Disclaimers

• The information provided in this presentation is the professional opinion of MountainView-McGuire, based on personal and client experience.

• No information provided in this presentation is represented as official guidance from any regulatory agency or governmental entity.

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Session Goals

• Review regulatory and related guidance that impact the scope and conduct of model validations
• Identify the foundations of any model validation
• Define critical model validation concepts that are commonly misapplied and associated risks
• Review common model review and validation techniques
• Explore these techniques in common model validations to determine what they do and don’t tell you
Model validation is the set of processes and activities intended to verify that models are performing as expected, in line with their design objectives and business uses. Effective validation helps ensure that models are sound. It also identifies potential limitations and assumptions, and assesses their possible impact. As with other aspects of effective challenge, model validation should be performed by staff with appropriate incentives, competence, and influence.

All model components, including input, processing, and reporting, should be subject to validation; this applies equally to models developed in-house and to those purchased from or developed by vendors or consultants. The rigor and sophistication of validation should be commensurate with the bank’s overall use of models, the complexity and materiality of its models, and the size and complexity of the bank’s operations.
OCC 2011-12/SR 11-7: Model Risk Management

Effective model validation helps reduce model risk by identifying model errors, corrective actions, and appropriate use. It also provides an assessment of the reliability of a given model, based on its underlying assumptions, theory, and methods. In this way, it provides information about the source and extent of model risk. Validation also can reveal deterioration in model performance over time and can set thresholds for acceptable levels of error, through analysis of the distribution of outcomes around expected or predicted values. If outcomes fall consistently outside this acceptable range, then the models should be redeveloped.

Examples of additional, model specific guidance
Inter-agency Advisory on Interest Rate Risk (2010-1a) for ALM models and NCUA Letter 12-CU-05
Interagency Policy Statement on the Allowance for Loan and Lease Losses (FRB SR0617a)
Model Validation Foundations

• The model’s intended purpose should frame the model validation techniques used (ALM model vs. ALLL model)
• Two distinct aspects of model performance must be evaluated
  • Model meets *necessary* conditions – capable of meeting needs of model’s intended *compliance* purpose
  • Model meets *sufficient* conditions – capable of meeting needs of model’s intended *business* purpose
• What is needed to confirm necessary and sufficient will vary across models
Validation Building Blocks

• Model Components
  • Inputs
    • Model setup review
    • Assess starting position vs systems of record
    • Assumption review
  • Processing
    • Statement of Positive Affirmation (third-party models) or
    • Other form of independent verification of computational accuracy of programming components
• Reporting (Output)
  • Techniques used will vary depending on model
  • Outputs should be assessed based on meeting both necessary and sufficient conditions for model purpose
Model Verification vs. Model Validation

• Define “Verification”
  o Dictionary.com definition of “verify”
    • To prove the truth of, as by evidence; to make true; to serve to confirm
  o A “model risk” definition of model verification
    • Sargent (2012) – …ensuring that the computer program of the computerized model and its implementation are correct
    • Morini (2011) – …verifying that model assumptions are turned correctly into numbers
Model Verification vs. Model Validation

• Define “Validation”
  o Dictionary.com definition of “validate”
    • To substantiate, confirm; support by facts or authority
  o A “model risk” definition of model validation
    • Sargent (2012) – ...substantiation that a model within its domain of applicability possesses a satisfactory range of accuracy consistent with the intended application of the model
    • Morini (2011) – ...the activity of assessing if the assumptions of the model are valid
Terms: Model Verification vs. Model Validation

• Not co-equal terms
  o Model verification and model validation are not synonymous terms
  o Model verification relates to identifying computational and coding errors
  o Model validation relates to identifying assumption and methodological errors

• These are two distinctly different components of model review and evaluation
Practices: Model Replication vs. Model Challenge

• Define “Replication”
  o Dictionary.com definition of “replicate”
    • To repeat, duplicate, or reproduce, especially for experimental purposes
  o A “model risk” definition of replication
    • A comparison of a model being independently reviewed to another, “valid” model
      » A “valid model” is one sufficiently similar to the model being reviewed which has also been independently verified and validated (leading practice)
    • A replicating model benchmarks (verifies) the model being independently reviewed
Practices: Model Replication vs. Model Challenge

