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# Adding Value Through Effective Model Validation

## Introduction

Model validation can be an important value-adding tool rather than a mere regulatory requirement. The Moody's Analytics vision for effective validation entails three main elements: independence, purposeful rigor and experience. This paper presents a detailed description of our process and addresses frequently asked questions posed by prospective clients.

# Adding Value Through Effective Model Validation

BY ANAMARIA PIESCHACON

**D**ue to the ever-changing nature of financial market regulation, the model validation process has received increased attention in recent years.

The stakes are higher than ever now in this environment of increased data requirements, with a larger number of models, heightened complexity, and amplified supervision. Model risk has significant financial consequences; therefore, it is critical for financial institutions to set in place a robust model governance framework that allows them to properly monitor and manage risks efficiently. Effective validation is paramount to the success of any model risk management program.

Financial institutions are all too familiar with the old-fashioned approach to validation. The process goes as follows:

1. Model developers receive from validators a long one-size-fits-all list of pre-canned tests to run.
2. In response, model developers produce a lengthy document filled with largely uninformative test results.

3. Model owners receive a validation report acknowledging that the boxes have been ticked and that the process is completed.

This narrow approach is a wasted opportunity, as it is unlikely to benefit model owners beyond fulfilling the regulatory requirement. There are important gains to be had if validation is executed as an advisory exercise, where independent expertise provides objective, actionable feedback.

This paper describes the Moody's Analytics broader framework for effective model validation.

## The model validation function

Model validation is a critical piece within a well-structured model risk management framework. When done properly, it provides impartial and constructive feedback, evalu-

ating whether the chosen model is capable of delivering sound results and whether it meets the needs for which it was designed.

First-rate validation strives to provide value added by aiming to maximize the model's performance, given its main purpose. Ultimately, financial institutions can make better underwriting, risk management and capital allocation decisions if their models help them predict risk accurately. Similarly, macro model users will also make more informed decisions with reliable macroeconomic projections.

As mentioned earlier, the stakes are high now that we have more data, more models, greater complexity and amplified supervision (see Figure 1). Model risk has significant financial consequences, so it is critical for financial institutions to set in place a robust model governance framework that allows them to properly monitor and manage risks

**Figure 1. Robust Model Governance as a Precondition for Effective Model Risk Management**



efficiently. Effective validation is paramount to the success of any model risk management program.

According to the Federal Reserve's supervision letter SR 11-7, model validation is the set of processes and activities intended to verify that models are performing as expected, in line with their design objectives and business uses. Effective validation helps ensure that models are sound, identifying potential limitations and assumptions and assessing their possible impact.

All model components—inputs, processing, outputs and reports—should be subject to validation. This applies equally to models developed in-house and to those purchased from or developed by vendors or consultants.

Validation activities should occur on an ongoing basis after a model goes into production, to track known model limitations and identify any new potential shortcomings.

**Key elements of effective model validation**

In our view, there are three key elements to effective model validation:

1. Independence
2. Experience
3. Purposeful rigor

Each is essential for a productive validation exercise (see Figure 2). Without independence, analysts may not feel comfortable raising issues identified during model review. Without experience, analysts may not know what to look for and why. Experience allows analysts to focus on certain areas or tasks and allows them to be thorough, with a well-defined purpose: identifying potential weakness and suggesting productive, innovative solutions.

**Independence**

Independent validation is often underestimated. Small financial institutions typically lack the internal headcount to have a separate team of analysts conduct model validation. Sometimes, model developers think they are wearing a second hat and review their own models, hoping to substi-

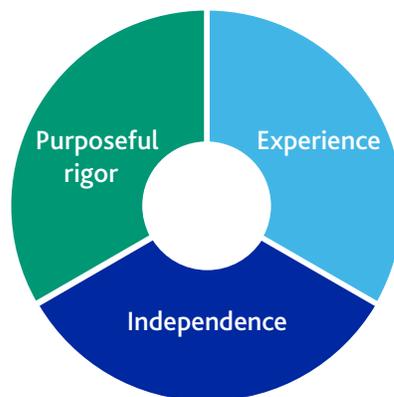
tute the role of the validator. But the truth is, model developers should always validate their models prior to declaring victory when finding a "final" model, and they should always have an independent reviewer confirm their findings.

