ALM Model Validation: Assessment, Benchmarking, and Comparative (Back-Testing) Approaches

Tuesday, June 24, 2008

Presented by:
Fred Poorman Jr., CFA
Managing Principal
The ALMnetwork
1815 Horace Ave.
Abington PA 19001
610-283-2668
fpoorman@almnetwork.com
Why validate ALM models?
Top 10 list

10 Internal Audit checks it off their list
9 ALM model validation lunch is better than BSA training lunch
8 Corporate Governance & related buzzwords
7 Opportunity for informed, honest feedback
6 Consultant “better practice” recommendations
5 Regulatory suggestion
4 Regulatory request
3 Regulatory requirement (MOU)
2 More ALCO/Board confidence in ALM model & model team
1 More reliable ALM model = better decisions = better profits
Why validate ALM models?
Consultant answer: to improve ALM processes!

- Improves profitability
  - NIM is bulk of banking earnings
  - Improve forecasting
  - Better tactical decision-making
  - Integrate with strategic planning
- Improves risk management processes
  - Risk measurement
  - Risk monitoring
  - Risk management
Why validate ALM models?
To improve financial management processes.

- More accurate financial reporting
  - Management Discussion & Analysis
  - Fair Value Accounting & Reporting
- Model validation is part of sound Corporate Governance
- Compliance with regulatory requirements
Why validate ALM models? Bank regulators require it.

- From the OCC:
  - “to help financial institutions mitigate potential risks arising from reliance on computer-based financial models that are improperly validated or tested.”
  - We have “observed several instances in which decision makers either relied on erroneous price or exposure estimates, or on an overly broad interpretation of model results, with serious consequences for their bank’s reputation and profitability”
  - “using unvalidated models to manage risks to the bank is potentially an unsafe and unsound practice”.
  - “Even where the risk is not particularly material, the reliance on unvalidated models can be a poor business practice”.
When should a model be reviewed?
Best practices says annually.

• Risk Standards Working Group (1997)
• Best practices approach from 10 years ago still applies.
• Risk Standard 19: Independent review of methodologies, models and systems: All methodologies, models and related systems should be independently reviewed or audited prior to use as well as annually.
When should a model be reviewed? It depends on how large and risky your institution is.

- U.S. Bank supervisors; depends on size and risk exposures
- Large banks
  - Ongoing, or annual validation and quarterly back-testing
- Mid-size banks
  - Annual validation and back-testing
- Small banks
  - Periodic validation and back-testing
Who does the model implementation validation? 
An independent party

- Independent review is required
  - “Optimally, validation work is performed by parties completely independent from the model's design and use. They may be an independent model validation group within the bank, internal audit, staff with model expertise from other areas of the bank, or an external vendor”. (FDIC)

- Internal parties?
  - Requires expertise and resources not available at most small- and mid-size banks, so a third-party validation is usually applicable.

- External parties
  - “Vendors are sometimes used to meet the need for a high level of independence and expertise. They can bring a broad perspective from their work at other financial institutions, providing a useful source for theory and process benchmarking”. (FDIC)
Who does the model implementation validation?
“Round up the usual suspects”

• Is the validation independent?
  – Accounting and auditing firms
  – ALM consulting firms
  – ALM model vendors (Hint: this should exclude the vendor that designed, sold, and implemented the model used by your bank from reviewing the same model & implementation. The same vendor may do a good job of validating another vendors’ model.)

• Experience
  – Single model vs. multiple model expertise
    • “If you sell hammers, every problem is a nail”

• Rotate model validation firms as a better practice
Where is the model implementation validation done?
Onsite and/or offsite

• Onsite: at the Bank
  – Pro: allows for interaction and ready access to data, applications, “workarounds”
  – Con: costly from a time & resource perspective

• Offsite: at the vendors’
  – Pro: allows for extensive testing using same applications configured properly
  – Con: frequently does not work due to linked files and applications
  – Con: many banks are hesitant to do so
  – Con: does not allow for interaction

• Both
  – Along with most ALM consultants, we believe this is the best approach
What should a model validation include?

Best practices: Almost everything

• Risk Standard 19: “Examples of items to address include:
  – How appropriate are the models chosen to value the instrument?
  – How do the valuations compare with those calculated by others?
  – How appropriate are the assumptions and data to the model of choice?
  – How thorough is the effort to independently verify the choice of model and assumptions?
  – How sensitive is the portfolio to the timing of data capture and the valuation calculation? How does this affect risk and return measurement and related reporting?
  – Does the methodology provide a consistently high or low picture of an instrument’s or portfolio’s risk and return characteristics?
  – How would the risk and return picture change under alternative assumptions (including stress scenarios), models and methodologies?”
What should a model validation include?

