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Actuarial Modeling Controls

A Survey of Actuarial Modeling Controls in the Context of a Model-Based Valuation Framework

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Executive Summary

As the life insurance and annuity industries move toward model-based approaches to reserve and capital valuation, actuarial models are increasing in complexity and sophistication while the imperative to avoid modeling errors also increases. These model-based approaches include U.S. statutory principle-based approaches, U.S. GAAP, Solvency II, market consistent embedded value, economic capital and proposed International Financial Reporting Standards (IFRS) approaches. In the new environment, the high reliance that companies and regulatory agencies will place on model results will require a well-developed, monitored and maintained control system to assure the quality of all models and supporting processes.

A team from Deloitte Consulting LLP, led by Jason Morton and Jeffrey Lortie, performed the research and analysis contained within this report. The team received administrative support from the Society of Actuaries (SOA) and direction from the Project Oversight Group. Through a combination of an online survey, follow-up discussions with survey respondents, and additional sources, the current state of actuarial modeling controls within U.S. and Canadian life insurance and annuity companies was established. After determining the current state of actuarial modeling controls, the research team then evaluated the current state against the controls expected to be in place upon adoption of model-based valuation (MBV) approaches and increased external scrutiny, and proposed considerations for enhancing the current state to get to the necessary controls within a more highly controlled model framework.

In conducting this research project we found that there is a wide variety of actuarial model governance and controls currently in place in the industry. We discovered that companies that had experienced an adverse event caused by actuarial modeling errors or companies that are subject to Canadian or European reporting requirements were generally further along in implementing leading practice actuarial model controls.

Our key findings include:

- The current robustness of controls over desktop applications and spreadsheet applications exhibited at companies will need to be significantly enhanced in order to meet the heightened levels of auditor scrutiny when reserves are reported under an MBV framework.

- The tools in place (typically spreadsheets) to migrate actuarial modeling software results to financial statement entries are generally well controlled. Other output management tools, such as those used for peer review and management analysis, tend to be less controlled. There exists the risk that information provided for decision-making purposes could be incorrectly constructed and lead to flawed decisions.

- Governance frameworks should be set forth in order to ensure the sustainability and repeatability of the modeling process by visibly demonstrating structure and oversight. Governance of the modeling process has taken on several forms, dependent upon the structure of the company, uniqueness of product design, and current accounting regimes under which a company falls.

- Companies that have established an independent, centralized model steward function, and appropriately empowered the steward, generally have more robust and effective controls in the current state, and as such have fewer areas to improve when moving toward controls under an MBV framework.

- Information technology (IT) involvement in the modeling process is currently minimal in the industry, but increased involvement could improve automation and controls. Processes should be enhanced to remove the manual aspect of creating data files and referencing data files in the model, where feasible.

Industry Readiness Assessment Scorecard

Below is a high-level evaluation of the current state of actuarial model governance and controls in the life insurance industry for each of the key areas addressed in this report. These results are based on our analysis of current industry practices compared with leading industry practices. Additional details can be found in the body of the report.

There is a range of practice, but the scale is meant to represent where the majority of companies seem to currently self-rate. The scale is from 1 to 5, where a 1 indicates that current industry practices are generally aligned with industry leading practices (highest rating), and a 5 indicates that current industry practices differ significantly from industry leading practices (lowest rating).

Modeling Governance Theme	Score	Current State Synopsis
Governance Standards	3	While many companies employ a variety of model governance policies, few companies have a holistic, formal and documented model governance structure.
General Modeling Process	3	Many companies have multiple models and modeling platforms and few companies incorporate a model steward role in the modeling processes.
System Access and Change Control	4	Model changes are not generally governed by a formal change process.
Model Assumption Management	3	Assumptions are regularly reviewed and updated, but with few controls in place to ensure assumptions are approved and input appropriately.
Model Input Management	2	Many companies use automated feeds from admin systems for model inputs of liabilities. Other model inputs are often less automated.
Model Output Management	2	Model output used for financial reporting purposes is generally well controlled, while model output for analysis and other purposes is generally less controlled.

Key Next Steps to Move Toward Leading Industry Practices

For each section of the report, we have identified key next steps to move from the current state to leading practices. The leading practices represent those practices recognized during the research team's analysis of survey results to be most consistent with the requirements of a model-based framework (though no single respondent currently performs them all). These steps are summarized here and elaborated on in more detail throughout the report.

1. Establish a formal and documented governance policy for actuarial modeling processes.
2. Regularly review models and the modeling process against the governance policy.
3. Develop a corporate culture that values and aligns with the governance policy.
4. Consolidate models to a single platform or a single modeling system where feasible. Where this is not feasible, implement additional controls to ensure model integrity across all modeling platforms.
5. Establish a model steward with clearly defined responsibilities for ensuring adherence to the model governance standards.
6. Implement a formal change management process for governing model code changes and model updates.

7. Determine the calendar for internal model releases to ensure consistency of the model of record across the organization.
8. Automate the input of assumptions into the models.
9. Implement a formal sign-off process for the setting of model assumptions.
10. Analyze and document the impact of each significant assumption change.
11. Obtain model input data feeds automatically from a centralized data warehouse.
12. Automate and standardize a set of test analytics performed to test model input.
13. Automate and standardize model output used for reporting and analysis.
14. Store model output in a data warehouse that can be queried to allow for additional analysis and evaluation of model results.

We have provided a scorecard in Appendix D in order to provide companies an opportunity to self-rate against these leading practices and to facilitate discussion and planning for model control updates.

Contents

Disclaimer of Liability 2
Executive Summary 3
Industry Readiness Assessment Scorecard 4
Key Next Steps to Move Toward Leading Industry Practices 5
Project Overview 9
Survey Method 11
Online Survey 11
Follow-Up Discussions 11
Demographic Information of Respondents 12
Data 12
Survey Results and Analysis 15
Governance Standards 16
Current State Assessment 16
Leading Practices—Governance Standards 18
Industry Readiness Assessment 20
General Modeling Process 21
Current State Assessment 21
Leading Practices: One Platform, One Model 25
Leading Practices: Establishment of a Model Steward 27
Industry Readiness Assessment 28
System Access and Change Control 29
Current State Assessment 29
Leading Practices—System Access and Change Control 32
Industry Readiness Assessment 33

Model Assumption Management 34
Current State Assessment 34
Leading Practices—Model Assumption Management 36
Industry Readiness Assessment 37
Model Input Management 38
Current State Assessment 38
Leading Practices—Model Input Management 40
Industry Readiness Assessment 41
Model Output Management 42
Current State Assessment 42
Leading Practices—Model Output Management 43
Industry Readiness Assessment 45
Appendix A: Acknowledgments 46
Appendix B: Actuarial Modeling Controls Survey 47
Appendix C: Survey Participants 48
Appendix D: Model Readiness Scorecard ..... **Error! Bookmark not defined.**

Project Overview

As model-based valuation (MBV) progresses toward becoming a reality in the United States through U.S. statutory principle-based approaches, U.S. GAAP approaches and other methods, the reliance upon models throughout organizations, and the direct linkage model results will have to financial statements, becomes more critical. In order to establish sustainable, repeatable, well-documented processes around models, extensive controls are required.

Even without the adoption of such approaches, actuarial models are undergoing increased scrutiny from external reviewers such as regulators, auditors and rating agencies, and from internal reviewers such as boards of directors, internal audit departments, or management functions within companies. One of the results of the increased examination of actuarial models by parties outside of a company's actuarial area is the realization that the governance and controls of actuarial models need to be robust and effective in order to instill confidence in the integrity of the results produced. Actuaries need to be able to communicate the effectiveness of actuarial model controls and governance to non-actuaries.

Many of the controls that are prevalent today for formulaic reserve determination should be brought over to the MBV framework, but will not comprise a complete set of controls as the models to be used in MBV will be more complex and customized than current formulaic actuarial models. Our project, at its core, is a readiness assessment of the current state of actuarial modeling controls in light of the more stringent control environment that will be required in an MBV framework.

This research project was performed via the usage of a survey, carried out by Jason Morton, Jeffrey Lortie and Sara Veit Kaufman of Deloitte Consulting LLP (the research team) in conjunction with Ronora Stryker and Jan Schuh of the Society of Actuaries (SOA) and members of a Project Oversight Group (POG). Through administration of an online survey and follow-up live discussions with survey respondents to clarify responses and solicit additional information, the research team confirmed the current landscape of actuarial modeling controls that exists, with a particular focus on those aspects of the modeling process that have a higher perceived level of risk:

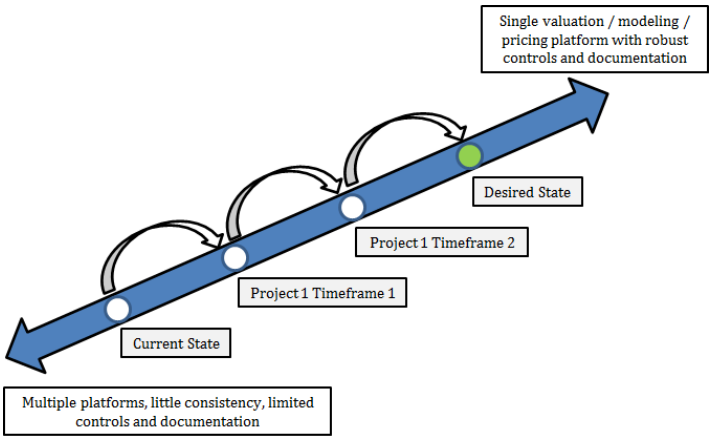
- Stand-alone desktop applications and spreadsheets
- Projection models
- Spreadsheets that directly interact with modeling software
- Management of assumptions, input parameters and data input streams.

After obtaining survey data from the respondents, the research team synthesized the information and examined the current state of controls against the controls needed as the life and annuity

industries gravitate toward the requirements of an MBV framework and as external auditors increase scrutiny. The research team, through extensive project and auditing work, is conversant with the types of controls that will be necessary to ensure the integrity of actuarial modeling systems from which financial results are recorded. This evaluation of the current state and leading practices offers a series of readiness assessments for several aspects of the actuarial modeling process. This report is intended to help companies to be more proactive in their approach to actuarial modeling governance by providing specific examples that can be used to improve in this area. This will help companies to prevent adverse events caused by actuarial modeling errors and to be ready for future changes in financial reporting. It will also help provide the industry knowledge that comes from understanding current leading practices and how other companies are applying them, and where these leading practices align with best practices.

In this report we focus on comparing current practices to *leading practices*, rather than *best practices*. The set of practices against which we are comparing the current state of actuarial modeling controls represents a combination of those practices noted during the gathering of data that were most advanced and those practices that are generally viewed as leading practices across the industry. It is recognized that best practices are the ideal, but leading practices are the top practices currently in place across the industry. The research team also acknowledges that while there are instances in which certain leading practices are in use, no company has achieved leading practices in all areas of actuarial modeling within their company. Companies should look to make improvements to their modeling controls and governance that will add value to their organization through decreased risks and increased preparation for the future modeling environment. These improvements will likely not occur all at once, but could be part of a strategy to achieve a desired state over a period of time. The figure below illustrates this approach, which begins with defining the desired future state and then determining the specific projects that will need to be completed to arrive at the end state in the desired time frame.

Figure 1: Actuarial Modeling Control Spectrum



Survey Method

The research team gathered information from participants in two ways: an online survey for all respondents, plus a subsequent follow-up discussion with those respondents who volunteered to participate in a live call/meeting.

Online Survey

The online survey consisted of 55 core questions, spanning all aspects of the actuarial modeling process. Depending upon the way in which core questions were answered, additional questions were asked. The online survey was developed by the research team, and circulated for review by the Project Oversight Group. The online survey was administered using the Qualtrics© system. Online survey results were collected during May through July 2012. The survey was delivered electronically to actuaries representing 200 life and annuity companies in the United States and Canada. The distribution list was compiled from the Society of Actuaries' member database, identifying primarily chief actuaries and appointed actuaries. While the research team distributed the survey to a specified actuarial contact within each company, we allowed and encouraged those who were selected to solicit participation from, or entirely delegate to, another representative within their organization who was better equipped to respond. In doing this, we received information from various areas within an organization that use actuarial models: financial reporting, valuation, pricing and modeling. We received responses to the online survey from 30 unique companies.

Follow-Up Discussions

At the conclusion of the online survey, participants were asked to participate in a follow-up conversation. The objectives of the conversation were:

1) To clarify respondent interpretations of online survey questions
2) To better understand the rationale behind certain responses
3) To more precisely itemize the controls in practice.

Of the 30 responses to the online survey, half of the companies provided a follow-up discussion. We conducted the follow-up conversations according to a discussion agenda developed to ensure the consistency of covered topics.

Our analysis also incorporates information from two additional companies who provided information via a live interview, but did not complete the online survey.

Demographic Information of Respondents

The respondents of the online survey represent a diverse group of companies across size, reporting structure, and type of company. The level of diversity affords us the opportunity to better dissect the information, stratify responses by size (for example), and make the survey results and conclusions more directly applicable to the reader.

