



FINANCIAL MODEL VALIDATION

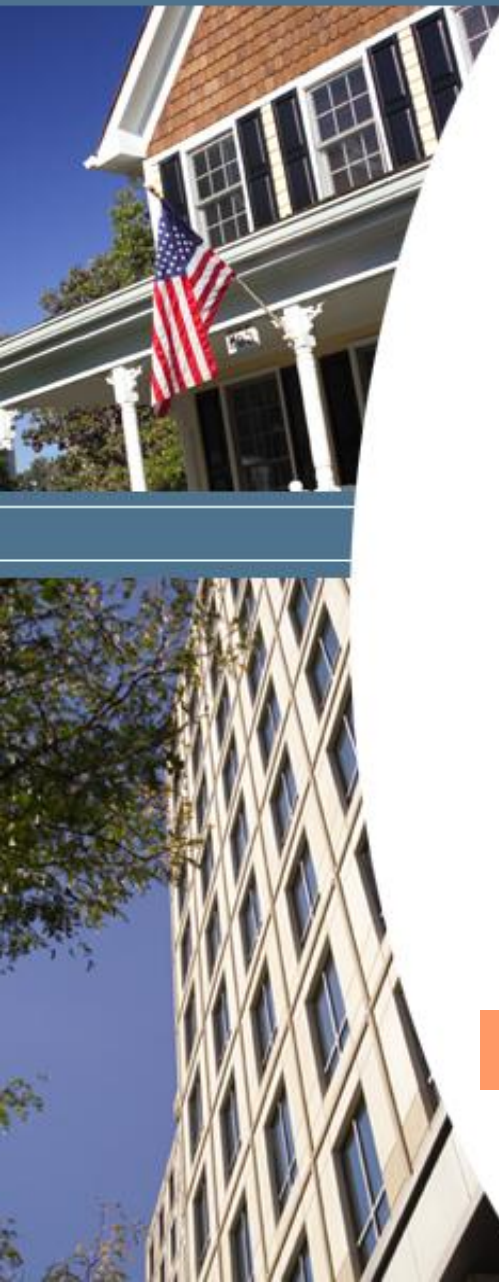
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MBA's Accounting, Tax and Financial Analysis Conference

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Although modeling necessarily involves the opportunity for error, strong governance procedures can help minimize model risk by:

1. Providing reasonable assurance the model is operating as intended;
2. Contributing to ongoing model improvement to maintain effectiveness; and
3. Promoting better management understanding of the limitations and potential weaknesses of a model.

Source: FDIC Supervisory Insight – Dec. 2005

A Sound Model Validation Program is essential to All Three.

Regulatory Expectations

Governing Documents

OCC Bulletin 2000-16 (Issued 30 May 2000) (Institutions regulated by the Comptroller of the Currency)

OCC 2000-16
OCC BULLETIN

Comptroller of the Currency
Administrator of National Banks

Subject: Risk Modeling Description: Model Validation

TO: Chief Executive Officers and Compliance Officers of All National Banks,
Department and Division Heads, and All Examining Personnel

PURPOSE

This bulletin provides guidance to help financial institutions mitigate potential risks arising from reliance on computer-based financial models that are improperly validated or tested. The guidance outlines key model validation principles and the Office of the Comptroller of the Currency's (OCC) expectations for a sound model validation process. The expectations included in this bulletin supplement previously issued model validation guidance, generally found in the subject matter booklets of the *Comptroller's Handbook* or *OCC Bulletins*.

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BACKGROUND

Computer models are abstract representations of the various relationships among events and values in the real world. They are used in banking to estimate risk exposure, analyze various business strategies, and estimate fair values of financial instruments and acquisitions. Due to a better understanding of their potential enhancement to management information systems, and due to the ongoing reduction in the cost of computing power, models are playing a progressively more important role in the banking industry. The tools are now routinely used for credit scoring.



ADVISORY BULLETIN 2006-AB-02

March 20, 2006

*Federal Housing Finance Board
Office of Supervision*

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
Director, Office of Supervision

Subject: Model Documentation and Validation

Background:

Quantitative financial models are used by the Federal Home Loan Banks (FHLBanks) and the Office of Finance (OF) in a variety of areas including financial instrument valuation, 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 that quantitative models are appropriately documented and validated.

