Demystifying validation tools

Clarifying the notion of validation and providing insight about validations tools and their roles within the validation process

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March 2013

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Introduction

Background

The boards of many insurance groups requested the development of an Internal Model to help them understand their Solvency II regulatory capital requirement. This mirrors the approach taken by the banks, who adopted the advanced IRB approach for Pillar 1 capital calculation.

Demonstrating a strong approach is a key to achieving regulatory approval to use the model. The objective of the validation, which is a regulatory requirement, is to generate confidence about the model and its outcomes to ensure the model is and remains appropriate for measuring the risks.

The supervisory guidelines (GL10 from CEBS/EBA or CEIOPS-DOC-48/09 (formerly CP56) from CEIOPS/EIOPA) describe the tests and standards for internal model approval. Different terms are used: validation, independent review, testing, stress testing and others. Some of these steps need to be applied by the modelers during the development stage, while some others by independent parties after the model development, and possibly on a recurrent basis.

The term “validation” is sometimes misleading. Generally, it is used to indicate “testing”. In the Basel/ CRD regulation, it can be understood as “testing” or as ”independent assessment”, while in the Solvency II regulation, “validation tools” are the testing methodology applied by the modeler or the person in charge of an independent assessment.

In the context of a financial institution’s regulation, the undertaking has to use validation tools to validate its internal models. A quite generic definition is given by the regulator (CEIOPS-DOC-48/09; 8.33): “any approach designed to gain comfort that the internal model is appropriate and reliable. It may be a mathematically well defined test, a qualitative judgment or any other process with such an aim.”

Demystifying Validation

The goal of this paper is to clarify the notion of validation and provide some insight into validation tools and their roles within the validation process. The focus is set on insurance related examples but these may easily be translated into a banking environment.

This paper is divided into five sections:

Section 1 – What is validation? Were we describe the motivations that lie behind a model validation as well as the main stages of its lifecycle.

Section 2 – Validation and the model lifecycle: We then position validation within the lifecycle and describe the parts of the internal model that have to be covered during the validation process.

Section 3 – Tools, Types and Techniques: We provide an overview about the test objectives for different stages of the model lifecycle, with examples of validation tools which can be used to support these tests objectives.

Section 4 - Validation and Independent Review: We describe the link between validation tools and independent review as well as the underlying roles and responsibilities.

Section 5 – In conclusion: Lessons learned and conclusions from Risk Dynamics’ experience of validating over 700 models.

Section 1 – What is validation?

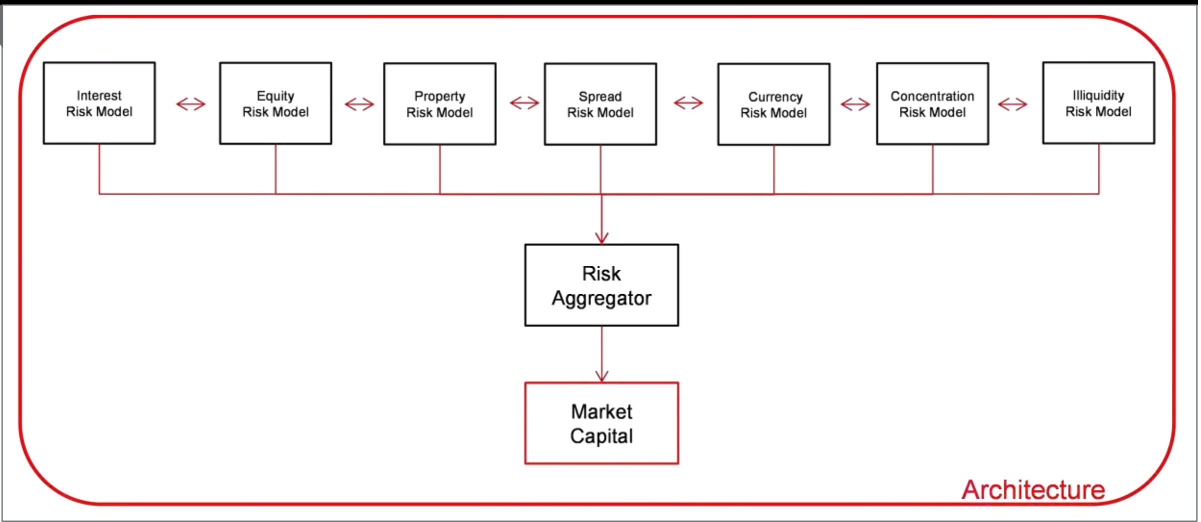
Validation aims to provide confidence about the model and its outcomes and to ensure that the internal model is appropriate for the purpose for which it is to be used.

