Actuarial Model Governance
A Survey of Actuarial Model Governance and the Industry Evolution

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Caveat and Disclaimer

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Section 1: Disclaimer of Liability

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Section 2: Executive Summary

The life insurance and annuity industry is moving toward increased demand for projection-based models used for reporting and management decision making. In this new environment, the high reliance that companies and regulatory agencies place on modeled results will require a well-developed, monitored and maintained control framework to ensure the quality of all models and supporting processes.

A team from Deloitte Consulting LLP, led by Jason Morton and Thomas Chamberlain, 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 (POG). Through a combination of an online survey and follow-up discussions with survey respondents, the current state of actuarial modeling controls within U.S. and Canadian life insurance and annuity companies was established. The current state was then compared to prior research conducted in 2012 in the report "Actuarial Modeling Controls: A Survey of Actuarial Modeling Controls in the Context of a Model-Based Valuation Framework" to highlight the evolution in actuarial model controls and governance over the past four years. After reflecting on the current state and recent developments, the report provides an industry assessment and proposes considerations for enhancing the current state toward a well-controlled governance framework.

2.1 Overall Results

In conducting this research project we found a wide variety of actuarial model governance components and controls currently in place in the industry. As a summary, we compared the findings to the industry "scorecard" from the 2012 survey. 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	2012 Score	2016 Score	2016 Current State Synopsis
Governance Standards	3	2	Many companies have developed and implemented a formal, holistic model governance framework covering several of the components addressed in this report.
General Modeling Process	3	2.5	Companies are consolidating systems, but there are opportunities to redesign processes and utilize technology to govern and control actuarial modeling processes.
System Access and Change Control	4	2.5	Many companies have implemented formal change control processes, but projection models are still less controlled than valuation models.
Model Assumption Management	3	2	Formal assumption management governance and processes are in place, but assumption storage and input are still highly manual.
Model Input Management	2	2	Many companies use automated feeds from administrative systems for model inputs of liabilities. Other model inputs are often less automated.
Model Output Management	2	2	Model output used for financial reporting purposes is generally well controlled, while model output for analysis and other purposes is generally less controlled.
Organizational Design	n/a	4	Companies are developing the appropriate roles, responsibilities, processes and technology to maintain effective actuarial model governance while also becoming more efficient

2.2 Model Governance—Effective and Efficient

Figure 1 depicts the progression of actuarial modeling controls within the industry. When the first survey was administered in 2012, the report indicated that most companies were in the initial stages of developing model governance standards. The focus was on "what" to implement to meet the enhanced model governance demands.

Based on this most recent research, we have observed actuarial model governance has matured across the industry. Companies have done significant work during the last four years and are establishing more robust actuarial model governance and control frameworks. With all this effort, the focus within the industry has started to shift toward "how"—how to implement actuarial

model governance in a way that is robust and effective, but also efficient and sustainable. Actuarial model governance is essential, but for the industry to reach a mature state, actuarial model governance will need to become more efficient and embedded within companies' processes, technology and culture.

Figure 1: Model Governance Maturation
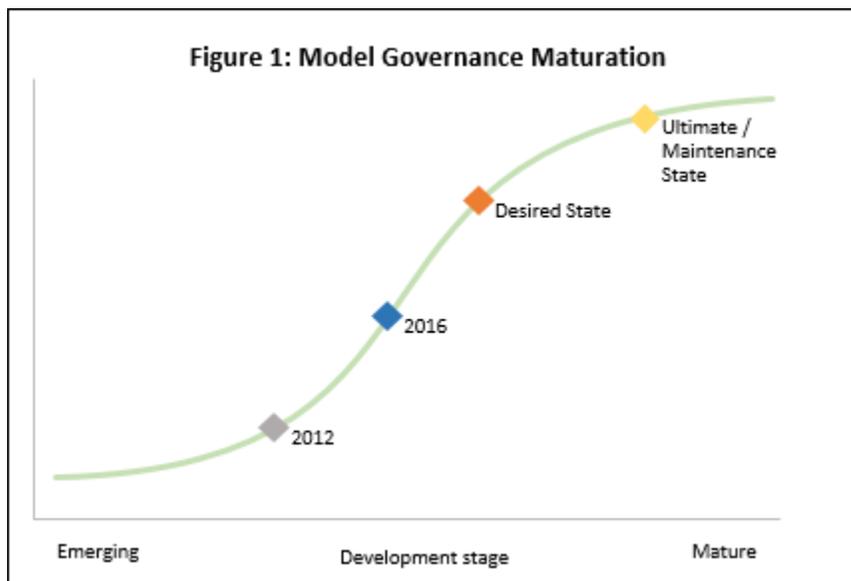
In reviewing the results for the 2016 study, two common themes emerged—themes that are consistent with the maturity of actuarial model governance within the industry, where companies have implemented actuarial model governance and are now looking to optimize what is done:

- **Efficiency**. The demands of a robust, formalized governance framework have constrained organizations' time and resources. Almost all companies, both small and large, expressed the need for more resources to accomplish governance goals. Organizations are being asked to do more without significant additional resources, so companies are looking for ways to increase efficiency, such as enhanced automation or partnership with IT.
- **Consistency.** Organizations are striving toward consistency in assumption, methodology and documentation requirements. The creation of committees and risk groups will help facilitate consistency across organizations.

In addition to the common themes, additional observations can be made based on the analysis of the survey results and interviews:

- Governance frameworks have become more formalized over the past four years to ensure the modeling process is well-controlled and repeatable. Management has been a key driver at organizations recognizing the increased need for governance to ensure models used for making financial decisions can be trusted and relied on.
- The organizational design of companies has changed to accommodate the increased demands of governance requirements. Many organizations have hired new personnel or created new roles to address their needs.
- The governance and controls surrounding valuation reporting tend to be more robust than projection-based models. As the industry is moving toward projection models, companies should standardize actuarial model governance across all actuarial functions regardless of model purpose.
- Model assumption management has seen a greater focus as compared to model input or output management. Many organizations have created assumption management committees to formalize the assumption management process.
- Information technology (IT) involvement in the modeling process is still 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.