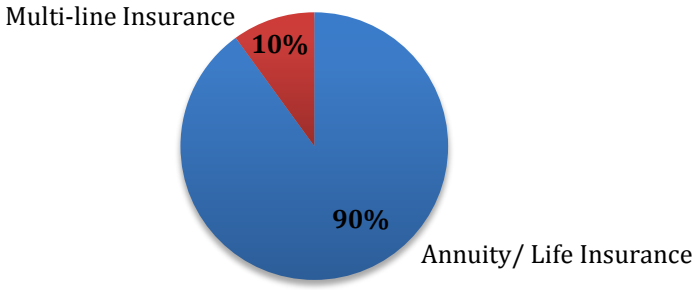
The breadth of companies that responded to the survey provides many perspectives that have influenced the current state of controls: size, product lines and accounting regimes. Leading practices, and the movement toward leading practices, will have different implications for different companies within the industry. It is expected that actuaries reading this report will benefit from this report by identifying with certain groups of the respondent pool and benchmarking against those groups. Having this diverse pool of respondents allows for the analysis of consistency of practice as well as identification of items that are more applicable to a particular subsegment of the industry.

Data

Industry

The majority of companies participating in this survey are life insurance and annuity companies, while the remaining respondents were multi-line insurance companies. Therefore, this report is not considered to fully capture the current state of actuarial modeling controls for property and casualty or health insurance companies. However, it is expected that the current state of controls would be comparable, and that property and casualty or health insurance companies can derive value from the research and identify with certain respondents with respect to robustness of controls and governance.

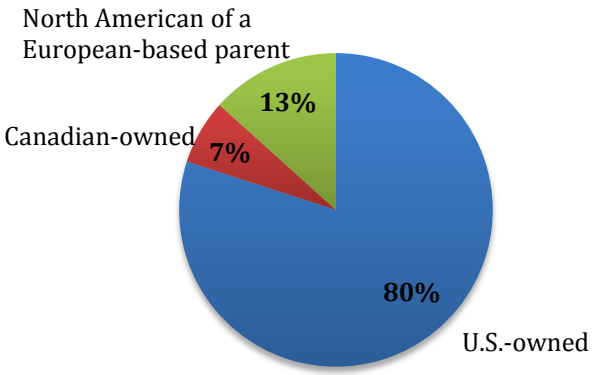
Figure 2: Respondents by Industry



Geographic Distribution

Approximately three-quarters of the respondents are U.S.-owned companies with most of their operations in the United States. In addition to the U.S. respondents, we also received responses from Canadian and U.S.-based subsidiaries of companies with European parents. The diversity in geography is valuable, as different locations have been under different regulatory and reporting environments that require various levels of modeling and, therefore, model controls.

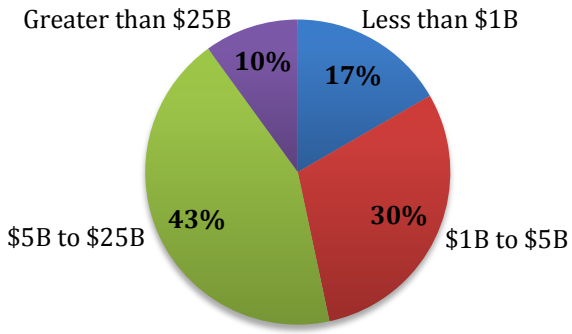
Figure 3: Geographical Distribution of Respondents



Company Size

The companies that participated in the survey represent a cross-section of different sizes. Much of our respondent group is characterized as mid-size ($1 billion to $25 billion of assets). Approximately one-fifth have assets less than $1 billion and only three companies that responded have assets over $25 billion. Such diversity allows us to group companies and identify discernible patterns of controls and governance according to size.

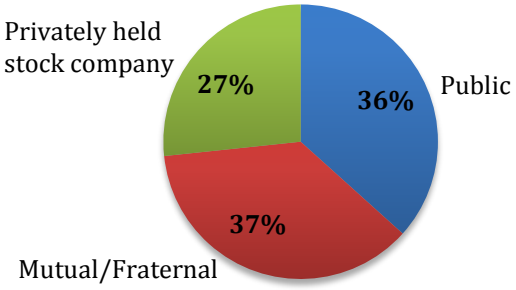
Figure 4: Asset Size of Respondents



Company Type

The mix of respondents between public, private and mutual/fraternal companies was fairly evenly split. Of the responses, 36 percent are public companies, 37 percent are mutual/fraternal companies, and 27 percent are privately held stock companies. Thus, the companies contained within the survey have been subject to Sarbanes-Oxley (public) as well as Model Audit Rule (MAR) controls.

Figure 5: Type of Company



Survey Results and Analysis

We have structured the sections of the body of this report in which we present survey results, discuss leading practices, and assess industry readiness to follow the sections that were included within the online survey. The sections are:

- Governance Standards
- General Modeling Process
- Systems Access and Change Control
- Model Assumption Management
- Model Input Management
- Model Output Management

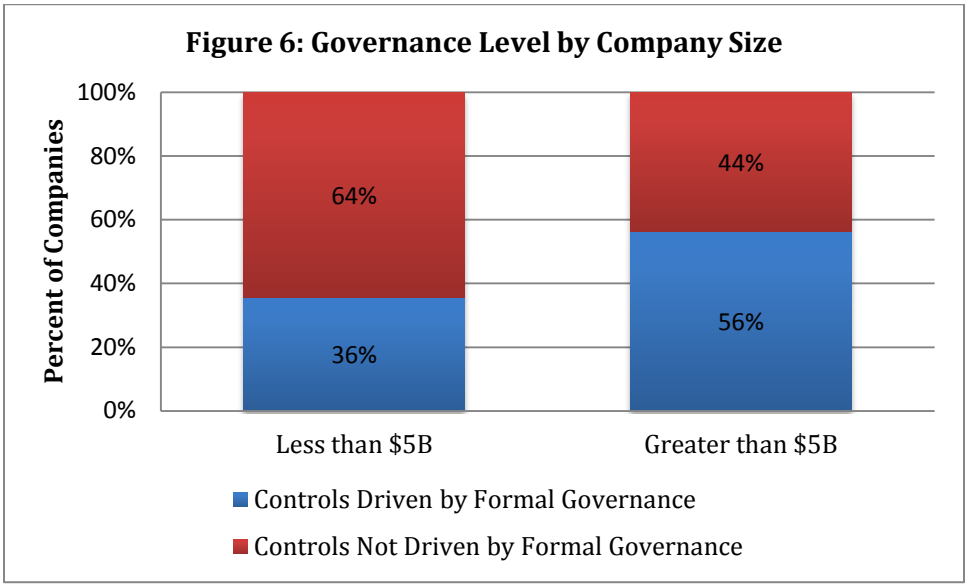
Within each section, we will provide an analysis of the current state of controls combining our online results and follow-up discussions. Where meaningful to do so, we stratify results to allow for a greater depth of understanding (for example, examining the manner in which key person risk is mitigated in large vs. small companies). Leading practices within an MBV framework are also provided, along with commentary on the readiness of the life and annuity industries for the control environment within an MBV framework.

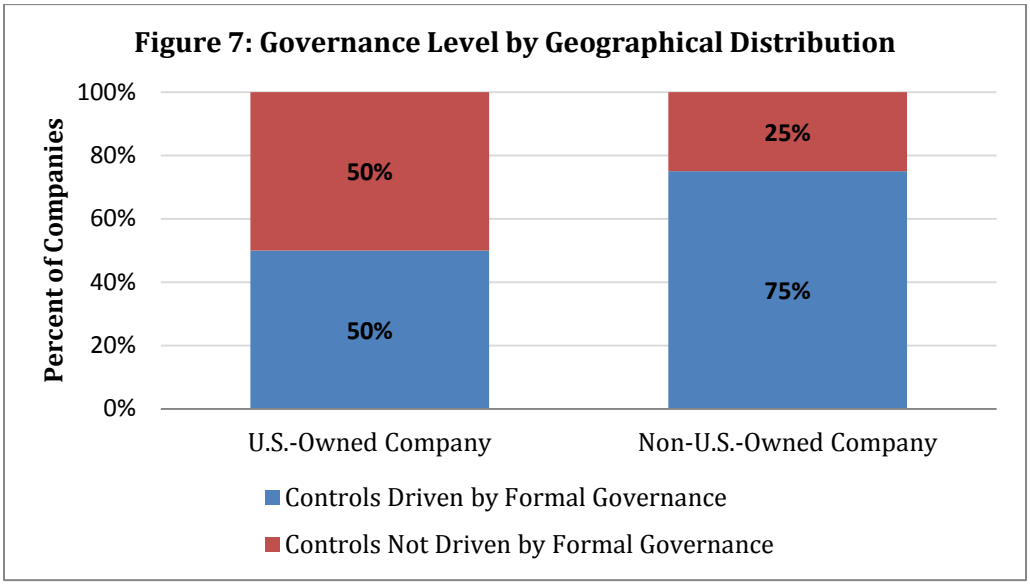
Governance Standards

Governance over the modeling process will take on increased importance as the industry moves toward MBV and models continue to fall into scope for auditors, both internal and external. A governance framework establishes the process, ownership and controls in order to ensure the consistent execution of the modeling process. The purview of governance should include development of data and assumptions, management of the calculation engine, review of results, and the reporting process. Though an overarching governance policy is necessary to maintain continuity, currently formal governance is not prevalent throughout the life and annuity industry.

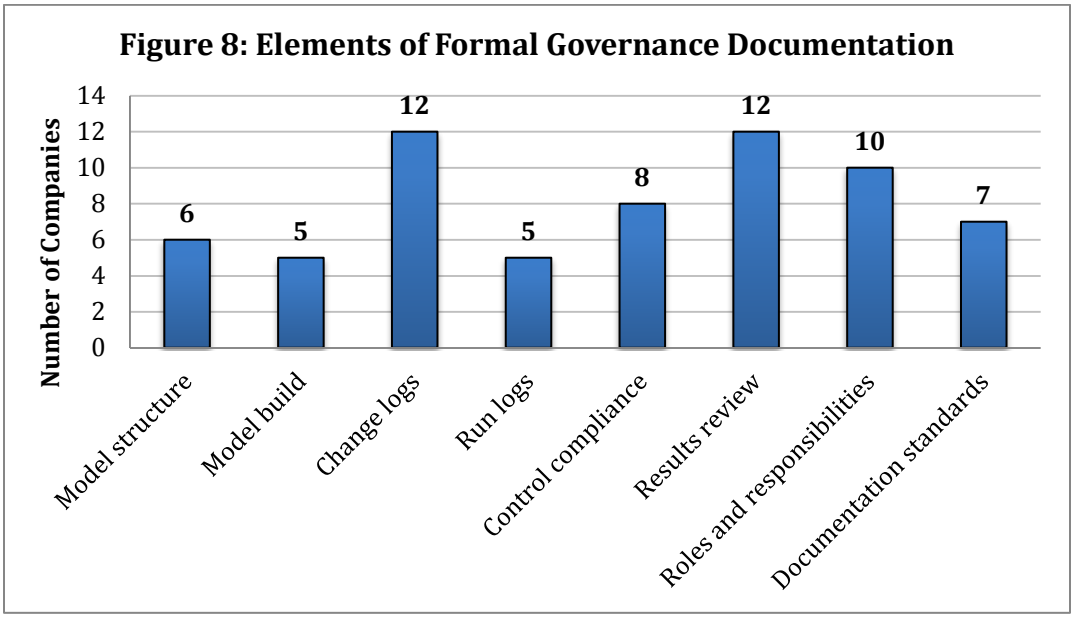
Current State Assessment

Based upon our survey data, while modeling processes and controls exist, approximately one-half of our respondents do not have a formal, written policy that governs the modeling process.





Considering only those companies with formal model governance documentation, divergence exists with respect to the contents of such documentation. The most common elements of formal governance documentation were around change logs, results review, and division of responsibilities to ensure an appropriate review function.



Note: Respondents were asked to select all options that applied, and as such, multiple responses from a single company were allowed.

Some companies with a formal governance documentation process have had third-party reviews of their policies and models. These reviews have been used to evaluate the current governance policy and to determine whether the modeling standards are being followed. These reviews have been initiated by the modeling unit, internal audit, or by risk management functions within the organization. While these reviews are not currently standard across the industry, they appear to have provided valuable feedback and prompted important changes at the companies where they have been performed.

From our follow-up discussions we were able to conclude that the degree of formal governance depends primarily upon events within organizations, and the extent to which models are used for quantitative financial reporting and analysis. This bottom-up approach is reactive in nature, and the governance structure that is built is rooted in the current model structure and does not challenge the model process to be more efficient and holistically controlled. At the other end of the spectrum, we note that some organizations have established a top-down approach to governance, defining guiding principles and structure around the model approval, validation and external review process, and existing models are thereby aligned to these principles and structures. We found that companies with managers in the actuarial modeling area who were relatively new to their positions were generally enacting changes to actuarial model governance based on their experiences in other positions and were less influenced by the existing modeling process.

Also, from the data gathered during the course of the survey and the subsequent follow-up discussions, it can be seen that, while processes were in place and currently functioning adequately at organizations, there existed little formal documentation that clearly established roles and responsibilities for all aspects of the modeling process.