• Define “Challenge”
  o Dictionary.com definition of “challenge”
    • To take exception to; call into question
  o A “model risk” definition of challenge(r model)
    • An alternate model with decidedly different methods, input variables, and assumptions from the existing model (champion) being reviewed
    • A challenger model assesses (validates) the model being independently reviewed
      » If the champion outperforms the challenger, the champion is thereby validated (affirmed)
      » If the challenger outperforms the champion, the champion’s validity is thereby questioned (challenged)
Practices: Model Replication vs. Model Challenge

• Not co-equal practices
  o Replicating models must retain the same or substantially similar methods, input variables, and assumptions => the goal is to verify that “model assumptions are turned correctly into numbers”
    • Replicating models benchmark (verify)
  o Challenger models purposely include different methods, input variables, and assumptions => the goal is to validate that “the assumptions of the model are valid”
    • Challenger models assess (validate)
Why Definitions Matter

• Confusing model verification and model validation can contribute to a “false positive” or a “false negative” model review result
  o Type I Error (Case One): A replicating (verifying) model disguised as challenger (validating) model results in the rejection of an otherwise valid model
  o Type II Error (Case Two): A verified (but not validated) model results in the acceptance of an otherwise invalid model
• This is a fundamental risk of relying on a “parallel” model run as a singular form of validation
Common Model Validation Techniques

• “Front-End”
  • **Data audit and reconciliation**
    • Confirms consistency of model inputs to the Institution’s systems of record
      • Starting position data reconciles to G/L for same time period
    • Provides a reconciliation of model structure to underlying data attributes
      • 5 Year ARM category would not expect to see material repricing cash flows beyond month 60 in the starting position
Common Model Validation Techniques

• **Data audit and reconciliation**
  - What does it tell us about the accuracy of the model outputs?
  - Important validation task but neither verifies nor validates a model implementation on its own
  - Typically, a periodic rather than regular part of model validation scope

• **Assessment of starting position data to external system of record**
Common Model Validation Techniques

• Model Setup Review
  • Chart of Accounts or other category structures
    • Underlying data mapping
    • Attributes associated with each (Key rate ties, interest accrual method, contractual terms)
  • Assess level of structural detail
  • Completeness of definitional setups
    • Default settings or no selection
    • Institution/category-specific settings
  • Other System Drivers
    • Key rate definitions
    • Custom or user defined specifications
Common Model Validation Techniques

- **Model Setup Review**
  - Benefit: Verifies and validates that the *model structure* is configured appropriately to conduct modeling activities
  - When coupled with a statement of positive affirmation on the computational capabilities of the underlying model programming, *possibly* capable of assessing whether the model meets the *necessary* condition of meeting compliance requirements

- **Limitations**
  - Focus of model setup may be on processing efficiency rather than most appropriate and accurate definitions
  - Without review of additional model dimensions, does not conclusively validate the model implementation
Common Model Validation Techniques

- **Assumption Review**
  - All models have some level of assumptions
  - Assumptions are a critical factor that determines the model’s ability to meet necessary and sufficient conditions of the model’s intended purpose
  - Nature of assumptions will vary depending on the model’s intended purpose
    - **ALM Models**
      - Rate scenarios
      - Loan prepayment and non-maturity deposit behaviors
      - Balance sheet growth/mix
    - **ALL Models**
      - Historic loss rates are predictive of future rates
      - Qualitative adjustments
      - Non-maturity deposit models
Common Model Validation Techniques

- **Assumption Review**
  - Validates that assumptions are appropriate and reasonable
    - Varying degrees of assumption “quality” that requires different validation conclusions
      - Assumptions defined
      - Based on institution-specific experience
      - Derived from a valid approach or method
      - Timely (not using assumptions developed 10 years ago)
      - Assumptions used in risk management models should vary depending on the risk variable of interest
  - Provides greater confidence in the model’s ability to meet both necessary and sufficient conditions...but until the output is assessed, we simply don’t know
Common Validation Techniques

• “Back-End”
  • Model Outputs Assessment
    • Benchmarking
    • Back Testing
    • Parallel Model Run (model replication)
    • Customized model diagnostics
  • No single outputs assessment method on its own can fully validate a model
    • Still need front-end assessment
    • Outputs assessments tell us different things about the model’s results
Back Testing

• Very important validation tool for any sort of forecasting model
• Confirms the ability of the model to predict actual outcomes given the occurrence of certain conditions
  • Budgeting models
  • Model assumptions
• Limited additional validation value for certain types of models
  • ALM Models:
    • Risk oriented and forecast the variability of NII and EVE/NEV around interest rate changes
    • What back testing tells us about the validity of the other rate scenario results
  • Stress Test Models:
    • By definition, stress scenarios are unlikely to occur over a reasonable back test horizon
Benchmarking

