

A Financial Statement Simulator to Aid Stress and Reverse Stress Testing

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ABSTRACT

Forecasting balance sheet and income statement line items has long been a required activity, especially given the increased regulatory attention after the economic crisis of 2007–2010. Traditionally, financial institutions (FIs) have approached this activity through scenario and stress testing, which basically tests for outcomes arising from changes in circumstances. Unfortunately, the top-down approach and state of modeling to support line item level projections lag far behind other types of modeling being performed at FIs. Additionally, regulators have found additional weaknesses in approaches based on expert knowledge or historical evidence *a priori* and are increasingly advocating the exploration of tail risks that can render an FI's business models unviable, and likely cause the institute to default or become insolvent.

The SAS® Financial Statement Simulation Model presents a new approach to modeling an FI's line items and encompasses support for both scenario-based and outcome-based testing. Our approach avoids the typical inversion problems arising out of traditional independent line item modeling and accounts for the ties between line items through correlations, concentrations, and migration dynamics. Further, the SAS Financial Statement Simulation Model generates the full simulated distributions of balance sheet items, income statement items, and capital ratios that are visualized directly or through SAS® Risk and Finance Workbench.

INTRODUCTION

In the United States, due to the Dodd-Frank Act, bank holding companies (BHC) are annually required to submit stress test results (Dodd-Frank Act Stress Test, DFAST) to their supervisor. This submission requires a full forecast of the FI's balance sheet and income statement to support its capital adequacy claims. The FIs must subject their forecast to a supervisory-defined severely adverse economic scenario and show that the regulatory defined capital ratios remain above the mandated thresholds throughout the forecast.

Historically, most balance sheet and income statement line item (PPNR) modeling has been done at the FR Y-9C line item level through the application of time series models constructed from the history available within the FI. Some FIs have augmented this with industry peer data for a longer time span, while other FIs model at a more granular level to consider business drivers more directly. Regardless of these differences, the main problems have been poor performing and/or non-intuitive models, inconsistency between models with each other and with other internal FI forecasts, and an overreliance on management judgment with overrides.

We developed the SAS Financial Statement Simulation Model to address each of these issues, in addition to the benefits that a unified system of models can provide in a simulation environment.

The SAS Financial Statement Simulation Model employs a full simulation of the balance sheet and income statement of an FI through a Monte Carlo simulation process. In addition

to the direct relationships between macroeconomic factors with line items are the volatilities and correlations between line items.

This is more than just a set of individual models. The key is the system and its dynamics. During development, we found very low explanatory power from purely macroeconomic drivers alone but strong relationships between the random movements of one line item with the others. It is the power of these relationships between line items that we harness in the SAS Financial Statement Simulation Model.

THE PROBLEM

Determining capital needs has always been difficult (as evidenced by the lack of capital carried by most banks at the time of the 2008-2009 financial crisis).

Top-down models are the baseline an FI uses to populate its complete balance sheet and income statement. This is all that is done for many smaller line items and those with little sensitivity to economic conditions. For larger and more sensitive line items, a bottom-up approach with a detailed evaluation of individual business lines with consolidation provides many benefits and makes the practice more relevant to line of business heads. However, this practice also has shortcomings, including:

- Typical forecasts provide only a single outcome for a given scenario (where any variation in performance or responsiveness is ignored).
- The process requires many models and there is potential for compounding of model errors or inconsistencies in sensitivities (that is, misleading covariances).
- The quality of the data for a given line of business might be poor or unrepresentative of future performance expectations.
- There are multiple points at which management can influence results that might not be transparent or documented.

Perhaps the biggest shortcoming of those listed here is the first, the representation of a single outcome for a macroeconomic path. Given the complexity of modern banks, it is courageous to believe that such a point estimate can be consumed with much confidence.

THE SOLUTION

The SAS Financial Statement Simulation Model offers an alternative, or perhaps complementary, approach to stress testing that considers high-quality data from across the industry (that is, a panel of data representing individual FIs and, when taken as a whole, the industry responsiveness to differing economic conditions, including crises). It is using this data from FR Y-9C submissions available from the Federal Reserve, including more than 20 years of quarterly data for several hundred FIs, that we have constructed a family of models that takes advantage of cross-sectional and time series data simultaneously. The models function both individually with sensitivities to economic drivers and as a system with each other.