More precisely, the motivations behind the model validation are driven by two main objectives. The first is to ensure that the internal model is appropriate for the calculation of regulatory capital, in particular that the level of regulatory capital is not so materially misstated that it decreases the level of the policy holder protection. The second is to ensure that risk management as a whole and its underlying decision making process are based on reliable figures. As a demonstration of the undertakings confidence in its output, they also need to demonstrate that their internal model is widely used and plays an important role in its system of governance.

By implication all (sub-) models of an internal model should be included in the scope of the validation process. For instance, in a market environment, the market capital model can be composed of an interest risk model, equity risk model, property risk model, spread risk model, currency risk model, concentration risk model, illiquidity risk model and a risk aggregator for computing the total capital. As any building block can potentially influence the total capital, each one must be assessed. However, the way the different components interact with one another as well as the global consistency of the whole must also be assessed. This is what is called the validation of the **model architecture.**

In the following figure, an example of market architecture and its sub-models is displayed:

FIGURE 1: Typical model architecture for market risk



In addition, for each component of the architecture and more globally from the standpoint of the architecture itself, specific areas need to be validated. This includes at least:

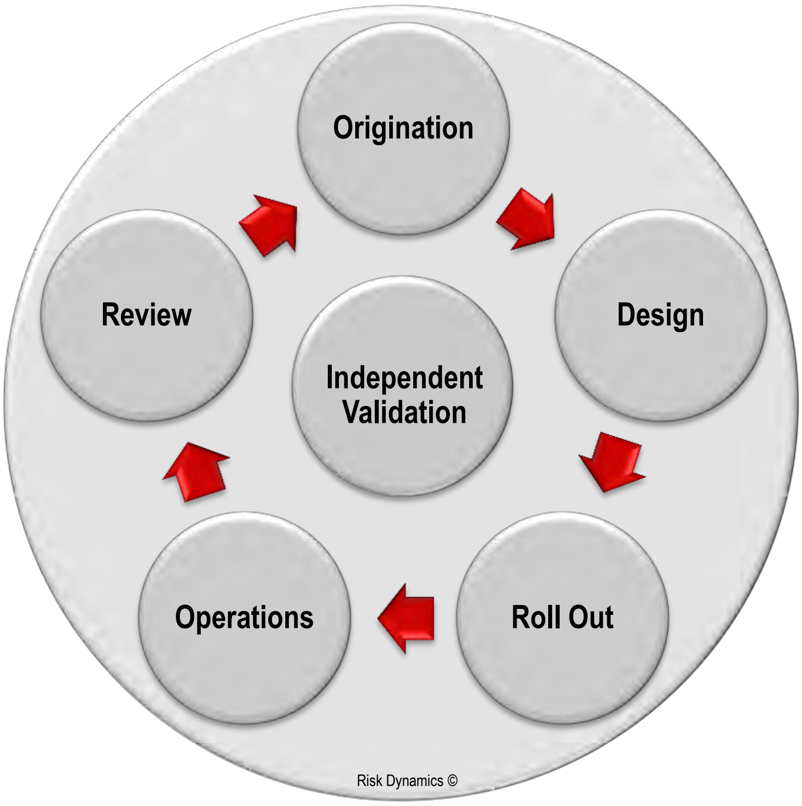
- **Model inputs (internal, external):** quality, stability
- **Methodological aspects (methodological choices, model architecture, assumptions):** applicability of the assumptions, robustness of the methodology to the inputs and parameters, effective conservatism
- **Calibration (methodological choices, assumptions):** applicability of assumptions, robustness of methodology, effective conservatism
- **Parameters:** robustness of parameters to the estimation methodology, accuracy
- **Modelling techniques (input treatment, simulation technique, aggregation technique):** identification of biases, appropriateness
- **Model outcomes:** accuracy, closeness to reality, stability in time, evolution follow up and reconciliation

Section 2 – Validation and the model lifecycle

In the validation process, two types of assessment can be distinguished. On the one hand, we have what regulation calls validation. This first type of assessment has to be performed by the modelers themselves, and is also usually called testing. On the other, we also have what regulation depicts as independent review. This second type of assessment has to be performed by a team that is independent of the modelers.

