



A RANDOM WALK THROUGH MODEL RISK MANAGEMENT

Presentation by Federal Reserve and OCC

FRB Richmond/Charlotte MRM Forum

September 2016



Background/Context

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- ❑ Agencies now have a half-decade of experience in evaluating MRM frameworks that are based on the 2011 model risk management guidance (MRMG)
- ❑ OCC and FRS have established formal supervisory processes for evaluating MRM frameworks
- ❑ Also are integrating MRM assessments into broader supervisory assessments (such as of business lines or risk stripes or for CCAR/DFAST)
- ❑ Tying together assessments of individual models or modeling areas with assessments of “programmatic” elements of MRM
- ❑ OCC and FRS continue to work closely together on MRM assessments, as well as on industry outreach

Background/Context (cont)

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- ❑ In this presentation we are trying to highlight positive practices and examples seen over the years (“glass half full” or the “inverse of MRAs”)
- ❑ “Random” means we are not planning to touch all aspects of MRM – picking & choosing a selection in no particular order
- ❑ In each area we visit, we will touch on some points, not all (i.e., not an exhaustive discussion)
- ❑ Most of these are “based on a true story” with some tweaks
- ❑ Not necessarily describing minimum expectations, but different ways to meet minimum expectations
 - Practices noted here are not intended to be new or enhanced standards
 - Instead, a description of what has worked well for some firms

Stops on Our Walk

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- ❑ Governance
- ❑ Model design
- ❑ Parallel validation
- ❑ Overlays
- ❑ Vendor models
- ❑ Policies and procedures
- ❑ Internal audit

Governance

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- ❑ Significant attention and internal discussion to evaluate current MRM practices (gap analyses) and develop remediation plans
- ❑ Firm-wide committee and governance of MRM with better integration across LOBs – more systematic policies, procedures, and practices
- ❑ Attention to monitoring the entire cycle of development, implementation, use, and validation
- ❑ Entire firm views MRM as a process, not a project or an event
- ❑ Model evaluation resources/expertise broadened - not only technical review process, but also includes risk managers, finance, audit, IT, etc.
- ❑ Greater attention to MRM by board members and careful consideration of information board members need to oversee MRM
 - Reports appropriately scaled for board vs senior management
- ❑ Healthy skepticism about model output and appreciation of limitations
- ❑ Firm pays attention to model materiality, scales MRM accordingly

Model Design

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- ❑ Firm-wide standards for model design, as well as more detailed procedures to guide development of specific model types
- ❑ Clear process for deciding to build the model, with proper approvals that follow established policies & procedures
- ❑ Intended use of the model is clear and approval is needed for expanding/altering use
- ❑ Clear documentation about the original model design and processing components – allows third party to follow the path of development
- ❑ Evidence that model developers have conducted research about industry/academic theory & practice relating to the model
- ❑ Consideration of data choices and accounting for exposure characteristics
- ❑ Assumptions clearly identified and tested

Parallel Validation

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- ❑ Firm chooses to conduct validation activities as model development proceeds, rather than waiting for developers to finish the model
- ❑ Firm recognizes that it should have additional safeguards to preserve effective challenge if it pursues such “parallel validation”
 - Validation staff not involved in making any decisions about the model
 - Policy states clearly that validation’s role is to determine if there are model limitations; developer has to decide how to address those limitations
- ❑ Once a discrete stage of the development process is completed and documented, then corresponding validation activities begin
 - But clarity that this is not the “final say” from validation on this topic
- ❑ Once all model stages finished, next step in validation commences
 - Taking into account previous results but also taking a fresh look at all of the developmental evidence and how the model works in full
 - Evaluating all the parts of the model as an integral whole is fundamental to assessing it thoroughly
- ❑ Model should then be reviewed on an ongoing basis

MRM for Model Overlays

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- ❑ Firms includes overlays/overrides in overall MRM program
- ❑ Has clear and detailed policies and procedures for overlays
- ❑ Firm makes distinction between one-time vs ongoing overlays (and tries to minimize the latter)
- ❑ Firm has well documented support for overlay rationale (first line)
- ❑ Strong effective challenge for model overlays (scaled by materiality)
- ❑ Internal standards for tracking model and overlay performance, separately and together
- ❑ Firm also ensures that it applies effective challenge to overlays set by management committees
- ❑ Combination of technical expertise & business expertise in overlay review
- ❑ Confirmation that overlays called “conservative” are indeed so
- ❑ Firms revisits underlying model to explore recalibration/redevelopment
- ❑ More significant overlays require higher-level management approval

MRM for Vendor Models

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- ❑ MRM for vendor models fits into broader approach for vendor management
 - And linked to other supervisory guidance on vendor management
- ❑ Same or similar standards for development, implementation & use apply
- ❑ Sample test data sent to vendor before purchase (with extreme values)
- ❑ Internal benchmark model built for more important vendor models
- ❑ Appropriate skepticism for vendor models deemed “industry standard”
- ❑ Obtain sufficient developmental evidence that allows for an evaluation of conceptual soundness during validation
- ❑ Vendor model validation looks at the specific manner in which they will be applied and implemented at that firm (e.g., checking all the settings)
- ❑ Clearly understand model limitations and assumptions of vendor models to determine whether the model is appropriate for the intended use
- ❑ Updates to vendor methodology, data, etc are tracked and reviewed

Policies and Procedures

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- ❑ Firm has policies that apply to models everywhere in the organization, and then procedures that apply to specific modeling areas
- ❑ P&P are appropriately cross-referenced – for example, MRM policy has description of audit’s role, but also links to firm’s broader audit standards
- ❑ P&P tie to supervisory expectations (and not just for MRMG but other areas such as vendor management, audit, and IT/change controls)
- ❑ Evidence that P&P serve as key guiding documents to help ensure practices are consistent and sufficiently rigorous, and to minimize chances for misinterpretation
- ❑ Clear to all in the firm which P&P are the “law of the land” and there are negative consequences for not adhering to P&P
- ❑ P&P regularly updated – and not just ahead of exams
- ❑ Firm has mechanisms to assess conformance with P&P - such as QA function

Internal Audit

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- ❑ Audit makes a full assessment of the whole MRM framework, not just discrete elements (e.g., not just validation)
- ❑ Planning and scopes are clearly and communicated ex ante
- ❑ Audit focuses on evaluating processes and controls, not individual models
 - But conducts sampling and transaction testing to confirm
- ❑ Audit has sufficient standing in the organization to feel comfortable pointing out shortcomings and to have them addressed
- ❑ Work is consistent with other existing supervisory expectations for audit
- ❑ Work is rigorous, appropriately critical, and has clear conclusions
 - Audit is able to identify thematic issues and root causes
- ❑ Audit specifies clearly what was covered and what was not
- ❑ Regular reports provided to senior mgmt and the board (or its delegate)
- ❑ Supervisors observe that issues they find in first and second line have been already identified by audit

Closing Thoughts

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- ❑ As outlined above, we are seeing a lot of good practices and a lot of resources devoted to MRM
- ❑ But we note a few areas still needing attention
 - Good policies without compliance do not help
 - Uneven application of better practices, even within a bank
 - How to keep it going will be a challenge – ensure sustainability and regular updates
 - Good to demonstrate within the firm that MRM is worth the substantial costs (not just to make supervisors happy)
- ❑ Supervisors will continue attention on MRM as firms progress
- ❑ We will maintain our outreach to the industry and help promote better practices



Break 9:45 – 10:00



MRM in CCAR Panel Discussion

**Moderator: Vishant Sharma
Federal Reserve Bank Of Atlanta
September, 2016**

Agenda

- ❑ Panelist Introduction
- ❑ Panel Choice Discussion
- ❑ Q&A Session

MRM in CCAR: Panelists

- ❑ *Deniz Senturk, SVP/ Head of Model Risk Management, State Street*
- ❑ *Elizabeth Mays, Chief Model Risk Officer, PNC*
- ❑ *Angela Reindollar, Model Risk Director, Comerica Bank*



Managing Model Risk in CCAR/DFAST Processes to Ensure Forward Looking Risk Management

Deniz Senturk, State Street

Managing Model Risk in CCAR/DFAST Processes to Ensure Forward Looking Risk Management:

Critical Success Factors

Correctly Scoping the Work, enabled by effective processes

Shared Accountability, enabled by effective reporting

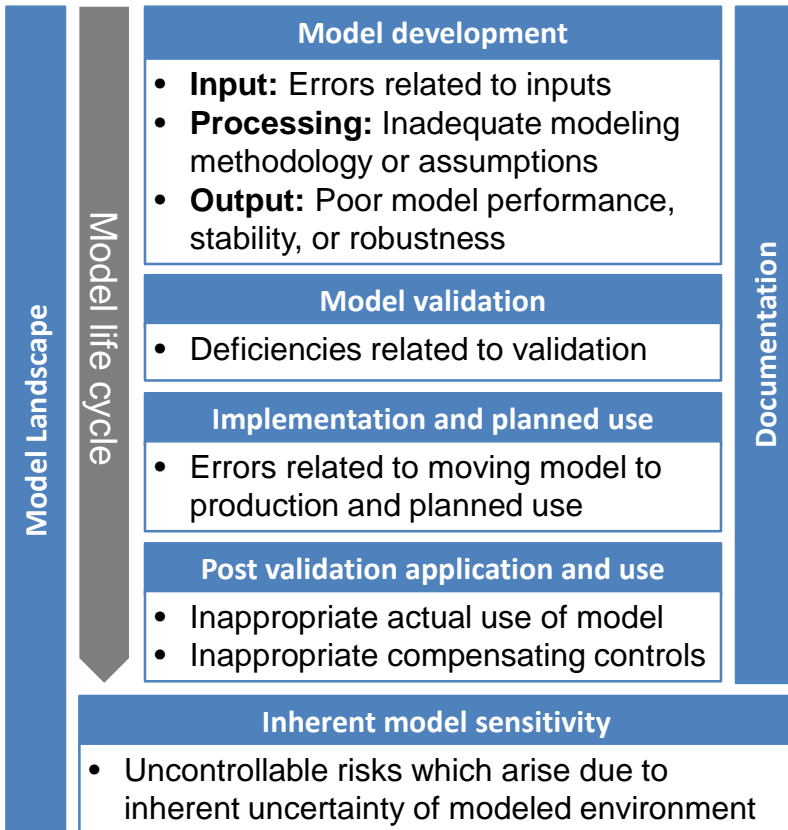
Full Transparency coupled with the Risk Appetite

Only Eliminating Risk # 36 and Effectively Managing other Risks

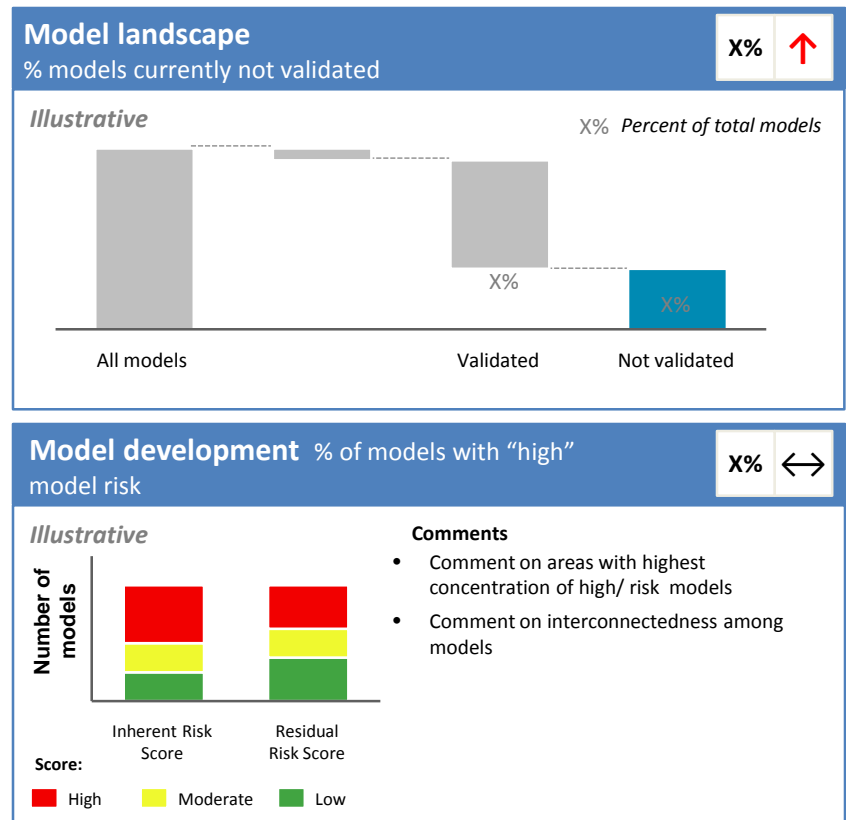


Actionable Reporting

Model Risk Appetite should be based on sources of risk across the model life cycle



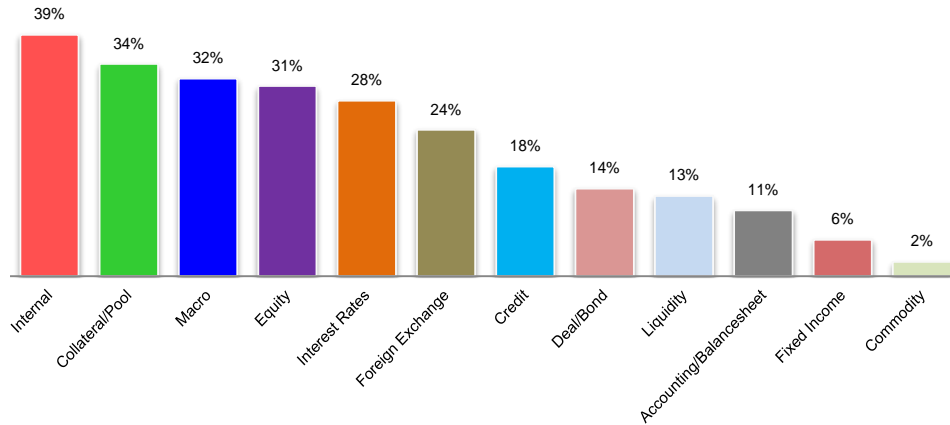
Regular and actionable metrics/reporting will enable us to monitor and take action to reduce model risk



Agile and simplified but comprehensive information sharing is the key

CCAR Models: Key Sensitivity Factors

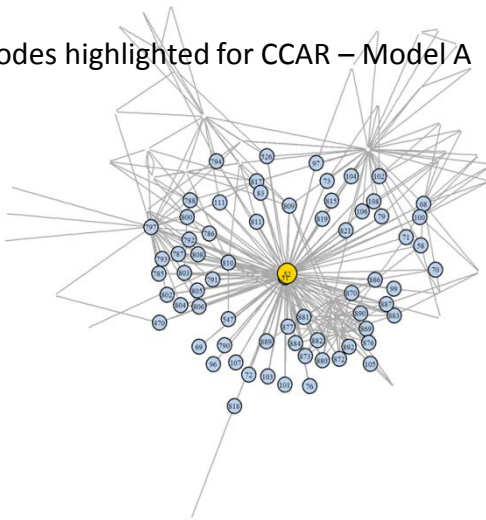
% of Models Driven by Key Factors



Model Family ¹	Risk Rating ²	Top 3 Factors
CCAR - A	Elevated	(1) Liquidity (2) Interest Rates (3) Accounting/Balance sheet Factors; Credit; Equity; Foreign Exchange; Internal Factors; Macro Factors
CCAR - B	Elevated	(1) Collateral/Pool Factors (2) Macro Factors (3) Deal/Bond Factors
CCAR - C	Moderate	(1) Foreign Exchange (2) Equity (3) Liquidity
CCAR - D	Moderate	(1) Credit; Equity; Interest Rates; Internal Factors
CCAR: E	Moderate	(1) Accounting/Balance sheet Factors; Foreign Exchange
CCAR: F	Moderate	(1) Internal Factors (2) Credit (3) Equity; Interest Rates

Interconnectedness of Regulatory models

Nodes highlighted for CCAR – Model A




Top 10 Feeder Models risk-ranked by model interconnectedness

Model	Systemic importance ³	Number of Downstream ⁴	Risk Rating
CCAR-A	100	68	●
CCAR-B	91.7	67	●
CCAR-C	7.7	20	●
H1	6.4	6	●
H2	3.8	4	●
H3	3.5	3	●
G	3.4	6	●
CCAR-X	3.3	3	●
H4	3.3	3	●
CCAR-Z	3.0	6	●

Top 10 Downstream Models risk-ranked by model interconnectedness

Model	Systemic importance ³	Number of Upstream ⁴	Risk Rating
F2	100	23	●
CCAR-L	89.4	7	●
CCAR-M	87.1	10	●
CCAR-G	85.5	5	●
F3	83.9	4	●
B	83.2	3	●
CCAR-C	83.2	3	●
CCAR-Y	83.2	3	●
F4	83.2	4	●
F1	82.9	3	●



Challenges in Managing the Model Development and Validation Timeline for Stress-Testing Models

Elizabeth Mays, PNC

The Challenge

Every Year

MRM must complete several dozen model reviews by a date that is set in stone.

A significant number of these models are modified or fully redeveloped.

Developers want to work on their models as long as possible, causing further delays in validation.

Validation work piles up in the last few weeks before the submission.