The SAS Financial Statement Simulation Model provides, for a given macroeconomic scenario, a distribution of outcomes for each line item and, hence, for the ultimate capital-related metrics of interest. This application of models leverages the variance and the covariances represented in the model across banks and over time.

DISTRIBUTIONAL RESULTS

By analyzing the volatilities and correlations of line item movements across hundreds of FIs for each given economic state, we can replicate this variability in the forecast results.

Results are available at a low level and then roll up to the aggregate items. Due to the correlations between line items, this might lead results to either offset or reinforce each other when creating the distributions of the aggregate line items. Because this is in a Monte Carlo simulation space, it is important to remember that this varies per simulation.

Macroeconomic drivers have a large impact on the results of some line items, but this is just one of the factors because the random variation per simulation is still the major factor. To illustrate this point, we ran a sample FI through the system to create the forecasted charge-off results of the FI's home equity line of credit portfolio. Three scenarios were run: Federal Reserve Base, Adverse, and Severe macroeconomic scenarios.

Figure 1 shows the expectation of the results per quarter. As expected, the Severe scenario has higher charge-offs than the Adverse scenario, which is itself higher than the Base scenario.

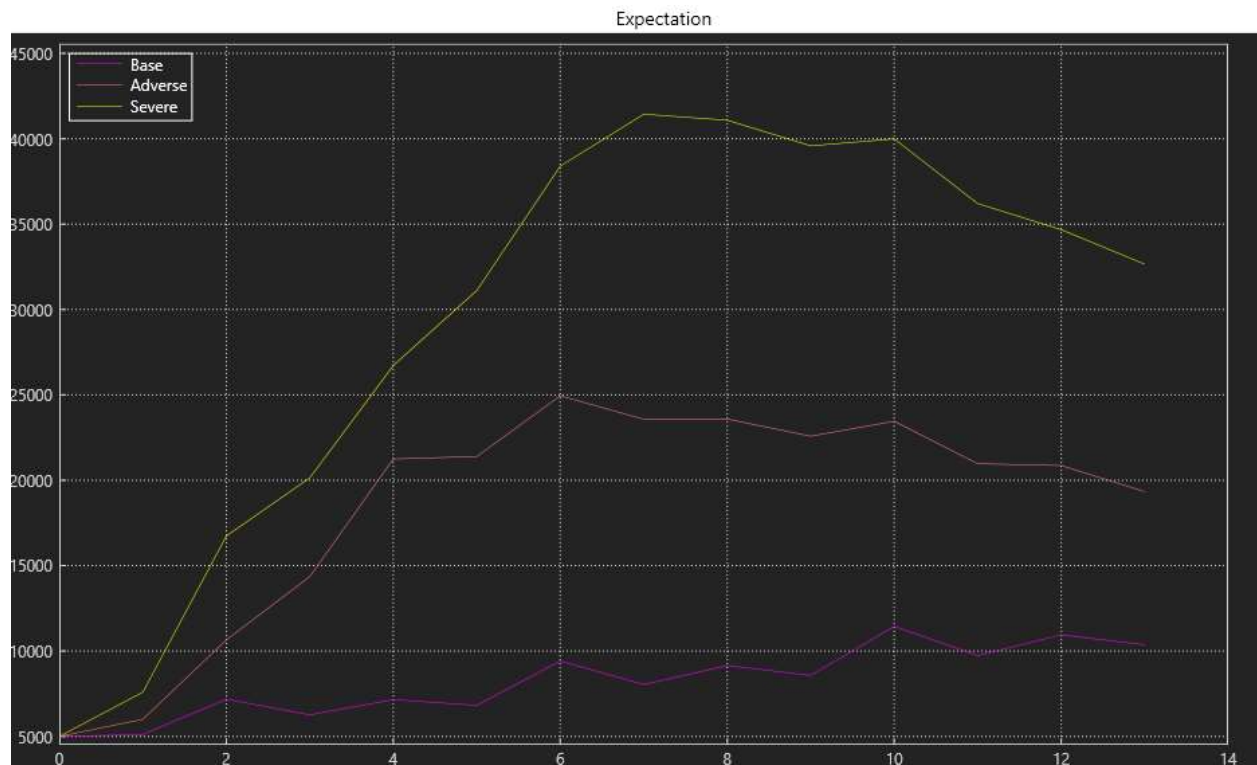


Figure 1. Expectation of HELOC Charge-Offs Per Scenario

But as can be seen in Figure 2, this was not the case for every simulation for those scenarios. There is significant overlap in the distributional results. This implies that there are unobserved factors that might impact the FI's charge-offs so that the FI will not always have lower losses under better economic scenarios.

