

I. INTRODUCTION

Use of models within the banking and financial services industries continues to grow in complexity and scope. Advances in technology along with increased competition have driven banking organizations to leverage innovative approaches to improve efficiencies, better mitigate risks, and help maximize profits. Continued use of models is essential to maintaining the competitiveness of banking organizations in the financial system.

Use of models also can present substantial risk. Such risk, generally referred to as “model risk” for purposes of this guidance, can lead to financial loss, errors in financial statements and reporting, and flawed financial and risk management decisions, among other types of risk events. Model risk can be mitigated through active and appropriate risk management, recognizing that the relevance of model risk depends on the nature, scale, and use of the models in relation to the associated business risks.

This guidance highlights sound principles for effective model risk management. As reflected in this guidance, model risk management practices vary from banking organization to banking organization. Each banking organization ultimately is responsible for adopting model risk management practices that are appropriate and effective for managing the specific risks the banking organization faces or is likely to face.

There are a variety of ways for a banking organization to structure model risk management practices. Not all models present the same level of risk, and a similar model at two different banking organizations may present different risks. As such, practices that are appropriate and effective for one banking organization may be inappropriate and ineffective for a banking organization with a different risk profile or that uses a model for a different purpose.

Although this guidance may be useful for any type of model, the general expectation is that it will be most useful for models supporting a banking organization’s significant business lines, operations, services, and functions. This guidance does not set forth enforceable standards or prescriptive requirements; accordingly, non-compliance with this guidance will not result in supervisory criticism against a banking organization.¹

II. PURPOSE AND SCOPE

Based on supervisory experience and industry feedback, as well as technological advancements in modeling over the past several years, the Office of the Comptroller of the Currency, Board of Governors of the Federal Reserve System, and Federal Deposit Insurance Corporation (the “agencies”) are issuing this revised model risk management guidance to clarify model risk management principles, and to set forth a risk-based approach to model risk management, tailored to a banking organization’s model risk profile and the size and complexity of its operations.

This guidance is expected to be most relevant to banking organizations with over \$30 billion in total assets.² Models used by banking organizations with total assets of \$30 billion or less typically are subject to internal risk management and governance practices appropriate for the size and risk profile of these banking organizations, and generally excluding them from this guidance is consistent with a tailored supervisory approach. However, in some situations, this guidance also may be relevant to banking organizations with total assets of \$30 billion or less that have significant exposure to model risk because of the prevalence and complexity of their

¹ See 12 CFR Part 4, Subpart F, Appendix A (OCC); 12 CFR Part 262, Appendix A (Board); 12 CFR Part 302, Appendix A (FDIC). However, supervisory action may result for any violations of law or unsafe or unsound practices stemming from insufficient management of model risk.

² For a description of the banking organizations supervised by each agency, refer to the definition of “appropriate Federal banking agency” in section 3(q) of the Federal Deposit Insurance Act (12 U.S.C. 1813(q)).

models or because of activities outside the scope of traditional community banking.

For the purposes of this guidance, the term “model” refers to a complex quantitative method, system, or approach that applies statistical, economic, or financial theories to process input data into quantitative estimates. The term “model” in this guidance excludes simple arithmetic calculations, such as those found within spreadsheets, as well as deterministic rule-based processes and software where there are no statistical, economic, or financial theories underpinning their design or use.³

III. OVERVIEW OF MODEL RISK AND MODEL RISK MANAGEMENT

Models are simplified representations of real-world relationships among observed characteristics, values, and events; they are based on assumptions that make them useful in estimating values and predicting events, but which also can have limitations and create model risk. The term “model risk” refers to the potential for adverse financial consequences associated with models, which may result from decisions made based on model output. Model risk is influenced by a model’s inherent risk, exposure, purpose, and use, each of which are discussed below.

A model’s inherent risk reflects several fundamental factors, such as the assumptions made in developing the model, the model’s complexity, the quality of inputs for the model, and data constraints. Inherent risk increases with model complexity and the criticality or number of assumptions necessary, among other factors.

Model exposure refers to the significance of the model output to a banking organization’s

³ Generative AI and agentic AI models are novel and rapidly evolving. As such, they are not within the scope of this guidance. Nonetheless, a banking organization’s risk management and governance practices should guide the determination of appropriate governance and controls for any tools, processes, or systems not covered in this document. However, the principles described in this guidance apply to traditional statistical and quantitative models and non-generative, non-agentic AI models.

business decisions, which tends to be greater for models affecting larger portfolios or having a larger business impact. Model exposure can be quantitatively measured (*e.g.*, by portfolio size).

Model purpose is a qualitative consideration that involves the nature and importance of the models used by banking organizations. For example, models developed to help meet regulatory requirements or manage a banking organization's financial risk exposures are generally considered to be of greater risk than models that are not used for such purposes.