Leading Practices—Governance Standards

A governance policy should include many of the following components:

- Develop a single set of standards regarding model building and documentation
- Create a corporate culture in which employees understand the value of and seek to improve governance and controls across all functions
- Establish a dedicated structure related to the modeling organization, with clear and delineated responsibilities for development, maintenance and change management of models, including:
    - Establishment of an inventory of models, to ensure the complete list of models subject to governance standards
    - Creation, maintenance and communication of all change requests
    - Management of the approval process

  - Integration of changes
  - Communication of leading practices
  - Coordination of user-acceptance testing
  - Management over spreadsheets involved in the process, such as "top-side" adjustments and reports used for analysis and recording financial statement entries
- Define change request procedures for revisions to production model and clearly communicated prioritization of requests across user groups
- Appropriate delineation of responsibilities for model functionality
- Establish protocol for updates/upgrades related to actuarial modeling platforms, operating systems and other systems that support the modeling process (e.g., spreadsheet programs), updates, operating system, including regression testing (different from regression testing associated with logic changes)
- Controlled and automated attribution testing process to identify and quantify differences due to system, logic or data updates, which is an even more critical component of model integrity in the cases where multiple areas use a common model
- Establish a prioritization scheme to rank models, or specific components of models, and use prioritization to establish frequency and intensity of reviews
- Develop a production model "check-out" process for sensitivity analysis and new product pricing (then checked back in once deemed compliant with standards)
- Ongoing model code optimization process to maintain model efficiency and minimize run time
- Ongoing review of model functionality against new developments
- Model documentation is sufficiently comprehensive and instructive
- Monitoring of model user skills including training and development/software accreditation.

The establishment of a strong governance function is critical as models are more heavily relied upon and scrutinized. Governance over the models should be a fluid, active component of the actuarial modeling process, with appropriate, independent oversight and the ability to effectively monitor the process. One possible manner to enable the effective monitoring of the process is to establish a centralized group (led by a "model steward", a role to be discussed later) independent from the group(s) required to generate analysis and reports.

Industry Readiness Assessment

While it is apparent from the survey data that controls and processes exist, in looking forward toward an MBV framework, a clearly defined governance framework that defines and monitors the modeling process will be critical and will need to be more robust than what is currently in use at most companies within the life and annuities industries. Establishing a formal and documented governance framework across all modeling functions provides a structure for the modeling process to function within, with clear rules and guidelines on how to execute the process, and provides continual review and validation of the models themselves. The risks of having informal (or no) governance include risk of divergent models and possibly bias in or manipulation of the results (if no change management structure is defined, or one is defined without clear delineation of performer and reviewer), errant calculations (if no formal review process exists), and/or lack of consistent execution.

Key Next Steps to Move from Current State to Leading Practices: *Governance Standards*

1. Establish a formal and documented governance policy for actuarial modeling processes
2. Regularly review models and the modeling process against the governance policy
3. Develop a corporate culture that values and aligns with the governance policy

General Modeling Process

The modeling process is generally complex, and no one type of operating model in which to execute fits all cases. Considerations should be made to business organization, actuarial team structure and product type (plain vanilla vs. innovative). When evaluating the modeling process, the risks exposed and the controls needed to mitigate those risks should also be considered.

Current State Assessment

Types of Platforms

The data from the survey indicates that common practice is to utilize third-party closed systems[1] for the development of formulaic reserves and related items, while for pricing, reserve adequacy, and other cash-flow projections third-party open systems[2] and home-grown systems[3] are used. This is a byproduct of the fact that required functionality for cash-flow based models differs from formulaic reserve development. Within the survey, there were instances of multiple platforms used for cash-flow projections. Two out of 30 companies used the same system for traditional valuation and modeling.

> *Note: Respondents were asked to select all options that applied, and as such, multiple responses from a single company were allowed.*

Below is a comparative view of the three platform types:

Figure 10: Comparison of Modeling Platform Types

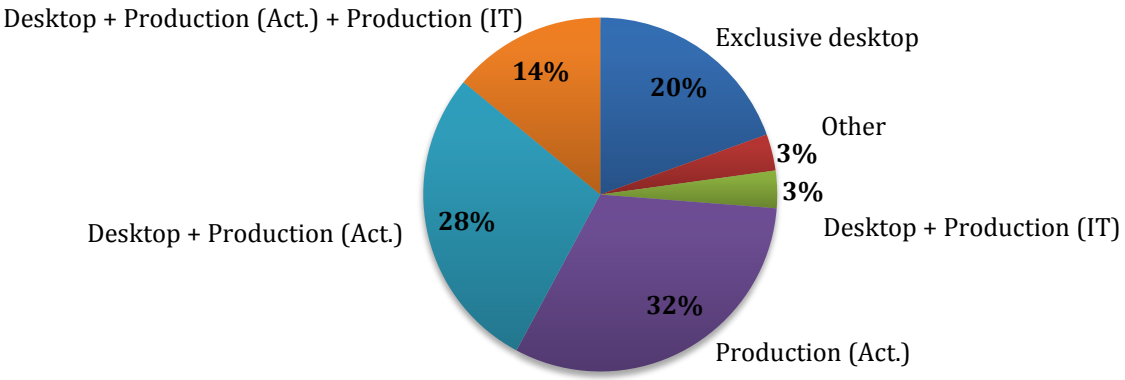
System	Flexibility of Code	Vendor Support	Change Management	Out-of-the-Box Reporting	Key Person Risk
Third-Party Open	High	High	Medium	Low	Medium
Third-Party Closed	N/A	High	Medium	Medium	Low
Home-Grown	High	N/A	High	N/A	High

Modeling Environment

[1] Third-party closed system: a locked-down model to prevent users from making formula changes.
[2] Third-party open system: a free-form model with the ability to make unlimited formula changes.
[3] Home-grown: a specialized, internally developed tool used in the execution of actuarial functions.

Currently, actuarial models are predominantly run via desktop applications, meaning that a local installation of the software exists on a user's computer, and the user has control to adjust settings and/or manipulate code.

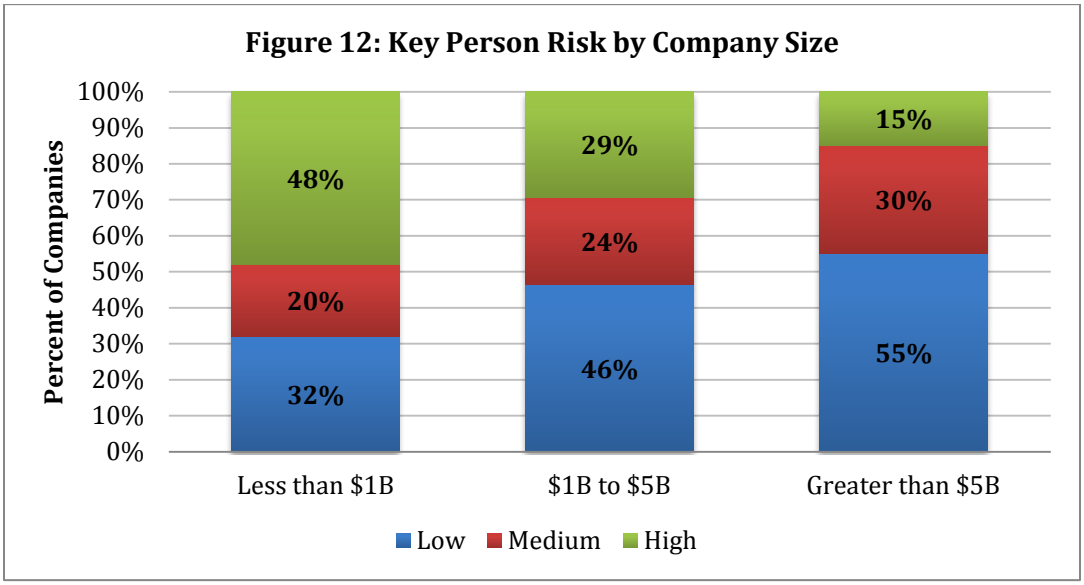
Figure 11: Modeling Environment



The supplemental live discussions indicated that while desktop applications empower the user to make changes, there exists an array of controls to ensure the integrity of results and mitigate risk of model error. Some of the respondents have a required and documented step that the results from the prior model be reproduced prior to making any model changes. Other respondents rely upon tools that accompany the software, such as comparison functionality, to track the changes between the model used to generate the most recent results and the final model from the prior period.

Key Person Risk

An additional risk related to complex actuarial models, in particular those that reside within home-grown systems based upon more archaic platforms and languages, is key person risk. This is the risk to the integrity of model results, and ultimately financial statements, that the knowledge is so concentrated with one or two people that the process is in jeopardy if these individuals were to leave the organization. Those companies that employed a single model for traditional valuation and model functions considered themselves to be of low key person risk. Other companies that do not have such a structure in place had various ratings. Common mitigation strategies for key person risk include adequate documentation of the model and the manner in which models are updated, and establishing a program by which two or more people can execute any single modeling function. This cross-training can be achieved by a formal rotation program in which responsibilities are rotated on either a temporary or permanent basis.



Other key person risk mitigation strategies in use include:

- Narratives and process flows in place for the entire modeling process
- Control matrix documenting key risks, controls and testing process for those controls with link to internal audit function
- Strong documentation to support any manual adjustments required for blocks of business that are not directly modeled.

Model Archiving

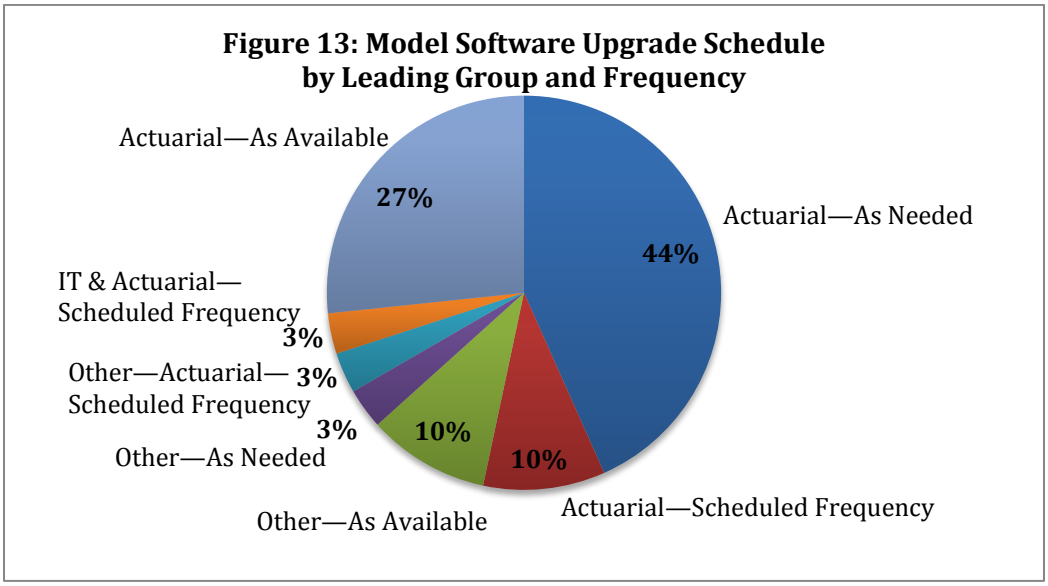
Due to responsiveness to auditors and other such interested parties, model archiving is important. All but two of the respondents maintain models for more than two years. As will be noted later, though archiving exists, there do not exist documented procedures to ensure that the most recently archived model is used as the starting point for the current period analysis.

Model Software Upgrades

A key task within the model framework is the incorporation of version updates from the software vendor. This presents several challenges, including the testing of customized logic to ensure sustained integrity, and the process to roll out to ensure consistency of platform across the organization. These efforts, based upon our survey data, if not entirely performed within the

actuarial group, are led by actuarial with assistance from information technology (IT). Also, updates are predominantly made on an as-needed basis.

Figure 13: Model Software Upgrade Schedule by Leading Group and Frequency

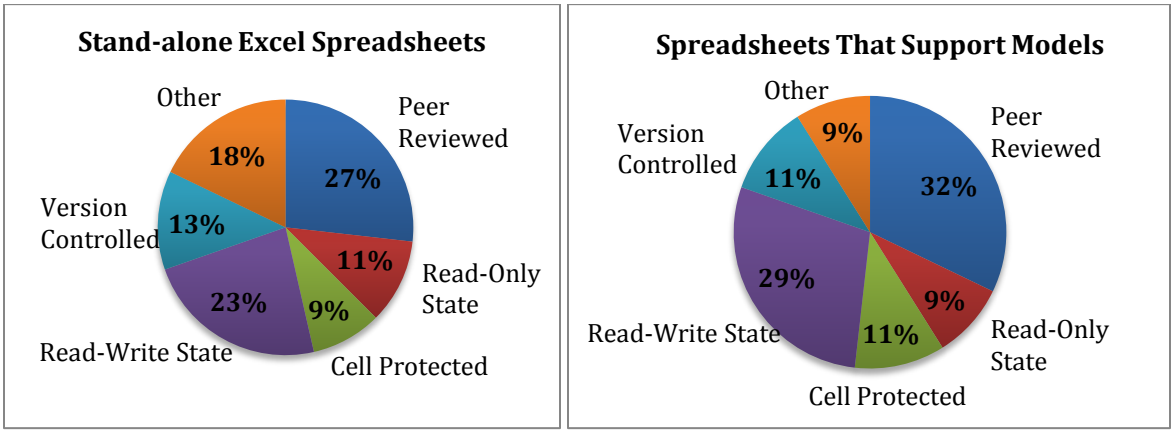


Regular updates to latest vendor system and "sync up" to vendor business logic across all modeling functions are considered leading practice. Risks that are introduced by having models that significantly (e.g., by two or three versions) lag the "latest and greatest" version include not updating for vendor-identified error corrections, a missed opportunity for more robust functionality, and the potential lack of support that a vendor might give for past versions.