To ensure these assessments cover all aspects of the Internal Model, validation should follow the stages of the model lifecycle (Figure 2).

FIGURE 2: Model lifecycle



Model Lifecycle

The model lifecycle (Figure 2) consists of five stages.

Stage 1: Origination : During this stage, the business requests are collected, key stakeholders are identified and decisions are made as to whether or not a model (re)-design/ (re)- implementation is justified.

Stage 2: Design : This second stage encompasses all design steps. Based on the model specification, it ensures that the model is designed in line with the model users' requirements, the internal business characteristics, market regulations and modeling best practice.

Stage 3: Roll Out : During this stage, all organisational and technical aspects are set up in order to allow the developed model to be used in operation. It also ensures that the model is consistently and adequately integrated within business processes and the model outcomes properly used.

Stage 4: Operations : This stage is the one in which the model is run in live production (i.e. the outcome is used for business operations). During this stage, the model is integrated/used in different business processes of the institution (hence, making the use test effective)

Stage 5: Review : This stage consists of assessing if the model, once in operation, keeps delivering the expected performance and is used with integrity. The consequence of a review may eventually lead to the request for a new model development or model adaptations in terms of design and/or implementation.

The objectives of the tests also vary throughout the lifecycle:

Origination / Design / Roll Out: to support the selection of the best performing modeling approach and articulate the model strengths and weaknesses;

Operations: to ensure the calibration and the run of the model are done appropriately and that the outcome of the run is in line with expectations;

Review: to identify deterioration in model performance.

Section 3 – Tools, Types and Techniques

Validation Types

Two different types of testing need to be applied on the model during its validation and its independent review.

The first, and the focus of this paper, **methodological testing,** considers the model's underlying methodology and covering the appropriateness and shortcomings of the inputs, assumptions, choices and outcomes.

The second, **technical testing,** assesses technical aspects inherent to the model's implementation and running. It covers the data flow, the supporting system and associated infrastructure.

Specific objectives for methodological tests are applied at different stages of the model lifecycle.

In the **Design** and **Roll Out** stages**,** methodological testing has to be performed on either a prototype or during a shadow/parallel run. The objectives of this testing phase include the selection of the best performing model to achieve the objectives set in the **Origination** phase, the comparison of the intrinsic performance of the model with the users' expectations prior to model acceptance and the clarification of the model strengths and weaknesses as well as the model usage requirements.

During **Operation**, methodological testing has to be carried out during the calibration and monitoring phases, each with their own objectives.

During the calibration phase:

- That the model parameters have been calibrated appropriately

During the monitoring phase:

- That the calibration and the running of the model have been done appropriately (in particular, it aims at verifying that all methodological conditions necessary for the model to perform properly were met and that simulations converge)
- That the outcome of the run is in line with the expectations

Finally, methodological testing is also performed during the **Review**, testing the model performance. It aims at identifying deterioration, as compared to the initial performance. Monitoring reports and their related testing outcomes are used as inputs for this assessment.

Validation techniques

The testing techniques described below correspond to the different categories of test that can be used when performing methodological testing. These are often referred to as "validation tools" in regulatory documents.

Validation techniques are usually articulated only at a high level, as they cannot be specific to a given model or stage given the almost limitless possible combinations of business and internal models.

Validation techniques can be split into 5 categories: **environment**, **comparison**, **"what if" analysis**, **understanding** and **generic** techniques.

The **environment** techniques include stability tests. These are performed in order to test the stability of the inputs/outcomes over time and the stability in time of the risk profile.