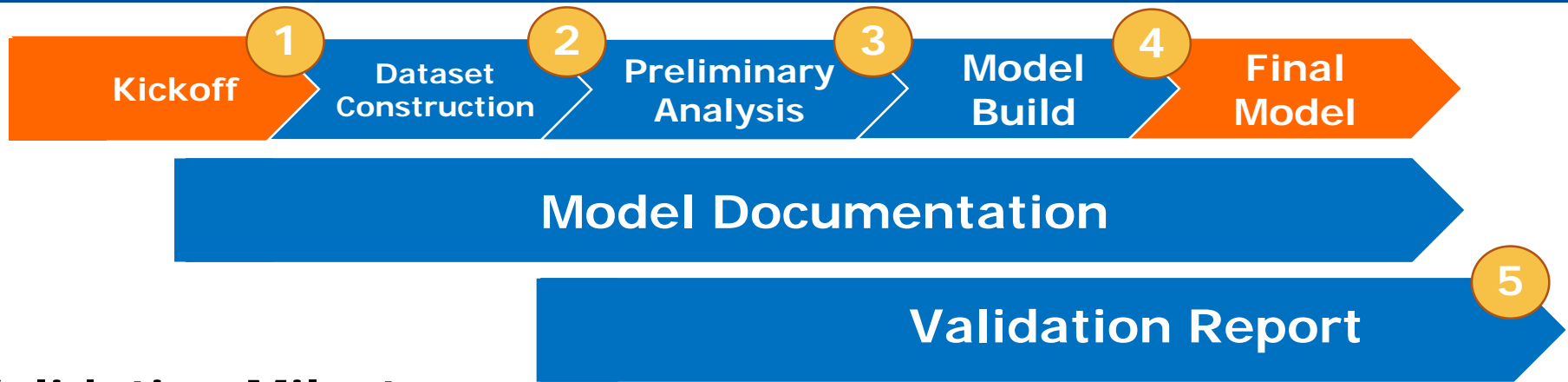
Constraints

Finite number of validation resources

Models to be redeveloped not completely clear until late summer when regulatory feedback is received



Parallel Review Process Allows Validation to be Completed Shortly After Development Work



Validation Milestones



Ongoing feedback from validators to developers, while maintaining independence



“Observation and Request Log” documents interactions



“Any Showstopper” Issues Identified early



Validation finished shortly after development

How to Improve the Process and Lower Risk of Not Completing Validations

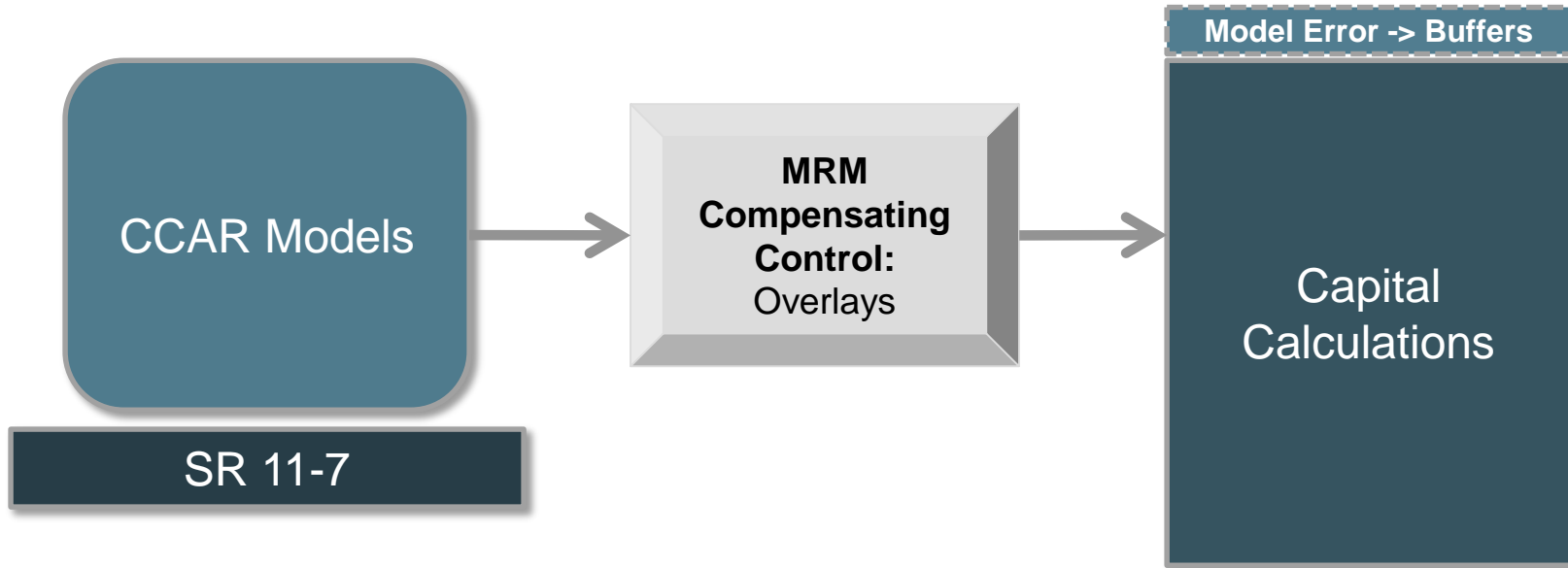
- **Immediately after one submission, start a work plan for the next year**
 - **Plan should lay out:**
 - Which models will be re-built or changed,
 - Any brand-new models that will be built,
 - Agreed-upon dates when developer will put “pencils down” and stop iterating on the model build so validation can be finalized.
 - **“Pull Forward” to earlier in the year the validations for any models not being changed, even if it is before their annual review is due.**
 - **Frequent updates to stress-testing governance committee on status of model builds and validation. If pencils are not put down (or developers desire to pick them up again) committee can determine priorities based on materiality of the model or other factors.**
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Implications of SR 15-19 on SR 11-7

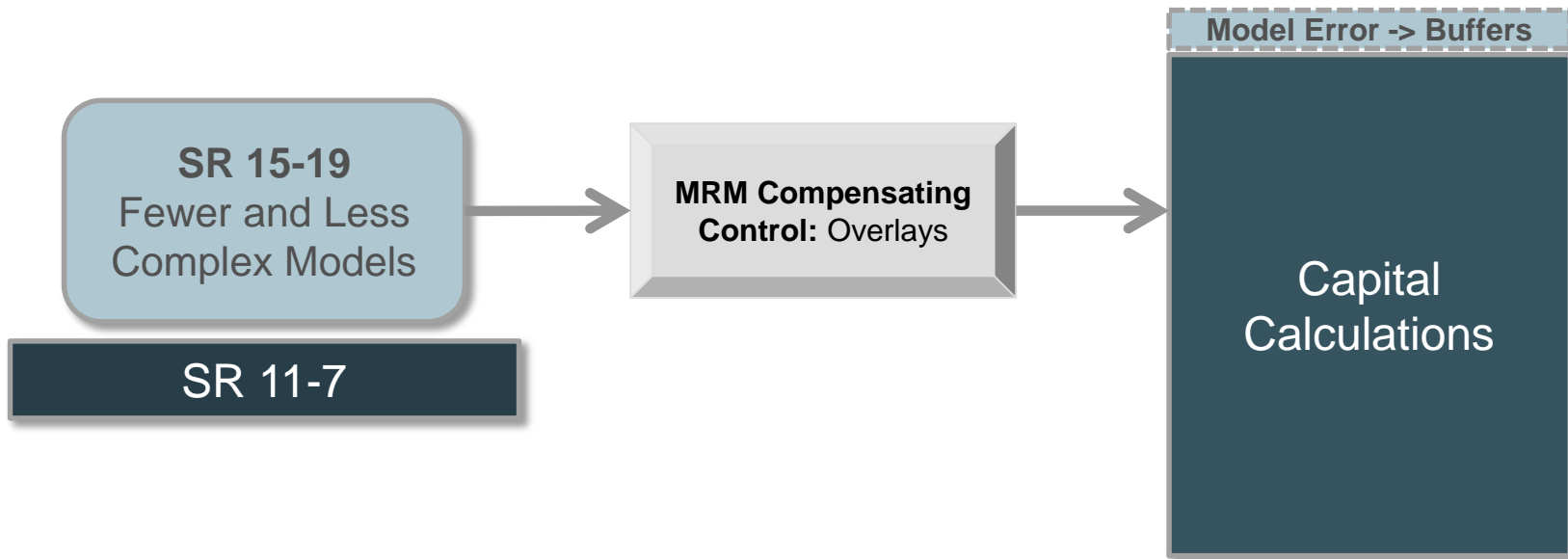
Angela Reindollar, Comerica

SR 11-7 and Capital Planning



- SR 11-7 is the foundation of the safety and soundness of the models used in CCAR calculations
- Model Overlays are used as a Model Risk Management compensating control to address weaknesses in models that are not addressed through standard modeling practices
- A firm may choose to further address residual model risk (after the use of overlays) by applying capital buffers

