



‘No Creditor Worse Off’: Resolution Mechanisms Update

Also in this issue

- Black Swans Mean Business (Part II)
- OTC Clearing Evaluation (Part II)
- Your Internal Audit: Is it Delivering For You?
- Understanding Model Validation
- Islamic Finance: Unique Risk Management Challenges and the Impact of Basel III

Understanding Model Validation

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In this article, the authors describe the essentials needed to understand model validation as part of risk management and in particular what are the key principles and the core components of model validation, the model validation framework, key assessment criteria, tools, models and risk management systems, documentation and a reminder that it is required by regulators.

In recent years the financial services industry has become increasingly reliant on models to help manage risk. The Advanced Approach to risk analysis requires creation of models for each risk type used for the determination of capital requirements under the Basel II Capital Accord (banking and financial institutions) and for the “internal model” under the Solvency II Directive (insurance).

What is a Model? Why do we use them?

Models allow us to reason about things we do not know. The US Federal Reserve defines a model as “a quantitative method, system or approach that applies statistical, economic, financial or mathematical theories, techniques and assumptions to process input data into quantitative estimates. Some inputs to a model could be partially or wholly qualitative or based on expert judgment.” A model is a simplified picture of the real world. Or, said another way, a model makes a series of simplifying assumptions to describe the interrelationships among variables for

risk analysis purposes. A model is a deliberate and often crude simplification of reality. The ultimate goal of a model is to improve the quality of decision-making, analyze business strategies, identify and

**World is suddener
than we fancy it.
World is crazier and
more of it than we
think,
Incorrigibly plural.**

**From ‘Snow’
By Louis MacNeice
(1907-1963)**

measure risk, improve capital and liquidity planning and more importantly, creating the environment for properly meeting regulatory, financial and public disclosure reporting requirements.

While models are used for many purposes, the remainder of this article will focus primarily on models used for risk management and reserve capital determination processes.

What is Model Risk?

“Model risk” refers to the exposure that arises when a risk model is created which has embedded errors and/or limitations in one or more of its dimensions such as the underlying theory, code and/or inputs when measured against its design objectives or/and intended business uses, or when management does not interpret the results of the model correctly (misinterpretation is something that can also amplify model risk), which leads to incorrect estimates of the risk that the entity faces.

Or, said another way, the primary concern related to model risk is where the model fails to capture reality as, by their nature, models are a simplification of the real world and model risk exists where the simplifications materially impact the results of the model relative to the real world. Thus, business decisions are

Understanding Model Validation

being made based on incorrect or misunderstood outputs. Model risk increases with the degree of model complexity and with the increase in model usage inside a financial organization.

An effective solution to mitigate model risk is model validation.

“Model validation” is an independent review of both the models themselves and the governance structure surrounding them to ensure that the model is suitable for the uses to which it is put and that it functions as intended and can be demonstrated to do so. The model must be subjected to critical analysis by objective and well informed parties that can identify its limitations and capable of suggesting ways of model improvement. No part of a model should remain unchallenged.

Basel II requires model validation by way of independent reviews to validate models used within the financial institution (FI). Under the Basel II Accord, financial institutions are required to have sound, independent model validation programs. Under Solvency II, the firm must establish governance and validation processes to ensure that the ‘internal Model’ (as defined by the firm) is properly validated and used appropriately in compliance with the Directive.

Objectives of Validation of Risk and Capital Models

The primary objective of validation is to obtain ongoing affirmation (positive assertion), through testing and analysis, that the risk and capital models:

- Produces appropriate, accurate, consistent, reliable and meaningful Capital-related information, with a key focus on capital requirement (regulatory and economic) and other key uses.
- Remains appropriate and fit for purpose (i.e., on-going appropriateness of its specifications).
- Continues to be compliant to the regulatory approval for the model (i.e., capital requirements).

Key Principles in the Validation of Models

The firm must establish governance and validation processes to ensure that the risk and capital models are properly designed, developed, tested, implemented, validated and used appropriately in the FI in compliance with its authorized use.

There are a number of key principles that provide guidance in the validation of models, they are:

- The financial institution (FI) has primary responsibility for validation.