Model developers' validation is a critical step of model development. It creates a first line of defense that substantiates and supports the choices made during development, and verifies performance by holding the model's feet to the fire. It is, however, not a substitute for the second line of defense, which is provided by independent model validation (see Figure 3).

Modeling best practices are a necessary but not sufficient quality control tool. Independent validation is essential to ensure impartiality. It can provide dependable, unbiased advice for model improvement or reassurance of model quality, as model developers will often have a biased view about their models, albeit inadvertently.

It is optimal for the financial institution to remove conflicts of interest by allowing model validation to operate independently from the first line of defense. As Figure 3 shows, under best governance practices, the complete ownership of model risk should be assigned to the first line of defense, which includes the model developers, owners and implementation managers. Incentives align when model validators can freely express

**Figure 2. What Constitutes Effective Model Validation?**



their views without fear of retribution. Then, they can critically evaluate the models, identify potential shortcomings, and suggest viable solutions.

Even with these separate lines of defense, in-house validation teams may lack the capacity to effectively monitor all models. Therefore, they rely on the expertise of seasoned third-party validators.

**Experience**

Experienced validators will have the ability to identify relevant concerns and discriminate between the sound and the noise. At Moody's Analytics, we have a deep bench of analysts with ample

**Figure 3. Best Model Governance Structures Prescribe Independent Model Validation**

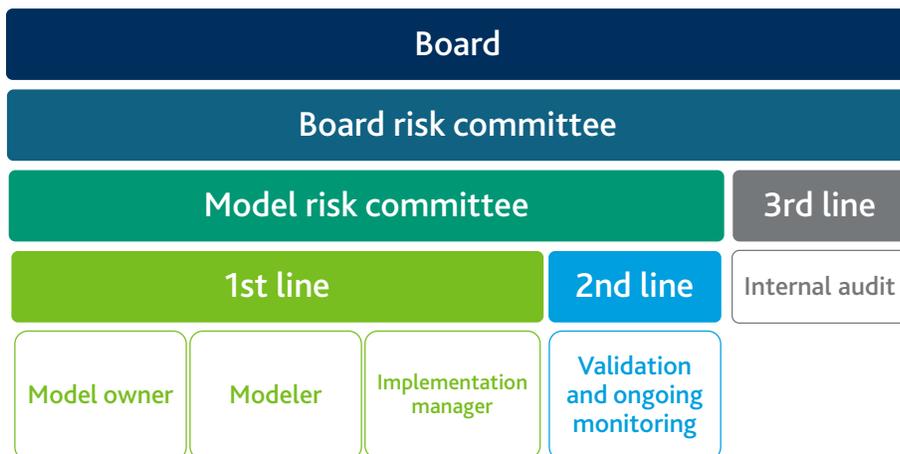


Figure 4. Moody's Expertise in Validation and Advisory Services

**Loan life cycle management models**

Application, pricing, origination, monitoring, loss mitigation, disposition

**Other advisory services**

Gap analysis, best practices and model governance

**Business & strategic planning models**

Credit policy, marketing, etc.



**Regulatory capital & stress-testing models**

Basel, CCAR, PRA, EBA, etc.

**Financial reporting**

IFRS 9 and CECL

**Credit portfolio management models**

Risk appetite, concentration risk, counterparty, operational, etc.

experience in advisory services and validation of a wide range of models (see Figure 4).

**Purposeful rigor**

It is important to be thorough with a purpose—not for the sake of industriousness, but to identify potential weaknesses and provide effective validation. That is why we do not require clients to run a boilerplate list of tests just to tick a long list of boxes. Instead, we take a targeted, deep-dive approach to identify potential problems.