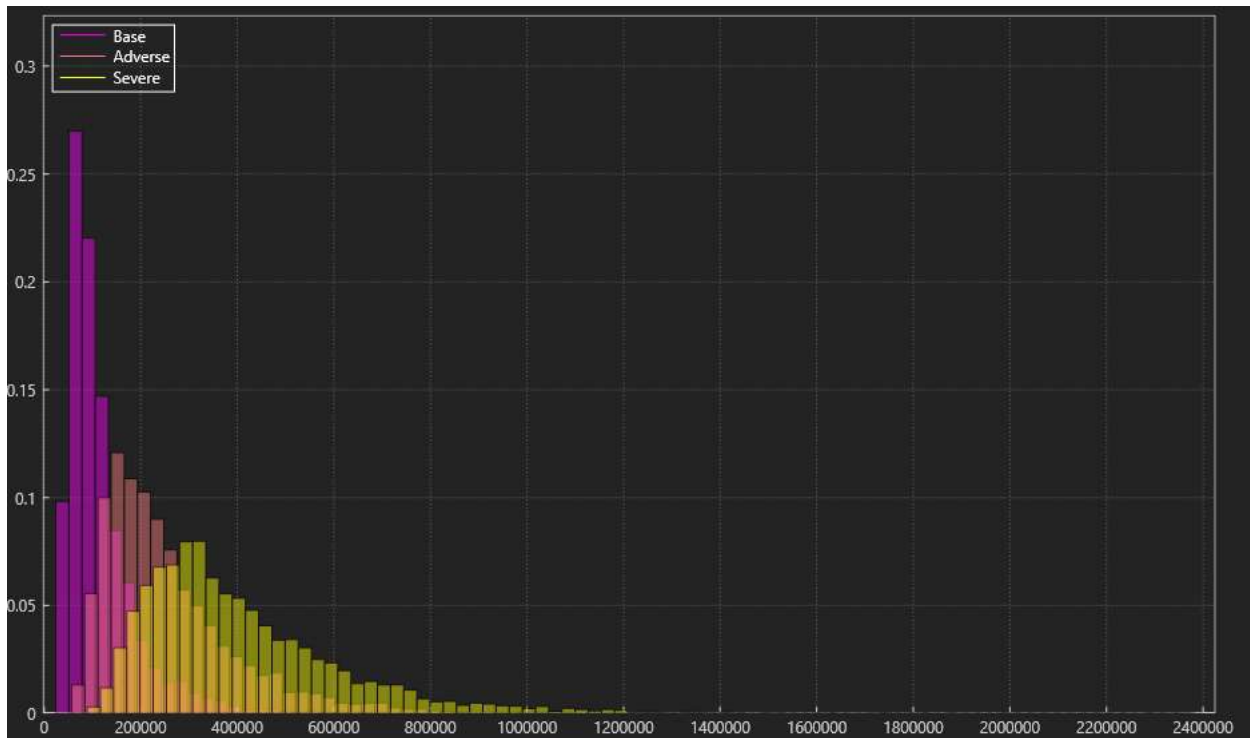


Figure 2. Distribution of Cumulative HELOC Charge-Offs Per Scenario

In addition to just providing an expectation, distributional results such as this can potentially be very useful to a risk manager to understand the variability they can expect to observe in their portfolio performance.

DISTRIBUTIONAL RESULTS' IMPACT ON STRESS TESTING

This leads to the question of how a distributional result can be used to gain additional insight into the meaning of a stress test result. To delve into this, we lay out an example of a stress test submission with a point estimate of their expected capital ratio compared to one with a distribution.