In each section of the report, we have identified the industry assessment and the next steps to move toward leading practices in which actuarial model governance is both effective and efficient. The leading practices represent those implemented by some organizations but not yet widely adopted throughout the industry. These steps are summarized here and elaborated on in more detail throughout the report:

- Use a risk-based approach for actuarial model governance that prioritizes and aligns governance requirements with the largest risks
- Redesign modeling processes to embed actuarial model governance and controls and eliminate manual processes
- Partner with IT to leverage IT solutions and skill sets for modeling process automation, controlled modeling environments, model development and model testing
- Consolidate actuarial modeling systems and platforms where appropriate
- Centralize components of the modeling process (inforce files, assumptions, production runs, etc.) where significant similarities exist
- Require reported results to come from a model that is governed by robust change control processes
- Centralize storage of assumptions, model input and output
- Align skills with roles and responsibilities and regularly review as model governance standards mature

Section 3: Survey Method

This research project was performed via use of a survey, carried out by Jason Morton, Thomas Chamberlain, Charles Deak, Katie Egan 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 the Project Oversight Group (POG).

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 that volunteered to participate in a live meeting.

3.1 Online Survey

The 2016 online survey consisted of 52 core questions, spanning seven key aspects of the actuarial modeling process. Depending upon the way in which core questions were answered, additional questions were asked. Similar to the 2012 online survey, the 2016 online survey was developed by the research team and circulated for review by the POG. The online survey was administered using the Qualtrics system. Online survey results were collected during March through May 2016. The survey was delivered electronically to actuaries representing 150 life and annuity companies in the United States and Canada. The distribution list was compiled from the SOA's member database, identifying primarily Chief Actuaries and Appointed Actuaries. The survey was also distributed to the SOA Modeling Section. Although the research team distributed the survey to specified actuarial contacts 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 from 56 unique companies to the online survey.

3.2 Follow-up Discussion

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

1. To clarify respondent interpretations of online survey questions
2. To better understand the rationale for the manner in which certain responses were determined
3. To more precisely itemize the controls in practice

Of the 56 responses to the online survey, more than half of the companies (29) volunteered to participate in a follow-up discussion. We conducted the follow-up discussions according to a discussion agenda which was developed to ensure the consistency of the covered topics. Each discussion was facilitated by a moderator along with support from other survey team members. Notes of the discussion were taken and summarized by team members to go back to the company with any additional questions and to include specific examples in this report.

# Section 4: 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 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 on the current state of controls: size, product lines and accounting regimes. Leading practices, and the movement toward leading practices, will have different implications for each company within the industry. It is expected that actuaries reading this report will have their own "viewing lens" that is based upon their company's size, culture, constraints and the level of sophistication required, but 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 sub-segment of the industry.

4.1 Data

4.1.1 Industry

Consistent with the 2012 survey, the majority of companies participating in this survey are life insurance and annuity companies, while the remaining respondents are multiline insurance companies (Figure 2). 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 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
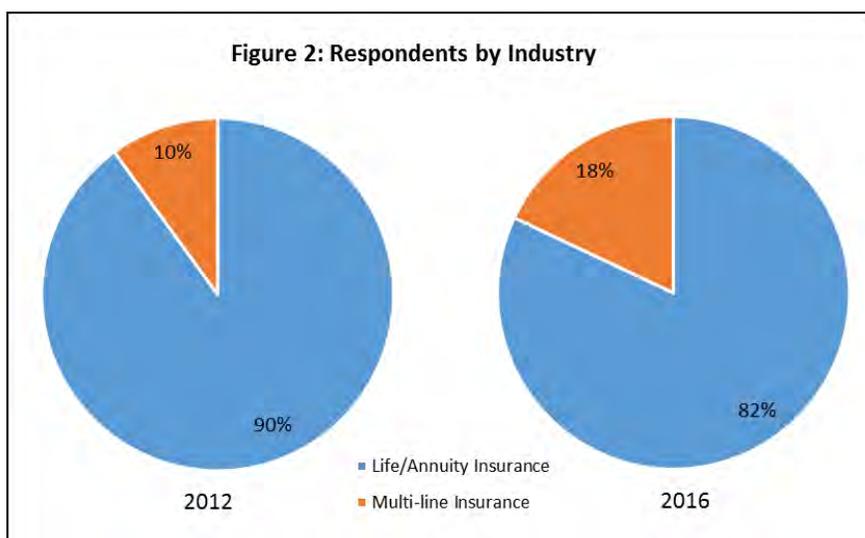
4.1.2 Geographic Distribution