In our practice, we believe that managing model risk involves the effective challenge of models. This includes critical analysis and the

identification of model limitations to produce appropriate changes. The effectiveness of the process will depend on a combination of incentives, competence and influence.

**Our model validation process**

Our model validation process consists of three basic parts. First, we conduct a qualitative review; second, we perform a quantitative evaluation; and third, we write a detailed report with findings and recommendations from the first two steps. A fourth element, benchmarking, is optional but very helpful for model risk management (see Figure 5).

The qualitative review involves an evaluation of the existing documentation to understand the model's mathematical foundation as well as the computational architecture employed to process the data and estimate the model. We also review the description of the data used and the explanation for how the data were cleaned. Next, we go over the methods used to establish variable selection criteria, variable transformations, and any segmentation methodology (if applicable). Often, a nontrivial amount of resources is dedicated to interviewing model owners, particularly when documentation is unavailable or in-

Figure 5. The Moody's Vision of Effective Model Validation

**Qualitative**

Evaluation of conceptual soundness

**Quantitative**

Replication and outcomes analysis



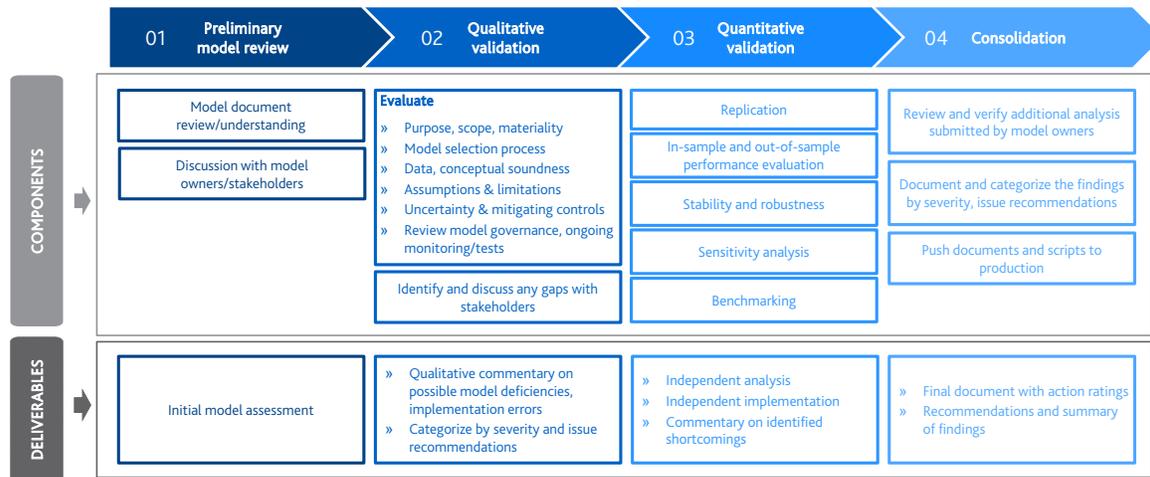
**Validation report**

Assessment based on the qualitative, quantitative and benchmarking analysis

**Benchmarking**

Comparison of inputs and outputs of estimates from alternatives allows for assessment and management of model risk

Figure 6. Typical Model Validation Engagement Process



sufficient, or to expand our understanding of the model.

In this phase, we evaluate the conceptual soundness, features and assumptions, as well as the reasonability and accuracy of the modeling approach. We identify model platform capabilities, versions, theory, mathematical background and logic. We also verify data quality and sustainability. We review the model's functional and technical specifications, development standards, developmental changes during the design and testing phases, and model documentation.

It is critical to understand the model's purpose to assess the effectiveness of the model. Once we identify the model's restrictions and stated conditions under which its results are not applicable, we make sure it aligns with regulatory guidance and best practices.

During a typical quantitative review, we dive into the data and code to evaluate modeling choices. In our data analysis, we assess whether the development dataset is complete, whether variables are properly populated, whether segmentation choices are supportable, etc. Then, we evaluate the soundness of the variable selection process. We verify that sampling was done correctly, whenever applicable. We also evaluate if segmentation is necessary and, when applicable, if it is performed properly.