Use of Spreadsheets

Spreadsheets currently play a significant role in the modeling process of many survey respondent companies. Spreadsheets serve two primary functions: to be a stand-alone model; or to support the modeling process, either through report generation, or determining model inputs. A less robust control of peer review of spreadsheets is currently in place at most organizations, while others have enacted stronger controls over the formulas within the spreadsheets to ensure integrity.

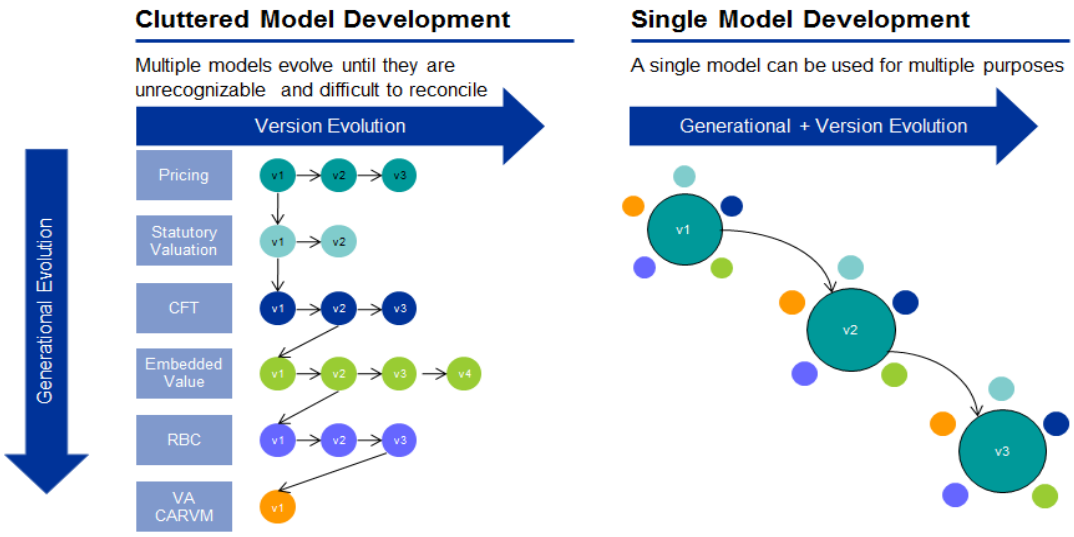
Figure 14: Controls over Spreadsheets



Leading Practices: One Platform, One Model

In a situation in which MBV is required, a single modeling platform used consistently across modeling, pricing, and financial reporting (valuation) functions is the optimal solution as the organization can reduce its model management efforts from a multitude of models on potentially different platforms, servers, etc., to a single, widely used, well-understood model. Even in advance of MBV, moving to a single model for all projection-based analysis (pricing, ALM, reserve adequacy) reduces risk of divergent models, helps to enable consistency, and reduces control efforts.

Figure 15: Multiple vs. Single Model Comparison



The graph above depicts the risk of divergent models that exists when multiple platforms and multiple models are used. Use of different platforms and even different versions of a model on the same platform can result in logic inconsistency and assumption inconsistency, and can lead to reproducibility issues. Benefits of adopting a single model approach include:

- Consolidation of model knowledge, model maintenance and production technology
- Improved system and data controls
- Enhanced efficiency through sharing of models—one model setup can be leveraged for multiple purposes
- Improved communication of model results due to consistency of terms, format, methodology
- Streamlined process, system, and methodology documentation
- Simplified (single) model input processes
- Consistency in approach and allows improved reconciliation of results
- A fresh start to a single system may support the development of model standards, control process, and the sharing/reconciliation of models
- A single system will facilitate developing automated data processes, as well as enhanced reporting and analytics
- Potential savings in licensing costs by using fewer systems.

Consistent with the notion of a single model that handles all necessary functions, the management of the modeling process is made easier by ensuring that key calculations are contained within the model as much as possible, minimizing the use of "top-side" adjustments to model output. To the extent that this is not feasible, such spreadsheets should be controlled. Possibilities for control would include cell protection (only allow the user to change inputs into the spreadsheet and eliminate risk of inadvertent formula changes), password protection and peer review. Some companies have employed a spreadsheet policy that provides guidance on the use and alteration of spreadsheets, especially when used in a financial reporting capacity.

Leading Practices: Establishment of a Model Steward

In order to maintain a single production model and to manage changes to the model, establishing the role of a centralized modeling organization led by a "model steward" that holds full responsibility for production models is considered a leading practice. Included in the possible scope of the model steward would be:

- Creating, maintaining and communicating a list of all change requests
- Providing scheduled updates
- Reviewing production models
- Monitoring and communicating leading practices
- Verifying compliance with the company's model policy standards
- Serving as a gatekeeper to the production model by approving all changes that are to be implemented in the production model.

From our survey data, only eight of 30 respondents have such a role in place today. Though for those companies that have established a model steward role, the responsibilities of the steward are varied and expansive:

Figure 16: Model Steward Activities

Company	Responsible for creating and maintaining production models	Communicates a list of all change requests	Provides scheduled updates	Reviews production models	Monitors and communicates best practices
A	Yes	Yes	Yes	Yes	Yes
B	Yes	Yes	No	Yes	Yes
C	Yes	Yes	Yes	Yes	Yes
D	Yes	No	No	No	No
E	No	Yes	Yes	Yes	Yes
F	Yes	Yes	Yes	Yes	Yes

G	No	No	No	Yes	Yes
H	No	No	Yes	No	No

A significant challenge of the modeling process is to find an appropriate balance between control and flexibility. The process needs to be able to ensure integrity of results, while at the same time allowing for "what if" analysis. Those processes noted within the survey data to maintain the balance well are processes by which periodic model integration occurs through a model steward or other designated function. This is the case because all instances of the model are based off of the most recent integrated model (no more than one quarter or one year), and it is therefore easier to identify changes to settings and/or code against the base model that has been subject to prior scrutiny.

A robust peer review process could be substituted in light of comparison functionality. In the cases where a centralized actuarial function exists, the end users are given the ability to change table references, model settings, and are locked out of logic changes.

Industry Readiness Assessment

It may not be feasible in all cases to develop a single model that performs all necessary functions of actuarial modeling and valuation. However, if the path of multiple models is selected, the governance and control over the models needs to be increased in order to meet the heightened requirements of an MBV framework to ensure that the models do not diverge in terms of functionality, assumptions (where applicable) and integrity.

Key Next Steps to Move from Current State to Leading Practices: *Modeling Process*

4. Consolidate models to a single platform or a single modeling system where feasible Where this is not feasible, implement additional controls to ensure model integrity across all modeling platforms
5. Establish a model steward with clearly defined responsibilities for ensuring adherence to the model governance standards

System Access and Change Control

Models are constantly evolving as they are modified and updated to provide the most accurate and applicable results. Models need to be dynamic and changeable to be useful, but this should not be at the expense of model controls. Controls around model system access ensure that a model or certain aspects of a single model can only be modified by the designated personnel. Through effective system access guidelines and change control practices, the integrity of a model can be maintained while allowing necessary flexibility.

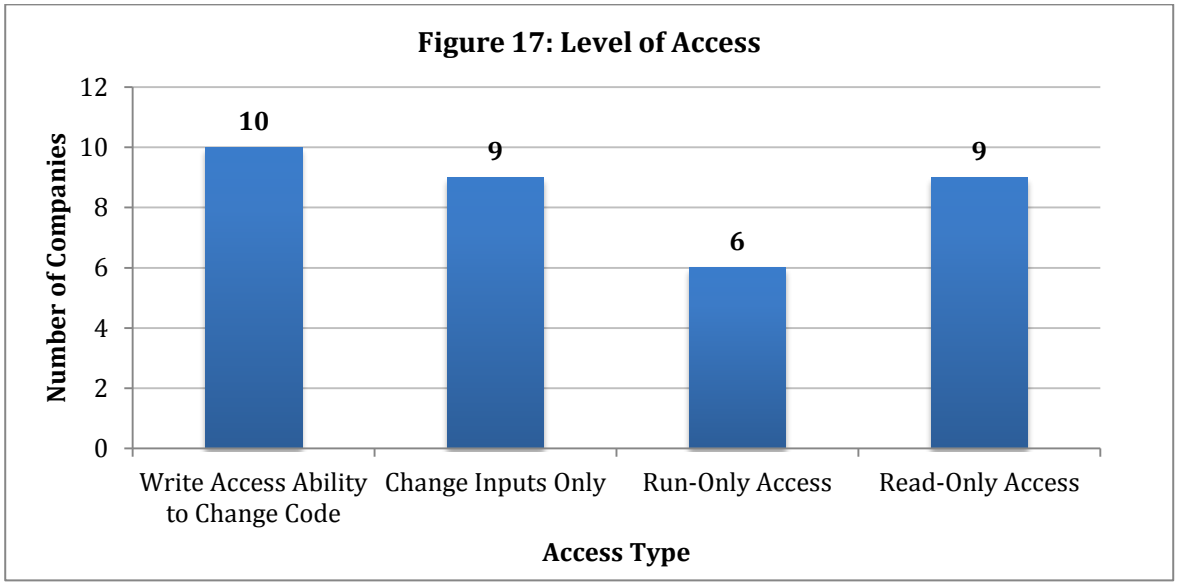
Current State Assessment

System Access

Many companies limit the access to actuarial models to only the actuarial staff, either through the use of ensuring installation only on necessary users' desktops (if that is the environment) or through a centralized model stored on a directory to which only the model users have access.

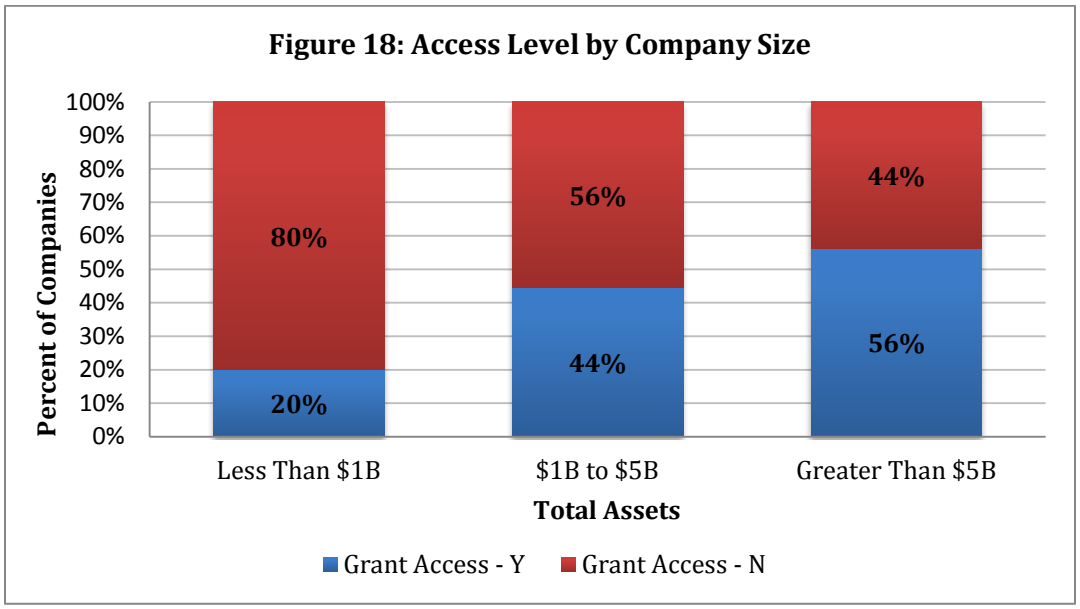
While access is generally limited to actuarial staff, less than half of the survey respondents grant different levels of access to key actuarial systems among the actuarial staff. The companies that do differentiate access levels generally use read-only, change inputs and change code, with the level of access determined by the roles and responsibilities of the staff. A smaller number of companies grant run-only access as well. In follow-up discussions, we found that some companies regularly review the access levels, often on an annual basis, to ensure they are up to date.

Figure 17: Level of Access



Note: Respondents were asked to select all options that applied, and as such, multiple responses from a single company were allowed.

Small companies with less than $1B in assets did not generally assign different levels of access, as they only have a few actuaries who perform the modeling, and those actuaries have complete access to the models. Granting different levels of access to actuarial models is slightly more common in companies that have a centralized modeling function overseen by a model steward.