Approximately 80% of the respondents are U.S.–owned companies with most of their operations in the United States. Several U.S.-based and Canadian-based companies noted operations in various other countries. In addition to the U.S. respondents, we also received responses from Canadian-owned, Japanese-owned and U.S.-based subsidiaries of companies with European or Japanese parents (Figure 3). The diversity in geography is valuable, because 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
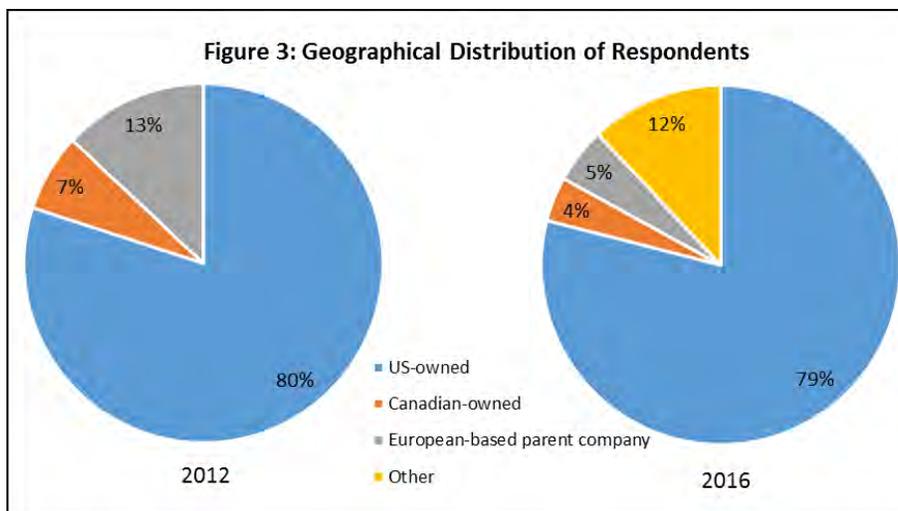
4.1.3 Company Size

The companies that participated in the survey represent a cross section of different sizes. The 2016 survey had a majority of responses from companies characterized as large (greater than $25 billion of assets), whereas the majority of the respondents in 2012 were characterized as midsize (between $1 billion and $25 billion of assets) (Figure 4). Approximately three-fifths of the companies responding to the 2016 survey have assets over $25 billion, one-third have assets from $1 billion to $25 billion, and only one-tenth have assets less than $1 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
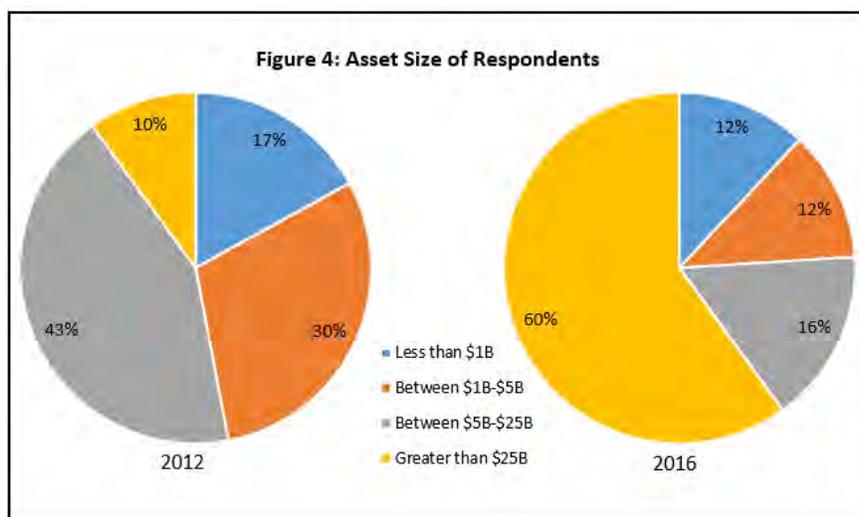
4.1.4 Company Type

The mix of respondents between public, private and mutual/fraternal companies is evenly split during the 2012 and 2016 surveys. Of the responses, 26% are public companies, 44% are mutual/fraternal companies, and 30% are privately held stock companies (Figure 5). Thus, the companies contained within the survey have been subject to Sarbanes-Oxley (public) as well as Model Audit Rule controls.

Figure 5: Type of Company
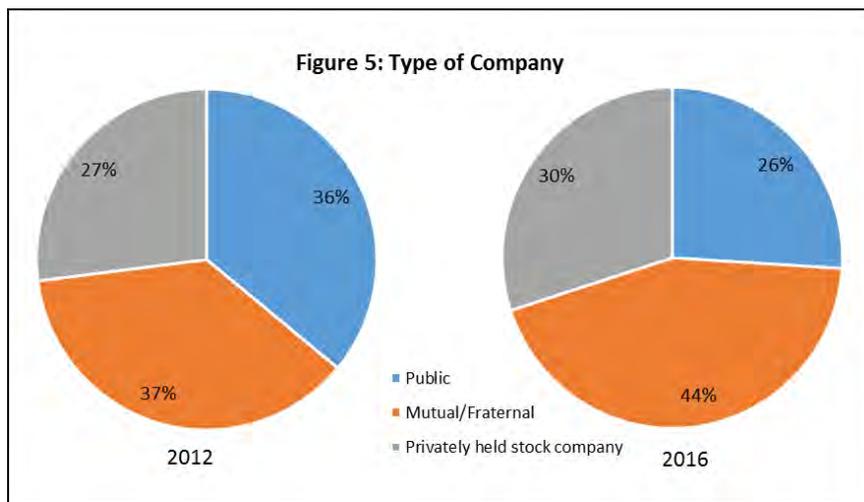
Section 5: Survey Results and Analysis

The body of the report is structured according to key components of the actuarial modeling process and is consistent with the structure of the online survey. Each section discusses survey results, changes since the 2012 survey, leading practices and overall maturity of the industry with respect to actuarial modeling governance and controls. The sections are the following:

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

Within each section, we provide an analysis of the current state of actuarial model governance and controls, combining data collected from the online results and follow-up discussions. Where meaningful to do so, we stratify results to allow for a greater depth of understanding.

Note: Because of the designed anonymity of the online survey, we cannot comment on the number of respondents who participated in both 2012 and 2016 with certainty. However, to baseline the responses, in our follow-up interviews we discussed improvements in model governance over the last several years with all participants.

Section 6: Governance Standards

Model governance standards are playing an increasingly important role in the life insurance industry as regulators and company management continue to recognize the potential risks of actuarial models. Model governance standards have allowed companies to create a formal framework and holistic application of actuarial model governance throughout the modeling process, including development of data and assumptions, management of calculation engines and review of output and results. Formal model governance standards also support consistency throughout the organization and communication of risks and risk management strategies.