Validation is the process of determining that a model's results accurately reflect the intended use of the model. Model validation typically includes an independent review of the model's logical and conceptual soundness, a comparison of it against other competing models, and a comparison of model predictions against subsequent real-world events. Validation procedures may include the review of computer code, and/or the construction of a parallel model to replicate the model being tested. 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. Model validation should be conducted while keeping in mind the business purpose(s) served by the model, recognizing there may be differences between market value and economic value due to factors such as bid-ask spreads, pricing conventions, and other factors.

"Mission critical" models, including trading models, hedging models, and market risk models, and those used in preparing public financial disclosures should be documented thoroughly and validated on an annual basis.¹ Less critical models should be documented adequately and validated in a manner that is consistent with formal policies established by FHLBank and OF management.

FHFB (now FHFA) Advisory Bulletin 06-02 (Issued 20 March 2006) (GSE's regulated by the Federal Housing Finance Agency)

OCC Bulletin 2000-16

- ✓ Independent review of logical and conceptual soundness
- ✓ Comparison against other models (i.e., “benchmarking”)
- ✓ Comparison of model predictions against subsequent real-world events (i.e., “back-testing”)
- ✓ Required Validation Policy Elements:
 - a) Independence;
 - b) Defined responsibility;
 - c) Documentation
- ✓ Required Validation Components:
 - a) Inputs (data and assumptions);
 - b) Processing (code and theory);
 - c) Reports (output presentation)

FHFB (now FHFA) Advisory Bulletin 06-02

- ✓ Validation by “qualified” personnel: internal staff (independent of model builders), outside consultants, or a combination.
- ✓ Inventories and documentation requirements
- ✓ Four Elements:
 - a) Data and assumptions (i.e., model inputs)
 - b) Model theory (i.e., is the underlying logic generally accepted and supportable)
 - c) Code and mathematics
 - d) Model reports (i.e., model outputs, includes benchmarking and back-testing “where possible”)
- ✓ “Mission-critical” models to be validated annually.

Common Guiding Principles

- ✓ Is there adequate documentation?
- ✓ Are the input data and assumptions reasonable, and do they come from a reliable source via a controlled process?
- ✓ Does the underlying theory make sense?
- ✓ Does the calculation function work as documented? (Can I re-create it?)
- ✓ How does the output benchmark against that of similar models?
- ✓ How does the output back-test against observed events?
- ✓ Do the outputs flow via a controlled process to reports that are useful to management for the model's intended purpose?

Documentation

- ✓ Documentation requirements vary by:
 - Model Type and Criticality
 - Bank Policy

- ✓ In general, *trading, hedging, market risk*, and models whose output flows to *financial statements* require more stringent documentation than other models.

- ✓ Per FHFA policy, every model documentation package should include:
 - Description of purpose
 - Operating manual
 - Procedures for verifying input, assumptions, and output
 - Copy of computer code (if developed in-house)
 - Access control policy
 - Change-control log (if developed in-house) or version number/latest version available (if vendor-developed)
 - Record retention policy

Model Inputs (Data and Assumptions)

- ✓ Are the data inputs logical?
- ✓ Are the assumption inputs sound?
- ✓ Is the rationale behind the inputs justified (and documented)?
- ✓ Are adequate controls in place? What is the source of the inputs:
 - An internal or external model?
 - Some other internal or external source?
 - Are the sources regularly validated?

Specific Input Questions Vary by Model Type

Institution Credit Risk Model

- ✓ Are the selected financial ratios reliable predictors of institutional default? Are they appropriately weighted?

Collateral Valuation/Pricing Model

- ✓ Which loan-level attributes is the model focusing on? Ignoring?

Default Loss Model

- ✓ Are HPI, LTV, and loss-given-default assumptions in line with current macroeconomic conditions?

Market Value/Risk Sensitivity/SFAS 133 Model

- ✓ Are market data feeds (account balances and rates) intact? Is the dataset complete? Has it been appropriately aggregated/stratified?

Theory, Code and Mathematics

- ✓ Spreadsheet models should be replicated
- ✓ Alternative testing often necessary for more complex models:
 - Line-by-line code proofreading
 - Compare to “well-validated” benchmark model (see next section)
- ✓ Theory should be clearly documented in non-technical terms
- ✓ Does the model developer have appropriate training in the theoretical tools and statistical methods used by the model?