Model Change Control Process

There are several different types of changes that can be made to a model. The most routine change is to update a model to reflect the current in-force and valuation date. The controls for this type of model change are addressed in the model input section.

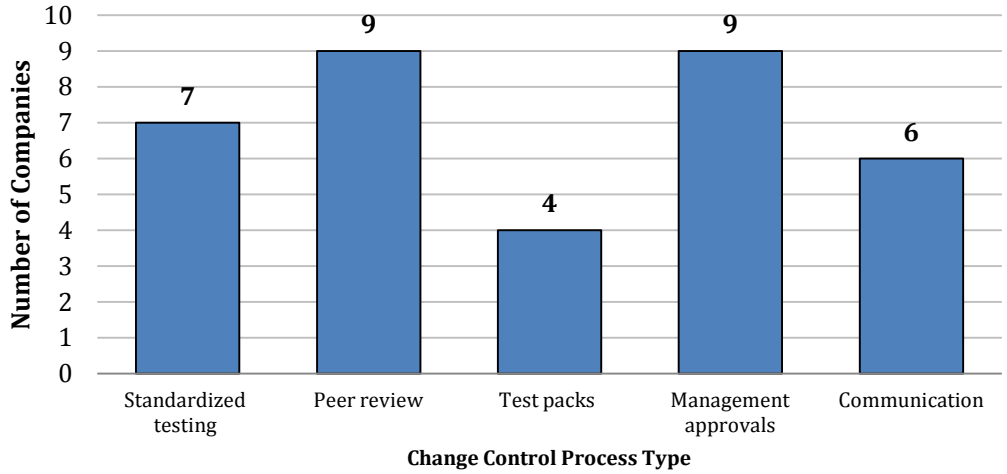
A more complex model change may involve changing or creating new model coding and/or variables that allow for model enhancements and revisions. Of the survey respondents, over half do not have a formal process in place for implementing code changes to models. In the follow-up discussions, we found that the formality of the code change process varied among the participants. Some companies have strict code change processes in place that are regulated by a governance policy, while other companies have only informal checks that are completed as necessary to ensure that code changes are appropriate. The primary risk of not setting forth controls over the change management process is the risk that changes may go undetected.

To check code changes, some companies use the "compare" tools that are available within their modeling software to track the changes between the model used to generate the most recent results and the final model from the prior period. Such compare tools appear to be a good starting point, but many respondents also commented that the compare tools are often difficult to read or to distill into the changes that really matter. With some additional tools for filtering changes or for setting expectations on what changes should have occurred, the compare tools could be a more useful control for the code changes in a model.

Most of the code changes are implemented by either the unit responsible for the model or by corporate actuarial. IT is generally minimally involved with code changes or model updates, which is consistent with the lack of IT involvement that is seen in the survey responses regarding the actuarial modeling environment in general.

Less than half of the survey respondents have a formal change control process in place to ensure that model-generated results are not based upon models changed in an unauthorized manner. The companies that do have this process in place generally use peer review or management approval to confirm that model changes are appropriate. Again, we found that the rigor and formalization of the peer review process varies from one company to the next. Some companies have another actuary or a manager review the code as needed. Others have a rigorous process in which a code change is quantified and goes through several levels of review prior to implementation in the production model.

Figure 19: Type of Change Control Processes



Note: Respondents were asked to select all options that applied to the change controls, and as such, multiple responses from a single company were allowed.

Only half of the respondents have a process by which code from desktop applications is integrated into a single corporate model. Some of the companies that responded do not have a single centralized corporate model, but others have the centralized model with no formal process for aggregating the code. Not integrating models into a single "model of record," can lead to divergent code, multiple models in existence, and lack of reproducibility of results. Controls on each of the individual models that check for consistency and clearly define the "model of record" can mitigate some of these risks.

Leading Practices—System Access and Change Control

Having a formalized governance process for managing model code changes helps ensure that model code changes are appropriate, consistent, understood and communicated. This is true regardless of the modeling structure that a company is currently using. Whether a company has individual desktop models run by a few actuaries or a centralized modeling unit that compiles models from several different sources, it is valuable to go through a formalized model change process. The level of documentation, the variety of testing performed, or the approval process may differ, but the basic need to justify, document and test model changes is the same. Understanding what changes have been made to a model and the impact of those changes provide comfort that the model results are reliable.

In subsequent discussions with survey participants, we found that companies with leading practices in model change control generally have a formalized process that involves four different steps:

Step 1: Establish a procedure to identify and prioritize model changes. This can be done by a centralized modeling area or it could be done on an individual model basis. With this step, model changes are consistent with a holistic view of model planning and strategy. This step also allows for model changes to be ranked according to the riskiness of the model, so that model changes with more risk can be handled more quickly than other model changes that might be less of a priority.

Step 2: Evaluate changes in a test environment and analyze the impact on financial results. To complete this step, it is important to first run the model and produce the prior period results to ensure that the model starting point is consistent with the model of record. After this is done, the model changes can be implemented with confidence that the quantification of the impact is attributable only to the model change being analyzed.

Step 3: Perform testing on the model code changes. This testing could involve regression testing, sensitivity testing, peer review, or testing the impact of the code changes on other models. Some companies have a formalized testing procedure, but other companies use different testing procedures, depending on the nature of the model change.

Step 4: Document and seek formal approval. The model code changes and rationale are documented, along with the results and discussion of the model code changes and any sensitivity tests. This documentation is reviewed by the appropriate parties, such as management or a modeling oversight committee, and formally approved or denied. With an approval, the code change officially becomes part of the production model.

This final step of the process is similar to a "system release" by a software vendor. This step treats the revised version of the model (with changes in assumptions or coding) as the current model version that should be the model of record for all users. Ideally, these internal model releases are scheduled well ahead of time and follow the same timing every year. This provides plenty of time prior to a quarter close for end users to work with the new model version. It also prevents one-off model changes, as the only system that can be used for reporting is the most recent release.

Industry Readiness Assessment

From our research, a wide variety of practices exist to manage model changes, both intentional and inadvertent. Establishing the appropriate level of access appears to be a concept that is consistently practiced throughout the industry. Going forward, access to the model, and to various components of the model, should be tightened to remove the remaining risk.

Some respondents indicated that change could be made to versions of models and go potentially undetected, in situations where a formal change management process does not exist. Establishing a modeling organization responsible for creating, maintaining and communicating a list of all change requests is critical. Responsibilities would include determining change request procedures for revisions to production models and clear prioritization of requests across user groups. For open code modeling systems or companies with a single centralized model, more IT involvement in the model code change process can increase control and consistency around the model code. In the case that models are used by multiple groups, all of which can make changes, there should be ongoing model evaluation to maintain model consistency and efficiency. Some companies have this process in place, but for others it is a significant area of improvement for actuarial model governance.

Key Next Steps to Move from Current State to Leading Practices: *System Access and Change Control*

6. Implement a formal change management process for governing model code changes and model updates
7. Determine the calendar for internal model releases to ensure consistency of the model of record across the organization

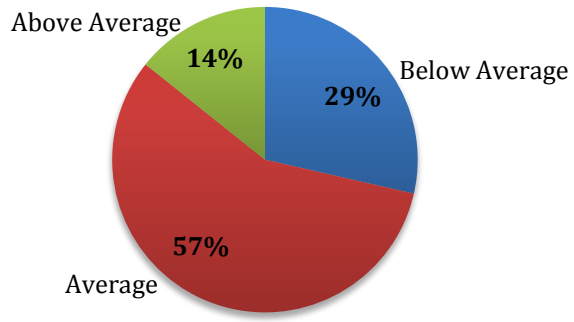
Model Assumption Management

The process by which assumptions are approved, stored, communicated, and ultimately included in models can expose the overall model process to risk, even in situations where a model is locked down and the code is appropriately maintained.

Current State Assessment

Many companies have controls in place to test the accurate input of model assumptions, including adjustments and modifiers to certain assumptions. The effectiveness of these controls was generally rated as average or above average by the survey respondents. Further discussions with survey participants provided additional details on the particular controls used and the items that were considered in determining their effectiveness.

Figure 20: Effectiveness Level of Assumption Control



Assumption Approval

Key assumptions are reviewed according to a regular assumption review calendar by almost three-fourths of the survey respondents. This calendar review is most often annual, while other companies review assumptions in conjunction with model changes or major deliverables.

Model assumptions are generally set based on experience studies performed by the company, but the degree of rigor around the assumption-setting process varies. Many companies have an assumption-setting committee that either directly sets the assumptions or signs off on the assumptions set by the modeling areas. This type of structure provides oversight of the assumptions to ensure that assumptions are reasonable, supportable and (when appropriate) consistent between different modeling functions. It also appears that the process of reporting to the assumption committee can improve the analysis and documentation of the assumption changes.

Assumption Storage

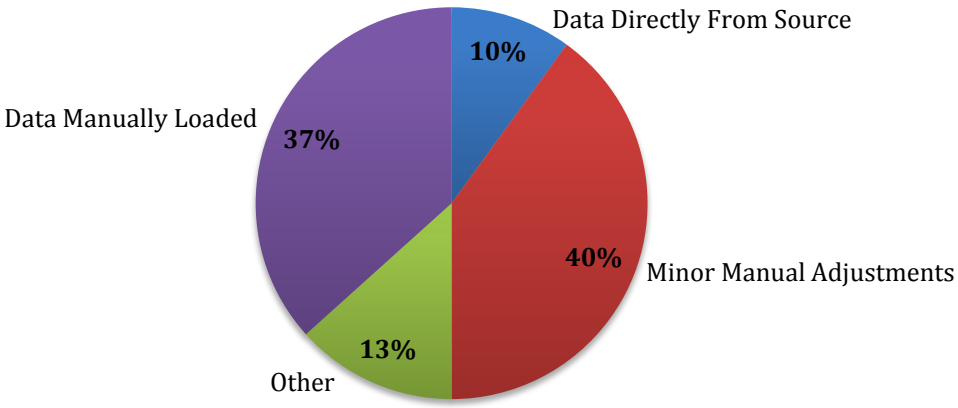
Only 39 percent of the respondents have a centralized location for storing assumptions. The size of the company or the presence of a model steward did not appear to correlate with the existence of a central location for storing assumptions. Central storage of assumptions ensures that all modelers have access to the assumptions that should be reflected in the current models. It can also be a beneficial part of the controls used to check the accuracy of the assumptions, because the peer reviewers can confirm that the centralized assumptions are the ones coded into the models. Finally, a centralized location for assumptions can be somewhat self-documenting, as the assumptions for each modeling period are recorded.

In follow-up discussions, a few companies indicated that they were in the process of building a centralized model assumption repository. Each company that was engaged in this type of project expected it to be a lengthy and complex process, as there can be hundreds of assumptions involved. There are also considerations for how the centralized assumption repository is updated and how assumptions are fed from the database to different models.

Inputting Assumptions into Models

According to the survey results, almost all companies currently input at least some assumptions manually into the actuarial models. Companies also use Excel, Access, or another platform to extract assumptions and feed into the model.

Figure 21: How Input Data is Fed into Actuarial Models



With the significant reliance on manual input of assumptions into actuarial models, companies have implemented a variety of controls to ensure that assumptions are input accurately. The most common controls are peer review, evaluation of the reasonableness of results, and management review. From our discussions, we learned that the peer review is often performed by someone who

was not involved in coding a particular model so there is a separation of duties. The evaluation of the reasonableness of results involves the comparison of results from a prior period with the results of the current model to ensure that changes are consistent with changes in assumptions. This evaluation of results is often done in a step-by-step (often referred to as a "waterfall") approach that analyzes the impact of each assumption change separately and quantifies the financial impact.

From our discussions, we found that other controls used by companies are visual verification of inputs, audits of assumptions for randomly selected model cells, and external calculations to verify model results. These controls can be even more effective when used on a model in the development environment so that any errors are identified and corrected prior to the assumption changes being implemented in the production model.

Leading Practices—Model Assumption Management

- Centralized approach for common assumption setting and approval
- All assumptions documented and signed off based on a specified process
- Current and historical assumptions maintained in centralized database
- Experience studies performed on a regular schedule; any associated assumption updates are performed at a consistent time each year (see the "system release" concept from the previous section of this report)
- Assumptions classified according to criticality and frequency of change
- Format of assumptions aligned with modeling efficiency (e.g., flat rates used where no duration or time dependence is required)
- Automated input of assumptions where feasible
- Assumptions applied consistently to all models, such as:
    - Across stochastic and deterministic models where appropriate; including noting the impacts that policyholder behavior formulas may have, such as with dynamic lapse formulas in a multi-scenario model
    - Across different blocks of business where appropriate
    - Across different reporting bases where appropriate
- Develop expectations for impact of assumption changes on model results and compare results to expectations
- Waterfall testing implemented to assess impact of assumption changes (i.e., re-running the model one change at a time to capture each impact)
- Impact of dynamic assumptions is tested under different economic scenarios

Industry Readiness Assessment

From our research, most companies have implemented controls around some aspects of the assumption management process, but few companies have controls in place for the entire process. In an MBV framework, the entire process of setting assumptions is critical, as a breakdown at one point in the process can negate the effectiveness of controls at other steps in the process.