Over half of the respondents to the survey indicated that model governance standards have helped their organization to identify and correct a model error prior to reporting results; this indicates that model governance standards are providing material value to companies.

6.1 Current State and Recent Developments

The prevalence of model governance standards has improved since 2012. In the most recent survey, 75% of participants indicated they have formal, written governance standards in place, up from 50% in the previous report (Figure 6). In follow-up discussions, companies indicated that they were at various steps in the process of implementing formal standards, which drove the strong interest and participation in the survey. Smaller companies still lag when compared to larger companies in implementing formal model governance standards, but they have made significant progress.

Figure 6: Formal Governance Standards by Company Size
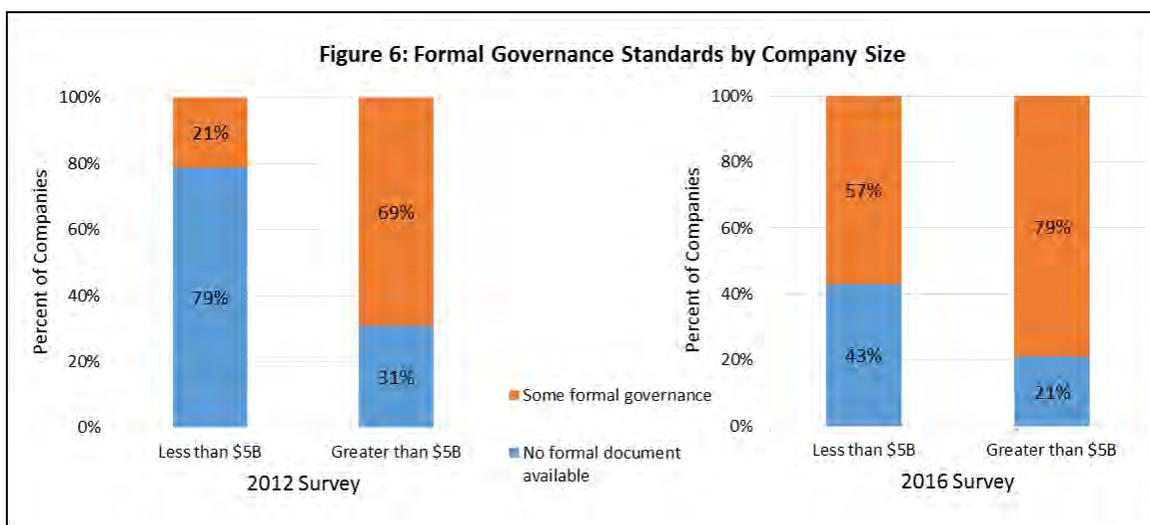
The drive to implement governance standards is most often coming from company management as noted by 75% of survey participants. It is likely that management is being influenced by the regulatory environment and external auditors, but company management within the industry generally appears to recognize the value of model governance.

There appears to be increased standardization across the industry as to what is included in the model governance standards. Almost all model governance policies address model change management and model validation, and a majority of the policies also include standards for model development, documentation, peer review and roles and responsibilities (Figure 7).

Figure 7: Elements of Formal Governance Documentation
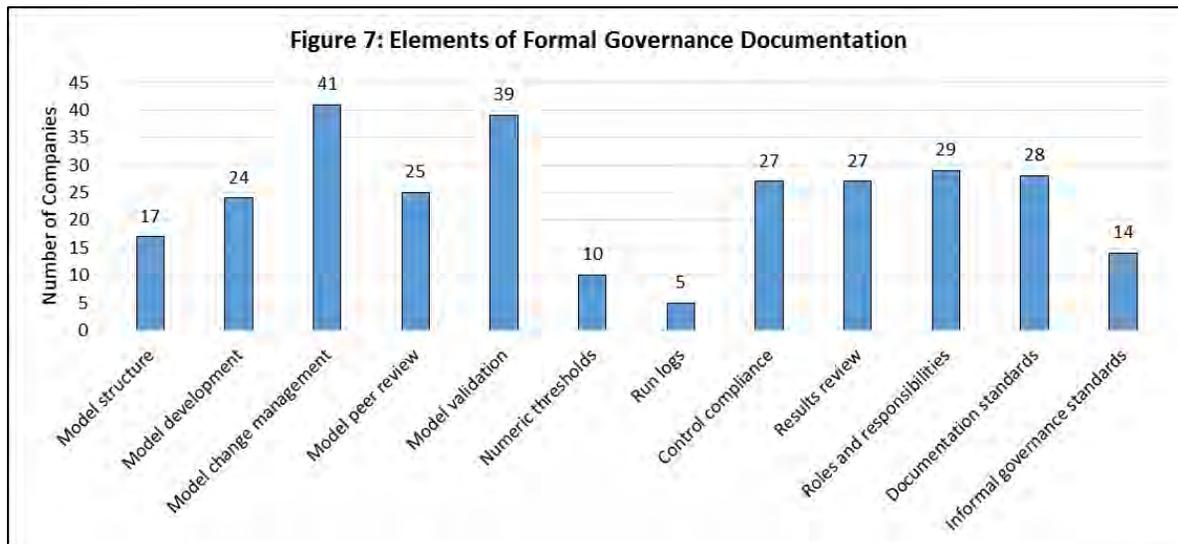
Larger companies that have formal governance standards most often characterize them as guiding principles as opposed to prescriptive requirements. The governance standards are often implemented across the enterprise, and it is left to the individual business units to determine the specifics on how the standards will be implemented. In follow-up discussions, many respondents noted consistency of actuarial models, as well as consistency of governance standards, as a concern. Letting individual business units or modeling areas interpret actuarial model governance requirements may drive inconsistency between models. On the other hand, smaller companies mostly noted that they have more prescriptive formal governance standards that are used to fulfill audit requirements, and the standards are updated on an as-needed basis.