Output and Reports

“Output reports should be analyzed and compared over time to assess their reasonableness and accuracy.”

--FHFA Advisory Bulletin 06-02

- ✓ **Benchmarking:** Against comparable model output (examples on following slides)
- ✓ **Back-testing:** Predicted outcomes vs. actual outcomes (examples on following slides)
- ✓ Is there an audit trail supporting the output reports (tracing the report data back to the input sources)?
- ✓ Do reports clearly report context? (Is the risk estimate presented a worst-case scenario or a 50th percentile estimate?)
- ✓ Do reports clearly identify the economic assumptions used?

Benchmarking Example 1:

Institution Credit Scoring Model

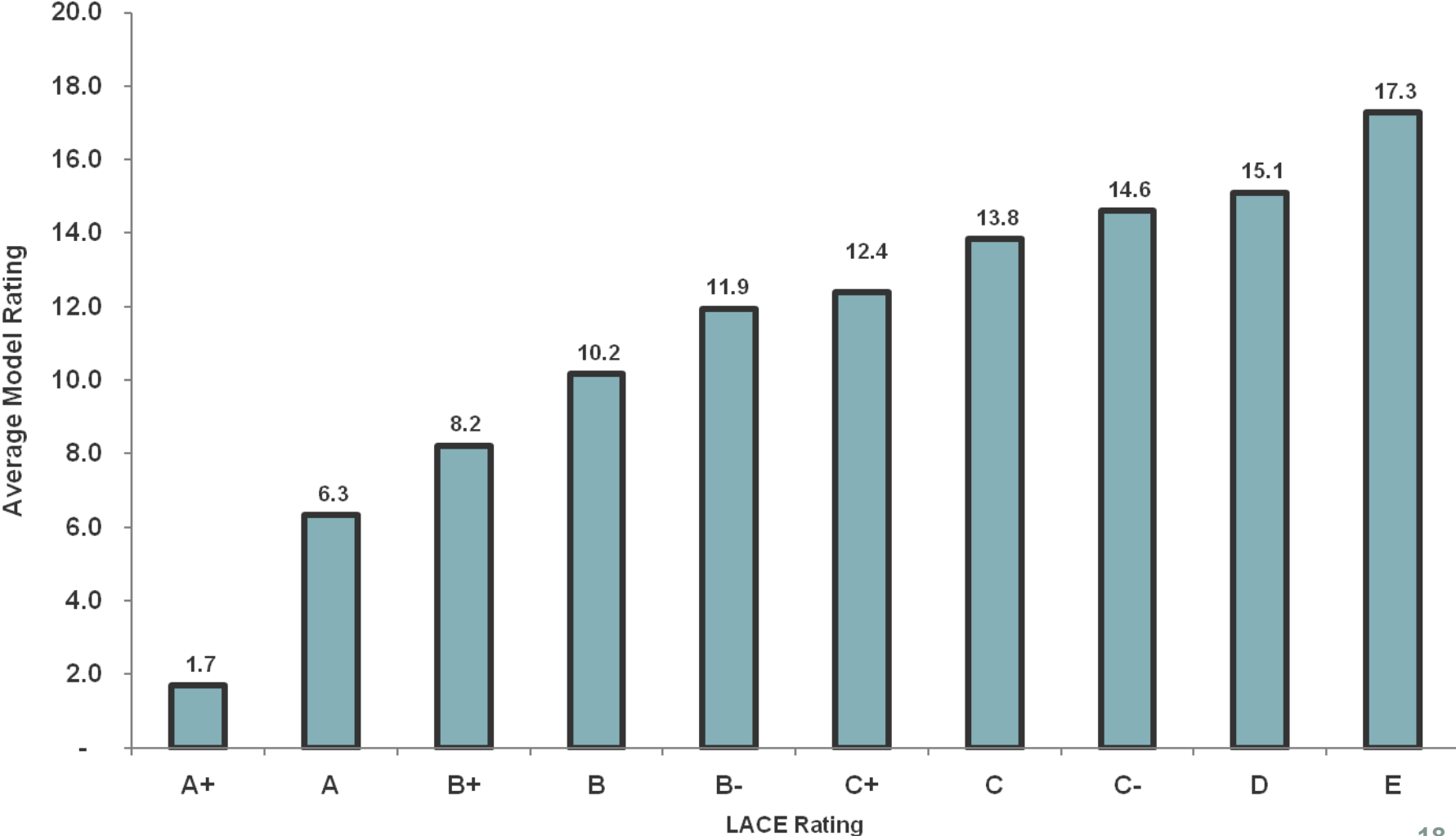
The model scores institutions on a scale from 1 to 20; the higher the score, the higher the risk of default.