SR 15-19 and SR 11-7



- SR 15-19 does not change the burden or restrictions associated with SR 11-7 governance or validation standards
- SR 15-19 allows for:
 - Greater reliance on business judgement where adequate models cannot be built (PPNR)
 - Simpler modeling methodologies where appropriate (Ops)
- The lighter burden for Development in turn lightens the burden for Validation
- Possibly lower the Bank's overall model risk profile and the need for the use of compensating controls like overlays and the size of buffers



MRM in CCAR Panel Discussion

**Moderator: Vishant Sharma
Federal Reserve Bank Of Atlanta
September, 2016**



Model Risk Management Forum: Establishing a Strong Firm-wide MRM Culture

**Moderator: Kathy Laidig
Federal Reserve Bank of Richmond
September 12, 2016**

Establishing a Strong Firm-wide MRM Culture: Panelists

- ❑ *Ajai Bambawale, Executive Vice President and Chief Risk Officer, TD Bank and TD Group US Holding, LLC*
- ❑ *Paul Fabara, President, Global Risk & Compliance and AXP Chief Risk Officer, American Express*
- ❑ *Clarke Starnes, Senior Executive Vice President and Chief Risk Officer, BB&T Corporation*



Strong Model Risk Management Culture as Part of a Strong Overall Risk Management Culture

Clarke R. Starnes, III
Chief Risk Officer
BB&T

A Strong Model Risk Management Culture



1. Alignment With Corporate Vision/Mission/Values Is Essential



2. It Is A Subset Of An Overall Risk Management Culture Requiring A Strong Tone From The Top

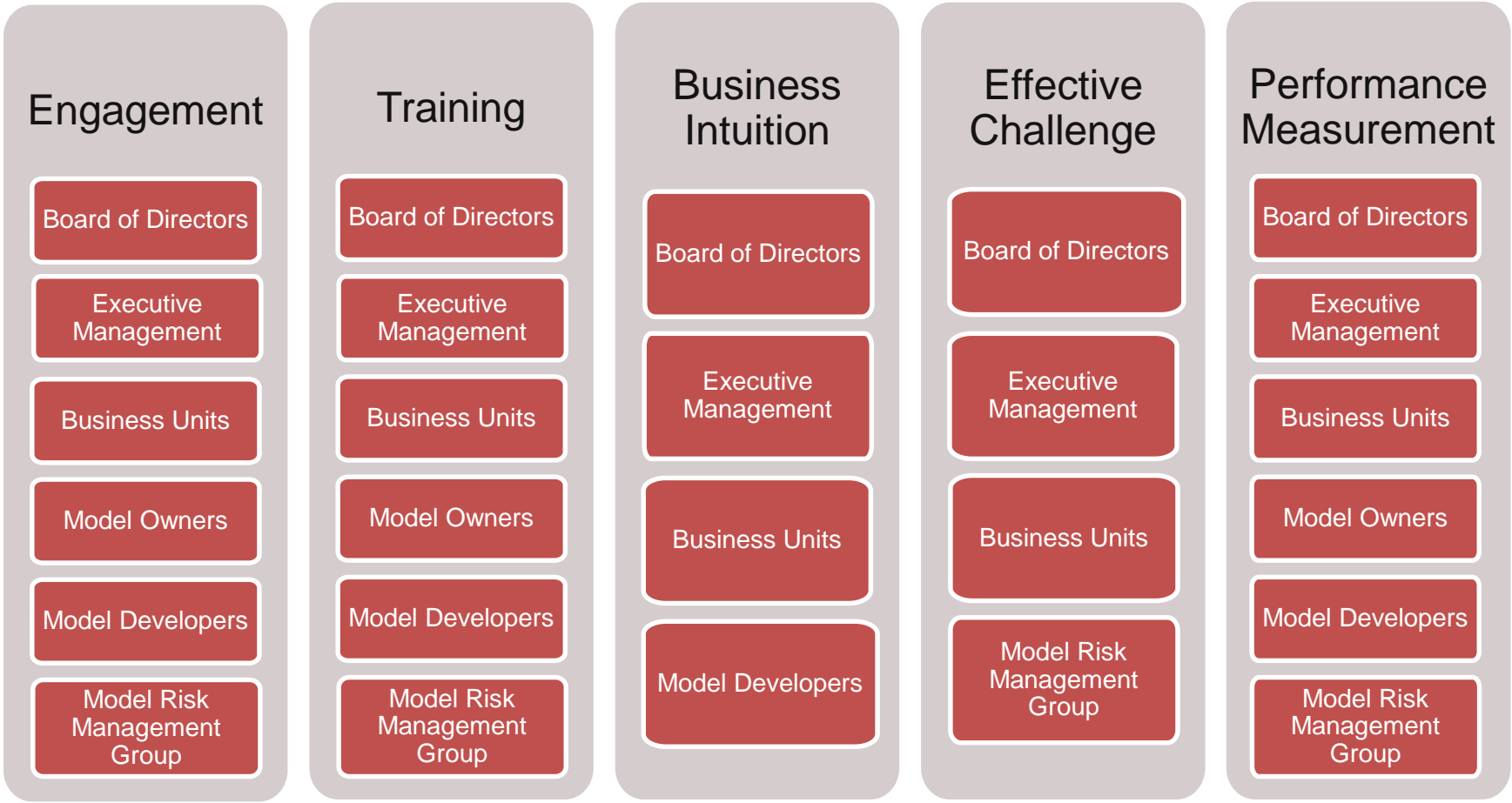


Model Risk Governance provides a strategic benefit; it's not just a compliance exercise

3. Integrated Engagement Of All Stakeholders Is Crucial



Model Risk Governance Framework



Audit Services

4. High Performance & Accountability Standards Support Execution



Overall Rank

Executive Scorecard – Exemplars of Reports

Business Unit
Data as of: End of Q1 2016

Q1 2016: **8.6**
Q4 2015: **8.3**

Report Responsiveness
- This Business Unit's average response time to draft Validation/Review reports was 12 day(s). For at least one model, the Business Unit took more than 14 days to provide a management response. MRMD recommends model owners submit management responses in no more than 14 days.

Vendor Model Governance
+ The Business Unit had 5 vendor model(s), out of 15 total model(s) in the MRMD inventory. Vendor model governance was evaluated based on the presence of change logs, governing bodies and validation exceptions.

SR 11-7 & FR Y-14A Required Inventory Field Completeness
+ The Business Unit had 100% of its SR 11-7 & FR Y-14A required inventory fields complete in the MRMD inventory.

Model Validation Exceptions
- The Business Unit had 2 model(s) under MRMD Policy Exception and 0 model(s) pending MRMD Policy Exception. MRMD policy requires that all models are validated prior to implementation.

Ongoing Monitoring Survey Responsiveness
+ The Business Unit did not have any past due Ongoing Monitoring surveys. MRMD recommends that model owners complete Ongoing Monitoring surveys in no more than 45 days.

Change Log
+ All of the Business Unit's models had a change log registered in the MRMD inventory.

Governing Body
+ All of the Business Unit's models had a governing body registered in the MRMD inventory.

Classification & Validation Rating
+ The Business Unit had 10 model(s) with an Acceptable validation rating, 3 model(s) with an Acceptable - Higher Risk validation rating, 0 model(s) with a Restricted Use/Rejected for Use validation rating, 2 model(s) Pending Validation, and 0 model(s) with a Legacy validation rating.

Issues
+ The Business Unit had 0 open Condition(s), 14 open High priority issue(s), 15 open Moderate priority issue(s), 8 open Low priority issue(s).