To the extent that it is feasible, given a company's modeling platforms and structures, the automated input of assumptions into models is preferable. This limits the manual intervention and chance for human oversight and error as assumptions move from the assumption-setting process to the actuarial model. Automated assumption inputs also provide self-documentation, as the files used to feed the models capture all of the assumptions used for a particular model. If automated assumption inputs are not feasible, controls on the setting of assumptions (formal signoff and approval process), the input of the assumptions into the models (verification of inputs, peer review of model inputs) and the model results (step-by-step analysis of model results after each assumption change) should be considered.

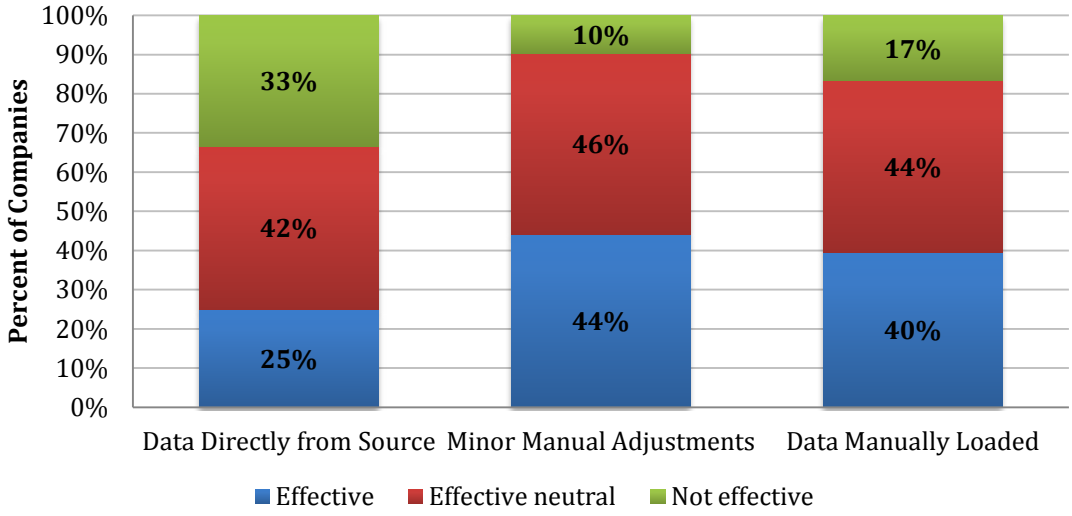
Key Next Steps to Move from Current State to Leading Practices: *Model Assumption Management*

8. Automate the input of assumptions into the models
9. Implement a formal signoff process for the setting of model assumptions
10. Analyze and document the impact of each assumption change

Model Input Management

For the purposes of the survey and this report, model input represents data files, assumptions, and various model settings that are selected in order to perform the task at hand and other front-end-user aspects, and does not consider the logic executed after having established the inputs.

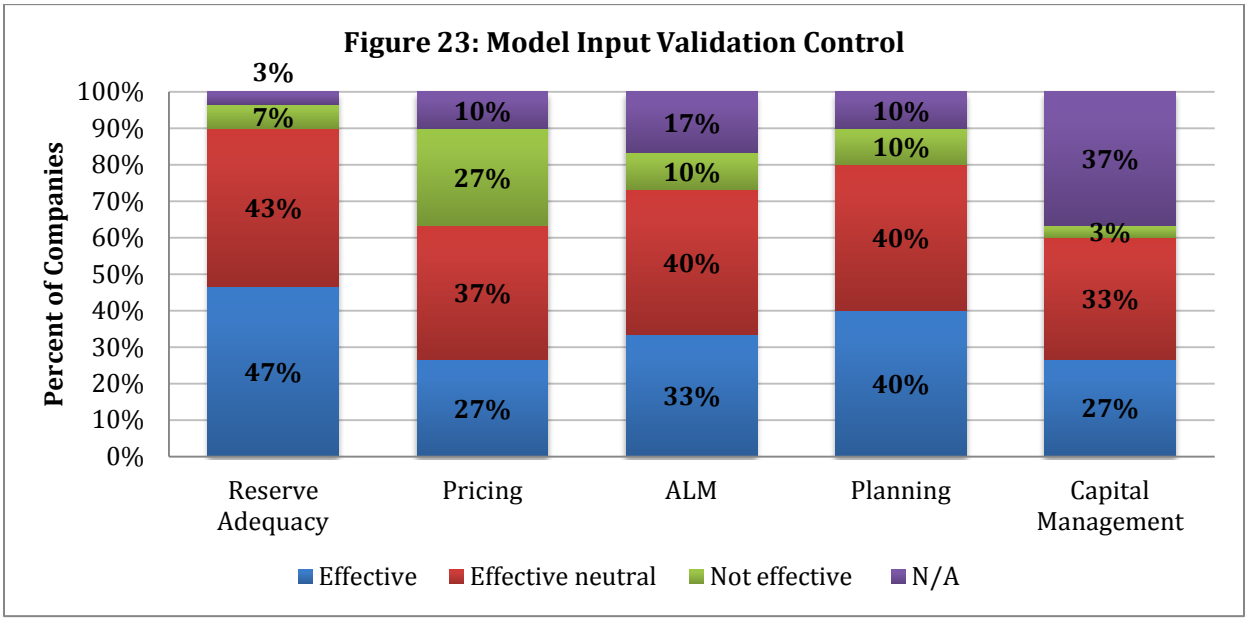
Figure 22: Model Input Control Effectiveness by Data Input Type



Current State Assessment

Input Development and Validation

The respondents have rated themselves overall to be adequate with respect to controls around the model input process. The existing controls and validations appear adequate with respect to the current required analyses that are model-based in nature.



There are many practices employed by companies to ensure the appropriate input of data into the models:

- Some systems have functionality by which the user can compare two models (or tasks within models potentially) to obtain the exhaustive list of differences. Some companies will compare the current version of the model/task with the final version from the previous cycle and determine if the changes are appropriate. While this method has merit, there should be a basis of expectation that goes with the evaluation, in order to determine if both the items that changed were in fact changed, and those items expected to be unchanged were in fact not.
- Other companies have instituted significant peer review processes in advance of running the model/task. While this situation may be better suited for companies with several actuarial staff members who are proficient with the software, the review that is conducted here is valuable as the modelers will have a better understanding of variable names and how the setting of those variable names (via table reference or drop-down menu selection) impact model results and can provide challenge. As was the case in using the comparison functionality, an expectation basis to serve as a benchmark for changes is valuable.
- In the absence of the above, many companies fully rely upon back-end analytics to catch significant movements. This is less of an all-encompassing test, as only those issues that are apparent can be identified. The subjective nature of the review process and the experience of the reviewer expose the process to inconsistency. Also, if the review process differs by product or by actuary, it is conceivable that significant errors may exist, but the

presentation of results deemed suitable by the managing actuary may not uncover such errors.

- Within our survey data, a valuable practice one company has undertaken is to put the development of certain input files and their referencing in the model under the jurisdiction of the model steward, enabling a level of rigor around the front-end use of the model that is comparable to the rigor around the logic defined to process data.

Complex Pre-Modeling Processes

In addition to ensuring that the models are referencing the intended files and that settings are set correctly, there exist complex processes prior to running the model. As an example, in-force liability files are critical to the modeling process. In order to reduce run times for actuarial models, liability data is often manipulated through a series of compression routines to create an in-force file that is intended to appropriately represent the liabilities. We see divergent practices with respect to the compression process. Processes span the spectrum from entirely manual processes (actuary receives data, inputs into a database, mapping rules subject to change at the actuary's discretion) to automated processes (an IT script is run to create the in-force file and validation statistics are provided).

Another complex pre-modeling process is the development of asset files. Validation exercises in the aggregate appear to be deficient. Many actuaries receive asset data from other experts within the organization, or from the external company that manages company assets, and while data reliance is placed upon the "other" person, very little is consistently done to verify that cash flows are being accurately projected. Other companies work to evaluate cash flows for single assets (e.g., callable bond, sinking fund bond) and compare cash flows to an independent source (e.g., Bloomberg).

Leading Practices—Model Input Management

- All data feeds into model (in force, product specifications, actual financial data) obtained from centralized data warehouse that also supports finance function
- Data feeds almost entirely automated and defined to be internally consistent
- Automated data verification procedures in place
- Model output (metrics, ratios, projected items) are compared to intended assumption inputs to identify any unintended assumption changes
- An item for consideration as to which controls to employ in an MBV framework is the manner in which input data is loaded. Those processes that are more manual in nature (e.g., updating file names, changing dates, etc.) may require more extensive peer review and use of comparison functionality, while models that receive data by way of automatic feeds,

which presumably may also be part of a controlled IT process, may only require a more robust back-end analytic that would suffice if the process is "hands off" in nature

Industry Readiness Assessment

In order to meet the more stringent requirements of an MBV framework, and to allow additional time for analysis, companies should move toward an environment in which data file development is less manual in nature. Optimally, all data feeds into the model (in force, product specifications and actual financial data) and is obtained from a centralized data warehouse that also supports finance function. This does not imply that there need not be any controls, as data feeds that are almost entirely automated and defined to be internally consistent need automated data verification procedures in place. Currently the more complex processes in place that provide data to the model are manual in nature, and expose the process to risk as current strategies to measure consistency and appropriateness, and systematically ensure integrity of the data, are not as robust as will be needed in an MBV framework.

Key Next Steps to Move from Current State to Leading Practices: *Model Input Management*

11. Obtain model input data feeds automatically from a centralized data warehouse
12. Automate and standardize a set of test analytics performed to test model input

Model Output Management

Current State Assessment

We can see currently that, depending upon the use of actuarial models, the level of rigor used to govern the process after generation of model results varies and is dependent upon the use of models in the recording of financial statement entries. Companies that use models that are not used to produce financial reporting statements, such as for cash flow testing, tend not to have controlled spreadsheets that extract pertinent information from the model, where the risk to material misstatements is low. However, we have also observed that the result generation process in organizations for which model results do in fact lead to balance sheet entries is not consistently controlled either. This jeopardizes the process, as the sustainability and repeatability of the model review process can be compromised.

Figure 24: Model Validation Control between Outputs and Inputs

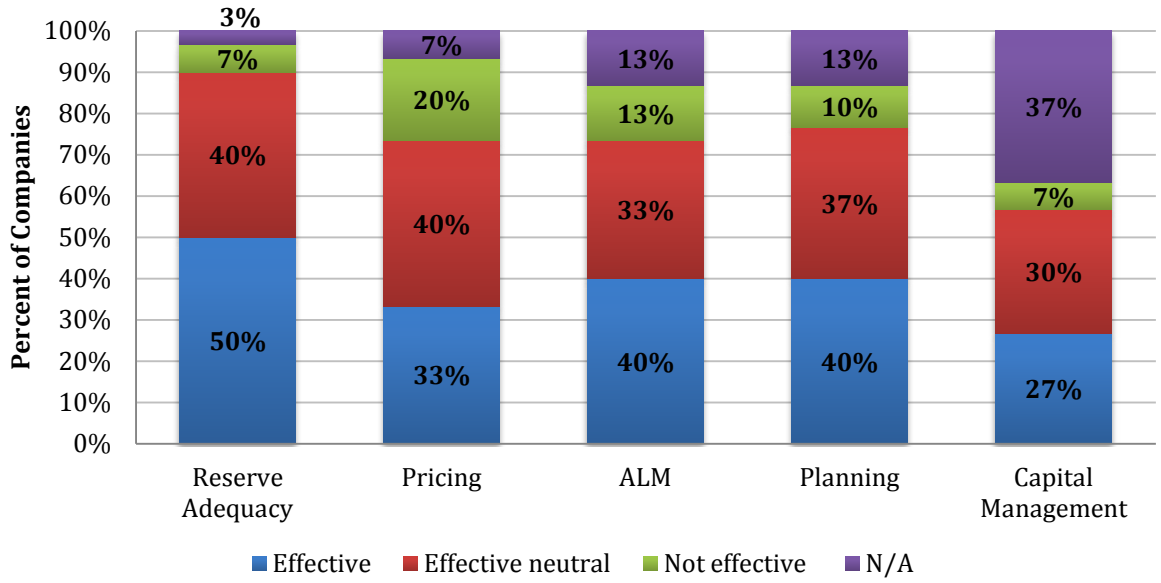
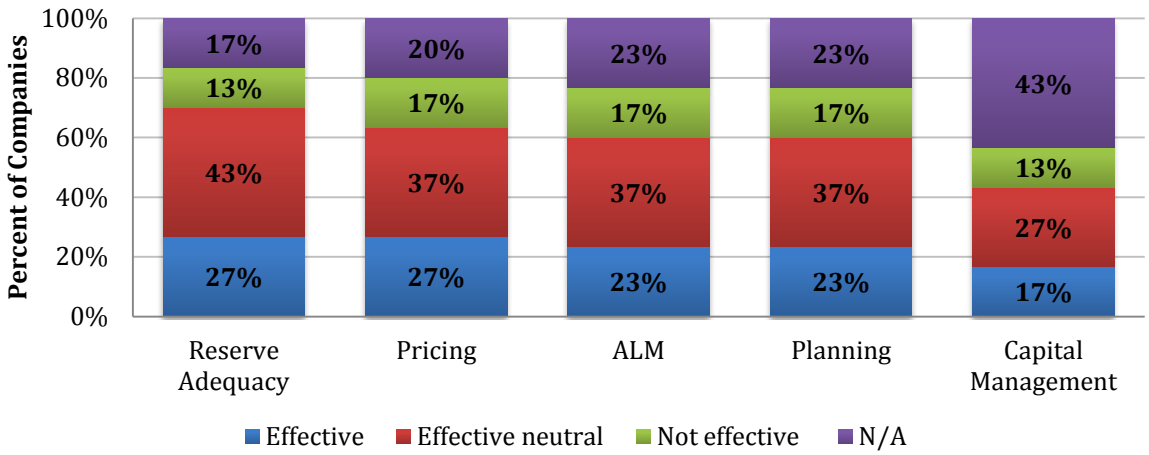


Figure 25: Interaction Validation Control between Spreadsheets and Software



Another consideration would be to have pre-defined reports built within the modeling software that are generated with each model run, thereby eliminating the risk associated with data transfer from the software results into other platforms. Among the most tightly controlled results extraction process identified in the survey was a process by which the model steward, in addition to having jurisdiction over the third-party open-code system, also had responsibility for the standard suite of reports used in various modeling processes, allowing the user only the ability to reference a set of model results while not allowing alteration of formulas within the spreadsheets, thereby mitigating the risk of divergent reports. Other controls structures that existed were demonstrably more manual in nature, whereby a modeler may import data into a database, run queries, copy results to spreadsheets, then adjust for presentation purposes. Each step of this process, if the process itself were to be maintained in an MBV framework, would need to be controlled at each step, including checks of records imported (scenarios multiplied by time steps), and internal consistency of presented results (for example, ensuring that a surplus roll-forward represents all aspects of the roll-forward, which when summed on the page match the result from the model).