Option 1: Benchmark model ratings against CAMELS ratings (difficult because bank examinations are infrequent and the ratings are hard to come by)

Option 2 : Benchmark against an NRSRO rating (a better option—see example on following slide).

Benchmarking Example 1

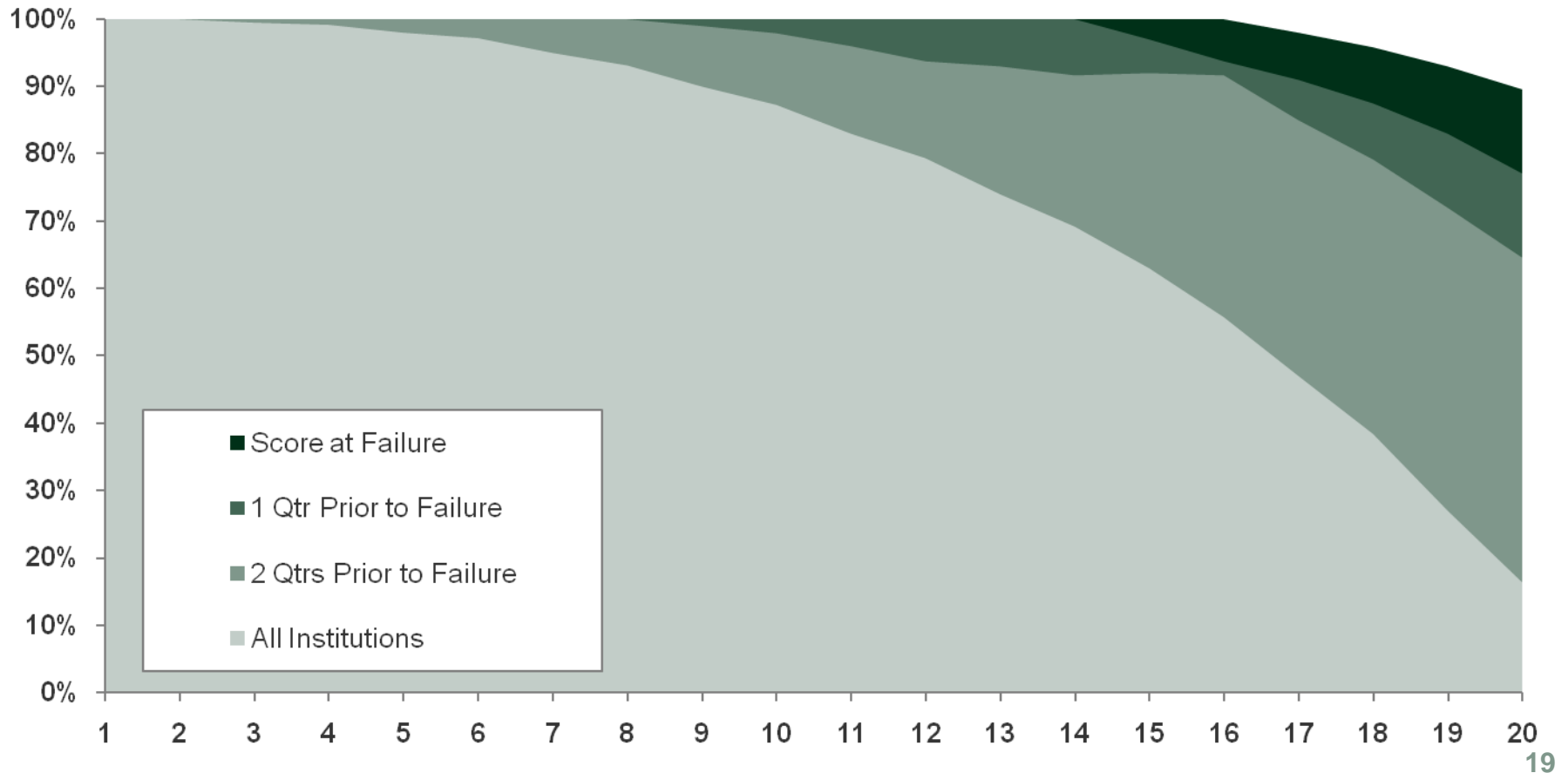
The upward progression shows the average institution rating deteriorating in step with the NRSRO rating. This is a favorable benchmark.