A key component of this phase is the independent model output replication and cross-validation. This step involves replicating the model output using our own code. For this step, we may use the same software used in development, but we may also decide to develop different code. The documentation needs to be descriptive enough to facilitate this process. Once the model output has been replicated, we proceed to cross-validation. We evaluate whether our cross-validation results match those presented by model developers in the documentation and the developers' code (see Figure 6).

Benchmarking is not mandatory from a regulatory point of view, but it is paramount to measuring model risk. Therefore, it should be seriously considered depending on the materiality of the portfolio.

During the benchmarking phase, we develop alternative model(s) aiming to attain levels of accuracy or performance that are equivalent or superior to those of the model under review, based on identified potential shortcomings. The benchmark model is developed using an alternative methodology or a different set of variables. We strive for parsimony, so whenever necessary, we attempt to simplify while maintaining accuracy. If the benchmark model outperforms the existing model, then we

recommend using the benchmark as the main model.

Finally, our validation report summarizes the analysis and findings from the qualitative and quantitative review, including observations, findings, suggested improvements or remedial actions. The report also provides an overall evaluation, with four possible outcomes: Satisfactory, Satisfactory With Recommendations, Needs Improvement, and Unfit for Use. The details are described in Figure 7.

In the report, we also break down the overall rating and provide a detailed assessment by risk category. In the example in Figure 8, the model obtained an overall rating of Satisfactory With Recommendations. There were, however, certain dimensions—such as their segmentation analysis—that earned a Satisfactory, and others—such as documentation—that earned a Needs Improvement grade. The comments section briefly elaborates on why the rating was assigned.

### Frequently asked questions

This section reviews some frequently asked questions from prospective clients.

#### Should all our models be evaluated by an external validator?

Not necessarily. The depth of the validation exercise should be proportional to the

Figure 7. Model Evaluation – Action Ratings



materiality and complexity of the portfolio (see Figure 9).

Even when there is qualified in-house staff, the level of intricacy and consequence of the model may be such that it is best from a model risk perspective to hire third-party advisory services. In that case, the in-house validation team can act as a liaison between model developers and external model validators.

In some cases, there is demand for external validation even with lower materiality, when there is limited internal expertise or limited independence.

But even when the model is very simple and is built for a small portfolio, it should be validated, and the model risk management team should still establish model performance thresholds for periodic monitoring.

**How do you measure model risk?**

Using models introduces risk. Model risk is the potential for adverse consequences from decisions based on incorrect or misused model outputs and reports. Model risk can lead to financial loss, poor business and strategic decision-making, or damage to a banking organization's reputation.

Model risk typically occurs for two reasons:

- » A model may have fundamental errors and produces inaccurate outputs when viewed against its design objective and intended business uses.
- » A model may be used incorrectly or inappropriately, or there may be a misunderstanding about its limitations and assumptions.

Moreover, model risk increases with greater model complexity, higher uncertainty

about inputs and assumptions, broader extent of use, and larger potential impact. Banking organizations should manage model risk both from individual models and in the aggregate.

In our model validation practice, we believe that validation should identify two key components of model risk: model estimation errors and model misspecification.

Benchmarking should address such errors or potential misspecification by considering omitted drivers, changing market conditions, and length of sampling period (if feasible), among other factors (see Figure 10).

**How is CCAR validation different from other validation processes?**

Some prospective clients wonder if there is anything structurally different between the validation of a Comprehensive Capital Analysis and Review model and the validation of other expected credit loss models.