Substantial gaps still exist between the application of governance standards for valuation models and those for projection models used in pricing, ALM or forecasting. Clearly, valuation models directly impact financial statements, but the industry may be underestimating the potential risks from other types of models, such as mispricing products, making suboptimal investment decisions or implementing management decisions based on faulty forecasts. As noted above, our follow-up discussions were with a variety of individuals with different roles and responsibilities (e.g., model stewards, members of risk committees, projection model managers). Our conversations solidified these points because many were either unaware of how model governance was applied outside of their respective areas or noted that valuation had stricter standards.

6.2 Leading Practices

The life insurance industry has matured in its understanding of actuarial model governance and controls. The report in 2012 focused on defining model governance standards: what components should be included in model governance standards, and what techniques should be used to implement those governance standards. With this latest analysis, the key question in the industry has shifted to "How can model governance be implemented most efficiently?" Companies are being asked to do more within more robust actuarial model governance frameworks, but many companies do not have additional resources for model governance, so optimization is critical.

Organizations that are tackling the question of efficiency in model governance standards are using a variety of techniques that will be discussed throughout this report. As it relates to the governance standards themselves, one of the key components is developing a risk-ranked inventory of models to ensure the level of effort required by the governance standards is consistent with the level of risk of a particular modeling process. In general, more robust model validation procedures are reserved for the riskiest models, whereas less rigorous methods such as peer review or results review are used more widely. This allows the company to dedicate time and resources more effectively, focusing on bigger risks rather than completeness.

More mature model governance standards have also streamlined model documentation requirements. Model documentation standards received some of the lowest ratings for effectiveness of all the model governance standards components. Many companies indicated that improved documentation is a priority, but few were spending effort on this initiative. Companies that were optimizing model documentation standards clearly defined the uses for additional documentation within the model governance framework and then aligned the content, detail and effort for the documentation with those goals. Documentation is also incorporated throughout the governance process as opposed to being a stand-alone process. Several benefits can result from improved documentation practices such as promoting understanding of the model purpose and design and identifying limitations to reduce duplicative effort, providing a cohesive document that supports the model validation processes and requirements, and having a prepared audit trail of model enhancements for management and any external parties.

Other leading practices related to formal model governance standards include the following:

- Applying model governance standards to projection models as well as valuation models
- Regularly updating and reviewing model governance standards to ensure they are meeting the needs of the organization
- Maintaining a model inventory and risk rating as part of an overall risk function to drive the rigor of controls and validation procedures
- Well-defined model governance policies with owners and accountability
- Explicit reference to and use of the standards in review and oversight processes, such as checklists or signoffs based on the standards or using the standards as a component of internal audit processes
- Formal plans for enhancing actuarial model governance initiatives

6.3 Industry Assessment and Next Steps

The focus for the industry to take the next step in maturation of governance standards is to:

- Focus on optimization and efficiency and
- Draft detailed plans to achieve targeted governance initiatives.

As an industry, significant improvement has been made in developing and implementing formal model governance standards. This is an important step in ensuring management has confidence in actuarial model results and in developing corporate cultures that align with the governance policies and values. It is also better positioning the industry for increasingly complex regulatory updates, such as FASB Targeted Improvements or Principles-Based Reserves.

As actuarial model governance standards mature, they will need to become more streamlined and efficient, so that companies can optimize the benefits gained from their actuarial model governance framework. The process of developing model governance standards and translating those principles into detailed implementation should be iterative. Reviews of the model governance process should look for areas where governance needs to be improved, but also areas where there is redundancy or where governance is not appropriately aligned with the risk.

Incremental improvements in actuarial model governance are happening across the industry, but companies that are taking significant steps toward more efficient actuarial model governance are doing so through targeted initiatives. These initiatives have specific goals about how the organization wants to improve an aspect of governance such as controls, documentation, analytics or change management, and the initiatives include a detailed plan for achieving those goals. Key milestones are mapped out so a periodic assessment of progress can be made.

Section 7: Modeling Process

Actuarial modeling processes across the industry are largely similar in the overall approach, but differ in the specific technology platforms, actuarial modeling systems and organizational design setup to support the actuarial modeling process. There is not a one-size-fits-all actuarial modeling process; different organizations have varying types of business, priorities, company cultures and actuarial modeling requirements, all of which influence the design of the actuarial modeling process. Governance of the actuarial modeling process needs to be customized to address the risks of a particular modeling process design.

7.1 Current State and Recent Developments

Based on survey results, actuarial models for valuation and projections are most often maintained on a network server or in a modeling environment maintained by IT (Figure 8). This is an improvement from 2012, when the majority of actuarial models were still maintained on desktop applications. Pricing models are still as likely to be a desktop application as stored on a network.