• Useful tool to use in conjunction with other validation techniques
• Confirms the reasonableness of model forecasts or results to comparable outcomes from other sources
  • Challenger model can be used as a benchmarking tool
  • Compare model outputs to industry or peer outcomes
  • Confirm model risk profiles to actual experience trends over a longer series of data that spans multiple scenarios

• Use caution when interpreting differences to benchmarks
Parallel Model Run

• Common assessment technique for vendor models (i.e. ALM)
• **Replicating Model:**
  • Uses the same model structure, inputs and assumptions
  • If results are comparable, what has that told you?
    • The two models process comparably
    • Errors in model setup or assumptions are processed consistently, but still erroneous
  • If results are not comparable, what has that told you?
    • There is a likely difference in model processing code
    • The difference in code is not a question of model implementation but rather one of programming
  • The Replicating parallel model run, is, in fact a “verification” of model computations
Parallel Model Run

• **Challenger Model:**
  - May use different analytical methods, configuration and assumptions
  - Depending on the nature of the model under review, the challenger model can be a very effective validation tool
    • More significant predictor variables
    • More robust equations
    • Stronger outcomes=better model
  - To be useful, the Challenger model also needs to be verified and validated
    • Challenger model uses industry or peer data for assumptions rather than those used in model that are based on institution experience
    • Model configuration or assumptions are consolidated due to structural differences between the two models
Customized Model Diagnostics

- Review tools and tests specifically oriented toward assessment of model results within the context of its intended purpose
- Example: ALM Model Validation
  - **Intended purpose:** measure the variability (risk) of net interest income and expected value of equity/net economic value to changes in interest rates
  - Assess not only the validity of the Base Case rate scenario forecast but also the validity of the rate shock forecasts based on the characteristics of the institution’s balance sheet
<table>
<thead>
<tr>
<th></th>
<th>-100</th>
<th>Base</th>
<th>+100</th>
<th>+200</th>
<th>+300</th>
<th>+400</th>
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<tbody>
<tr>
<td><strong>Total Resid 5 Yr F/ARM</strong></td>
<td>4,807</td>
<td>4,897</td>
<td>5,252</td>
<td>5,550</td>
<td>5,828</td>
<td>6,105</td>
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<td><strong>Resid 7 Yr F/ARM</strong></td>
<td>1,657</td>
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<td>1,764</td>
<td>1,845</td>
<td>1,910</td>
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<td><strong>Resid 10 Yr F/ARM</strong></td>
<td>1,288</td>
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<td>1,395</td>
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<td><strong>Commercial TDRs</strong></td>
<td>2,410</td>
<td>2,455</td>
<td>2,500</td>
<td>2,545</td>
<td>2,590</td>
<td>2,634</td>
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<td><strong>Total Loans Conv</strong></td>
<td>13,468</td>
<td>13,664</td>
<td>14,456</td>
<td>15,185</td>
<td>15,799</td>
<td>16,333</td>
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<td><strong>Comm Fix</strong></td>
<td>1,476</td>
<td>1,500</td>
<td>1,524</td>
<td>1,548</td>
<td>1,573</td>
<td>1,597</td>
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<tr>
<td><strong>Total Comm Fix</strong></td>
<td>1,476</td>
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<td>1,524</td>
<td>1,548</td>
<td>1,573</td>
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<td><strong>Resid Construction Fix</strong></td>
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<td>340</td>
<td>345</td>
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<tr>
<td><strong>Resid 15 Yr Fix</strong></td>
<td>1,183</td>
<td>1,267</td>
<td>1,364</td>
<td>1,426</td>
<td>1,429</td>
<td>1,453</td>
</tr>
<tr>
<td><strong>Total Resid 15 Yr Fix</strong></td>
<td>1,183</td>
<td>1,267</td>
<td>1,364</td>
<td>1,426</td>
<td>1,429</td>
<td>1,453</td>
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<tr>
<td><strong>Resid 30 Yr Fix</strong></td>
<td>3,520</td>
<td>3,665</td>
<td>3,827</td>
<td>3,925</td>
<td>3,948</td>
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<td><strong>Residential Loans AFS</strong></td>
<td>179</td>
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<td>281</td>
<td>331</td>
<td>382</td>
<td>433</td>
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<tr>
<td><strong>Total Resid 30 Yr Fix &amp; AFS</strong></td>
<td>3,699</td>
<td>3,878</td>
<td>4,107</td>
<td>4,256</td>
<td>4,331</td>
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<td><strong>Resid Single Pmt Int Only</strong></td>
<td>66</td>
<td>67</td>
<td>67</td>
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<td>69</td>
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<td>57</td>
<td>60</td>
<td>64</td>
<td>67</td>
<td>71</td>
<td>74</td>
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<tr>
<td><strong>RES RE TDR-Fixed</strong></td>
<td>777</td>
<td>780</td>
<td>782</td>
<td>785</td>
<td>788</td>
<td>790</td>
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<td><strong>Total Resid RE Mtg Fix</strong></td>
<td>6,118</td>
<td>6,392</td>
<td>6,730</td>
<td>6,953</td>
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<td><strong>Comm RE Fix Mtg 360/360</strong></td>
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<td>545</td>
<td>546</td>
<td>548</td>
<td>550</td>
<td>552</td>
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<tr>
<td><strong>Comm RE Fix Mtg Non Amort 365/360</strong></td>
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<td>16,255</td>
<td>16,475</td>
<td>16,696</td>
<td>16,916</td>
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<td><strong>Marine Term Fix</strong></td>
<td>1,410</td>
<td>1,416</td>
<td>1,458</td>
<td>1,470</td>
<td>1,482</td>
<td>1,493</td>
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</tbody>
</table>
Example Model Validation Tools: ALM Model