Key elements from the OCC

• OCC 2000-16: Model Validation, Elements of model validation
  – Independent review
  – Defined Responsibility
  – Model documentation
  – Ongoing validation
  – Audit Oversight
What should a model validation include?

ABC model validation procedures (from OCC 2000-16)

- Assessment procedures
  - “Independent review of logical and conceptual soundness”
  - Is the model suitable and implemented correctly?
- Benchmarking procedures
  - “Evaluate results versus the market and other models”
  - Have assumptions been compared to benchmarks?
  - Have results been benchmarked?
- Comparative procedures
  - “Compare model estimates to actual results”
  - The dreaded, but very useful, back-testing
    - “Without frequent feedback and specific feedback, performance varies and often fails”. Ferdinand Fournies
What should a model validation include?

3 model components (from OCC 2000-16)

- Input components
  - Data
  - Assumptions
- Processing components
  - Financial theory
  - Computer software
- Reporting component
  - System reports
  - Integration with bank Management Information Systems (MIS)
### What should a model validation include?

**ABC Validation Grid® (Bank ALM, 2002)**

<table>
<thead>
<tr>
<th>ABC Validation Procedures</th>
<th>Assessment Procedures: Independent Review of Logical and Conceptual Soundness</th>
<th>Benchmarking Procedures: Evaluate Results Versus the Market and Other Models</th>
<th>Comparative Procedures: Compare Model Estimates to Actual Results (Backtesting)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input Component: Data and Assumptions</td>
<td>Data: Is input automated or manual? Do balances tie to the ledger? Assumptions: Are the sources for yield curve, spreads, and prepayment estimates documented and reasonable? What is the source?</td>
<td>Assumptions: How do the scenario-dependent assumptions and estimates compare to historical and/or marketplace pricing estimates? Are non-parallel yield curve moves and basis risk considered? Is additional sensitivity analysis periodically performed?</td>
<td>Assumptions: Are assumptions and other sub-model projections compared to actual results? Is this monitored on a regular basis? Is there a consistent directional bias over time?</td>
</tr>
<tr>
<td>Processing Component: Financial Theory and Computer Models</td>
<td>Financial Theory: Are the models consistent with * ALCO’s business approach * Market and/or academic models? Computer Models: Has the underlying theory been migrated into software component?</td>
<td>Computer Models: Does the model price securities consistent with the consensus or marketplace pricing estimates in all scenarios? Are values benchmarked to another model (e.g., Bloomberg, Yield Book, BondEdge)?</td>
<td>Computer Models: Have projected and actual interest income been compared via a rate/volume or other analysis? Have scenario-dependent total return estimates been realized?</td>
</tr>
<tr>
<td>Reporting Component: Integration with Management Information Systems (MIS)</td>
<td>Integration with MIS: Is the report readily comprehensible to ALCO? Is ALCO aware of material model limitations? Is the level of reporting reasonable and sufficient? Is the account stratification consistent with internal reporting and/or marketplace convention?</td>
<td>Integration with MIS: Is the report’s content and form consistent with industry convention or regulatory and/or internal reporting? Is additional sensitivity analysis periodically performed? Are results compared to policy limits and external benchmarks?</td>
<td>Integration with MIS: Is ALCO provided with periodic actual vs. projected reports? Is the modeling and reporting set rich enough to allow for line-, portfolio-, and institution-level back testing? Are projections and results benchmarked to marketplace and peers?</td>
</tr>
</tbody>
</table>
Assessment Procedures

• Most smaller community financial institution validations focus on the Assessment component
  – Limited use of Benchmarking & Back-Testing
  – Better practice is to combine ABC procedures
• “Independent review of logical and conceptual soundness”
  – Is the model suitable?
  – Is the model implemented correctly?
Assessment Procedure
Validating the software model

• Validating the model (processing component)
  – “Model processing consists of the computer code and the theoretical models that the code implements...However, management cannot rely exclusively on a vendor's widespread industry acceptance as evidence of reliability”. (FDIC)
  – One common misconception is that validation of the computer processing is not necessary for vendor models, because these models have “met the market test.” In fact, banks that apply good validation procedures to vendor models often find material processing errors. (OCC)

• Model Certification,
  – Provides some comfort

• Model Benchmarking
  – Provides assurance
Assessment Procedure
Model Suitability

- Model Suitability
  - Is the model suitable for a banks’ current risk positions?
  - Is the model scalable as the bank grows?
- Model Taxonomy (what type or level of model)
  - Introductory
  - Standard
  - Advanced
Assessment Procedure
Model Documentation

• Importance of model documentation (OCC)
  – “Model documentation creates a corporate memory in the event of the departure of key modeling personnel”.
  – “At a minimum, model documentation should provide overviews of the general procedures used and the reasons for choosing those procedures, describe model applications and limitations”

• Importance of model documentation (practical)
  – Banks with good documentation are perceived favorably by regulators and reviewers
  – Tough to get top rating with poor or inadequate documentation
Assessment Procedure Implementation considerations

- Model implementation documentation
- Risk modeling metrics
- Market/rate models (only unrealistic shocks?)
- Data input
- Data sufficiency
- Balance sheet design
- Product configuration
- Behavioral models
- Assumption models
- Reporting
Assessment Procedure: Sample Account Review Modeling at an aggregated level can be problematic!