- Validation is fundamentally about assessing the predictive ability of a FI’s risk estimates and the use of ratings in credit/market/operational risk etc. processes.
- Validation is an iterative process.
- There is no single validation method.
- Validation should encompass both quantitative and qualitative elements.
- Validation processes and outcomes should be subject to independent review.

Core Components of Model Validation

The three core components of Model Validation are:

I. Conceptual and Theoretical Soundness

- Review of design objectives and intended business uses
- Review of Conceptual and Theoretical Soundness of model assumptions, inputs, outputs, functions and overall methodology.
- “Developmental Evidence” – Focus is on design and construction.
 - Can the model be expected to work as intended?
 - Consistency between model and business objectives.
 - Using statistics vs. expert judgment.
- A consistent assessment of two dimensions of model risk:
 - Model error potential (i.e. potential errors in estimation).
 - Impact of model errors (i.e. what is “bottom line” impact of errors).



Understanding Model Validation

2. Model Operations (Compliance)

- Confirmation of model operation: on-going monitoring of model and surrounding processes, which may include:
 - Key Performance Indicators.
 - Exceptions monitoring (i.e. Overrides).
 - Verification of “replicability”, appropriate use of model, data integrity.
 - Investigation in whether the effects of changes in model environment necessitate model adjustment, redevelopment or even replacement.
 - Validation of any extension of a model beyond its original scope.

3. Outcome Analysis (Performance Testing)

- Review of the IM’s historical and relative performance, including:
 - Back-testing – Predicted versus realized outcomes.
 - Benchmarking - Uses alternative models, methodology or data to draw inferences about the suitability of the predicted estimates, risk factors, or segmentations prior to observation of actual
 - Other methods
- Importance of tolerance levels and remedial action policy

Model Validation Framework

In the case of risk and capital models, the financial institution needs to have a regular cycle of model validation that will involve the assessment of many areas including the performance models, reviewing the on-going appropriateness of its methodology and for testing the results against experience. The model validation process should include an effective statistical process for validating the model that allows a demonstration that the resulting capital requirements are appropriate. A proportionate approach needs to be taken as not all validation tools will be applied to all components of the model at the most granular level. Validation should be independent from model development and use. It should be done by staff not responsible for model development and use and not having a stake in model validity.

For capital-related models, model validation should apply to the consolidated group level and for those legal entities that are subject to supervisory review by their respective local regulators.

Generally, each material component of the risk and capital models should be validated at least annually. Significant changes in the external environment may necessitate additional ad hoc checks on the validity of the model. The proportionality principle shall be observed in considering how frequently the model shall be validated. Some of the models and tools that are used as part of the model validation process may be run more or less frequently than annually.

The following are the key assessment areas for model validation:

- **Data** – Ensure that the data, used within the model, is complete, accurate and appropriate. Also, need to consider the data quality dimensions of: relevance, timeliness and consistency.
- **Assumptions** – Ensure that the assumptions, used in the model, are realistic, suitable, justifiable and appropriate. The key assumptions underlying the model are those variables which are important to the business and / or have a significant impact on the model’s results.
- **Method** – Ensure that the selected methods, used in the model, are based on adequate, applicable and relevant actuarial and statistical techniques. This includes ensuring that the written policy and procedures statements that detail the key elements of the model continue to provide the required guidance.

- **Expert Judgement** – Ensure that the expert judgement, used as input into the model, is justifiable. Expert judgement can take a number of forms, including: replacing of or complementing data, deciding how to use the available data and the selection of assumptions.

- **External Models and External Data** – Ensure that the external models, where used, and their generated data, used in the model, are suitable and sufficient. As well as ensure that the external data sources, used in the model, are suitable and sufficient. External models and Data that is used within the model needs to be consistent with the standards and requirements.