There are 3 main types of **comparison**. The comparison with **intuition** refers to the ability of an outcome/parameter to be close to what is expected from people expert in the field (expert testing) or to real data (reality check). The comparison with **past information** relates to the ability of a model to predict an outcome based on past observations, and finally the comparison with **other information** encompasses the comparability of the model outcomes and the model assumptions with benchmarks, other previously developed models or against the standard formula.

The **"what if" analysis** focuses mainly on **sensitivity**, **scenario** and **stress testing**. The first refers to the sensitivity of each module's output with respect to inputs and parameters. The second looks at the impact of the scenarios on the final output of the model. The last studies the impact of the stress tests applied on the final outcomes of the model. This part requires a clear definition of scenario, impact, etc.

There are also 3 tests for **understanding**. The first is the **decomposition of outcome**; it can be performed within the decomposition of calculations into all steps of the model process in order to understand the end-to-end process of the computation. The second relates to **the decomposition of data–to-data evolution** and refers to the ability to understand the reason for the evolution of the model outcome from one run to another. Final test is **P&L attribution**; its goal is to verify that actual profits/losses can be explained by the risks being modelled.

Finally, the **generic** tests are related to the **performance** and the **visual inspection**. Performance can be tested, for instance, by goodness of fit tests, or test of run convergence, and depends on the type of model and assumptions. Visual inspection is conducted through the analysis of the outcomes or the intermediary outcomes, in order to verify that there are no obvious miscalculations or mistakes.

Stress Testing as a validation tool

Model stress testing is a quantitative tool used in validation/testing. Indeed, stress tests can support the identification of possible limitations inherent to the scope of the model and hence provide a degree of confidence in the model.

For instance, stress tests can provide information relating to the dependencies between risks, give a good overview of the tail of the loss distribution, and identify possible shortcomings of the model. Thereby, stress tests can support model stakeholders in assessing model adequacy. Furthermore, the results of the stress tests can help justify the need for a revision of the scenarios and the calibration.

There are two types of stress testing:

Stochastic: To run the stochastic model with stress components, for instance, the data used for the calibration, the parameters or the modelling choices.

Deterministic: To replace stochastic scenarios by a finite set of deterministic stress scenarios. To perform the deterministic stress testing, the tool used is either the original stochastic model or a partially redeveloped model.

The scenarios used to perform these stress tests can be either historical or external. The external scenarios are based on sources such as external studies, market or supervisory guidance or academic papers. The historical scenarios might include the Asian crisis or Spanish flu.

Section 4 - Validation and Independent Review

All validation tools discussed above are part of the modeler toolbox. When the independent review takes place, the person responsible will verify that adequate tests have been applied and led to acceptable conclusions. Nevertheless, the independent review can also be conducted to perform additional tests if deemed necessary by the team in charge of this independent challenge. Independence within the validation process is essential to effective validation as it creates objective challenge to the internal model.

Whereas the validation, as defined by supervisors, has to be conducted by the modeler or the model user, the independent review has to be performed by an independent team. The risk management function always remains responsible for the overall validation.

The stakeholder in charge of the model design/development has to define the testing strategy and the person in charge of the review has to modify or confirm this strategy.

Furthermore, independent validation is also required in assessing the completeness and appropriateness of the testing strategy, both during the initial and periodic validations.

Section 5 – In conclusion

Lessons Learnt

Our experience is that a significant number of modelling assumptions are often set without providing a clear underlying rationale or evidence.

This is justified either by strong in-house practices, or alternatively, by a lack of internal challenge.

The adequacy and applicability of the modelling assumptions to the underlying risk are not always verified. This is usually due to:

- The absence of a mature model governance framework and modelling strategy; or
- Business pressure on meeting delivery dates; or
- Pre-selected modelling assumptions used are industry standards/best practice.

Another lesson learned is that model testing is not always performed or, when it is, is done late in the modelling process. This can lead to a complete redesign of the model as the model is already in operation.

Conclusion

Over time, the output of the Internal Model has become embedded in the key strategic decisions of financial services firms, as a result of the value it brings.

While it is understood that no model can be perfect, providing boards and regulators with confidence and understanding of the uses and limitations therefore becomes even more important.

Having already demonstrated value, there is now an opportunity to improve both the effectiveness and efficiency of Model Validation and Independent Review functions, processes and toolsets.

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