Back-Testing Example 1

This chart shows the cumulative distribution of credit ratings for the entire population of institutions compared to those of failing institutions at various periods points prior to failure. For example, only 27 percent of all institutions (the gray area) rated a 19 or 20 (the two worst ratings). This compares favorably with the 72 percent of institutions 2 quarters prior to failure (light green), 83 percent of institutions 1 quarter prior to failure (dark green) and 93 percent of institutions at the time of failure (black).

The chart demonstrates not only that the model identifies institutions that are about to fail, but also screens out most of the good institutions.



Benchmarking Example 2:

Callable Bond Model – Interest Rate Cost

Vendor-developed model that uses market-based inputs to predict the expected interest rate cost associated with the issuance of Callable Bonds across multiple maturities and option structures.

Benchmarking Vendor-Developed Models:

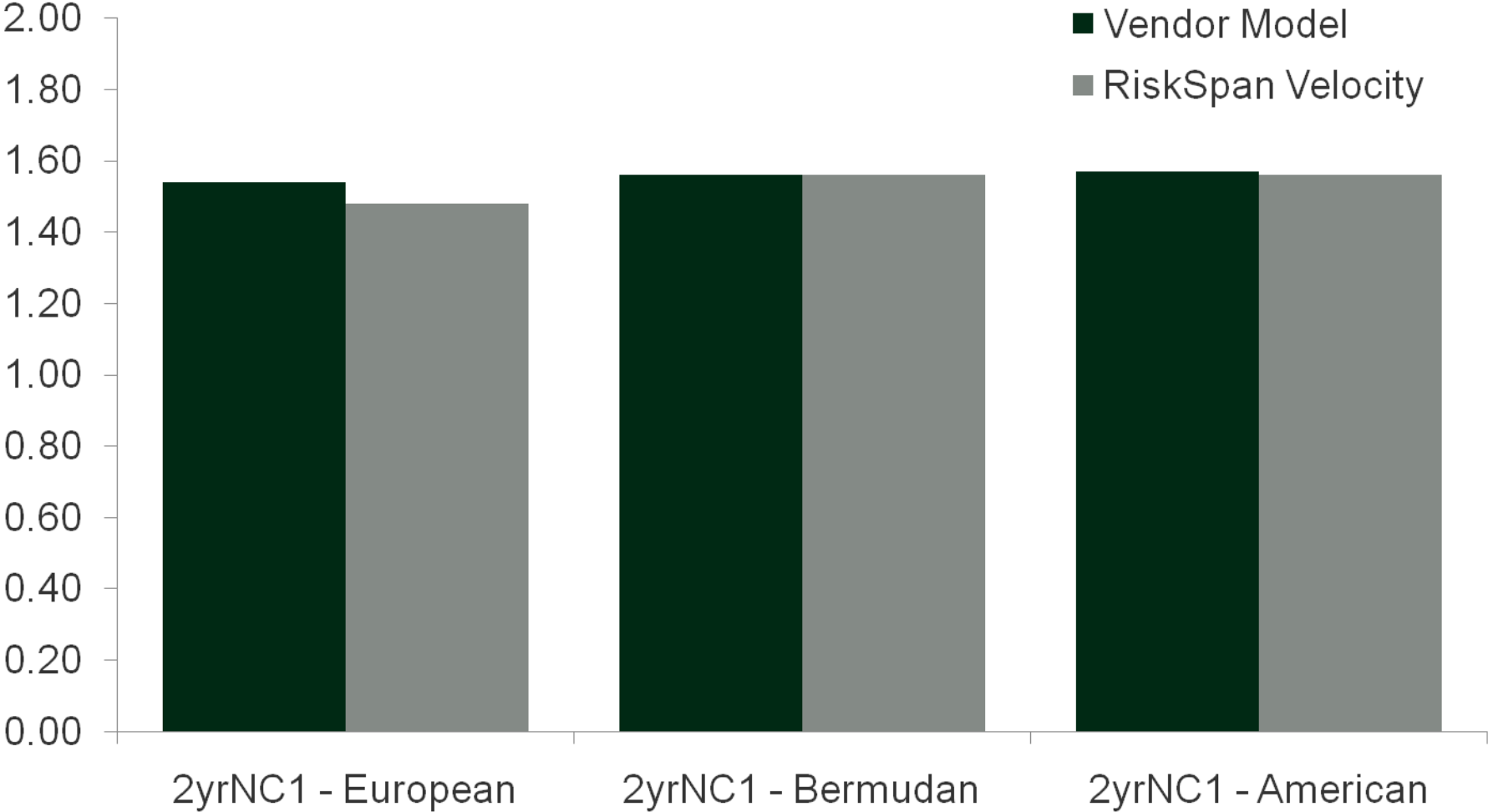
- Vendor's desire to protect intellectual property
- Limited access to model methodology
- Unable to complete code review