Figure 8: Modeling Environment
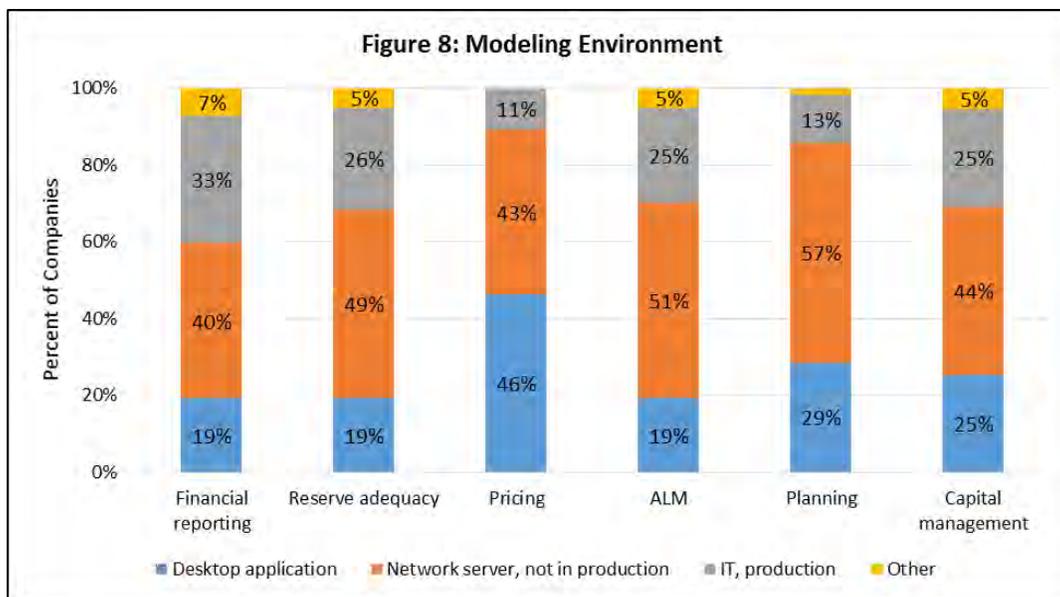
A variety of modeling platforms are still in use across the industry, including both modeling software maintained by third-party vendors as well as home-grown modeling platforms and open and closed systems. In open systems, the user can access the modeling code to make changes, whereas in closed systems, coding changes need to be made by the vendor. Closed systems are still most often used for valuation, and open systems are used for projections and pricing.

In follow-up discussions with participants, several companies indicated they are in the process of consolidating actuarial modeling systems. The goal is not necessarily a single modeling platform, but at least fewer modeling platforms. Companies can spend less time reconciling results across systems, and controls can also be streamlined, as they can be consistently applied across models. Companies also noted that utilizing more than one platform was necessary for their business because of limitations within the various available actuarial platforms.

There appears to be little change in how updates are completed with third-party software. They continue to be primarily led by the Actuarial department on an as-needed basis. Regular updates to vendor systems across all modeling functions are considered leading practices. Risks introduced by having models that significantly lag the latest versions from vendors include not updating for vendor-identified errors, missed opportunity for more robust functionality and inconsistency between versions across the organization.

Excel continues to be an important component of the actuarial modeling process, both as a model itself and as a tool supporting actuarial models. The effectiveness of Excel controls is much lower than those for other types of actuarial models, and primarily consist of peer review. An actuarial modeling process is only as controlled as the weakest link, and, therefore, the controls around Excel spreadsheets should not be overlooked. Through follow-up discussions, we found that spreadsheets that are used for financial reporting had more robust and formal controls such as reconciliation to previous reported values and storing spreadsheets used for reporting in a locked-down location (Figure 9).

Figure 9: Controls on Stand-Alone Spreadsheets
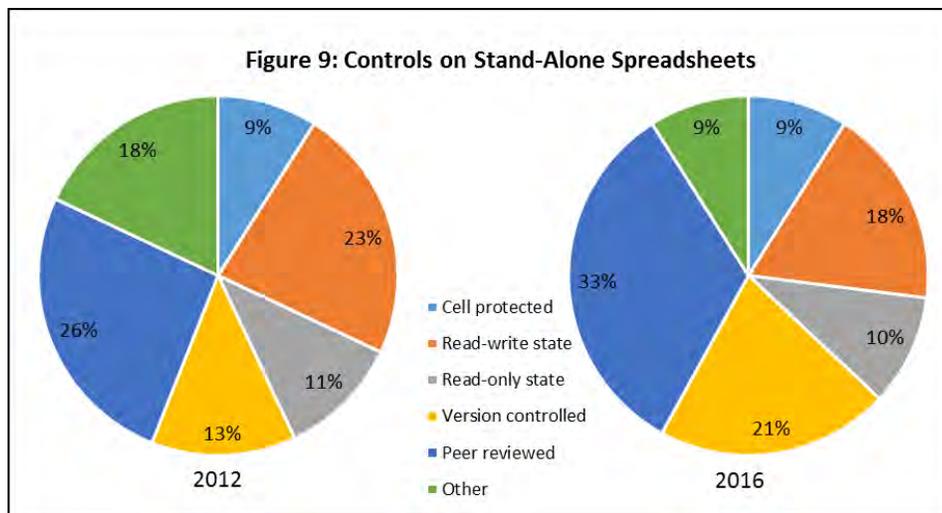
7.2 Leading Practices

Although actuarial modeling platforms differ, leading practices across the industry include streamlining model governance and controls through consolidation of actuarial modeling systems and through the use of technology and automation.

In general, companies that had implemented leading practices are taking advantage of control functionality already in place from IT or embedded within actuarial modeling software. Companies using an IT-controlled modeling environment can more easily automate components of the modeling process, including model controls such as system compares or run logs. Companies that maintain models in a centralized, IT-controlled environment have the framework to support more robust model change controls, to promote transparency of model runs, and to automate feeds to and from actuarial models.

There is a need to minimize manual intervention and the use of Excel components within the modeling process to provide greater control. Excel is a powerful analysis tool, but sufficient controls are not often in place to use it as a component of the actuarial modeling process.

7.3 Industry Assessment and Next Steps

The next steps to evolve toward leading practice modeling processes are the following:

- IT-controlled modeling environments
- Actuarial modeling system consolidation
- Process improvement and automation

System consolidation can be a critical component of improving actuarial model governance and controls, but it is not automatically the case that fewer modeling systems result in improved model governance. When converting actuarial models, companies often try to replicate old processes or reuse the same controls without thinking through their new modeling processes holistically, resulting in redundant or ineffective actuarial model governance. Instead, companies should take advantage of system conversions to think about the end-to-end processes, model controls and automation. Actuarial model governance and control should not be an afterthought to a model conversion, but should be integral to the actuarial model design and implementation.