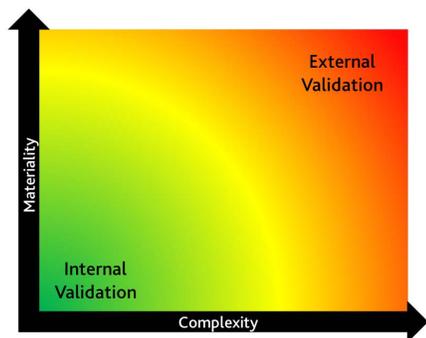
As Figure 11 shows, the components are still the same as with other validation processes. The quantitative phase of the validation process includes replication, in-sample and out-of-sample performance, stability analysis, and sensitivity analysis. During the latter, we evaluate the performance under the baseline and the alternative CCAR scenarios, assessing, as always, the adequacy of the model's separation ability. In this case, benchmarking considers the CCAR scenarios to assess sensitivity.

Figure 8. Model Ratings by Category Example

Overall rating 

Risk category	Rating	Comments
Documentation		<ul style="list-style-type: none"> <li>» Counts and bad rates reported in the tables do not match the numbers in the datasets.</li> <li>» Documentation should include candidate models considered and why they were not selected.</li> </ul>
Data		...
Variable selection		...
Segmentation		...
Model performance		...
Model replication		...
Monitoring and performance tracking		...

**Figure 9. Model Complexity and Materiality May Define Need for External Validation**



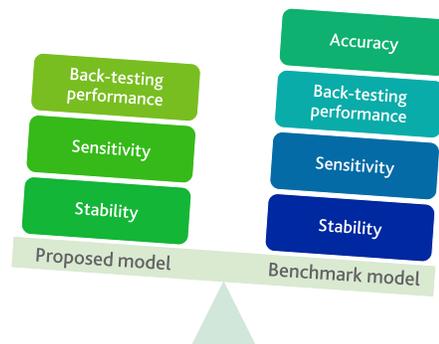
**How big should our validation department be?**

The size of an in-house operation very much depends on the institution's size and whether it is a systemic or nonsystemic bank. It also depends on how many portfolios it has. The quantity, complexity and materiality of the models under each portfolio are another key dimension that will determine how many in-house staff members need to work on model validation. This will, of course, be influenced by the systems that the financial institution has in place to develop and optimize the validation and monitoring process, and by how frequently the periodic monitoring needs to take place (see Figure 12).

**Figure 11. Phases of CCAR Validation**



**Figure 10. We Measure Model Risk by Benchmarking**



**What should model risk management comprise?**

A comprehensive model risk management framework ties together four pillars:

1. Model life cycle management
2. Model control
3. Risk quantification
4. Governance

Figure 13 provides a detailed description of an effective model risk management framework. To guarantee proper functioning, the framework should be supported by robust technology that optimizes each element and effectively integrates and optimizes the processes to successfully manage risks.

As noted by the Federal Reserve in its supervision letter SR 11-7, developing and maintaining strong governance over the model risk management framework is fundamentally important to its effectiveness. Strong governance provides explicit support and structure to risk management functions through policies defining relevant risk management activities, procedures that implement those policies, allocation of resources, and mechanisms for testing that policies and procedures are being carried out as specified.

Strong governance also includes documentation of model development and validation that is sufficiently detailed to allow parties unfamiliar with a model to understand how the model operates, as well as its limitations and key assumptions.

The model risk management team should maintain an inventory of models implement-

ed for use, under development for implementation, or recently retired.

**What is "model monitoring" about?**

As shown in Figure 14, a well-established monitoring system should assess performance from three aspects: discrimination ability, stability and accuracy.

- » Discrimination refers to the model's ability to discriminate between events and nonevents, for example, defaults and performers, and the power to rank-order risk.
- » Stability focuses on comparing distributional aspects of the development sample, on the one hand, with those of any other sample, usually during production.