Leading Practices—Model Output Management

In a framework in which model output is directly used for accounting entries, a leading practice would be that model output feeds into centralized data warehouse, and reporting tools (Cognos, Hyperion, etc.) are used to create standard and custom reports. The concept of transferring model results to a data warehouse is only applicable to those model structures that reside on servers and is normally not attainable for desktop applications. In cases where this construct is not practical, controls can be put around the result extraction process to ensure completeness, accuracy and consistency. For example, a database, with pre-written routines that are protected, can be used to

read data and populate a consistent set of reports (in a spreadsheet, subject to appropriate controls) to enable the peer review and booking process. As was the case when discussing the general modeling process, care needs to be given to allow for some degree of flexibility to be reactive to requests to evaluate data differently, and to allow the peer review line of sight into additional data upon which to exercise professional judgment.

The evolution of model output management at companies has been driven in part by the current level at which model results are used for direct entry into financial statements. Companies that have historically used models for asset adequacy analysis and other assessments that are not directly reported on financial statements have been less apt to adopt a rigorously controlled process for result extraction and reporting. At the other extreme, companies that are required to report on the Canadian Asset Liability Method (CALM) have implemented systems by which model output is fed into a warehouse, maintained by IT, off of which queries are run to provide results. This approach is consistent with the design of SAP and other accounting databases, and such a design should be considered as the direct impact that actuarial models have on balance sheet items increases.

Controlled reporting tools enable drill-down into details. As noted above, an MBV framework calls for increased rigor and control around the standard set of reports used for analysis, and, potentially, for booking. Yet, this rigor and standardization should not come at the expense of professional judgment and the ability to more deeply analyze results. Appropriate flexibility should be in place to enable the company to quickly drill down to evaluate results. Flexibility should be enabled through development of queries that read from the same data warehouse used to generate the standard reports, as the structure would be in place to ensure the completeness of the data.

Industry Readiness Assessment

As a result of the use of models in the past (e.g., qualitative pass/fail analysis), there do not exist robust controls around output management in many companies. However, as there will be a direct connection between the model output and financial statement entries, the management of output, including the transfer of data, population of templates, and review of results, needs to be better controlled and made less manual and subjective in nature. This is not to say that the peer review process should not have flexibility for professional judgment, but the set of automated reports that is generated should allow sufficient insight and supplemental detail if needed.

Key Next Steps to Move from Current State to Leading Practices: *Model Output Management*

13. Automate and standardize model output used for reporting and analysis
14. Store model output in a data warehouse that can be queried to allow for additional analysis and evaluation of model results

Appendix A: Acknowledgments

In addition to the survey participants who made this report possible, we would like to thank the members of the Project Oversight Group (POG) for their input and review throughout the survey design, data collection, analysis and presentation.

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Appendix B: Actuarial Modeling Controls Survey

LINK TO ACTUARIAL MODELING CONTROLS SURVEY QUESTIONS

Appendix C: Survey Participants

The following identified companies provided responses to the online survey, live discussion, or both:

Alfa Life Insurance Corporation
American National Insurance Company
Ameriprise Financial Inc.
Ameritas Life Insurance Group
Citi Assurance Services
CMFG Life Insurance Company
Erie Family Life
Farmers New World Life Insurance Company
Forethought Financial Group
Generali USA Life Reassurance Company
Great Western Insurance Company
Great West Life and Annuity
HSBC Insurance North America
ING Life Companies
John Hancock
Knights of Columbus
Lincoln Financial Group
Modern Woodmen of America
Mutual of Omaha
Nationwide Financial
OneAmerica Financial Partners
Pacific Life Insurance Company
Protective Life Insurance Company
Securian Financial Group, Inc.
Sentry Life Insurance Company
The Cincinnati Life Insurance Company
The Penn Mutual Life Insurance Company
Thrivent Financial
Vantis Life Insurance Company

Those responses provided by companies other than those cited above were provided anonymously.

Appendix D: Model Readiness Scorecard

The SOA Actuarial Modeling Controls Report, written by a research team from Deloitte Consulting LLP, highlights 14 leading practices for governance, processes, change controls and data management. The scorecard below is intended to provide a way to self-rate your company against these best practices, to facilitate discussion and planning for model control updates as the industry moves toward a model-based valuation framework and external auditors continue to increase focus on the actuarial model results.

Topic	#	Leading Practice	Rating (1-5)*
Governance Standards	1	We have established a formal, documented governance policy for actuarial modeling processes that is actively and periodically reviewed.	
	2	We regularly review models and the modeling process against the governance policy for compliance purposes.	
	3	We have developed a corporate culture which values and aligns with the governance policy.	
The Modeling Process	4	We have consolidated models to a single platform or a single modeling system where feasible. Where this is not feasible, we have implemented additional controls to ensure model integrity across all modeling platforms.	
	5	We have established a model steward with clearly defined responsibilities for ensuring adherence to the model governance standards.	
System Access and Change Control	6	We have implemented a formal change management process for governing model code changes and model updates.	
	7	We periodically have internal model releases to ensure consistency of the model of record across the organization.	
Model Assumption Mgmt	8	We have automated the input of assumptions into the models.	
	9	We have implemented a formal sign-off process for the setting of model assumptions.	
	10	We analyze and document the impact of each significant assumption change as part of the formal assumption approval process.	
Model Input Mgmt	11	We obtain model input data feeds automatically from a centralized data warehouse.	
	12	We have automated and standardized a set of test analytics performed to test validity of model input.	
Model Output Mgmt	13	We have automated and standardized model output used for reporting and analysis, to ensure a consistent presentation of information.	
	14	We store model output in a data warehouse which can be queried to allow for additional analysis and evaluation of model results to prevent loss of data.	

*1 = leading practice and 5 = not effective

Leading practices are controls that are routinely adhered to by all practitioners, sufficiently documented, well designed (i.e., user is unable to circumvent), catch inaccuracies/violations above typical staff review, etc.

RSVP 6/04 SOA Actuarial Modeling Controls Survey

Welcome to the Actuarial Modeling Controls Survey.

As the life insurance and annuity industries move toward model-based approaches to reserve and capital valuation (MBV), actuarial models are increasing in complexity and sophistication while the imperative to avoid modeling errors is also increasing. This survey is being conducted to better understand the current landscape of actuarial modeling control practices, and the effectiveness of such controls when compared to the requirements of a model-based valuation framework. Thank you for your participation.

Please be advised of some guiding principles when taking the survey:

- All respondents are encouraged to answer all survey questions if possible.
- It is assumed that respondents will submit only one survey which covers a majority of the company's models. If there are multiple controls and governance standards employed for different models/products across your organization, respondents are encouraged to utilize the "Other" open-ended answer options throughout the survey and provide detail on key differences.
- Responses will not be identifiable by company name or respondent to the research team or Project Oversight Group.
- The survey requests your contact information for the purpose of offering the survey via a live telephone conversation, if you elect to do so. For those companies that submit a survey response, a pre-release version of the report will be shared via email.

If additional information is needed based upon your responses, an SOA research staff member may contact you.

Each time you press the “Next” button, the questions you answered will be saved, but will not be finalized until you have pressed the “Submit” button. Should you be interrupted while taking the survey, you can return to the survey from the same computer at a later time. Thank you again for taking the survey.

If you would like to print out the entire survey for reference, please use the link below to download a copy:

Please click here for a print-friendly version of the survey

For the best viewing of the survey, please maximize your browser window.

Demographic Information

1. What best describes your company. If you work for a subsidiary of a diversified parent, please respond based on the primary focus of the subsidiary you work for)?

- ❍ P&C
- ❍ Life/Annuity
- ❍ Health
- ❍ Multi-line

2. Is your company:

- ❍ US-owned, with most operations in the US
- ❍ Canadian-owned, with most operations in Canada
- ❍ A North American arm of a European-based parent company
- ❍ Other _____

3. What is the size of your company, as measured by assets?

- ❍ Less than $1 billion market capitalization
- ❍ Between $1 and $5 billion market capitalization
- ❍ Between $5 and $25 billion market capitalization
- ❍ Greater than $25 billion market capitalization

4. Is your company publically-held or private (i.e., mutual or fraternal)?

- ❍ Public
- ❍ Mutual/Fraternal
- ❍ Privately held stock company

Understanding the Modeling Process

Note: A production environment refers to a centralized, protected model that is the single official version of the model. A desktop application is a model that resides on a individual user's machine, with the ability to update assumptions and/or formulas. Desktop applications are typically under lesser controls and guidance.

5. In what sort of environment are models currently run for financial reporting/reserve adequacy (Please check all that apply)?

- ❑ Desktop application
- ❑ Other _____
- ❑ IT-maintained production environment
- ❑ Actuarial-maintained production environment

6. For each of the models used within your organization, please categorize the model for each of the following functions. (Please check all that apply) Third-Party Open System is defined as a free-form model with the ability to make unlimited formula changes. Third-Party Closed System is defined as a locked-down model to prevent users from making formula changes. Home-grown is defined as a specialized, internally-developed tool used in the execution of actuarial functions.

	Reserve Adequacy	Pricing	ALM	Planning	Capital Management
Third-Party Open System	❑	❑	❑	❑	❑
Third-Party Closed System	❑	❑	❑	❑	❑
Home-grown	❑	❑	❑	❑	❑
Other	❑	❑	❑	❑	❑

7. For each of the different accounting regimes, please categorize the models. (Please check all that apply) Third-Party Open System is defined as a free-form model with the ability to make unlimited formula changes. Third-Party Closed System is defined as a locked-down model to prevent users from making formula changes. CALM is Canadian Asset Liability Method. Home-grown is defined as a specialized, internally-developed tool used in the execution of actuarial functions.

	GAAP Reserves	DAC	Loss Recognition	Statutory Reserves	Cash Flow Testing	IFRS	CALM	Solvency II
Third-Party Open System	❑	❑	❑	❑	❑	❑	❑	❑
Third-Party Closed System	❑	❑	❑	❑	❑	❑	❑	❑
Home-grown	❑	❑	❑	❑	❑	❑	❑	❑
Other	❑	❑	❑	❑	❑	❑	❑	❑

8. Rate the level of risk associated with a "key" person leaving your organization on a scale from 1-5 for each of the following models, where 1 = low risk and 5 = high risk. (A "key person" is defined as an individual who has significant knowledge with respect to the structure, operation and/or output of a model that very few (if any) others in the organization also possess.)

	Low Risk 1	2	3	4	High Risk 5	N/A
Reserve Adequacy	❍	❍	❍	❍	❍	❍
Pricing	❍	❍	❍	❍	❍	❍
ALM	❍	❍	❍	❍	❍	❍
Planning	❍	❍	❍	❍	❍	❍
Capital Management	❍	❍	❍	❍	❍	❍

9. How long are prior versioned models archived?

- ❍ Less than 1 year
- ❍ 1-2 years
- ❍ 2-5 years
- ❍ 5+ years
- ❍ Other (May cover either an indefinite or undefined length of time.) _____

10. How are software updates and releases merged into the third-party models?

- ❍ As available
- ❍ Pre-determined calendar date
- ❍ Other _____

11. Who leads the process of merging software updates and releases into the third-party models? If you feel there are certain processes which are led by each group, please select "Other" and describe.