Solution:

- Utilized RiskSpan's Fixed Income Analytics Platform
- Validated model input
- Compared results for sampled structures from both models

Benchmarking Example 2

Duration of representative callable securities.



Back-Testing Example 2:

Projection of Callable Bond Redemptions

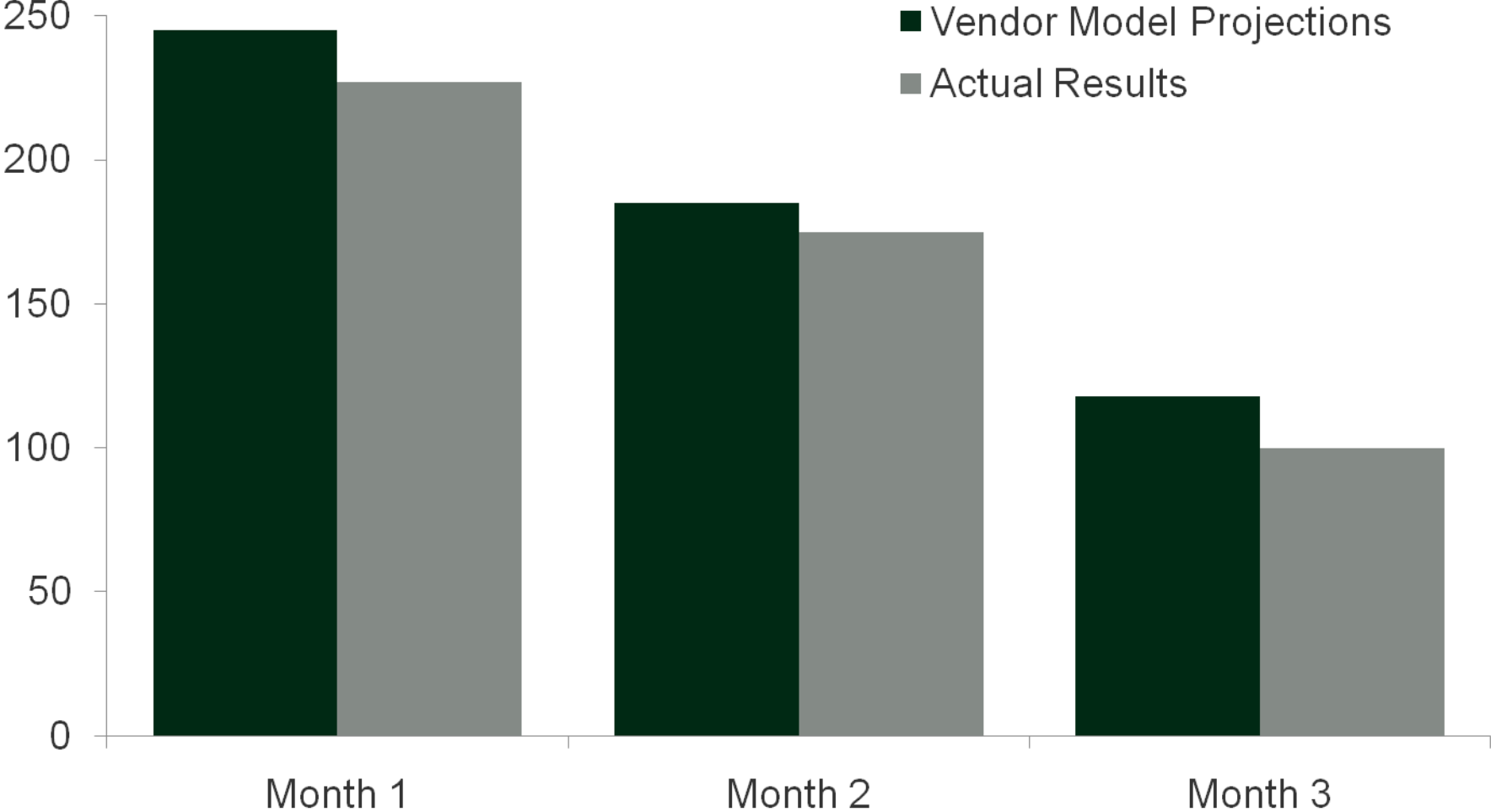
Vendor-developed model that projects the callable securities that would be redeemed in the upcoming month.