Model Distribution		
High Risk Model 5	Moderate Risk Model 5	Low Risk Model 5

Score
Business Unit 8.00
Average 8.54
Desired Goal 9.00

Score
Business Unit 9.00
Average 7.55
Desired Goal 7.50

Score
Business Unit 9.00
Average 8.68
Desired Goal 9.00

Score
Business Unit 7.93
Average 7.92
Desired Goal 9.00

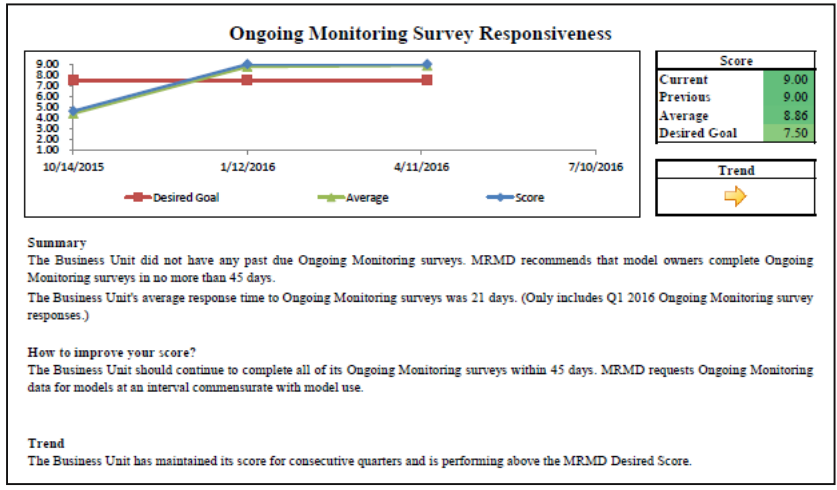
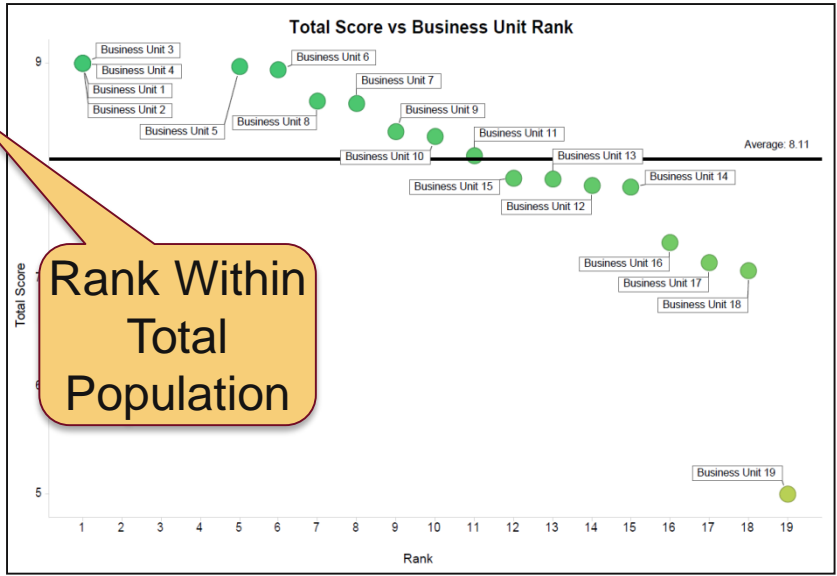
Score
Business Unit 9.00
Average 8.86
Desired Goal 7.50

Score
Business Unit 9.00
Average 8.88
Desired Goal 9.00

Score
Business Unit 9.00
Average 8.50
Desired Goal 9.00

Score
Business Unit 8.08
Average 8.31
Desired Goal 7.50

Score
Business Unit 8.08
Average 8.22
Desired Goal 7.50





Model Risk Management Culture Panel

Paul Fabara

President, Global Risk & Compliance and
AXP Chief Risk Officer

**AMERICAN
EXPRESS**

Model Risk Management Forum

September 12, 2016

AMERICAN EXPRESS

WHO WE ARE



Our History

Fun Facts



- Our Brand is 166 years old - Est. 1850
- Who We Serve
 - Consumers
 - Merchants
 - Businesses
 - Partners
- Our Core Businesses
 - Global Consumer Services Group
 - Global Commercial Services
 - Global Merchant Services and Loyalty
- We operate in more than 130 countries
- We have over 117.8 million cards-in-force



The Money Order was Amex's first payment product



First international expansion was to Mexico in 1852



Our famous green charge card was introduced in 1958

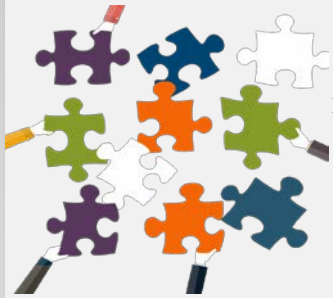


Launched Shop Small in 2010



Passed 1T dollars in annual charge volume in 2014

TRANSFORMATION



Point Of Departure (Fragmented Control Points)

Functions were spread across a number of different places in the organization, which at times led to duplicate work and overlapping roles and accountabilities.



Point Of Arrival (Fully Calibrated across the Business)

Centralized organization structure where our risk management functions and compliance group operates.

STRONG RISK CULTURE

STRONG 2ND LINE = EFFECTIVE CHALLENGE

By creating a solid 2nd line we are able to achieve best-in-class industry standards and good practices, focus on leadership and development, and create state-of-the-art programs, all of which are enabled by a strong risk management culture.

CAPABILITIES



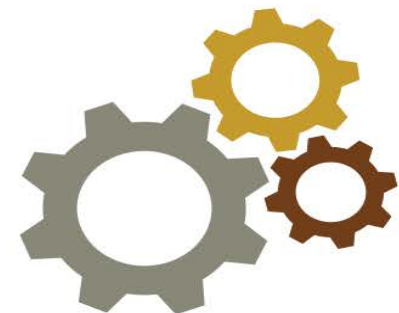
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EMPOWERMENT



=

EFFICIENCY & QUALITY



STRONG RISK MANAGEMENT CULTURE

Good Communication Matters

- ▶ Key Model users must understand the models objectives (can/ cannot do)
- ▶ Modelers must understand implications/ impacts across the company
- ▶ Willingness to work together

Be An Expert

- ▶ Know your data
- ▶ Documentation must be clear and concise
- ▶ Pro-active automated performance monitoring

Credible Challenge

- ▶ Assumptions must be well vetted
- ▶ Understand Macro and business environment
- ▶ Consider that all models become obsolete at one point– have a Plan B



A growth mindset is required to learn and continuously challenge...

Accelerating Change in Model Risk Culture

Model Risk Management Forum

FRB, Charlotte NC



Ajai Bambawale, EVP & CRO
TD Bank | September 2016

Accelerating Model Risk Culture Change

A risk culture where we follow a prudent and disciplined approach to managing Model Risk to enable good decision making based on model outputs



Right Leadership

Tone From the Top

Clear Accountabilities

Model Risk Appetite & Goals



Model Risk Management Forum: Establishing a Strong Firm-wide MRM Culture

**Moderator: Kathy Laidig
Federal Reserve Bank of Richmond
September 12, 2016**



Lunch 12:30 – 1:45



Model Risk Management Forum: MRM Resource Challenges across the Three Lines of Defense

**Moderator: Mark Pocock
Comptroller of the Currency
September, 2016**

MRM Resource Challenges : Panelists

- ❑ *Griselda Rondon, EVP-Chief Model Risk Officer, KeyBank*
- ❑ *Sanjay Mithal, Managing Director, Citigroup*
- ❑ *Harish Sharma, EVP, Independent Model Review, HSBC*

Some Excerpts from MRM Supervisory Guidance

- ❑ Staff doing validation should have the requisite knowledge, skills, and expertise.
- ❑ As with other aspects of effective challenge, model validation should be performed by staff with appropriate incentives, competence, and influence.
- ❑ As a practical matter, some validation work may be most effectively done by model developers and users; it is essential, however, that such validation work be subject to critical review by an independent party, who should conduct additional activities to ensure proper validation.
- ❑ Policies should identify the roles and assign responsibilities within the model risk management framework with clear detail on staff expertise, authority, reporting lines, and continuity.

MODEL RISK MANAGEMENT FORUM

MRM RESOURCE CHALLENGES

Griselda Rondon
Chief Model Risk Officer

KeyBank

Attracting and Retaining Staff

Clear Path to Success: Goals, Roles and Responsibilities Facilitate Movement Among Teams

- Efforts for filling open positions are targeted to internal and external hires:
 - Grow qualified candidates from our Quant Rotational Program
 - Strategic hiring by considering current employees for promotion and hire at entry levels
 - Partner with colleges, universities and referral programs
 - Post job openings with specialized groups and organizations
 - Proactively source external candidates using LinkedIn
- Use targeted interview days with offers made the next day. This is proving to be highly effective!
- We are competing with cities with more diverse opportunities and better weather!
 - Enhance technology to offer flexibility in location, fully or partially mobile status
 - Grow quantitative teams in other locations where Key has a presence
 - Highlighting Cleveland's benefits as low cost of living, quality of life, breezy commute and diverse population.
 - Ticket to see the CAVS!!
- To retain our staff we:
 - Allow for talent movement among teams for employees looking for a change
 - Clearly define career paths that allow for vertical and horizontal growth
 - Establish clear performance goals
 - Find opportunities for special trainings, participation in important projects, etc.
 - Understand each individual career aspiration

