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Federal Housing Finance Agency
Division of Federal Home Loan Bank Regulation

To: Federal Home Loan Bank Chairs, Presidents, Chief Financial Officers, Chief Risk Officers, Community Investment Officers, and Directors of Internal Audit
Managing Director of the Office of Finance

From: Stephen M. Cross
Deputy Director, Division of Federal Home Loan Bank Regulation

Subject: Validation and Documentation of Models and Related Controls on Internal Processes

Purpose

This Advisory Bulletin replaces Advisory Bulletin 2006-AB-02, *Validation and Documentation of Models and Related Controls on Internal Processes*. The earlier Advisory Bulletin focused on market risk models. This Advisory Bulletin explicitly includes credit risk models and also addresses the validation of externally-managed vendor models, internally-managed vendor models, and the importance of validating and documenting the controls over models and their use. In addition, this Advisory Bulletin discusses model validation and documentation in the case of a model that is jointly used by several FHLBanks. The guidance provided in this Advisory Bulletin is effective immediately.

Background

The Federal Home Loan Banks (FHLBanks) and the Office of Finance (OF) use financial models in a variety of areas including financial instrument valuation, market and credit risk measurement and control, and financial forecasting. While models are essential in managing large, complex institutions, reliance on inaccurate or inappropriate models may lead to poor or costly decisions. To mitigate model risk, each FHLBank and the OF should implement policies and procedures to ensure appropriate documentation and validation of all "mission-critical" and important models. FHLBanks and the OF should apply the same principles outlined in this Advisory Bulletin to internally developed and vendor provided models, whether used and managed in-house by the FHLBank or the OF, or externally by the vendor. *Throughout this advisory bulletin "model documentation and validation" should be read to include proper testing of related controls on the processes surrounding those models.*

Validation is the process of determining that a model's results accurately meet the requirements of its intended use. Model validation typically includes an independent review of the model's logical and conceptual soundness, a comparison against competing models, and a comparison of model predictions against subsequent real-world events. Validation procedures may include the review of a model's

mathematics and computer code or the use of a parallel model to replicate the model's results. The level of documentation and frequency of validation should be commensurate with the relative importance of a model to an institution's decision-making or risk management processes.

Guidance

Each FHLBank and the OF should have policies and procedures to ensure that all its models are documented and validated. The FHLBanks and the OF should thoroughly document and validate, at least annually, all mission-critical models, including pre-purchase models, hedging models, market risk models, credit risk models, collateral "haircut" models, and models used in preparing public financial disclosures. In the case of mission-critical models managed externally by a vendor, the FHLBank and the OF should require the vendor to provide its model validation or quality assurance results. If the vendor considers such results too revealing of proprietary mathematics and code, it can provide evidence of the results and of the steps taken to generate them. The FHLBanks and the OF should document and validate less critical models in a manner consistent with established formal policies and with the models' importance to the institution.

Management should validate and approve all models and changes to models before putting them into production. If management has not validated and approved existing models, they should do so as soon as practicable in accordance with a schedule determined by executive management. Prior to relying upon results from proprietary vendor models, whether managed internally by the FHLBank or the OF or externally by the vendor, the FHLBank and the OF should require the vendor to provide technical documentation and any available results from its own internal testing. (The provided documentation and results need not reveal any actual math or code from a proprietary model.) The FHLBanks and the OF should also require regular confirmation from vendors, including third-party pricing services, that they are updating their models to reflect relevant changes in market conditions. The vendor-provided information, together with the FHLBank's or the OF's internal validation of the processes surrounding the vendor-provided model and periodic benchmarking of the model's results against those of other models or calculation methods, will serve to complete the validation of the externally managed model.

Only qualified personnel who demonstrate the necessary knowledge, skills, and experience necessary should carry out model validation. These personnel may be internal staff, external consultants, or a combination of the two. More complex models may warrant the engagement of third-party experts to supplement internal validations. Qualified experts can bring a fresh perspective to the modeling process. When internal staff validates a model, management must ensure that the staff is independent of the staff responsible for operating or using the model. To the extent that the FHLBanks or the OF use external consultants in the validation process, management should consider changing providers every three or four years to ensure client-consultant independence. If a group of FHLBanks jointly use a model, such as the modeling of private-label security cash flows for the purpose of determining the credit risk component of other than temporary impairment (OTTI), the applicable group of FHLBanks may jointly document and conduct, or contract for, a single model validation. If, however, an individual FHLBank were to conduct further modeling based on the results of the jointly used model or to supplement those results, it would be responsible for documenting and validating any additional models used for that work.

