



Managing Model Risk

by Ric Pace and Steve Robertson

FINANCIAL INSTITUTIONS RELY HEAVILY ON financial and economic models for a wide range of applications, such as:

- Financial instrument valuation and risk profiling;
- Sensitivity analysis;
- Credit risk evaluation;
- Fraud detection;
- Loan loss forecasting and reserving;
- Borrower collections management; and
- Financial planning and forecasting.

The level of sophistication of models used for such applications varies widely from relatively simple spreadsheet tools to complex statistical models based on millions of historical data observations. Regardless of the level of sophistication, model usage exposes a financial institution to some level of model risk, from input errors resulting from “fat fingers” to invalid theoretical underpinnings. The

result is that model errors may cause decision-makers to rely on incorrect valuations or exposure estimates, impacting the profitability and reputation of a financial institution.

Recognizing the importance of proactively managing model risk, banking regulators have recommended that national banks implement a model validation program to avoid safety and soundness problems that can arise from model errors. The Office of the Comptroller of the Currency (“OCC”) issued Bulletin 2000-16 in 2000 to address the issue of model validation; subsequently, many of the other federal regulatory agencies have informally adopted this bulletin to reflect their expectations for the depository institutions under their supervision.

Key Focus Areas

To manage model risk, financial institutions should ensure that a sound model validation program is in place — specifically,

- **The Model Validation Program should include all of the following important elements:**

- *Independent Review* — the personnel performing the model validation should be as independent as possible from the personnel who construct the model. Many large financial institutions use internal audit or an external reviewer to perform the model validation;

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- *Defined Responsibility* — The responsibility for model validation should be formalized and defined. Furthermore, consistent with best practices, company policies should specify that, before a model can enter production,
 - The independent model-validation unit or external reviewer must document the model validation tests performed, the specific test results, and the reviewer’s bases for concluding that the model is valid, and
 - An independent function (such as internal audit) must verify that the validation unit formally approved the model.
- *Model Documentation* — Model documentation is extremely important as it creates a corporate memory in the event that key modeling personnel depart the company. Within this area, management should ensure that:
 - A corporate-wide catalogue of models is centrally maintained and timely updated; and
 - Corporate policy requires that documentation for specific models is adequate to facilitate independent review, training of new staff, and detailed enough to allow exact replication of the model should key personnel depart the company.

At a minimum, model documentation should provide summary overviews of the general procedures used and the reasons for choosing those procedures, describe model applications and limitations, identify key personnel and milestone dates in model construction, and describe validation procedures and results.

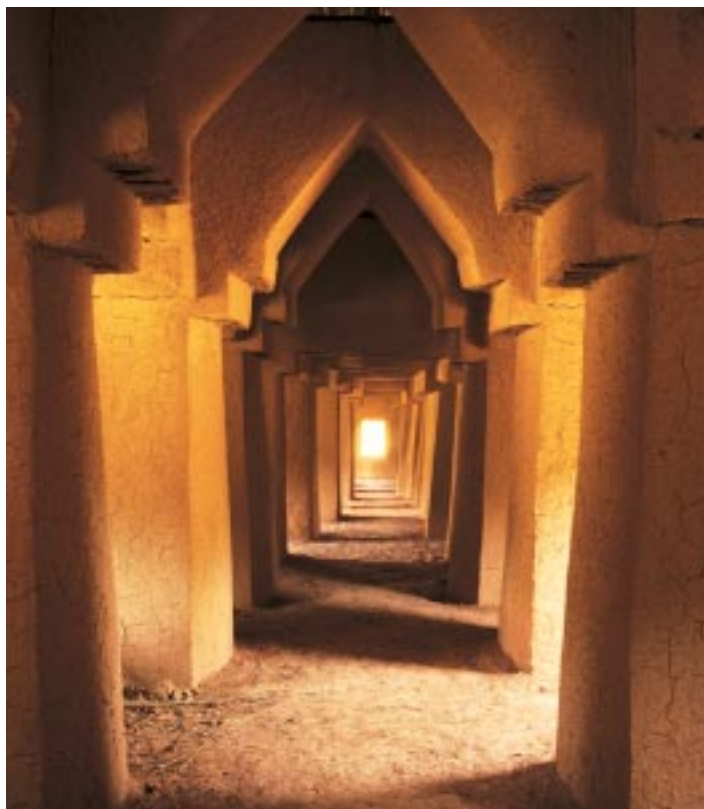
- *On-going Validation* — Even after entering production, most models are frequently altered in response to changes in the environment, to incorporate improvements in the modelers’ understanding of the model’s subject, or updated to reflect more current data. Best practices for model validation policies require