**Figure 12. The Size of a Validation Department Depends on These Criteria**

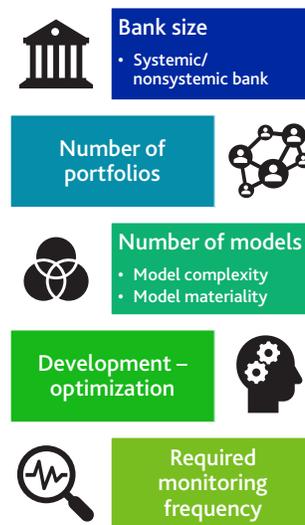
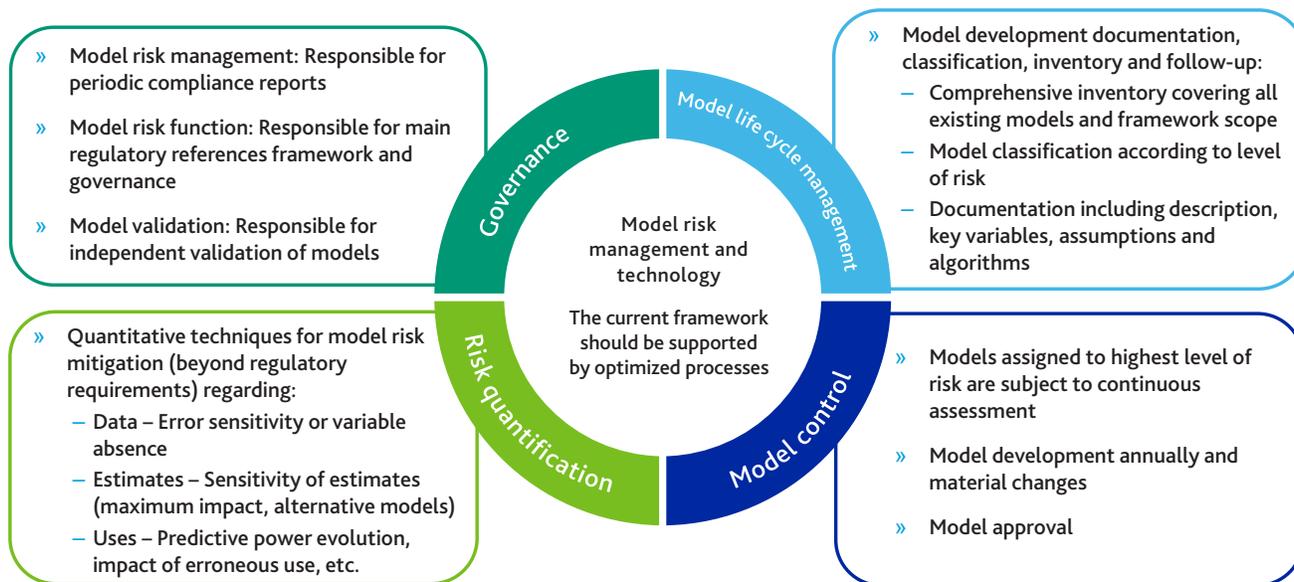


Figure 13. Comprehensive Model Risk Management



» Accuracy assesses the model's ability to deliver accurate best estimate/prediction of output. This is applicable to virtually all models with quantifiable output and an observable real-world counterpart.

**What constitutes good documentation?**

Documentation supports business continuity and makes compliance with policy transparent. It also helps track recommendations, responses and exceptions. Developers, users, control and compliance units, and supervisors all benefit from effective documentation.

Clear, consistent and detailed documentation is also essential for validators to be able to understand the model development process and to replicate and cross-validate.

According to the SR 11-7 letter, documentation of model development and validation should be sufficiently detailed so that parties unfamiliar with a model can understand how the model operates, its limitations, and its key assumptions:

"The data and other information used to develop a model are of critical importance; there should be rigorous assessment of data quality and relevance, and appropriate documentation. Developers should be able to demonstrate that such data and information are suitable for the model and that they are consis-

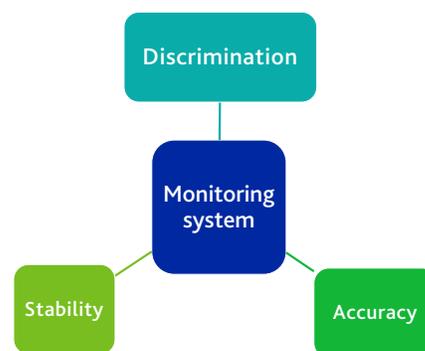
tent with the theory behind the approach and with the chosen methodology. If data proxies are used, they should be carefully identified, justified, and documented. If data and information are not representative of the bank's portfolio or other characteristics, or if assumptions are made to adjust the data and information, these factors should be properly tracked and analyzed so that users are aware of potential limitations. This is particularly important for external data and information (from a vendor or outside party), especially as they relate to new products, instruments, or activities."