Those who conduct the mission-critical model validation should provide reports to senior management and the board of directors (or to an appropriate committee of the board) for review. Model validation and testing of process controls for less critical models should be reported to senior management and an appropriate management level committee. The FHLBanks and the OF should make these reports available to examiners

and other Finance Agency personnel. If management chooses not to implement changes suggested by the model validation report, it should document the basis for its decision.

Formal Policies

Policies should require sufficient model documentation to facilitate model validation, replication, and training, *i.e.,* staff training on the model's purpose, underlying theory, mathematics, operation, and maintenance. Policies also should address the retention and safekeeping of model inputs, model documentation, model results, and validation reports.

Before a model enters production, management must fully document, validate, and approve it. Policies should establish model change-control procedures for implementing significant changes and updates to a model. They should also identify those individuals responsible for ensuring adherence to procedures and processes governing documentation and validation. Prior to relying upon a vendor's model results, policies should require the vendor to provide its independent model validation results and that the FHLBank or the OF test its own internal processes surrounding the use of the model. Policies should also require regular confirmation that vendors are updating their models to reflect all relevant changes in market conditions. Finally, policies should require that model results, whether produced by vendors or internally, are regularly benchmarked against results from alternative sources.

Documentation

Each FHLBank and the OF should have a corporate model policy (self-standing or part of a broader document) that defines what qualifies as a model and lays out the responsibilities of the business units and of risk oversight for the development and of each model. The designation of responsibilities must clearly indicate the parties responsible for evaluating the model's output (e.g., risk metrics), inputs (e.g., data inputs and assumptions), and any manipulation of the output that goes into final reports. Each FHLBank and the OF should also maintain an up-to-date inventory of mission-critical and important models it uses or are used on behalf of the organization by a vendor.

Documentation for each model should include:

1. A brief summary that provides a clear description of the purpose of the model and its major assumptions and limitations.

2. An operating manual or similar document that describes the model's inputs, assumptions, underlying theory, mathematics, output reports, and risk metrics. The manual should also describe the procedures used to operate, maintain, and update the model. The manual should be sufficiently detailed to enable a qualified third-party to independently operate and maintain the model.

3. Procedures for checking the accuracy, reliability, and reasonableness of the model input, assumptions, and output. Such procedures should include performance tracking and actionable thresholds for model performance.

4. For internally developed models, an annotated copy of the model's computer code.

5. Procedures for controlling access to the model and, where appropriate, access to the model's computer code. The documentation should contain a list of personnel responsible for operating and maintaining

the model. The list should identify each person's responsibilities. For internally developed models, the procedures should identify those individuals who have responsibility for maintaining and changing the model's computer code and who have the authority to change the code. The documentation should also describe the procedures for changing the code. Change-control procedures should ensure that only approved parties can alter the code.

6. A change-control log that lists all changes to the model, when the changes were made, and the individuals and departments who made, reviewed, and approved each change. For vendor models, the log should identify the version number of the model in use as well as the latest version of the model that is available in the marketplace.

7. Policies and procedures for record retention that specify the retention requirements for data inputs, assumptions, output reports, and model changes.

8. Policies and procedures to ensure that models are kept current and continue to meet the needs for which they were designed.

The FHLBanks and the OF should store copies of the model documentation in a safe place, preferably off-site, to facilitate disaster recovery.

Elements of a Sound Validation Program

A model validation program should apply the same principles to internally developed and vendor provided models, whether used and managed "in house" by the FHLBank or the OF or externally by the vendor. The program should include the validation of the following four elements:

1. Data and Assumptions.

   A model validation program should include a review of the data and assumptions used as inputs for a model. It also should include a review of the adequacy of the controls in place to ensure the accuracy, integrity, and appropriateness of the model inputs. Each FHLBank and the OF should evaluate the accuracy, integrity, and appropriateness of data and assumptions used as model inputs. They should periodically review external data and, where possible, check market data and instrument pricing data against alternative sources. For externally managed vendor models, the FHLBanks and the OF should require the vendor to provide evidence of a model validation program that satisfies these criteria.

   Each FHLBank and the OF should have well-defined procedures for updating and validating assumptions used as model inputs. They should evaluate assumptions for their appropriateness and reasonableness in light of current business and market conditions and other factors. They should ensure that assumptions are supportable and result in accurate estimates of risk. Their evaluation of the reasonableness and appropriateness of assumptions should consider prevailing industry practices with regard to the selection of assumptions for similar purposes. Modelers should provide a clear rationale for their assumptions and should identify, explain, and justify departures from industry practice. Senior management should review assumptions on a regular basis. Vendors who provide modeling services to the FHLBanks or the OF and manage those services off-site (e.g., some vendors who model the credit worthiness of advance collateral) should provide enough documentation or descriptions of their modeling assumptions and data sources for the FHLBanks or the OF to compare them to industry standards.

2. Model Theory.

   A model validation should include an assessment of the statistical, financial, and economic theories underpinning the model. Those responsible for validation should have access to model documentation that contains a clear description of the underlying theory and logic of the model. The validation should include an assessment of whether the theory and logic underlying the model are generally accepted and supportable. With respect to vendor models, the validation should include a review of any vendor information that describes the theory and logic supporting the model and an assessment of whether the theory and logic are generally accepted and supportable. For credit risk models, a validation should evaluate the appropriateness of the distributional assumptions related to default risk and risk given default. It should also evaluate any assumptions related to correlations among the key factors that drive the model's results.

3. Model Code and Mathematics.

   A model validation should, where possible, examine the model's computer code and mathematical formulae, including calculations performed during data preparation in spreadsheets or other applications external to the primary model, for potential flaws in logic or coding. In the case of proprietary models where vendors will not allow access to computer code and mathematical formulae, a model validation should produce comparable results from alternative models or from mathematical equations that are appropriate for the task.

4. Model Reports.

   A model validation should include a review of the model's output reports. It should analyze and compare output reports over time to assess their reasonableness and accuracy. Where possible, they should compare output results against those of comparable models or other benchmarks. Also where possible, they should periodically compare model results to actual results, a procedure referred to as "backtesting" or "out-of-sample testing." A model validation should include a review of the adequacy of the audit trail documenting and supporting output reports. This audit trail should provide information on the inputs (data and assumptions) used to generate output reports.

Market Value Reporting

Marking to market is the valuation of positions at readily available closing prices that are sourced independently. Examples of readily available closing prices include exchange prices, screen prices, or quotes from independent brokers. FHLBanks should mark positions to market prices where possible. FHLBanks should ensure that market values for assets, liabilities, and derivative accounts generated by internal market risk models are independently validated and based on accurate and reliable inputs and sound valuation procedures.

Marking to model is an alternative to marking to market when market prices are not available. It is defined as any valuation that has to be benchmarked, extrapolated, or otherwise calculated from a market input. The FHLBanks should ensure that:

- Senior management knows which balance sheet accounts (financial positions) are marked-to-model and which of these are subject to a high degree of valuation uncertainty;

- Validation of the appropriateness of the market inputs for the valuation process occurs regularly and includes a review of yield curves, other market rates, volatility inputs, data feeds, and sources of information;

- Financial position inputs are accurate by, among other things, reviewing terms and conditions and selecting and validating a sample of financial position including some complex instruments;
- The effects of credit risk sensitive instruments on market value are clearly reported;

- Scenario selections, including stress test scenarios, are reviewed and assessed for reasonableness and usefulness in identifying the exposures of the institution;

- Accepted valuation methods are used for all financial instruments;

- Documentation describes in detail how financial instruments that are marked-to-model are modeled, including a description of the method and all model inputs used to value the instruments, *i.e.*, the terms and conditions, yield curve, and assumptions;

- An independent validation report is issued for any model used to estimate market values and that it includes a discussion of financial instruments or positions that are difficult to value or for which the FHLBank's valuation is particularly uncertain;

- Special attention is given to the valuation of "less liquid'' or relatively illiquid positions and that these valuations consider the average volatility of bid/offer spreads, the availability of market quotes (number and identity of market makers), trading volume, and the volatility of trading volume;

- Valuation models that frequently generate values for financial instruments that differ significantly from "dealer marks" are reviewed to determine the cause of differences, as persistent differences may indicate model weakness; and

- Validation reports address any known weakness of the model and any concerns relating to the accuracy and appropriateness of model inputs and assumptions used to estimate market values.

Principal Finance Agency Contacts:

Comments and questions on this Advisory Bulletin are welcome and should be directed to:

Fred C. Graham, Associate Director, Risk Modeling, 202-408-2960, fred.graham@fhfa.gov.