For illustration, Common Equity Tier 1 Capital Ratio results submitted by a bank holding company would be included in a capital ratio projection result table such as in Table 1:

	Actual Q4 2017	2018 CCAR/ Regulatory Minimum	Stressed Capital Ratios	
			Q1 2020	Minimum
Common Equity Tier 1 Capital Ratio (%)	9.3%	4.5%	7.6%	7.5%

Table 1. Illustrative BHC Capital Ratio Projection Results

In this case, the FI would use this as evidence of capital adequacy because the minimum stressed capital ratio was 7.5%, well above the regulatory minimum of 4.5%.

Using the SAS Financial Statement Simulation Model, we ran this same IF's financial statement projections under the same supervisory stress scenario and it returned an expectation of the common equity tier 1 capital ratio of 7.4% in Q1 2020. This is very similar to the result submitted by the IF.

The key difference, however, is that the SAS Financial Statement Simulation Model also provides a distribution of results, one capital ratio for every simulation executed. As can be seen in Figure 3, this distribution provided resulting capital ratios as high as 15.2% and as low as 1.6% in Q1 2020. But most importantly, it showed that the common equity tier 1 capital ratio fell below the required regulatory minimum of 4.5% in a total of 4.3% of the simulations. This, the probability of falling below the minimum required capital ratio, we believe is the key metric that defines the capital adequacy of the IF and its vulnerability to stressed economic conditions.

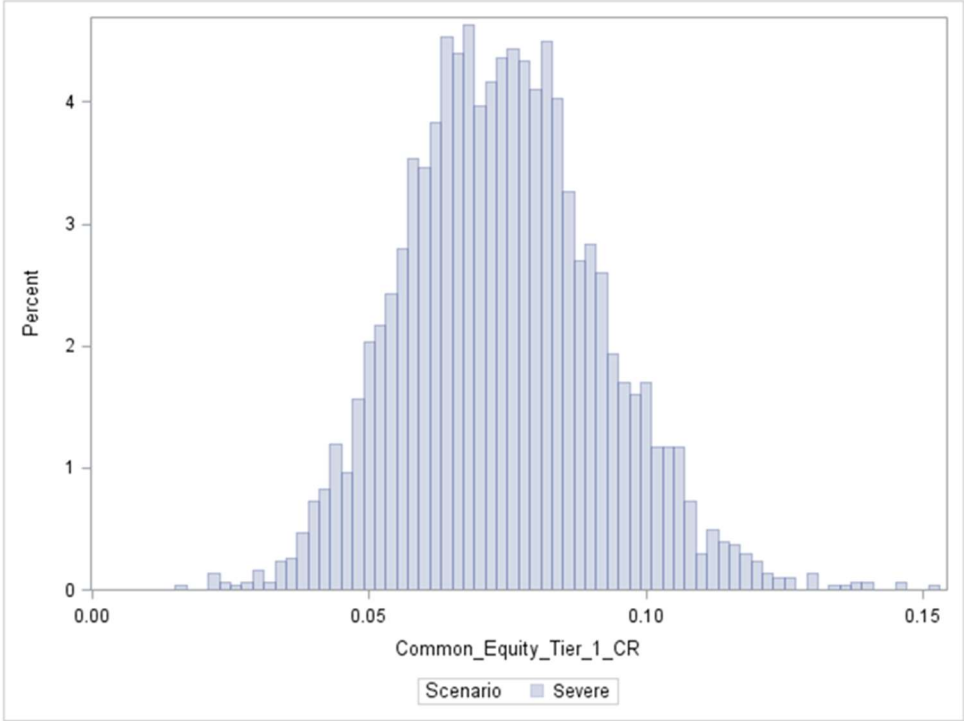


Figure 3. Distribution of Common Equity Tier 1 Capital Ratio in Q1 2020

From this result, the risk manager has the ability to work backward by running what-if tests such as adjustments to portfolio sizing or changes to planned capital actions to analyze the impact of these actions on the likelihood of insolvency.

CONCLUSION

A measure of central tendency can provide an answer to the question: did we pass the stress test? But perhaps more important is the question: what is the probability that we do not pass the stress test? Having such an answer, and digging into the line items, provides management with direction for reducing the tail of the distribution (perhaps even without needing to add capital).

With the SAS Financial Statement Simulation Model, it is now possible for risk managers at financial institutions to answer these questions to move beyond the old limitations and start to leverage distributional results with a system of models that work together as one.

REFERENCES

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