Solution:

- Obtained model projections of securities to be redeemed from three separate observation periods
- Received actual results of callable securities redeemed during applicable observation periods
- Constructed database to match projected model results versus actual observations

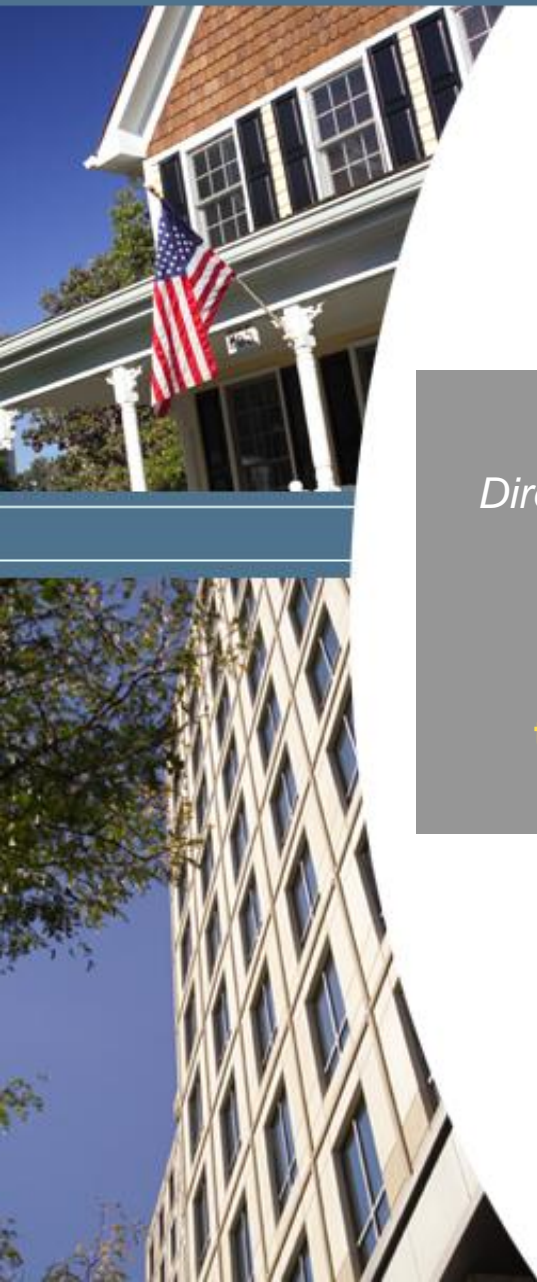
Back-Testing Example 2

Number of Securities Redeemed during Observation Period.



This is where you can add disclaimer notes about the data being represented in the chart.

- ✓ Follow Advisory Bulletin Outline.
 - Happy Regulators/Auditors can easily find what they're looking for
 - Facilitates review by internal parties
- ✓ Should contain recommendations.
- ✓ Recommendations should be prioritized.
 - High Priority: Issues that threaten the integrity of Model outputs
 - Medium: Less-pressing issues standing between the model and industry best practices. (Often controls-related.)
 - Low: Documentation/other minor deficiencies that should be addressed at some point.
- ✓ Should include Management's response to each recommendation and Management's action plan for implementation.
- ✓ Some clients require validator to review action plan and verify that it is carried out.



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