- ❍ IT
- ❍ Actuarial
- ❍ Other _____

12. How would you categorize stand-alone Excel based models (Please check all that apply)?

- ❑ Peer reviewed
- ❑ Read-Only state
- ❑ Cell protected
- ❑ Read-Write state
- ❑ Version controlled
- ❑ Other _____

13. How would you categorize spreadsheets that support the modeling software (Please check all that apply)?

- ❑ Peer reviewed
- ❑ Read-Only state
- ❑ Cell protected
- ❑ Read-Write state
- ❑ Version controlled
- ❑ Other _____

14. Please add any additional detail regarding your company's modeling process that you would consider relevant for this survey.

_____

Governance Standards

15. Which of the following are covered in your company's formal model governance document (Please check all that apply)?

- ❑ Model structure
- ❑ Model build
- ❑ Change logs
- ❑ Run logs
- ❑ Control compliance
- ❑ Results review
- ❑ Documentation standards
- ❑ No formal document available
- ❑ Other _____

16. Does your company have a centralized modeling organization formally led by a model steward with full responsibility for production models?

- ❍ Yes
- ❍ No

16a. If yes, please check all that apply.

- ❑ Responsible for creating and maintaining production models
- ❑ Communicates a list of all change requests
- ❑ Provides scheduled updates
- ❑ Reviews production models
- ❑ Monitors and communicates best practices
- ❑ Other _____

17. Rate the effectiveness of the governance structure in place at your organization for each item below using the scale 1 to 5, where 1 = leading practice and 5 = not effective. (For the purposes of this survey, leading practice are controls that are routinely adhered to by all practitioners, sufficiently documented, well designed (i.e. user is unable to circumvent), catches inaccuracies/violations above typical staff review, etc.)

	Leading Practice 1	2	3	4	Not Effective 5	N/A
Third-Party Open System	❍	❍	❍	❍	❍	❍
Third-Party Closed System	❍	❍	❍	❍	❍	❍
Home-grown	❍	❍	❍	❍	❍	❍
Stand-alone Excel-based models	❍	❍	❍	❍	❍	❍
Other	❍	❍	❍	❍	❍	❍

18. Rate the effectiveness of governance standards in place at your organization for each item below: Using the scale 1 to 5, where 1 = leading practice and 5 = not effective.

	Leading Practice 1	2	3	4	Not Effective 5	N/A
Data management	❍	❍	❍	❍	❍	❍
Assumption setting	❍	❍	❍	❍	❍	❍
Process and controls	❍	❍	❍	❍	❍	❍
Model standards	❍	❍	❍	❍	❍	❍
The use of expert judgment	❍	❍	❍	❍	❍	❍
Decision logs	❍	❍	❍	❍	❍	❍
Minimum documentation standards	❍	❍	❍	❍	❍	❍
Other	❍	❍	❍	❍	❍	❍

19. Rate the effectiveness of the controls for stand-alone Excel-based models and spreadsheets supporting models at your organization using the scale 1 to 5, where 1 = leading practice and 5 = not effective.

	Leading Practice 1	2	3	4	Not Effective 5	N/A
Stand-alone Excel based models	❍	❍	❍	❍	❍	❍
Spreadsheets that support the modeling software	❍	❍	❍	❍	❍	❍

20. Does your company have procedures in place to maintain the integrity of production models such as "checking out" the model for what if's and new product pricing? (i.e. allowing the user the needed flexibility to complete scenario analysis without introducing unintended changes into the core production model)?

- ❍ Yes
- ❍ No

21. Please add any additional detail regarding the governance standards at your company that you consider relevant for this survey.

System Access

22. Many companies have tools and/or processes in place to limit access to key actuarial systems. Rate the effectiveness of these controls throughout your organization for the following models using the scale from 1-5, where 1 = leading practice and 5 = not effective.

	Leading Practice 1	2	3	4	Not Effective 5	N/A
Reserve Adequacy	❍	❍	❍	❍	❍	❍
Pricing	❍	❍	❍	❍	❍	❍
Planning	❍	❍	❍	❍	❍	❍
Capital Management	❍	❍	❍	❍	❍	❍
ALM	❍	❍	❍	❍	❍	❍

23. What levels of access to key actuarial systems does your company grant? (Please check all that apply)

- ❑ Write access ability to change code
- ❑ Change inputs only
- ❑ Run only access
- ❑ Read access only
- ❑ Other _____
- ❑ N/A

24. Where spreadsheets are used to provide data/assumptions to models, is there a controlled directory to which spreadsheets are stored to be used by the model?

- ❍ Yes
- ❍ No

25. Please add any additional detail regarding system access at your company that you consider relevant for this survey.

_____

Change Control

26. Rate the effectiveness of change controls in place at your organization for the following reporting regimes using the scale 1 to 5, where 1 = leading practice and 5 = not effective.

	Leading Practice 1	2	3	4	Not Effective 5	N/A
GAAP Reserves	❍	❍	❍	❍	❍	❍
Statutory Reserves	❍	❍	❍	❍	❍	❍
IFRS	❍	❍	❍	❍	❍	❍
Cash Flow Testing	❍	❍	❍	❍	❍	❍
DAC	❍	❍	❍	❍	❍	❍
Loss Recognition	❍	❍	❍	❍	❍	❍

Canadian Asset Liability Method	❍	❍	❍	❍	❍	❍
Solvency II	❍	❍	❍	❍	❍	❍

27. Many companies use change controls to confirm impact of code changes and to ensure no unintentional changes have been introduced. Rate the effectiveness of these controls throughout your organization for the following models using the scale from 1-5, where 1 = leading practice and 5 = not effective.

	Leading Practice 1	2	3	4	Not Effective 5	N/A
Reserve Adequacy	❍	❍	❍	❍	❍	❍
Pricing	❍	❍	❍	❍	❍	❍
ALM	❍	❍	❍	❍	❍	❍
Planning	❍	❍	❍	❍	❍	❍
Capital Management	❍	❍	❍	❍	❍	❍

28. For models in a production environment, are there change request procedures in place for revisions to production models with a clear prioritization of requests across user group?

- ❍ Yes
- ❍ No

28a. Which of the following areas are covered within the change request procedures? (Please check all that apply)

- ❑ Standardized testing approach
- ❑ Test packs (i.e. standard sets of data (e.g. test bed, test scripts, etc.) to run through the model to validate incorporation of changes)
- ❑ Communication
- ❑ Other _____

29. For companies that use desktop applications, does there exist a process by which code is integrated and a single corporate model is distributed for testing to various functions?

- ❍ No
- ❍ Yes, and our company's Technology group (IT) is involved in the process
- ❍ Yes, but our company's Technology group (IT) is not involved in the process

30. Does your company have a process in place to ensure that model-generated results have not been changed in an unauthorized manner?

- ❍ No
- ❍ Yes (please describe the process below). _____

31. Does your organization have a formal process for implementing coding changes?

- ❍ No
- ❍ Yes (please describe the process below). _____

32. Who is responsible for implementing the coding changes in your organization?

- ❍ IT
- ❍ The area from which the change originates
- ❍ Corporate actuarial
- ❍ Other _____

33. Which of the following model standards does your organization use? (please check all that apply)

- ❑ Informal coding conventions
- ❑ Documented coding conventions
- ❑ Table configuration
- ❑ Naming convention
- ❑ Formal change review process by model steward
- ❑ Other _____
- ❑ N/A

34. Please add any additional detail regarding model change control at your company that you consider relevant for this survey.

Model Assumption Management

35. Many companies have control processes in place to test the accurate input of model assumptions, including adjustments and modifiers to certain assumptions. Rate the effectiveness of these controls throughout your organization using the scale from 1-5, where 1 = leading practice and 5 = not effective.

- ❍ 1
- ❍ 2
- ❍ 3
- ❍ 4
- ❍ 5
- ❍ N/A

36. Does your company have a centralized location that houses common assumptions?

- ❍ Yes
- ❍ No

36a. If yes, where are the assumptions stored? (Please check all that apply)

- ❑ Database with Read/Write privileges
- ❑ Database with ability to designate read-only access
- ❑ Manual spreadsheets
- ❑ Production database
- ❑ Other _____

37. How would you describe the process by which assumptions are implemented within actuarial models? (Please check all that apply)

- ❑ Manually input directly into the actuarial models
- ❑ Extracted from Excel and fed into models
- ❑ Extracted from Access and fed into models
- ❑ Extracted from other platform and fed into models
- ❑ If other, please specify. _____

38. Are all assumptions documented for internal consistency and frequently reviewed among various models?

- ❍ Yes
- ❍ No

38a. How frequently are assumptions reviewed and the corresponding documentation updated (as necessary)?

- ❍ Annually
- ❍ Semiannually
- ❍ Other _____

39. Does there exist an assumption review calendar which dictates the frequency of review for specific assumptions (e.g. timing/frequency for completion of experience studies)?

- ❍ Yes
- ❍ No

40. Describe the control processes used to test the accurate input of model assumptions and the testing of the impact on financials, including the level of review performed.

41. Please add any additional detail regarding model assumption management procedures at your company that you consider relevant for this survey.

Model Input

42. Many companies have controls in place to validate model input for completeness and accuracy. Rate the effectiveness of these controls throughout your organization for the following models using the scale 1 to 5, where 1 = leading practice and 5 = not effective.

	Leading Practice 1	2	3	4	Not Effective 5	N/A
Reserve Adequacy	❍	❍	❍	❍	❍	❍
Pricing	❍	❍	❍	❍	❍	❍
ALM	❍	❍	❍	❍	❍	❍
Planning	❍	❍	❍	❍	❍	❍
Capital Management	❍	❍	❍	❍	❍	❍

43. Which best describes how input data is fed into your actuarial models?

- ❍ Feeds directly from source system (e.g. administration system)
- ❍ Minor manual adjustments made to source data prior to placing in staging area/tool for automated loading.
- ❍ Data is manually loaded into model
- ❍ Other _____

44. Is there anything else you would like to mention about model input controls?

Model Output

45. Many companies have controls in place to validate model output against inputs and expectations. Rate the effectiveness of these controls throughout your organization for the following models using the scale 1 to 5, where 1 = leading practice and 5 = not effective.

	Leading Practice 1	2	3	4	Not Effective 5	N/A
Reserve Adequacy	❍	❍	❍	❍	❍	❍
Pricing	❍	❍	❍	❍	❍	❍
ALM	❍	❍	❍	❍	❍	❍
Planning	❍	❍	❍	❍	❍	❍
Capital Management	❍	❍	❍	❍	❍	❍

46. Rate the effectiveness of controls in place to validate interactions between spreadsheets and actuarial software using the scale 1 to 5, where 1 = leading practice and 5 = not effective. For example, is there a control in place to validate model output against model input and expectation, etc.?

	Leading Practice 1	2	3	4	Not Effective 5	N/A
Reserve Adequacy	❍	❍	❍	❍	❍	❍
Pricing	❍	❍	❍	❍	❍	❍
ALM	❍	❍	❍	❍	❍	❍
Planning	❍	❍	❍	❍	❍	❍
Capital Management	❍	❍	❍	❍	❍	❍

47. Assuming a third-party modeling software is used for financial reporting purposes (e.g. GAAP Reserves, Statutory Reserves, etc.), does your company maintain independent validation spreadsheets as a control to verify the appropriateness of the model calculations and provide transparency?

- ❍ Yes
- ❍ No

47a. If yes, which of the following apply to the validation spreadsheets? (Please check all that apply)

- ❑ Version controlled
- ❑ Streamlined to work for a broad range of input cells (as opposed to requiring manual intervention to capture cell-specific features)
- ❑ Developed internally by the company (as opposed to being provided by the third-party vendor)
- ❑ Updated as necessary to incorporate new releases/functionalities of the third-party modeling software
- ❑ Other _____

48. Which best describes how the model output is fed into your financial reporting tools?

	Feeds Directly into reporting tools	Minor Manual Adjustments	If Other, please describe
Reserve Adequacy	❍	❍	
Pricing	❍	❍	
ALM	❍	❍	
Planning	❍	❍	
Capital Management	❍	❍	

49. Please add any additional detail regarding model output controls at your company that you consider relevant for this survey.

Regulatory and External Audit

50. Has your company considered the current regulatory environment and external audit in creating the control system?

- ❍ Yes
- ❍ No

51. Has your company considered upcoming model-based valuation frameworks (e.g., PBA, Solvency II) in designing the current model and governance structure?

- ❍ No
- ❍ Yes (please describe below) _____

52. If your company uses vendor-based systems for determining formula-based reserve and related balances, that are different from your actuarial projection models, would you consider the actuarial projection models to have a similar or less rigorous control structure?

- ❍ Similar
- ❍ Less rigorous

53. In addition to external audit scrutiny, does your company subject its actuarial models to external review?

- ❍ Yes, regularly (such as annually)
- ❍ Yes, but ad hoc and infrequent timing
- ❍ No

54. Please add any additional detail regarding regulatory and external audit considerations that you consider relevant for this survey.

55. Would you be willing to participate in a live follow-up interview?

- ❍ Yes
- ❍ No

CONTACT INFORMATION

56. Please provide contact information.

Name:

Company:

Work Phone:

E Mail: