

Risk Modeling

Introduction

The FHLBanks have complicated balance sheets that include assets and liabilities with imbedded optionality. Many of them also have significant positions in derivatives, including swaps, options, and swaptions. Because of the complicated nature of their positions, the FHLBanks require models to measure their exposure to interest rate risk. Each FHLBank uses numerous models to project the likely effects of interest changes on its market value of equity, on the prepayment rates on its mortgage related assets, and on current and future earnings. Each FHLBank also uses models to estimate the market value of instruments for which actual market prices are often not available.

The Risk Modeling Division (RMD) provides technical and analytical exam support in five main areas: (i) measurement of interest rate risk exposure, (ii) modeling systems, (iii) modeling assumptions, (iv) mortgage prepayment modeling, and (v) value-at-risk (VaR) model review. The RMD uses a variety of models and model review procedures to test FHLBank risk-modeling capabilities. The RMD's overarching goal is to verify independently the market values and market value sensitivities of the FHLBanks' positions using a consistent set of assumptions and algorithms.

To provide this support, the RMD has developed four templates for collecting essential data from each FHLBank. These templates are the **Modeling Assumptions Template**, two **Mortgage-Related Asset Templates**, and the **Liabilities Template**. They are part of the material requested, in the Alert Letter, prior to the examination and can be downloaded from: <http://resource.fhfb.gov/>. The RMD uses a fifth template, **Data Items for Off-Site Market-Risk Monitoring**, to collect estimates of the FHLBank's interest rate sensitivity during the quarterly supervisory reviews. The RMD completes much of our analysis and data collection prior to the start of the examination.

Regulatory Environment

The primary authorities governing Risk Modeling activities are set forth below.

- 1) ***Rules and Regulations of the Federal Housing Finance Board***, which includes Section 932.5, Market Risk Capital Requirement
- 2) ***Advisory Bulletins of the Federal Housing Finance Board*** that provide supervisory guidance relating to the topic of modeling are the following:

Advisory Bulletin 06-02, dated March 20, 2006, provides guidance to model documentation and validation.

Advisory Bulletin 05-06, dated June 10, 2005, outlines the process and describes the type of documentation required for an FHLBank to avail itself of the notification process to make changes to a previously approved internal market risk model.

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Advisory Bulletin 04-5, dated September 29, 2004, provides guidance to senior management and boards of directors of FHLBanks on risk limits for the management and control of interest-rate risk.

Advisory Bulletin 03-10, dated October 6, 2003, provides guidance on a number of issues relating to the calculation of market value at risk (VaR) and market risk modeling.

Advisory Bulletin 03-9, dated October 3, 2003, provides FHLBanks with a uniform methodology for calculating Duration of Equity (DOE) under a smaller parallel down shock when a full - 200 basis point shock would cause some rates to fall below 35 basis points (0.35 percent).

Advisory Bulletin 03-7, dated May 9, 2003 directs each FHLBank, post implementation of its capital plan, to conduct, at least annually, an independent validation of its internal market risk model.

Risks Associated with the Risk Modeling Function

An FHLBank's primary risks relating to the Risk Modeling function are set forth below.

1) Operational Risk

Potential sources of operations risk include:

- a) Processes and controls for the data that are fed into the FHLBank's models. Such data include market data and data on the FHLBank's positions (assets, liabilities, and derivatives).
- b) Model calibration.
- c) Model assumptions, including
 - (1) The FHLBank's choice of discount curves, and spreads, for discounting different types of cash flows; and
 - (2) Assumptions used in modeling complex advance, debt and swap instruments.
- d) IT capacity and controls to run the models and process the results efficiently.
- e) The level and expertise of the risk management department at the FHLBank.
- f) The adequacy of the documentation to support the valuation model and changes to the model, such as a change log for changes to its models or model assumptions.
- g) Adequacy of the FHLBank policies and procedures for model-related issues, such as model validation, back-testing and error tracking.

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2) *Market Risk*

Without sound risk modeling, the FHLBank will not have accurate measures of its Duration of Equity (DOE) or other interest rate risk limits or of the sensitivity of its market value of equity (MVE) or income to changes in market interest rates. Accurate measures of these risks and sensitivities are imperative in making sound risk management decisions.

3) *Model Risk*

No one vendor model is clearly superior in measuring the full variety of risks encountered by the FHLBanks, including both market value and income sensitivity. The RMD has gained knowledge and expertise regarding some of the particular strengths and weaknesses of various Asset Liability Management (ALM) packages used by the FHLBanks. During examinations, the RMD uses some of these methods and models to spot-check the FHLBank's model results as a test of the quality of its modeling and valuation methods.

The focal points of the RMD's work are consolidated obligations (COs) and mortgage-related assets. For a sample of COs, the RMD estimates base case values and measures the interest rate sensitivity of these values. For mortgage-related assets, the RMD develops a reasonable range for Option-Adjusted Spread (OAS), effective duration, and other interest rate sensitivity measures at the instrument level. If an FHLBank has estimates for these measures outside this reasonable range, it is likely to have other defective risk measures, such as VaR. Unreasonable OAS estimates may also result from inaccurate base case prices for the mortgage-related asset. When possible, the RMD checks outlying FHLBank prices for these assets against known pricing sources.

VaR model review includes verifying consistency with Finance Board regulations and approvals, and in the context of best practices as enunciated by Basel Committee on FHLBank Supervision and other regulators. The RMD also reviews any independent validations of VaR models conducted by the FHLBank (much of the VaR model review is done outside of the normal exam process). FHLBanks also simulate their income for a short time horizon as part of their risk management. Various models and assumptions are employed to generate these income projections. These models and assumptions used for income projection should also be validated during the examination.

Specific Risk Controls Related to the Risk Modeling Function

An FHLBank's controls relating to the Risk Modeling function are:

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- 1) Validation of model inputs against the general ledger.
- 2) Validation of the processing component of the models – calibration, securities valuation, etc.
- 3) Annual independent model validation report.
- 4) IT change control procedures.
- 5) Back-testing the model’s results against actual results.
- 6) External benchmarking – comparing model results to external, third-party prices.
- 7) Policies and procedures for model validation, model change, and testing.

Examination guidance

A work program for Risk Modeling accompanies this narrative. What follows are illustrative examples of attributes that should be considered by the examiner in completing the analyses required in that work program. In determining the extent of review and testing to be conducted in completing each analysis, the examiner should take into account his or her assessment of the quality and effectiveness of corporate governance, risk management, internal controls and audit coverage relating to the institution’s risk modeling activities.

1) Pre-Exam (See also “Testing” below):

- a) Prepare and deliver Model Status Report to the Examiner-in-Charge (EIC) three weeks prior to start of the examination. Also, be prepared to discuss model status issues in any “pre-alert” meetings with the EIC, Portfolio Manager, and other interested parties.
- b) Request the following FHLBank documents through the EIC (prior to the Alert Letter):
 - (1) Current risk management policy.
 - (2) Most recent independent, risk model validation report.
 - (3) Monthly market risk management report.
 - (4) List of modeling assumptions (discount curves, spreads, interest rate processes, etc. for all instruments)-completed Modeling Assumptions Template.
 - (5) Most recent Asset-Liability Committee (ALCO) report.
 - (6) Completed Mortgage-Related Assets Templates.
 - (7) Completed Liabilities Template.
 - (8) Written procedures for pricing/valuing mortgage related instruments including any pooling or sorting rules that the FHLBank might follow as part of its AMA valuation procedures and FHLBank procedures for adjusting, calibrating, or “tweaking” mortgage prepayment models.
 - (9) List of instruments that the FHLBank is unable to model or that require “work-arounds” along with descriptions of any work-arounds.
 - (10) Spreadsheet showing market value by FHLBank sub-account of all VaR scenarios. If available, a written description of the relation between the worst-case scenarios and the FHLBank’s risk factors.

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- (11) Any documents pertaining to special concerns for the FHLBank under examination.
 - (12) If available, a list of end-user applications the models rely upon.
 - (13) SARBOX (or other FHLBank) diagrams pertaining to the model's data and inputs, the model, and the model outputs.
 - (14) Documentation listing model, assumption or data input changes.
- c) Review previous Report of Examination.
 - d) Review any work by Finance Board analysts that pertains to the FHLBank.
 - e) Read and evaluate the FHLBank's risk exposure discussion in its SEC submissions (10K, 10Q, etc.).
 - f) Using the table from the Quarterly Market Risk Monitoring Report for the most recent end of quarter and, when possible, the three previous quarter ends, prepare Market-Risk Monitoring Report for delivery to the EIC three weeks prior to exam start date. (The data tables for this report are available at: Q:\OS\Risk Modeling Division\FHLB Mkt-Risk Exposure Reports. A link to this address can be found under "Other Useful Links:" on the Reference Page of the Finance Board intranet site.)
 - g) Based on the Model Status Report and in consultation with the examination team, prepare and deliver Model Review Plan (a description of planned activities and focus of the model review during the period of the examination) three weeks prior (subject to provision of the necessary data by the FHLBank) to the examination start date.

2) *Organizational structure*

- a) Functional organization and reporting structure;
- b) Identification of key personnel;
- c) Primary duties, responsibilities and technical expertise of personnel;
- d) Segregation of duties;
- e) Cross-training of personnel;
- f) Coordination with other departments; and
- g) Significant changes in the foregoing since the last examination.

3) *Establishment of risk tolerances and development of key policies and oversight by the board of directors. Evaluate the adequacy of senior management oversight and the risk management function for risk modeling activities, which may include the following:*

- a) Input of the division primarily responsible for modeling the FHLBank's interest rate risk into decisions about risk limits made by senior management and the board of directors;
- b) Communication to the FHLBank modeling staff of the FHLBank's risk limits; and

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- c) Policies and procedures for FHLBank risk modeling staff to communicate violations of risk limits or triggers to senior management and other relevant FHLBank divisions.

4) *Key FHLBank policies and procedures, which may include those relating to the following:*

- a) Modeling Assumptions:
 - (1) Review modeling assumptions for internal consistency as well as consistency with industry practices;
 - (2) Review the FHLBank's choice of discount curves, and spreads, for discounting different types of cash flows;
 - (3) Review assumptions used in modeling complex advance, debt and swap instruments.
- b) Compare of base-case mortgage security prices to LehmanLive and Bloomberg prices.

5) *Risk assessment under Part 917 and internal control evaluation under SARBOX*

- a) Evaluate the effectiveness of the annual risk assessment under Part 917 that identifies the key risks arising from and controls established by the institution over risk modeling activities and includes quantitative and qualitative evaluations; and
- b) Evaluate the effectiveness of the evaluations conducted pursuant to SARBOX that identify the key risks and controls pertaining to financial reporting and evaluate potential fraud, and procedures implemented to periodically attest to the adequacy of the control environment.

6) *Testing performed by external and internal auditors and outside consultants*

- a) Evaluate the adequacy of the scope and testing performed by external and internal auditors; and
- b) Evaluate the adequacy of the scope and testing performed by outside consultants such as penetration testing.

7) *Information technology and controls*

Identify and assess the automated and manual systems and applicable controls for processing transactions, including:

- a) Authorized users;
- b) Vendor technical support;
- c) Use of spreadsheets; and
- d) Business continuity and recovery.

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8) *Identification and evaluation of controls and significant changes to the activity or function*

- a) Evaluate workflow and processes as well as controls, including the level and direction of risk and the quality of risk management; and
- b) Evaluate any significant changes that have been implemented since the last examination or are being considered that may affect the FHLBank's risk profile such as management, systems, key personnel, regulatory requirements and processing.

9) *Testing (primarily pre-exam)*

- a) Use PolyPaths/AFT and/or PolyPaths/ADCO to model mortgage related assets; obtain OAS, duration, and convexity estimates for comparison to FHLBank estimates. Prepare Mortgage Report for delivery to EIC three weeks prior to the examination start date. (As this report takes between one- and two-weeks to prepare depending on the size of the FHLBank's mortgage-related asset portfolio, the timing of its delivery is dependent on the timely delivery of the necessary data by the FHLBank.) When possible, check questionable results against LehmanLive or other pricing source.
- b) Use PolyPaths, including the Kalotay callable bond options model when appropriate, to model a sample of COs to obtain base case valuations and rate sensitivities for comparison with the FHLBank's results. Prepare Liabilities Report for delivery to EIC three weeks prior to exam start date.
- c) Assess compliance with policies, procedures, and internal controls. Specific attributes include, but are not limited to the following:
 - (1) Mortgage prepayment modeling review includes the following:
 - (a) Evaluation of the FHLBank's testing procedures for comparing and/or calibrating its model results with historical prepayments;
 - (b) Evaluation of the FHLBank's testing procedures for comparing and/or calibrating its model results with Wall Street models;
 - (c) Evaluation of the FHLBank's controls and procedures for model "tweaks";
 - (d) Discussion and attempted resolution of any significant differences between FHLBank results for OAS, duration, etc. and Risk Modeling Division results reported in the Mortgage Report.
 - (e) Validate FHLBank's written procedures through verbal descriptions of processes and procedures.
 - (2) Review and verify modeling assumptions from Template.
 - (3) Evaluate model and data verification and reconciliation.
 - (4) Determine if any risk-limit violations have occurred and discuss the reasons for the event.
 - (5) Review and verify interest rate and volatility scenarios used in VaR for consistency with FHFB regulations.
 - (6) Assess the data sources and feeds into the risk model.

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- (7) Determine if there are pre-processing adjustments applied to the data.
- (8) Discuss SARBOX or FHLBank-produced diagrams that depict the data feeds into the risk model, and the output from the model.
- (9) Review any new instruments and how they are modeled.
- (10) Discuss any specific issues for the FHLBank under examination.
- (11) Discuss any work-arounds, and end-user applications used in these work-arounds, the FHLBank uses and the FHLBank's longer term plans for addressing the model shortcomings that produce the need for the work-arounds.
- (12) "Walk through" (simulate) how FHLBank personnel would use the valuation models, including the model used for income simulation. Note any undocumented assumptions, inputs or work-arounds used during the procedure. Note the FHLBank personnel and his/her experience using the model.
- (13) Discuss any post-processing adjustments applied to the model's estimates.
- (14) Discuss how the model outputs are used for risk management purposes (which reports use the model estimates).

10) Assessment of Risks

Summarize the results of the activity or function examined in a separate memorandum. The memorandum must articulate the risks and the management of those risks. It should also clearly and specifically describe the basis and analysis for the assessment. The memorandum should discuss the type(s) of risk (market, credit, operational); the level of the risk (low, moderate, high); the direction of the risk (stable, decreasing, increasing); and the quality of risk management (strong, adequate, weak). A memorandum must be prepared irrespective of whether the examiner's assessment is positive or negative.

11) Items requiring follow-up at the next on-site visitation

Identify key issues that have been communicated to management (written or oral) that require follow-up during the next on-site visitation.