- **Model outputs** – Ensure that the outputs, of the model, are complete, accurate, timely and meet the stated (e.g., regulatory) requirements. Including, ensure that the model meets the needs of its various stakeholders, with different data requirements depending on their particular area of interest and focus, and that the Management Information remains widely used, and plays an important role, in the management of the firm. The granularity of the model output needs to reflect the levels of detail in risk and capital management and decision-making processes

- **Documentation** – Ensure that the documentation effectively supports the model and is regulatory compliant. The design and



Understanding Model Validation

operational details of the model needs to be documented. The documentation also needs to provide a detailed outline of the theory and assumptions underlying the model. The documentation should provide information on the intended use of the model and define the model's operational limits.

Tools used in Model Validation

The following are some of the key tools for model validation:

- **Back-testing** – Testing of the model results against experience, including an assessment of discrepancies between the range of outputs from the model and actual realisations or justified comparable data.
- **Sensitivity Analysis** – Varying individual model parameters to assess the impact on capital.
- **Stability Analysis** – This is used to test the robustness of the model, for e.g. a change of inputs should not produce model outputs contrary to expectations or a re-run of the model with different random numbers should not produce materially different results. This is linked to Sensitivity Analysis.
- **Scenario & Stress Testing** – An assessment of the impact of a single event (stress) or combination of events (scenario) on how results may look under various conditions in order to identify possible limitations in the model.
- **Reverse Stress Testing** – Determination of the level of loss which would lead to insolvency (or failure to deliver the plan) and work backwards to determine the scenario(s) which might lead to that level of loss.
- **Benchmarking** – Comparison of a model, either in total or part, with peers and / or available academic literature and research.
- **Analysis of Change** – Analysis of how the results of the model have changed from one period to the next, including underlying drivers.
- **Thematic Reviews** – Reviews of key aspects of the model in order to gain comfort over the theoretical basis of the model. This may include the mathematical framework and whether the model reflects the correct risk drivers.

Models and the Risk Management Systems

Financial Institutions must ensure that the models they are using are supported by risk management systems that are conceptually sound and implemented with integrity. Qualitative criteria include:

- There is an independent risk unit who provide a governance role over models
- The FI's internal risk measurement and capital model must be closely integrated into the day-to-day risk management process of the institution
- Institutions should have a routine in place for ensuring compliance with a documented set of internal policies, controls and procedures concerning the risk measurement system and
- An independent review of the risk measurement system should be carried out regularly by the bank's own internal auditing process (best is once a year).

Documentation of Models

An important component of the firm's model control framework is the standards for the required supporting documentation for models.

The documentation standards include: (1) sufficient detail to understand the way in which models are validated and (2) clarity around acceptable operating thresholds of the models. Additionally, models are required to be periodically reviewed to assess their ongoing appropriateness of approach given changes in the underlying market conditions and/or generally accepted valuation methodologies and this must be documented.

Standards should include that: documentation is clear, thorough and complete, incorporating assumptions, underlying theory, test data, model structure, justifications for model and parameter selection, model results and the validation criteria for an effective model.

Other Considerations

There is a need to embed models into decision-making processes. Executive/Senior management needs to understand and support the risk

models' parameters used in the decision-making process (e.g., for provisioning, limit approval, etc.).

The use of models is an important vehicle to measure and monitor risks across the bank, enhance risk management and ultimately determine capital requirements. These need to be established (embedded) into the regular processes of the firm. .

As a component of good corporate governance, the bank should endeavour to achieve segregation of duties between model development, model operation and model validation.

Summary

The banking industry has become increasingly reliant on models (i.e., risk models) to help monitor, measure and manage risk.

The goal of a risk model is to improve the quality of decision-making, reduce the decision risk, and, more importantly, favorably influence or even shape the future internally-based environment.

"Model risk" arises when a model is created with embedded errors in one or more dimensions such as the underlying theory, code and/or inputs or when management does not interpret the results of the model correctly, which leads to incorrect estimates of the risk that the institution faces.

This results in business decisions being made based on incorrect or misunderstood outputs.

An effective solution to help mitigate model risk is model governance and validation.

Model validation is an independent review of both the models themselves and the governance structure surrounding them.

Under the **Basel II Accord and the Solvency II Directive**, financial institutions are required to have sound, independent model validation programs in place.

The authors invite comments and feedback via email to MJD@riskrewardlimited.com