Enhancing actuarial model governance and control through automation and technology will require more partnership between actuaries and IT. Utilizing IT resources to control actuarial modeling environments, processes and systems can free up actuarial resources for more analysis without compromising actuarial model governance.

Consolidating actuarial systems is not the only way to streamline the actuarial modeling process. In instances where multiple actuarial models are desired or required, companies can leverage components of the actuarial modeling process across actuarial

models. For example, automating input file creation, standardizing assumption sets or sharing product features across actuarial modeling processes can support enhanced consistency and control. This is illustrated in Figure 10, where the horizontal bars illustrate certain modeling process components that can span multiple types of models.

Figure 10: Leading Practices for Modeling Process
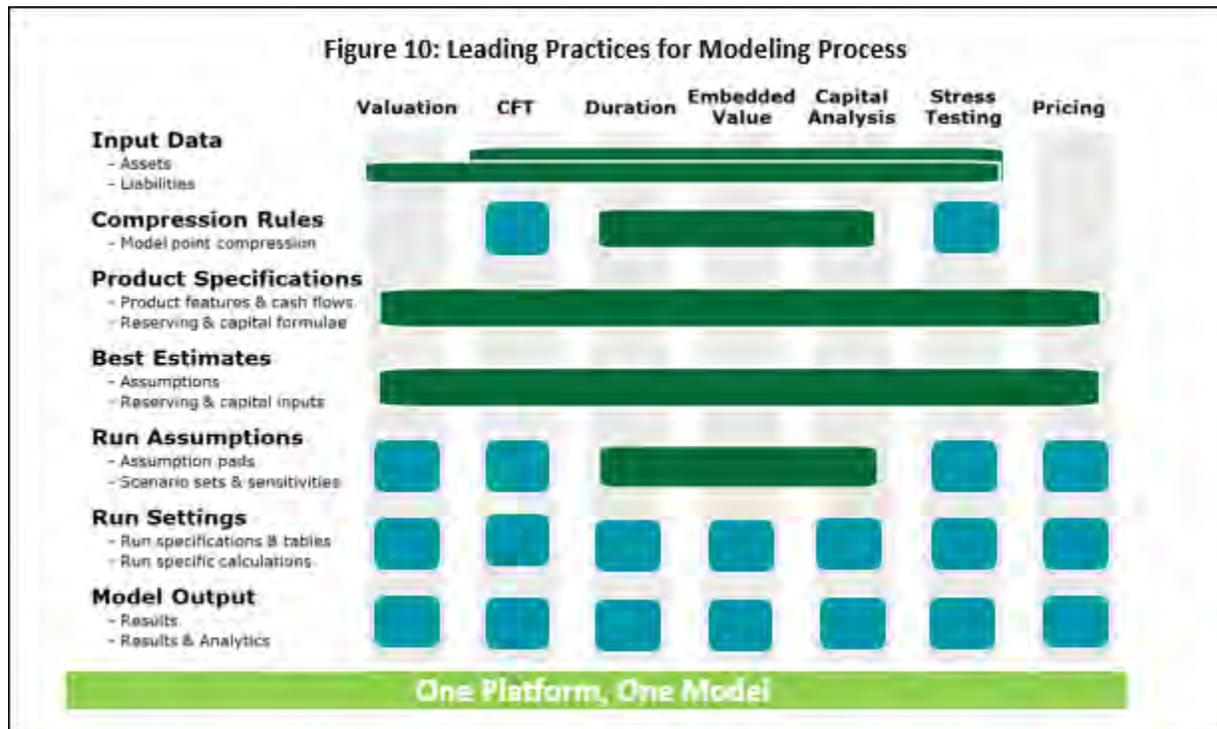
Source: SOA 2015 Valuation Actuary Symposium Session 69 PD, Improving Model Efficiency through Model Platform Consolidation and Design, Corey Carriker

Section 8: System Access and Change Control

Change control is a systematic approach to managing all changes made to a model or actuarial system. The purpose is to ensure that no unnecessary changes are made and that all changes are documented and approved. Granting different levels of system access is one such control that ensures a model or certain aspects of a model are modified only by the designated personnel with proper authority. Through effective system access guidelines and change control practices, the integrity of a model can be maintained while allowing necessary flexibility.

8.2 Current State and Recent Developments

8.2.1 System Access

It is common practice across the industry to limit system access to actuarial models to only the actuarial staff. Depending on the company's modeling environment, system access can be limited through software installation, differentiation in software licensing (read versus read/write privileges) and/or limiting access to the server or folder storing the model.

Nearly all the survey respondents grant different levels of access to key actuarial systems. During our follow-up interviews, we found that the system access is generally controlled by IT with authorization and approvals required from the responsible actuarial area or model owner. The two most common types of access differentiation are read-only and read-write access. The degree of access limitation tends to correlate with company size and the degree of centralization of the modeling function.

8.2.2 Change Control

Several different types of changes can be made to a model. The most routine changes are in updating the model to reflect the current in-force and valuation date. The controls for these types of model changes are addressed in the model input section.

The non-routine changes that tend to be more complex in nature and therefore necessitate a defined process to consistently execute to ensure proper control. These types of changes may involve a revision to existing coding methodology, creating an entirely new model or adding a new variable to allow for model enhancements and revisions.

Of the survey respondents, approximately 80% stated they had change request procedures in place for revisions to production models. This is a significant improvement from the 2012 survey, where only approximately 40% stated they had change request procedures. The majority of the survey respondents this year stated that changed requests were documented, communicated to modeling function and formally approved or signed off (Figure 11).