that all changes in the modeling process be documented and submitted for independent review. Furthermore, model changes should be tightly controlled — allowed only for compelling reasons, implemented only after independent review and approval by the appropriate level of the bank’s decision makers, and subject to strict change-control procedures so that code cannot be altered except by approved parties. Additionally, to preserve an audit trail, the bank should ensure that it maintains a complete historical record of each model — along with documentation of the changes made from version to version. It should also store multiple copies of model code that are dated and catalogued to facilitate disaster recovery.

- *Audit Oversight* — The bank’s formal model validation policy should clearly specify that an independent function is responsible for ensuring that the model validation units adhere to the formal policy.

■ **The Model Validation Procedures should cover the following four dimensions of model development and use:**

1) **Data Inputs and Assumptions** — According to OCC Bulletin 2000-16, *“It is possible that data inputs contain major errors*



while the other components of the model are error free. When this occurs, the model outputs become useless, but even an otherwise sound validation process will not necessarily reveal the errors. Hence, auditing of the data inputs is an indispensable and separate element of a sound model-validation process, and should be explicitly included in the bank's policy."

"Whether drawn from public sources or from the bank's own research, important behavioral assumptions should be routinely compared to actual portfolio behaviors."

Therefore, management should ensure that the scope of its model validation procedures incorporate the following:

- Internally-supplied data is checked for accuracy — this needs to occur regularly because, among other reasons, it is common for IT to re-define data fields and their storage locations without notifying all affected users;
- Where possible, external data is checked against multiple sources to ensure accuracy;
- The model is reviewed to ensure that it has been developed with data that is representative of the business use to which it will be applied — for example, it would be improper to use data from a "prime" mortgage portfolio to develop a credit risk model that will only be applied to "subprime" credit applications; and
- Assumptions — such as assumed cash flows and maturities of interest rate sensitive instruments, assumed changes in market conditions, assumed loan volumes and pricing, among others — are evaluated for reasonableness and there exists a defined process to update/validate key assumptions on a regular basis.

2) Model Theory — According to OCC Bulletin 2000-16, *"Implementing a computer model usually requires the modeler to resolve several questions in statistical and economic theory. Generally, the answer to those theoretical questions is a matter of judgment. ... One of the largest sources of model error arises in the use of theoretical tools, most often statistical methods, by untrained modelers."*

Therefore, management should ensure that:

- The model developers and validators have sufficient training and expertise;
- The model developers provide clear descriptions, in non-technical terms, of the underlying theory of the models;

- The model developers demonstrate that the theory underlying the model — if uncommon, unique, or non-standard — has received recognition and support from professional journals or other forums;
- Vendor-supplied models are defensible and work as promised; and
- Vendors provide information on how they built and validated the model.

3) Model Code and Mathematics — To test for potential flaws in the model's computer code or mathematical formulas, management should consider:

- Assigning a modeling/computer professional with the task of line-by-line proofreading of the computer code; and
- Requiring model developers and validators to compare the model's results against those of comparable models, market prices, or other available benchmarks.

4) Use of Model Results — According to OCC 2000-16, *"It is equally important that the reports distilled from model output are clear and that decision makers understand the context in which the model results are generated."*

Therefore, management should ensure that its policies and procedures include the following requirements:

- Model documentation that includes an Executive Summary that is available to help senior decision makers understand the model's major assumptions and limitations;
- Independent review of the reports that transmit information from the modeler to the decision maker; and
- Reports contain sensitivity analyses that demonstrate how model estimates are affected using reasonable alternatives for the model's major assumptions. These sensitivity analyses should communicate to decision makers the robustness or fragility of outputs from the model.

If you have questions, please call Ric Pace in Washington, D.C. at (202) 414-1690 or ric.pace@us.pwcglobal.com or Steve Robertson in St. Louis at (314) 206-8125 or steve.robertson@us.pwcglobal.com.