- Investments
  - CMOs, CDOs require specialized feeds (Intex/Markit)
- Loans
  - Variable rate: Caps, floors, multiple indices
  - Fixed rate: Prepayment issues
- Deposits
  - Core Deposits: rate & liquidity sensitivities
  - CD: combining different terms, steps, calls, early withdrawal
- Borrowings:
  - Structured cash flows, embedded derivatives
- Derivatives: the “D” word

4% + 8% is not the same as 6% for floors and prepayments!
Benchmarking Procedures

- What is ALM model benchmarking?
  - “Evaluate results versus the market and other models”
- Benchmarking ALM model inputs
  - Prepayment assumptions
  - Call/put/convert assumptions
  - Deposit sensitivities
- Benchmarking ALM model outputs
  - Individual instruments
  - Risk metrics
    - Liquidity
    - Earnings
    - Value
Benchmarking ALM Model Inputs/Outputs
Prepayment Benchmarks

• Free sources of certain market consensus prepay estimates
  – www.sifma.org, the website of the Securities Industry and Financial Markets Association
  – www.ots.treas.gov, the OTS website
• Vendor sources of prepayment estimates
  – Bloomberg
  – BondEdge
• Vendor prepayment models
  – ADCO (Andrew Davidson Co.)
  – Applied Financial Technology/AFT is now FIS Applied Analytics
  – Certain ALM vendors (for example, ZMFS)
Benchmarking ALM Model Inputs/Outputs
Deposit Sensitivities: CD Benchmark (relatively stable)

- 1 yr. CDs vs. 12 month LIBOR, lagged 6 weeks (PA)
- Period 1: May 1999-April 2004 (251 weeks)
  - Constant (Alpha, or floor): 0.72
  - Sensitivity (Beta): 72%
  - $R^2$ (Correlation squared): 99%
- Period 2: June 2004-May 2008 (213 weeks)
  - Constant (Alpha, or floor): 0.39
  - Sensitivity (Beta): 83%
  - $R^2$ (Correlation squared): 96%
- 80% correlation, or 64% $R^2$ is required for hedge effectiveness
Benchmarking ALM Model Inputs/Outputs
Deposit Sensitivities: MMDA Benchmark (more sensitive)

- MMDA>10k vs. 3 month LIBOR, lagged 13 weeks (PA)
- Period 1: May 1999-April 2004 (251 weeks)
  - Constant (Alpha, or floor): 0.23
  - Sensitivity (Beta): 38%
  - $R^2$ (Correlation squared): 73%
- Period 2: June 2004-May 2008 (213 weeks)
  - Constant (Alpha, or floor): 0.11
  - Sensitivity (Beta): 64%
  - $R^2$ (Correlation squared): 88%
- 80% correlation, or 64% $R^2$ is required for hedge effectiveness
Benchmarking Procedure: Parallel modeling

• What is parallel modeling?
  – Duplicating an ALM implementation in another ALM model
    • Sensitivity analysis on model calculations, assumptions, etc.
  – Our suggestion is to use an Advanced model for this
    • Use of a less robust model is problematic
• Benefits
  – Capability to evaluate whether current model comprehensively evaluates risks
  – Better practices model validation approach
• Drawbacks
  – Resource and $ costs
Benchmarking Procedure: Case Study
Standard vs. Advanced Model

• Liquidity metric: 1 year projected cash flow, aka Liquidity Gap
  Base Liquidity Gap, bank: 20%  benchmark: 10%
  % change from base, -2%: +17%  benchmark: +35%
  % change from base, +2%: +13%? benchmark: -56%

• Earning metric: 1 year Net Interest Margin (actual=3.65%)
  Base NIM, bank:  3.90%  benchmark:  3.67%
  % change from base, -2%: -1%  benchmark:  +5%
  % change from base, +2%:  +1%  benchmark: -3%

• Value metric: Economic Value of Equity (EVE)
  Base EVE, bank:  8.90%  benchmark:  11.45%
  % change from base, -2%: -2%  benchmark: -12%
  % change from base, +2%:  +2%  benchmark: -1%
Comparative Procedures: aka Backtesting

• Backtesting approaches
  – Current practices: most smaller banks ignore
• Low cost approaches
  – Variance analyses
  – Rate/volume/mix
• Relatively low cost approaches, reload ALM model and compare:
  – Actual balance sheet/forecasted rates
  – Forecasted balance sheet/actual rates
  – To forecasts & actuals
Comparative Procedures: aka Backtesting