Training

Become a Risk Manager for Model Risk

- Mentoring by a senior member of the team:
 - How to produce challenge
 - What it means to be in a control area
- Biweekly Validation Seminar
 - Aim to reinforce standards and best practices
 - Serve as quantitative forum for validation techniques
 - Other topics include: effective communication skills and how to be influential, effective documentation
- Corporate wide Model Symposium aims to share best practices. All three lines of defense participate
 - Modelers present details on building specific models and how to meet standards
 - Validators present how to challenge specific models. For example, use of ARIMA for CCAR
 - Current stage of the Bank's Model Risk Management and best practices
- Annual mandatory training:
 - Development and Independent Validation Standards
 - Model Risk Management – Policy and how to manage Model Risk within Appetite
- Encourage participation in Industry forums and industry working groups

Use of Consultants

Ad Hoc Use to Meet Demand Opportunity to Benchmark to Industry

- The three lines of defense use consultants in their functions
- The 1st and 2nd Lines of Defense use consultants on an ad hoc basis for:
 - Meeting demands for development or independent validation
 - Benchmarking to industry. For example, compliance models
- The 3rd Line of Defense uses consultants for:
 - Supplementing their knowledge of a particular modeling concept when they may not possess sufficient expertise
 - For example, to review the effectiveness of a 2nd Line of Defense independent validation
- In every case the engagement is managed by senior members of the team who also set the scope of the engagement
- In every case the activities are carried out meeting internal standards, policy and procedures
- Regular meetings are held to evaluate the adequacy, quality and completeness of the tests performed
- Plans are established for transferring knowledge

2016 MRM Forum

MRM Resource Challenges Across the Three Lines of Defense

Sanjay Mithal - Product CRO Citigroup

Evolution of Model Risk Management: From Validation to a Risk Stripe

Stage	Characteristics	Resource Drivers	Key Resource Attributes
<p>Validation</p>	<ul style="list-style-type: none"> • Specification of a Models' lifecycle and associated governance emphasizing <ul style="list-style-type: none"> • Effective challenge • Independence • Accountability across the 3 lines of defense • Technical and Functional Validation as a means to explicitly address whether a model is fit for use and fit for purpose • Modularization and streamlining of the "Model Validation", "Model Administration" processes 	<ul style="list-style-type: none"> • Model Governance as an emerging function within MRM • Expanding model inventory across all lines of business • Validation process refinements amplify the need for variety of non-traditional skills/training • Implementing enterprise-wide Model Governance across the 1st and 2nd line firmly establishes Model Governance as a separate function within MRM 	<ul style="list-style-type: none"> • Combination of analytical skills and business intuition, especially to evaluate a models' "fit for purpose"
<p>Enterprise-wide Model Risk Management</p>	<p>Organizing to manage all Model Related Risks and creating the appropriate organizational structure to manage:</p> <ul style="list-style-type: none"> • Operational • Functional • Performance 	<ul style="list-style-type: none"> • Increased senior management and Board oversight highlights need for comprehensive measuring, monitoring, and reporting of model related risks 	<ul style="list-style-type: none"> • Comfortable with uncertainty, rather than precision
<p>Sustainability</p>	<ul style="list-style-type: none"> • Automation (i.e., Testing, Workflow, Reporting, Monitoring) • Location strategy • Process optimization • Career progression and mobility • Training • Optimized organizational structure 	<ul style="list-style-type: none"> • Industrializing MRM practices and processes underscores the role of product management, quality assurance, and project management, in addition to software development, automated testing, etc. • Capacity planning becomes an important strategic advantage to build scale, best practices, reliability • Focus on training, standardization, quality control, career management, 	<ul style="list-style-type: none"> • Process oriented with lens towards standardization, modularization, and optimization (i.e., not bespoke)

Food for Thought

- Should Model Validation really be Model Quality Assurance?
- Should the effective management of model risk result in a lower capital charge (e.g., CCAR)?
- What should the scope be of the 3rd line oversight over the 2nd line function?



Harish Sharma
EVP, Independent Model Review
HSBC

The three lines of defense

A strong and competent 1st LOD results in an efficient 2nd and 3rd LOD

Ideal state: Appropriate oversight on 1st LOD
Current state: Significant oversight on 1st LOD

Amount of
resources
dedicated

Third line of defense:

- Internal audit

Second line of defense:

- Independent model review
- Model oversight committee

First line of defense:

Model owners, Model developers, Model sponsors, Model users

❑ Quality of execution by 1st LOD:

- Understanding and adhering to regulatory expectation and industry best practices

❑ Stature/Influence of 2nd and 3rd LOD:

- Ability to influence the culture of the organization
- Ability to influence senior management and board of directors

❑ Qualification and incentives provided to 2nd and 3rd LOD:

- Familiarity across a broad spectrum of technical and business expertise.
- Up to date knowledge of evolving regulatory landscape.
- Ability to communicate and influence all stakeholders.
- Organization's focus to provide appropriate incentive to hire right talent.

Model Risk Management in a Global organization

❑ Challenges:

- Models developed centrally and often implemented under different regulatory jurisdictions.
- Review of global models for local use might depend on review performed by Global team
- Interpretation of standards within parent organization might be different from local organization.
- Work within complexities of a matrix organization with varied stakeholders
- Co-ordination across different time zones can be challenging

❑ Advantages:

- Access to a global workforce
 - Provides round the clock resource access to perform time sensitive reviews.
 - Handle seasonality in model review process.
- Ability to source staff around the world
 - Circumvents any skillset limitation of local market.
 - Better manage attrition risk
- Sharing best model risk management practices across the regions.



Break 3:00 – 3:15



Model Risk Management Forum: Assessing Model Risk in the Aggregate Panel Discussion

**Moderator: David Palmer
Federal Reserve Bank Of Governors
September, 2016**

Assessing Model Risk in the Aggregate: Panelists

- ❑ *Agus Sudjianto, Head of Corporate Model Risk, Wells Fargo*
- ❑ *Boris Deychman, Head of Model Risk Management & Validation, Citizens Financial Group*

A Few Opening Thoughts...

- ❑ Assessing model risk in the aggregate is an explicit expectation in the MRM guidance – several references in the document
- ❑ It is one of the more challenging aspects of MRM
 - Includes gathering information from across the entire organization
 - Involves incorporating information from different types of models
 - Requires consideration of model dependencies and interactions
- ❑ There are different ways to do this – no set expectations
 - A firm should use the approach that best fits its model use and MRM framework
 - Simplicity has certain advantages
- ❑ An assessment of aggregate model risk is important information to share with senior management and the board
 - Helps them make decisions about MRM, but also the extent to which they can rely on model output for other key decisions

A Few Opening Thoughts (cont)

- ❑ Supervisory guidance does NOT contain the expectation that firms should develop a single measure of model risk
 - Distilling down all aspects of model risk into a single number presents lots of challenges
 - Also, for other risk types (credit, market, IRR, etc), firms usually do not make assessments of aggregate risk using a single measure
 - Even for individual models, supervisors expect there to be several measures employed (e.g., performance, robustness, stability)
- ❑ A firm should not try to address all aspects of model risk simply by allocating a reserve or buffer
 - Sound MRM involves having strong practices at various levels of the organization
 - Truly managing model risk relies on applying proper judgment and appropriately evaluating qualitative information, in addition to employing proper quantitative expertise

A Few Opening Thoughts (cont)

- ❑ Assessing model risk in the aggregate is best done by looking across a variety of measures, factors, and other information
 - Such as a range of quantitative measures, but also qualitative info
 - Up to firms which information is best to include
- ❑ As part of assessing model risk in the aggregate, firms should evaluate dependencies among their models
 - Including any common assumptions, data, or methodologies
 - Or other factors that could adversely affect several models and their outputs at the same time
- ❑ Firms should be acutely aware of computational challenges, over- engineering, and oversimplification
 - Transparency is vital, including to those consuming the information
 - Model heterogeneity is a key complicating factor
 - Be sure to highlight key assumptions, limitations, and uncertainties

Assessing Aggregate Model Risk

Agus Sudjianto

Head of Corporate Model Risk

September 12, 2016

Together we'll go far



Model risk aggregate

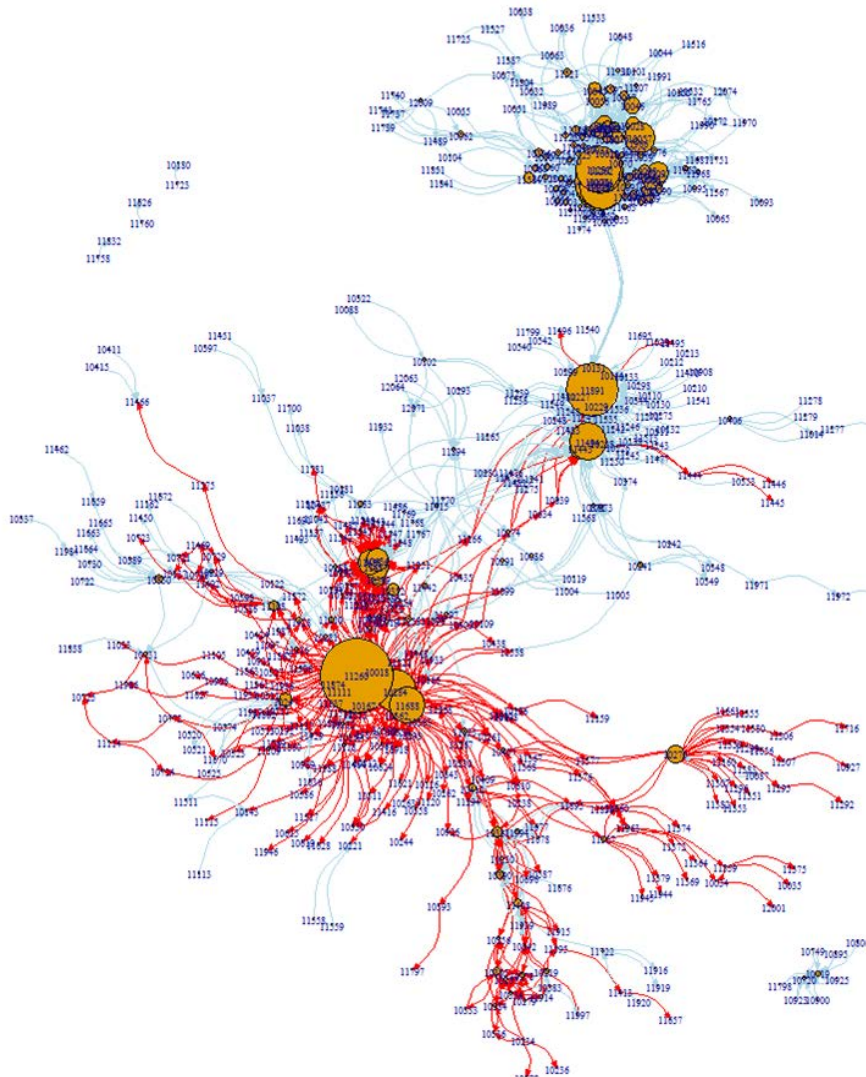
- A combination of quantitative and qualitative assessments
- Quantitative metrics measure levels of model risk
 - Metrics cover the lifecycle of the model and associated risks
 - Tie thresholds to risk appetite tolerance where applicable
 - Individual metric ratings roll up to an aggregate model risk rating
- Qualitative assessment considers risk factors not in quantitative metrics
 - Structured as an overlay to the quantitative assessment
 - Risks not capture in metrics (don't have a quantitative measure)
 - Emerging risks and risks that have occurred but are not yet reflected in metrics
 - Can be reductions in risk – where metrics may not adequately reflect the level of risk
- Quarterly reported to the Board

Quantitative assessment of model risk



- Statistics that measure management of model risk
- Examples of operational statistics that are being used
 - Stability of the model inventory
 - Unvalidated models
 - High risk model issues
 - Timely resolution of model issues
 - Model performance
 - Policy exceptions
 - Formal process ratings (effectiveness of existing LOB governance)
 - Resource adequacy
- Analysis is performed to establish/justify thresholds for metrics
- Methodology is established to aggregate risk into a single risk rating
- Metrics and thresholds are re-examined periodically for appropriateness

Aggregating risk for interconnected models



- Model risk needs to capture not only individual models but also stream of interconnected models.
 - Dependency risk (downstream models)
 - Contagion risk (upstream models)
 - Measure such as model ‘centrality’ can be employed
- Critical to manage the risk of interconnected models in its lifecycle:
 - Model identification and tiering
 - Model development and validation: understanding upstream and downstream risk
 - Risk mitigation during model usage
 - Monitoring and change control



Assessing Model Risk in the Aggregate

**Boris Deychman,
Head of Model Risk Management & Validation,
Citizens Financial Group**

Model Risk – its language and philosophy

- Before anything could be measured, clarity must be established on its nature
- As a risk discipline, model risk is a very young field and is still in search of its commonly accepted definitions and well established standards and practices:
 - Very far from the relatively descriptive certainties and well defined metrics of Credit and Market risks. The latter two risks pertain to a clear business/market activity, while model risk is related to an infrastructure/service and hence is harder to “point to”
- We are still creating the language in which to talk about model risk:
 - Often we are not sure how to start responding to a seemingly simple query of “Describe what your model risk is...”
 - Unlike credit and market risks that start with a basic business activity then converted into technical terms, model risk starts in the technical realm and must be translated into basic business terms. This presents a more difficult communication challenge
- What does all this have to do with Model Risk measurement practices?
 - Hard to rate something that is not defined but rather conceptualized
 - To succeed, ordinary most often used technique of brainstorming may not be enough. We have to establish the basic principles of measurement/judgment/aggregation for the sought after rating

Rating Model Risk

- The first instinct is to attempt to capture an average of the model errors or statistical uncertainties. Mathematical elegance breaks down quickly, especially across a large variety of model types.
- Must consider how the receiving audience processes the message. Most people tend to understand risk in High, Medium, Low terms.
- Balance must be struck to avoid folly of false precision, while providing clear and actionable information.
- Simple but reasonable always works best – consistent and long-term. With scaling and aggregation in mind, look at an individual model and define the reasonably orthogonal, additive measures that are the common characteristics of any model.
 - These simpler approaches usually rely on the build (such as complexity and operational controls) and use (including type of use and materiality) of the models
 - Recurring themes that show how model risk community, regulators and management (SR 11-7, SR 15-18 highlight some of them in reference to model risk) communicate
 - However detailed the derivation/waterfalls determining risk ratings are, it's helpful to enable non-technical audiences to relate those ratings to their customary h/m/l scale
- An indication that risk rating is reasonable would be seen in its alignment with the model tiering.
- As a tool, model risk rating should be:
 - Adequate to report on to a non-technical audience; useful as a trigger/risk appetite limit; a guide for the frequency and depth of model reviews; easily updated during scheduled model reviews or more often if needed; consistent in application across models (with some form of QC)


Model Risk Rating – is one measure enough?

- While a well-defined, theme/component-based rating is excellent as a relative and coherent measure of risk of models against each other, it usually shows stability over time as a function of the company's model inventory
- That stability limits usefulness of the measure as a detective and/or preventive control to alert on deterioration between the reviews. Clearly, more than one tool is needed.
- To supplement the strengths of the overall model risk rating (applicability across models of different types, aggregation, and yes, stability) the company may design another, more dynamic measure to assess model health.
- Unlike the original model risk rating, a “model health index” would incorporate non-thematic, derivative aspects of model reviews (for example, aspects that can and do change between scheduled reviews, such as intermediate performance monitoring results, governance considerations, etc., reflecting an immediate change in the view of the risk a particular model presents)



Model Risk Management Forum: Assessing Model Risk in the Aggregate Panel Discussion

**Moderator: David Palmer
Federal Reserve Bank Of Governors
September, 2016**



Model Risk Management Forum: Model Performance Monitoring by Developers and Validators

**Moderator: Martha Berube
Federal Reserve Bank of Chicago
September 12, 2016**

Model Performance Monitoring: Panelists

- ❑ *Marlene Lenarduzzi, Vice President and Head, BMO Model Validation, BMO Financial Group*
- ❑ *Evan Smith, Auto Finance Divisional Credit Officer, Capital One Financial*
- ❑ *Davide Meneguzzo, Managing Director, Bank of America*

Agenda

- ❑ Opening remarks by panelists on model performance monitoring at their firm
 - Marlene Lenarduzzo
 - Evan Smith
 - Davide Meneguzzo

- ❑ Kick-off question from moderator on assessing models whose performance is hard to measure

- ❑ Questions from audience for the panelists

Model Monitoring

Approaches and Challenges

September 12, 2016

A comprehensive approach to model monitoring helps ensure models are performing as expected at the onset and throughout the model life cycle.

- **Initial Validation** – First time validation or model change
- **Ongoing Validation:** Models are reviewed after initial approval to ensure they continue to perform as intended
 - ✓ **Scheduled Review** – Validated and approved models are reviewed periodically according to their Model Risk Rating;
 - ✓ **Annual Validation** – High risk models are subject to annual validation consisting of both quantitative and a qualitative components;
 - ✓ **On-going Monitoring** - Models are subject to on-going monitoring. On-going monitoring includes periodic monitoring review and annual attestation;
 - ✓ **Trigger Review** – specific triggers are identified to determine whether an out-of-cycle review is required.

