit risk; Bayesian analysis; CCAR.

1 INTRODUCTION

Modern credit risk modeling increasingly relies on advanced mathematical, statistical and numerical techniques to measure and manage risk in credit portfolios, consequently giving rise to model risk. Model risk refers to the possibility that a model used to assess financial risks does not accurately capture all necessary variations, and potentially understates inherent hazards stemming from very rare yet plausible occurrences. These hazards may not be in the reference data sets or historical patterns of variables it utilizes (OCC/BOG-FRB 2011).[1]

All regulatory capital models (RCMs) and bank internal economic capital models (ECMs) have the objective of assessing the amount of capital resources and liquidity required by a financial institution to support its risk-taking activities. This is contrasted with available capital and liquidity resources, which may differ from what either the bank (through ECMs) or the supervisor (through RCMs) believe to be required.

Following the recent global financial crisis, both domestic and international regulators have recognized the importance of stress testing, in part due to the impact of model risk, and have implemented supervisory requirements in both the revised Basel framework and the Federal Reserve's Comprehensive Capital Analysis and Review (CCAR) program (Basel Committee on Banking Supervision 2009a–c, 2010a,b; Acharya and Schnabl 2009; Demirguc-Kunt *et al* 2010). Stress testing is particularly relevant for, and challenging to implement in, measuring risk in credit portfolios.

Our research presents classifications and establishes techniques to formulate and implement robust credit risk stress tests. In our empirical analysis, we focus on typical credit portfolios that might be managed by any number of small or medium-sized commercial banks. Our motivation is driven, in part, by the predominance of credit risk as faced by the financial institutions that are engaged in lending activities. Further, the importance of credit risk has been accentuated for small or medium-sized banks,

[1] More precisely, model risk is defined as the risk that a model is faulty because (a) it does not capture the correct risk factors (model misspecification), (b) it does not correctly establish the relationship between the factors and risks being measured or (c) the model is calibrated with faulty data and/or implemented with error.