Model purpose, together with model exposure, determines model materiality. Assessing risk based on model materiality is an important consideration for sound model risk management. Banking organizations may deem certain models immaterial based on model exposure and purpose. In those cases, model risk management may consist of identifying those models and monitoring model performance and conditions under which the use of those models may become material to the banking organization in the future. In contrast, models deemed of higher materiality by the banking organization—either through model exposure or purpose—warrant more comprehensive and rigorous oversight.

The overall magnitude of model risk reflects a model's inherent risk in the context of model materiality (*i.e.*, model exposure and purpose). However, even a fundamentally sound model producing accurate outputs consistent with the model's design objective can exhibit high model risk if it is misapplied or misused.

Sound practice involves assessing model risk both individually and in aggregate. Aggregate risk reflects interactions and dependencies among models; reliance on common assumptions, data, or methodologies; and any other factors that could adversely affect several models and their outputs simultaneously.

Sound model risk management also involves “effective challenge,” which refers to the

critical analysis conducted by objective experts who evaluate model risk and effect appropriate changes throughout the model lifecycle, from model development to ongoing monitoring.

Effective challenge is performed by individuals with the appropriate expertise to conduct a critical and objective challenge, sufficient independence to maintain objectivity, as well as the organizational standing and influence to effect any change.

The size and complexity of the banking organization's operations also may influence the range of model risk management. A banking organization with simple operations may not conduct model risk management with the same rigor as an organization with relatively more complex operations. Furthermore, a banking organization may tailor portions of its model risk management practices that are relevant to the risks posed by a particular model and with a level of rigor commensurate with that risk. Effective model risk management therefore warrants consideration of model risk in the context of the broader business risks that models support or influence.

IV. MODEL DEVELOPMENT AND MODEL USE

Model Development

Sound model development activities are aligned with model purpose, business use, and banking organization policy. Model development is not purely a technical exercise. The developer's judgment influences the model's conceptual design and soundness, inputs, assumptions, and methodology, all of which affect a model's inherent risk. Because model development is often multidisciplinary, tailored to actual use, and involves significant subjectivity throughout its lifecycle, sound development practices are important for effective model risk management.

An effective development process generally begins with a clear statement of purpose to

maximize the likelihood that model development is aligned with the intended use. This fundamental step supports decision-making throughout the development lifecycle, including the selection of data, methodologies, and testing approaches.

Input from model users can enhance model development by providing business context and practical insights. Business managers affected by model outcomes may raise questions about the methods or assumptions, particularly when the outcomes are unexpected. Constructive engagement around model design and assumptions strengthens both model understanding and model quality.

Model testing is a core component of model development that evaluates whether a model performs as intended. Testing may include a range of activities, from out-of-sample and out-of-time testing, to a comparison of alternative assumptions and methodologies, to a critical assessment of data quality, relevance, and inputs. Testing may be performed by model developers in collaboration with model users. The specific approach depends on the model's characteristics. The rigor of effective testing is commensurate with model complexity and materiality. For models that have relatively less material impact or for banking organizations with relatively less complex operations, model testing may be more limited in scope.

Model Use

Effective model use depends on a clear understanding of a model's limitations. Model use enables ongoing performance assessment as conditions evolve. User feedback provides business insights that enhance future development. Constructive engagement, particularly around model design, assumptions, and outcomes, strengthens both model understanding and model quality. Using a model beyond its intended purpose introduces additional uncertainty and risk. When extending a model's use beyond its original application, sound practice involves

considering additional analysis of the new usage and its limitations, along with review of existing controls to manage the resulting risk.

V. MODEL VALIDATION AND MONITORING

Model validation evaluates whether models perform as expected and includes an assessment of a model's reliability and its limitations. The nature and rigor of validation generally align with the model's approach, use, and materiality. Sound validation identifies model limitations and errors and clarifies appropriate use and whether corrective actions may be warranted.

Validation provides insight into the reliability of a given model, based on its underlying assumptions, methods, data, and relevant theories, as appropriate. This understanding helps characterize the source and extent of the model risk. Validation can reveal performance deterioration over time and inform judgments about acceptable performance ranges. When performance deviates meaningfully from expectations, banking organizations generally consider whether model adjustments, recalibration, or redevelopment are warranted.

The timing, nature, and frequency of validation activities vary based on model purpose, model methodology, frequency and scope of model changes, data limitations, and other practical constraints. Sound practice recognizes that validation approaches may differ across models based on their characteristics and use. Validation generally occurs prior to a model's first use. However, certain circumstances (*e.g.*, an urgent business need) may necessitate using the model before validation is completed. In those cases, sound practice involves greater attention to the model's limitations when considering the appropriateness of its use, informing relevant stakeholders of those limitations, and determining appropriate controls (*e.g.*, placing limits on model use or more closely monitoring its performance).

The quality of validation process depends on the rigor and effectiveness of the review rather than on organizational structure of the banking organization's risk management function. Technical knowledge and modeling expertise enable appropriate analysis, meaningful critique, and sound judgment about model performance and risk.