- Triggers are formal monitoring rules designed to identify when a deeper review of a model should be undertaken outside of the usual model review cycle
- Triggers are set at the point of initial model validation and can be revised over time as the model changes
- Triggers can be linked to model monitoring – e.g., three consecutive “yellow metrics” triggers a model review, or “red” metrics require formal review.
- Triggers should be:
 - Meaningful
 - Measurable
 - Actionable
 - Specific

Formalized roles and responsibilities result in:

- Better coverage of issues as monitoring is reviewed by stakeholders with different perspectives
- Increased awareness of issues
- Increased stakeholder engagement

Model Owners	Model Developers	Model Validation	Model Governance	Corporate Audit
<ul style="list-style-type: none">• Focus on how performance changes may impact their business and usability of the model	<ul style="list-style-type: none">• Design the performance monitoring framework and metrics to be measured• Run the monitoring reports• Understand drivers of change in model performance	<ul style="list-style-type: none">• Approves the metrics and thresholds• Approves the implementation of the monitoring• Approves remediation plans as a result of monitoring	<ul style="list-style-type: none">• Ensures monitoring is in place and that stakeholders are engaged in reviewing it	<ul style="list-style-type: none">• Tests the adequacy of the controls• Looks for evidence of use of monitoring to manage model risk

- Frequency and extent of monitoring may not fully take into account the materiality of the model
- Automation is key to ensure consistency and accuracy
- Threshold for monitoring are set at the conclusion of the model development process. It can be challenging - particularly for new models new metrics or new portfolios – without real experience.
- How do we ensure model monitoring gets the appropriate level of attention it needs?
 - How should the cost of monitoring be balanced against the model risk?
 - How do we ensure that the monitoring is effective?
 - Are scheduled touchpoints with all stakeholders needed to ensure monitoring is reviewed?
 - Should we require formal feedback or acknowledgement that it was reviewed?



Model Performance Monitoring by Developers and Validators

Evan Smith

Auto Finance Divisional Credit Officer

Capital One Financial

In order to manage a system of models there are two key questions to ask

What is the model used for?

- How am I going to measure if it is doing it correctly
- Can I quantify the true value of the model

How good does the model need to be?

- What are the cost of errors
- How much error can I tolerate

Monitoring processes should be developed with these questions in mind

Clear accountability is critical for the successful model management

Business Owners

- **Accountable for all risks and use of the model**
- **Accountable for model monitoring and establishing performance thresholds**

Development

- **Accountable for creating views for model monitoring and summarizing findings**

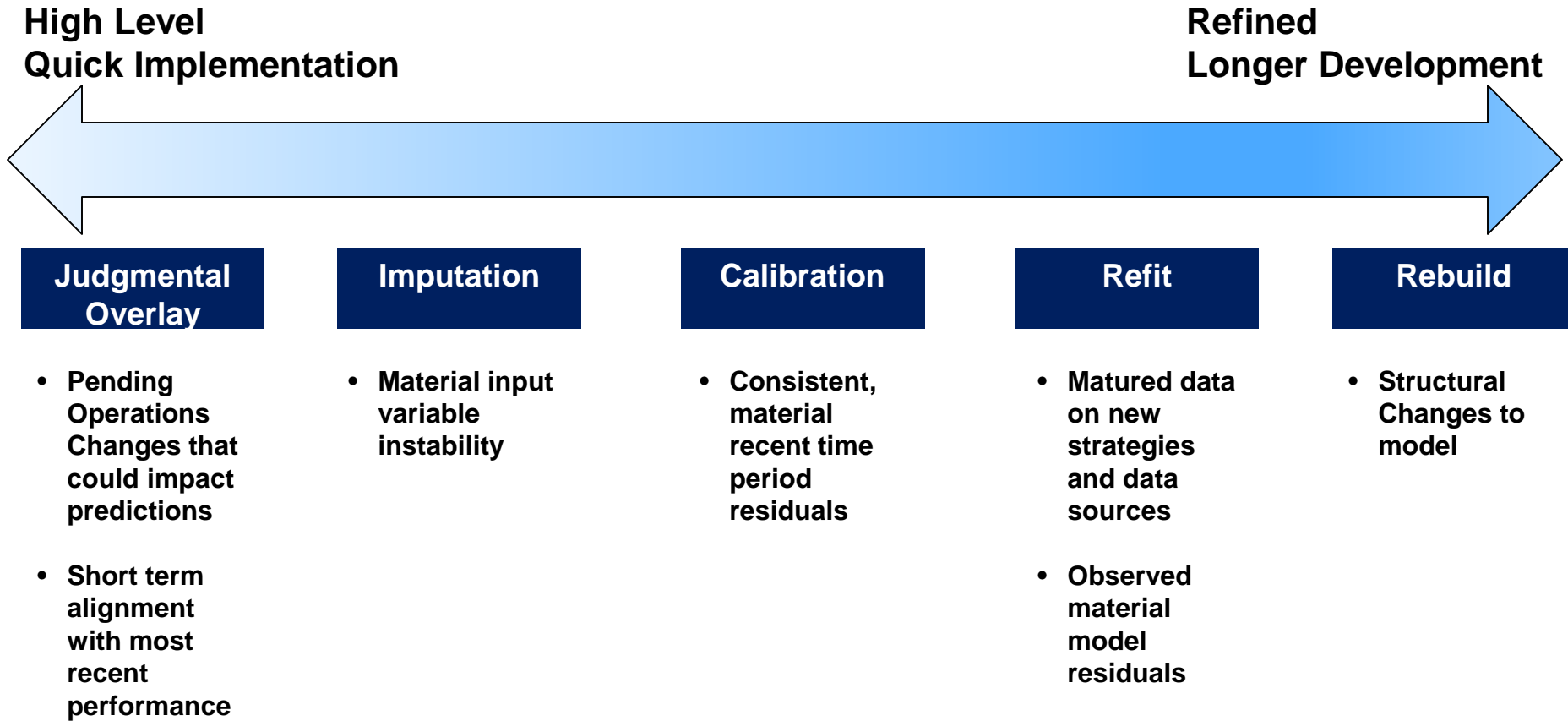
Model Risk

- **Accountable for challenging model performance and use**

End Users

- **Responsible for understanding limitations of approved uses of the model**

It is important to have long term and short term levers for adjusting model performance



2016 MRM Forum: Panel Discussion on Model Performance Monitoring

Comments for the Federal Reserve System's Model Risk Management Forum

September, 2016

Davide Meneguzzo, Model Risk Officer

Bank of America 

Bank of America Merrill Lynch U.S. Bank of America
America ynch Trust Merrill Lynch

Ongoing monitoring framework

- **Policy requirement that models have a plan for ongoing review after validation**
- **Clearly defined stakeholder roles/responsibilities**
- **Templates for standardized documentation of ongoing monitoring plans**
- **Ongoing monitoring guidelines for model owners, model developers and Model Risk Management (MRM)**
- **Common testing approaches, metrics and thresholds for models**
- **Flexibility to consider model specific idiosyncrasies (e.g. specific metrics and thresholds, extend of timing link to model risk classification)**
- **Required activities to be performed:**
 - Environmental changes
 - Process verification checks
 - Outcomes analysis/back-testing
 - Benchmarking
 - Periodic data/assumptions analysis
 - Sensitivity analysis

Enterprisewide accountability

Ongoing monitoring of model risk is integral to the risk culture, and is a shared responsibility of various stakeholders across the organization.

- **Developers/model owners (“*first line of defense*”) responsible for:**
 - Writing the monitoring plan as part of any request for model validation and approval
 - Performing the activities required by the model’s monitoring plan (with appropriate separation of duties)
 - Establishing metrics and thresholds to monitor model performance
 - Taking action to remediate issues and improve model performance
 - Businesses/model sponsors are responsible for providing the monitoring capabilities and reviewing results

- **Model validation (“*second line of defense*”) responsible for:**
 - Establishing ongoing monitoring requirements via the MRM Policy, standards and procedures
 - During validation, reviewing and approving ongoing monitoring plans
 - Reviewing results and reaffirming model approval, requiring appropriate action to improve model performance or revoke model approval
 - Re-performing monitoring tests to verify validity and reliability as appropriate

Thresholds/metrics definitions and communication of results

Governance requirements include not only policy and procedure but also guidelines and templates with guidance


directed towards model owners, model developers and MRM.

- **The ongoing monitoring guidelines define processes used to set thresholds or other metrics for acceptable model performance and analytical methods used to assess the performance.**

- Model developers write the monitoring plan that defines the initial set of monitoring metrics and thresholds.
- Model developers provide rationale for additional tests and metrics included in the the monitoring plan.
- Predefined threshold zones (red, yellow, green) are established, where applicable, with a description of required action steps in the event of a model performance breach.
- Model developers describe the rationale for the thresholds selection.
- MRM reviews, challenges and asks for additional metrics if needed.
- MRM ensures consistency of metrics with validation testing playbook.

- **The ongoing monitoring guidelines define processes for actions and escalation in case of threshold breaches.**

- Model developers investigate all threshold breaches and perform root cause analysis to assess if the model requires any compensating controls (e.g. overlays or overrides), redevelopment, or retirement.



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