<table>
<thead>
<tr>
<th>Model Component</th>
<th>Suggested Validation Technique(s)</th>
</tr>
</thead>
</table>
| Input           | • Chart of Accounts and Model Customization Review  
|                 | • Starting position assessment  
|                 | • Data Audit (as required/periodic)  
|                 | • Assumptions Assessment/Benchmarking  |
| Processing      | • Vendor Model: Statement of Positive Affirmation  
|                 | • Internally Developed: Parallel model run (replicating) using a validated alternate model  |
| Outputs         | • Customized Diagnostics to evaluate the scenario specific outputs relative to specific balance sheet structure  
|                 | • Back Test to confirm predictive accuracy of setup and inputs over a short horizon |
Example Model Validation Tools: ALLL Model

<table>
<thead>
<tr>
<th>Model Component</th>
<th>Suggested Validation Technique(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input</td>
<td>• Model definition review</td>
</tr>
<tr>
<td></td>
<td>• Assessment of technical structure of model</td>
</tr>
<tr>
<td></td>
<td>• Confirm historic loss rates</td>
</tr>
<tr>
<td></td>
<td>• Review qualitative adjustments</td>
</tr>
<tr>
<td></td>
<td>• Confirm proper designation of ASC 450 loans to other types</td>
</tr>
<tr>
<td>Processing</td>
<td>• Vendor Model: Statement of Positive Affirmation</td>
</tr>
<tr>
<td></td>
<td>• Internally Developed: Parallel model run (replicating) using a validated alternate model</td>
</tr>
<tr>
<td></td>
<td>• Coding review</td>
</tr>
<tr>
<td>Outputs</td>
<td>• Peer benchmarking</td>
</tr>
<tr>
<td></td>
<td>• Challenger model</td>
</tr>
</tbody>
</table>
Final Thoughts

• Model validation techniques and methods should be tailored based on the intended purpose of the particular model
• No single test or review will likely provide full verification and validation of the model
• A **verification** of a model’s programming and computational accuracy coupled with a satisfactory validation of model setup and inputs may help to determine the model’s ability to meet the **necessary** condition for compliance minimums...
• A further validation of model outcomes that are properly deployed provides the full validation of a model’s ability to meet **sufficient** conditions
• Be cautious with parallel model runs
  • Replicating model
  • Challenger model
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• ALM model verification and validation
• Specialized financial model verification and validation
• DFAST and CCAR model related validations and submission reviews
• Advanced statistical analyses of core deposit supply, repricing, and decay behaviors, loan prepayments, and CD early withdrawals
• Liquidity/Contingency Funding Plan function verification and validation
• ASC 820 (FAS 157) compliant CDI, CD, and loan valuations for fair value applications

MountainView’s Service Areas:

Valuation & Pricing | Credit & Interest Rate Risk | Model Risk | Transaction Advisory

MViewFS.com
References