Even with sound modeling practices and rigorous validation, material model risk can remain. Users of model output benefit from understanding and communicating limitations, monitoring performance, periodically reviewing relevance, and supplementing model output with complementary analysis and information.

Components of Model Validation

Conceptual Soundness

Validating conceptual soundness involves assessing and documenting model design (including key modeling choices, assumptions, qualitative judgments, and data selection), construction, and developmental testing. While evaluating theoretical construction may be important for some models, other assessments—such as interpretability measures or benchmarking to other models—may be more practical for other models. Sound practice subjects modeling aspects to critical analysis by evaluating both the quality and extent of developmental evidence.

Outcomes Analysis

Outcomes analysis compares model outputs to corresponding real-world outcomes to assess model performance relative to model objectives and business use. Outcomes analysis and other elements of the validation process may identify material errors or persistent deviations outside of the banking organization's established performance thresholds. In such cases, model adjustment, recalibration, or redevelopment may be warranted.

Outcomes analysis can take many forms, including testing conducted during model development, reports or analysis performed as part of ongoing monitoring, or standalone activities such as back-testing or outlier analysis. A banking organization's approach depends on the model's objectives, methodology, and data availability. As part of model validation, sound practice involves reviewing outcomes analysis to evaluate the reasonableness and appropriateness of the results, with additional analysis and testing, if warranted. When a model's design relies substantially on expert judgment, quantitative outcomes analysis helps to evaluate the quality of that judgment.

Ongoing Model Monitoring

Ongoing model monitoring involves an evaluation of the extent to which a model is performing as expected given potential changes in products, exposures, activities, clients, data relevance, or market conditions. A model that no longer performs as expected may warrant overlays, adjustment, or redevelopment of the model depending on a banking organization's model risk management policy as it pertains to model deterioration.

An effective ongoing monitoring plan may also include regularly assessing any model limitations at the development stage and over time, along with procedures for responding to any issues that may occur, before and after a model is approved for use. The frequency and scope of monitoring reports will depend on the nature of the model, the availability of new data or modeling approaches, and model materiality.

VI. GOVERNANCE AND CONTROLS

All components of the model lifecycle benefit from model governance that is supported by clear policies and effective controls. Effective policies define risk management expectations and establish a framework for assessing the magnitude of model risk and for applying model risk

management practices commensurate with that risk. Procedures support policy implementation by establishing a monitoring and control process and specifying the allocation of resources to that process. The nature and sophistication of a banking organization's model governance is typically informed by the extent and sophistication of model usage as well as the size and complexity of the organization.

Roles and Responsibilities

Model risk management benefits from clear roles and responsibilities with well-defined accountability, including with respect to potential conflicts of interest (*e.g.*, misalignment of incentives between different reporting lines, such as model development and validation groups). Sound governance practices delineate the individual(s) responsible for key activities throughout the model lifecycle, from development through validation and ongoing monitoring. In cases where internal audit is part of the banking organization's model risk management practices, internal audit would generally not duplicate model risk management activities such as model development or validation. Instead, internal audit's role is generally to evaluate whether the model risk management practices are rigorous and effective and whether related policies are implemented accordingly. For banking organizations that use external resources to help manage model risk, sound practice involves maintaining proper oversight and integrating that work into broader model risk management activities. Organizations benefit from clearly defining roles and responsibilities when delegating these activities.

Model Inventory

It is common industry practice for banking organizations to maintain a comprehensive set of information for models under development or in use to support effective model risk management. While the inventory may contain varying levels of information to reflect different

levels of model complexity and a banking organization's overall level of model usage, an effective model inventory includes sufficient information to understand model risks, so as to support effective model risk management at the individual and aggregate levels.

Documentation

Adequate documentation helps to support effective model risk management. For example, documentation can help maximize the likelihood of continuity of operations, including supporting the tracking of recommendations, responses, and exceptions; it can also be used to more effectively help manage any model remediation efforts.

VII. VENDOR AND OTHER THIRD-PARTY PRODUCTS

The widespread use of customized vendor and other third-party products—including data, parameter values, or complete models—can present unique challenges for validation and other model risk management activities. Additionally, because certain components may be proprietary, banking organizations may not receive from the vendor the underlying code, data, or methodology that they would have if a model were developed internally. Nevertheless, the principles of model risk management remain applicable.

An important element of model risk management is the validation of vendor products, either by internal or outside parties. Sound practice includes developing an understanding of the vendor model, including its conceptual soundness, design, development data, and performance. Similarly, sound practice involves conducting ongoing monitoring and outcome analysis to assess whether vendor models are accurate, remain fit for purpose, and continue to be reliable. Such analysis can also be used to support any overlay or adjustment to model output. In cases where vendor models are customized to fit a banking organization's specific business needs, sound practice also involves appropriately documenting, justifying, and evaluating adjustments

made to customize the model as part of model validation.