WHITE PAPER

Scenario stress testing: It's time for automation

Producing results for scenario stress testing has traditionally been a manual, time consuming and operationally error-prone activity.

Banks can automate part of this process – scenario expansion – using customized quant models and IT solutions to move towards a more strategic, cost-effective, and easily auditable risk management system.

We believe that implementing a Rapid Scenario Expansion Framework can be an effective first step towards streamlining the stress testing framework for any bank.

Executive summary

With the implementation of a rapid scenario expansion framework, stress shock scenarios can be calibrated at the click of a button

In this paper, we discuss a framework for 'rapid scenario expansion' that can support banks in expanding the stress test scenarios prescribed by regulators in a more automated manner. The quant models needed for the rapid scenario expansion framework can be selected from a myriad of methodologies available. Once the rapid expansion framework is built, the time spent on creating a model will drastically reduce over time, as a given set of code can be used for developing multiple models.

Once such a framework is implemented by a bank (i.e. all the models and IT systems are built and validated), ***stress test scenarios can be expanded at the click of a button***. The results from the expansion framework can be integrated into a bank's risk system to create a strategic, cost effective, and easily auditable regulatory compliance system.

Stress testing in banks

Regulatory focus on stress testing for banks has increased globally

Post the global financial crisis, regulators have put significant focus on rigorous and stringent stress testing programs for banks. Over the years, stress testing has become a critical regulatory tool to ensure higher resilience of the banking sector and goes beyond providing information on required capital levels.

Since global banks are subjected to multiple regulations around the world, they face intensified pressures to demonstrate the robustness of systems, processes, controls, and governance in place to support the stress testing exercise. This increased focus and scrutiny creates many challenges for banks.

Stress test challenges for banks

The three biggest challenges

1. **Data Collection –** The diversity of business operations within a bank increases the complexity involved in data collection for stress testing. Streamlining the front-office, middle-office and risk systems in such a way that the data needed for the stress testing exercise is easily available, accurate, consistent, and auditable is often a difficult task.

2. **Scenario Modeling and Calculations –** Stress scenarios prescribed by regulators (Macro Scenario Definition) usually provide shocks for about 50-100 variables, whereas banks need shocks for 50,000-100,000 variables to perform specific calculations. In the absence of a quantitative framework, this calculation process is usually cumbersome, error prone and time intensive.

3. **Governance –** Once the shocks are calculated, they typically need to go through a governance process or risk committee's approval, and often requires several iterations at regional and enterprise level. This process, when repeated for multiple asset classes, can be highly time-consuming.

Solutions and automation potential

- **Data Collection:** In order to address data collection challenges, banks might need to overhaul their entire data framework in a manner that has minimum impact on daily BAU processes and is in compliance with the BCBS 239 / IFRS9 guidelines. Such a change needs to be carried out in a phased manner because there are multiple sources of data which interact differently with the risk system and therefore requires customized re-building. The customization of each data source re-build merits the overhauling process to be more manual than automatic.

- **Governance:** The governance process is by definition a qualitative process and involves qualitative assessment of shocks / stress testing results by an individual or a group of individuals, making it an iterative and time-consuming task, and the scope of automation is often limited.

- **Scenario Modeling and Calculations:** The process of scenario modeling and calculation, on the other hand, is a quantitative process and dominated by quantitative models. There are clear guidelines by regulators on how to build such models (SR 11/7 for example). Banks can use those guidelines with automated model creation modules to create the necessary shock scenarios to run a stress test. Once all the models are created, the process of scenario shock calculation can become a fairly smooth and auditable process, while being regulatorily compliant. Automating the scenario modeling and calculation also helps address some of the data collection and governance process related issues:

  - Any quantitative framework for scenario modeling and calculation would need the data in a standard format - this could potentially be the format in which the data is generated and stored in the first place.

  - Any such quantitative framework would calculate shock scenarios in a stepwise manner. At every step, a governance committee can review the results and recommend the necessary alterations on a timely basis.

An automated scenario expansion is therefore the first step towards streamlining the stress testing framework for any bank.

What are banks doing currently?

The current process of scenario expansion used by most banks is cumbersome, time and resource intensive and relies heavily on expert judgment

As the shock scenarios described by the regulators are not granular enough to be applied on any bank's specific portfolio, the typical scenario expansion process involves translating a few hundred shocks to a more comprehensive list of shocks (that may run into thousands).

Take an example of a bank that has entered into a $10m fixed-for-floating swap arrangement with a shipping company in China. In the ECB stress test, the list of shocks many include shocks to GDP, equity markets, real estate prices etc. but may not necessarily include shocks to 3-month Libor or the Chinese company's Probability of Default (PD) (the two risk factors involved in this particular trade). As a result, in order to produce an ECB stress test compliant report, the bank would need to derive shocks to 3-month Libor and PD using the ECB's prescribed shocks.

The most common approaches to calculating shock scenarios to 3-month Libor would include:

- **Scalar multiplication –** The baseline shock for the 3-month Libor would be multiplied by a scalar to arrive at the final shock for the ECB stress test. The scalars are estimated based on expert judgment or derived using a qualitative relationship between the ECB stress test and some historical stress event.

- **Beta multiplication –** Similar to scalar multiplication, a Beta would be multiplied to the baseline shock for the 3-month Libor to arrive at the final shock for the ECB stress test. Beta could be calculated using regression, irrespective of whether the regression model is a quantitatively suitable model or not, or calculated based purely on expert judgment.