- Rate scenario considerations
  - Run more than parallel rate shifts/shocks
  - Hint: short rates are about twice as volatile as long rates
Comparative Procedures: Statistical Approaches

- Historical Analysis: Deposit Sensitivity
  - Similar to Benchmarking example above
  - Excel is adequate, or consultants do for relatively low cost
- Historical Analysis: Prepayment Sensitivity
  - Calculate historical prepayment experience
  - Benchmark to market instruments
  - Scale/calibrate vs. consensus forecasts or modes
Comparative Procedures: Statistical Approaches

- Historical Analysis: Margin Components
  - Measures actual experience (including behavioral & management responses) vs. rate moves
  - Useful in understanding level vs. slope risk

![Graph showing Asset Yield, 10 yr UST, and Fed Funds trends over time.]
ABC Procedures: Case study
Lack of validated model cost $millions

• Prepayment models
  – Before: Modeled minimal prepayments, so assumed bank was liability sensitive
  – After: With reasonable prepayment assumptions that were benchmarked and back-tested, the bank was actually asset sensitive

• Hedged liability sensitivity
  – Before: Via an interest rate swap
    • Receive floating pay fixed so they made $ when rates increased
    • Swap was backwards because earnings profile was backwards
  – After: Did offsetting swap, then swapped correct way

• Oops
  – Before: Rates went down, so the NIM decreased, swap was underwater
  – After: Realized asset-sensitive, included in pricing & hedging
ABC Procedures: Case study
Prepayment set up

• Prepayment models
  – SMM (monthly model, example 1%)
  – CPR (annual model, example 12%)
  – PSA (pre-defined behavioral model, example 200)
  – Model setup as CPR (12%); Model input used PSAs (200)

• Result
  – Prepayments were 100% to 1000% per annum
  – Average life of loan was < 1 year in all scenarios
    • Bank could have benchmarked prepayment estimates…
    • Went on for years….

• Oops
  – Pro forma was no Value risk
  – Pro forma was lots of Earnings risk
    • Earnings were relatively stable, so CEO & Board disregarded ALM
ABC Procedures: Case studies
Structured Advances & Repos

• Oops #1
  – AL model couldn’t model optionality
  – Bank modeled all scenarios like current scenario
  – Rates declined, Bank was stuck with advances with above market rates when they projected advances would convert

• Oops #2
  – AL model could model optionality
  – Bank modeled as callable rather than putable
  – Rates declined, bank thought they had a matched position as both assets and funding were rolling off, but advances stayed
ABC Procedures: Case study
Gap & 1 year Income simulation only

• Oops
  – Thought they had a matched position
  – Bought 10/2 callable agencies
    • They were called
  – Funded with convertible advances
    • They didn’t convert
  – Yield on portfolio < cost of advances
ABC Procedures: Case study
Better practice examples

• Yeah #1
  – Thorough documentation of mostly automated process
  – Cross-trained staff with capable management oversight
  – Reliable results with thorough back-testing
  – Opportunity to improve prepayment modeling

• Yeah #2
  – Thorough documentation of mostly automated process
  – Cross-trained staff with capable management oversight
  – Reliable results with acceptable back-testing
  – Opportunity to improve back-testing

Only we specialize in you!
www.fmsinc.org | 800-ASK-4FMS
Designing a model validation program (from the FDIC’s “Supervisory Insights”)

Figure 3

Ongoing Validation

Process Verification

Developmental Evidence

Outcome Analysis

Various Source Systems

Extracted Data

Model: Theory, Drivers and Assumptions Calculations

Mapping of source systems to model inputs performed to ensure accuracy and completeness.

Model structure and assumptions are optimized.

Back-testing/benchmarking results used to improve model.

Model Output Reports to End Users

Model Output Data Used in Validation
Value-added ALM model validation & review

• Develop & prioritize recommendations
  – **Higher Priority** items are those that will likely materially impact and/or improve the Banks’ IRR modeling and/or ALCO processes. They should be implemented as soon as practicable.
  – **Moderate Priority** items are those that may materially impact and/or improve the Banks’ IRR modeling and/or ALCO processes. They should be implemented when resources are available.
  – **Lower Priority** items are those that may impact and/or improve the Banks’ IRR modeling and/or ALCO processes. They should be implemented after High Priority and Moderate Priority items are implemented, or if their implementation is relatively cost-free from a resource perspective.

• Follow up review?
Why validate ALM models?
Partial Top 10 list

1. More reliable ALM model = better decisions = better profits
2. More ALCO/Board confidence in ALM model & model team
3. Regulatory requirement (MOU)
4. Consultant “better practice” recommendations
5. Opportunity for informed, honest feedback
6. Internal Audit checks it off their list
7. Only we specialize in you!