**Do you have a standard validation approach?**

While we always strive to provide effective model validation, we adjust the way we go about it to accommodate a wide range of client needs, model types and portfolio sizes.

Our validation service offering is designed to match the model complexity and state of the model risk management program. Whether the model risk management program is emerging or advanced, we make every effort to maximize our value added. Similarly, whether the model is highly qualitative (based on expert judgment) or highly quantitative (based on sophisticated econometric or machine learning meth-

Figure 14. Effective Model Monitoring Criteria

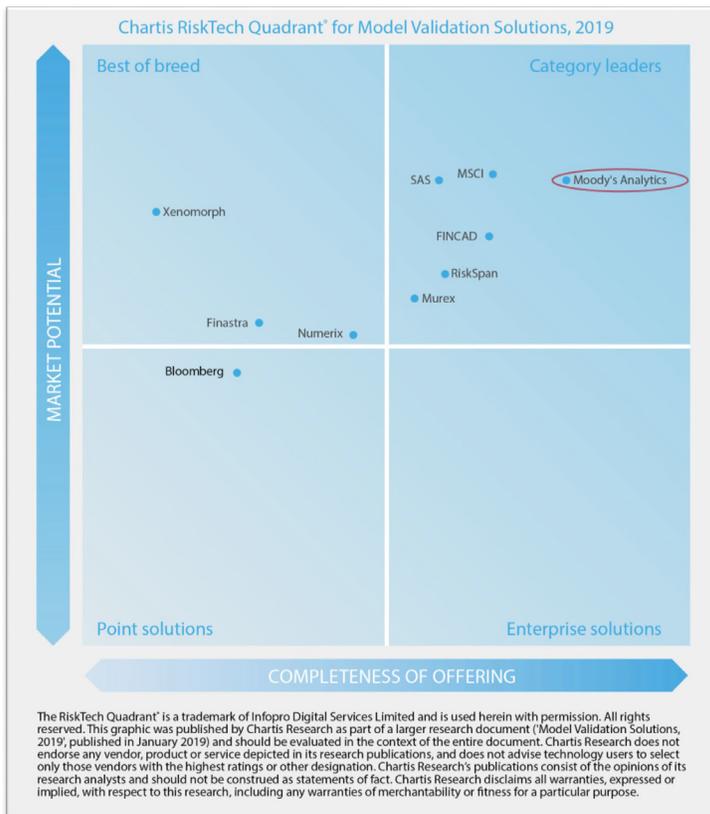


ods), we make sure to provide constructive feedback and actionable insights.

Some of our clients are seeking validation services as a tool to attract investors, rather than driven by regulatory requirements. When they have no experience with the validation process, we provide guidance to set up proper industry-level processes, including documentation that effectively describes the model at hand. But irrespective of the clients' level of experience or motive for validation, we always preserve and protect our autonomy and independence.

# Model validation awards

Our validation practice has been recognized for two years in a row as the Best in Class provider for Model Validation services in the industry.



## About the Author

[Anamaria Pieschacon](#) is a senior economist and Global Head of Model Validation for Consumer Credit Risk at Moody's Analytics. She is responsible for leading validation projects and has specialized expertise in credit risk model development, energy economics, and macroeconomic forecasting. Anamaria and the Moody's Analytics team were recognized by Chartis Research as a Category Leader in Model Validation solutions in 2019. Before joining Moody's Analytics, Anamaria was a vice president in the Global Investment Research division at Goldman Sachs in New York. Anamaria holds an MA and PhD in Economics from Duke University.

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