- **Expert judgment –** The 3-month Libor shock would be calculated purely based on expert judgment.

All these approaches are judgement driven, therefore prone to operational errors, redundancies and inconsistencies, and resource intensive – requiring on average 2-3 weeks of calculation work for every 1,000 risk factors.

Key recommendations

We suggest an integrated and automated approach to scenario expansion

A rapid scenario expansion framework is a suite of models collectively integrated through a standardized platform. The framework utilizes statistical tools for expansion of scenarios across various asset classes and geographies. The expansion of 50-100 shock scenarios (prescribed by regulators) to over 100,000 is a multi-step process:

Step 1: Calculate shock scenarios for a few Key Risk Drivers (KRDs) i.e. the most important risk factors for each asset class.

Examples of KRDs for different asset classes:

Equities	FX	Commodities	Interest Rates	Credit
S&P 500	USDEUR	Gold	US 2Y Treasury Rates	CDX IG Index
FTSE 100	USDGBP	Silver	US 5Y Treasury Rates	CDX HY Index
STOXX 50	USDCNY	Coffee	US 10Y Treasury Rates	iTraxx IG Index

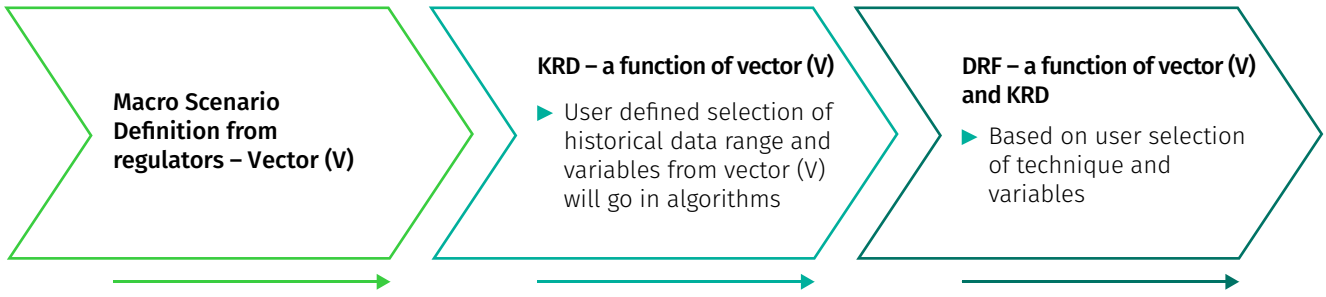
Step 2: Expand these KRDs to Derived Risk Factors (DRFs).

Examples of DRFs for different asset classes:

Equities	FX	Commodities	Interest Rates	Credit
US Finance Sector	USDRUB	USDRUB	US 3Y Treasury Rates	US AA corporate bond
UK Consumer Disc	USDMYR	USDMYR	US 7Y Treasury Rates	US BB corporate bond
EU Utilities Sector	USDPLN	USDPLN	US 20Y Treasury Rates	EU AA corporate bond

Step 3: Compute more risk factor shocks and repeat the process until all the relevant risk factors are covered.

Figure 1: A rapid scenario expansion framework systematically translates the shock scenarios prescribed by the regulators to risk factor shocks



Under a rapid scenario expansion framework, quantitative algorithms for modeling can be selected from a range of techniques for different asset classes. For instance:

- **Statistical Frameworks –** Establishing the relationship (i.e. Beta) between the shock scenarios prescribed by regulators and the bank's risk factor using historical data. Modeling techniques that can be used for estimating the Beta include:
  - ***Regression (OLS, logistic, panel) –*** Using OLS, logistic and panel regression techniques to determine relationships between the macro variables and risk factors.
  - ***Time-series Analysis (ARIMA, AR, MA, ARCH, GARCH) –*** Since macro variables usually have first order auto-regression, time-series based modeling is one of the most popular choices of models for expanding the macro variables for different geographies.
  - ***Structural Models (PCA, VAR etc.) –*** These models are statistically very robust but are less intuitive. This set of models can be used to derive the statistical relationship between the KRD universe and DRF universe.
- **Stochastic Frameworks –** This technique includes scenario expansion by using historical volatilities and mapping market information to run simulation on portfolio-specific risk factors.
- **Machine Learning Frameworks –** This includes scenario expansion using machine learning techniques such as clustering, neural network, and predictive modeling.

Implementing a rapid expansion framework would provide consistent scenarios across all regulations and can easily integrate shock scenarios into the banks' overall risk management system. For further effectiveness, the computed shock scenarios should be reviewed by the banks' internal governance committees at each step. Figure 2 describes our recommended approach to building a rapid scenario expansion framework, and the flow of data, information and results within it:

Figure 2: Recommended approach to building a rapid scenario expansion framework

Benefits for banks

Rapid scenario expansion solves the scenario calculation challenge and can potentially solve data and governance challenges as well

Regulatory guidelines on stress testing are constantly evolving and are only likely to grow in complexity in the years to come. Therefore, it is prudent for the banks to have a rapid scenario expansion framework in place to keep pace with regulatory change.

This framework can also be thought of as the first step towards solving the data and governance related challenges faced by the banks. The data collection issues could be solved by proposing an ecosystem which needs to have uniform, auditable data to be used in the quant models. The governance process can be streamlined by automatically assigning the review and approval of the results of the scenario expansion to the respective risk head.

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