Figure 11: Type of Change Control Processes
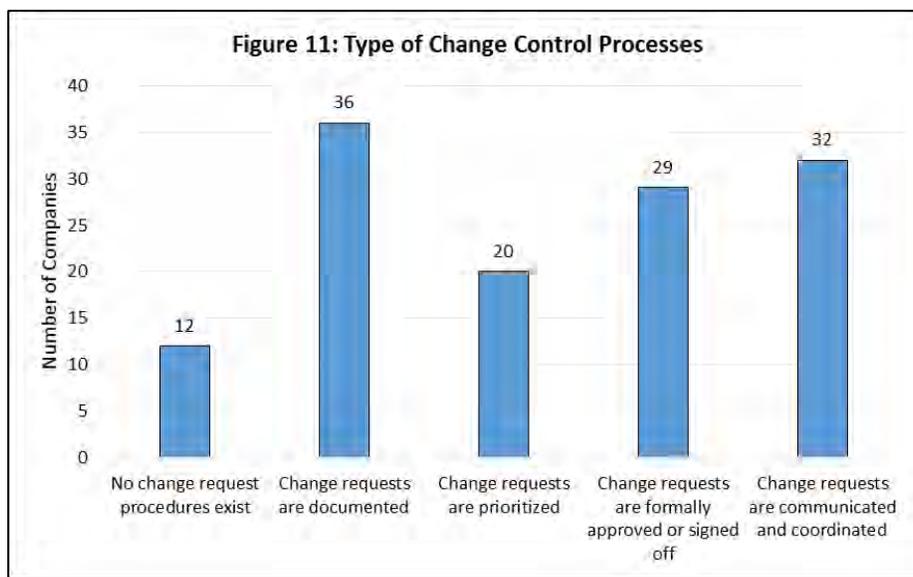
During the follow-up discussions, we learned that a few companies are utilizing third-party software to help manage the change control process. The software packages are well-established professional management packages that historically have been used in IT development. In the application of actuarial modeling change requests, the software is used to initiate the change request, communicate change requirements, document and approve.

Over half of the respondents do not have a process in place to ensure that the model-generated results are not based on models changed in an unauthorized manner. The primary risk of not setting forth controls over the change management process is the risk that model changes may go undetected. Creating a process to prevent unauthorized changes will help to gain more confidence in models used for management decisions.

The common themes in the change control process identified during our follow-up discussions were related to how the production model was reviewed before accepting and approving the change. The common practices included software comparisons, regression testing, attribution analysis and prior period results replication.

Throughout the change control process and consistent with observations made throughout the survey, the level of IT involvement is limited. The Actuarial area is typically responsible for creating the change requirements and development of code changes. Where we did see IT involved is in the final stage of the process when the model change is integrated into the production model and released for use.

8.3 Leading Practices

Improvements have been made toward change management and system access controls since the 2012 survey. The most notable progress has been in the formalization of the change control process. From our research, we noted a 40% increase in the number of respondents with change procedures in place for revisions to production models. Companies with leading practices maintain a log of requested changes within software as noted above. The log is discussed with stakeholders, and tasks are prioritized. Specs, requirements and examples are provided along with change requests to provide transparency to the model developers. The use of test environments to perform coding changes that separates production results and testing results has grown. Last, testing is performed by developers and model users with formal sign-off and documentation before integration into the production model by IT.

Little movement was seen in the controls in place to ensure the model-generated results are not based on model changes in an unauthorized manner, the process for implementing model design, and coding changes or formal code integration process. Many participants noted informal controls such as reconciling to prior results. Leading practices should include formalizing these controls as well as a secure location of the prior production model and the current production model that is locked-down once production begins.

Setting up modeling infrastructures with system access controls is an effective way to help manage change controls around production models. Based on our research we saw leading practice to grant system access to specific tasks or roles for model users. This ensures that only those personnel approved to make model changes are making the changes, and helps with segregation of duties.

8.4 Industry Assessment and Next Steps

Next steps to evolve toward leading practice in system access and change control are the following:

- Enhance change control processes for projection models
- Require reported results to come from models that are subject to robust change control processes
- Utilize IT for model coding and testing

We found that the majority of companies have more robust and formal change control processes in place for financial reporting, but projection-based models are lagging. In an environment moving toward projection-based modeling, the need for a well-defined change control process across all modeling purposes is essential. The immediate action item for the industry is to bring the change control processes for projection models up to the standards used for valuation models. Projection models may need more flexibility, but that should not be at the expense of effective change control standards.

The change control process ultimately needs to be embedded in the culture such that models are not used if they have not gone through the appropriate process. Having robust change control processes is important, but that is most effective if the reported results are required to come from only the controlled models.

IT should be utilized more in the change control process. Change control processes are a core function of software development cycles, and utilizing IT in the change control processes for actuarial models leverages that expertise. In the follow-up discussions, we found companies with efficient change control processes had often inserted the IT function primarily in the coding (model building) and testing roles. The ability to successfully transfer actuarial coding or model building has been a challenge in some organizations, but the keys to success have been well documented business requirements and using someone in the role of a translator to convert the actuarial expertise into IT language. If the industry is able to make better use of IT, this will free up actuarial resources to focus on other aspects of model governance that require actuarial specific skill sets.

Section 9: 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.

9.1 Current State and Recent Developments

Many companies have control processes in place to test the accurate input of model assumptions, including adjustments and modifiers to certain assumptions. The survey respondents rated the effectiveness of the assumption controls by model purpose, and the results did vary by modeling purpose, but in general most companies rated the effectiveness of controls to be above average to average (Figure 12). In reviewing the results by purpose, the number of respondents rating themselves above average increased from the 2012 survey, where only 29% rated themselves above average. (Note that the 2012 survey did not break out the question by modeling purpose, so we are extrapolating the result.)

Figure 12: Effectiveness of Assumption Control
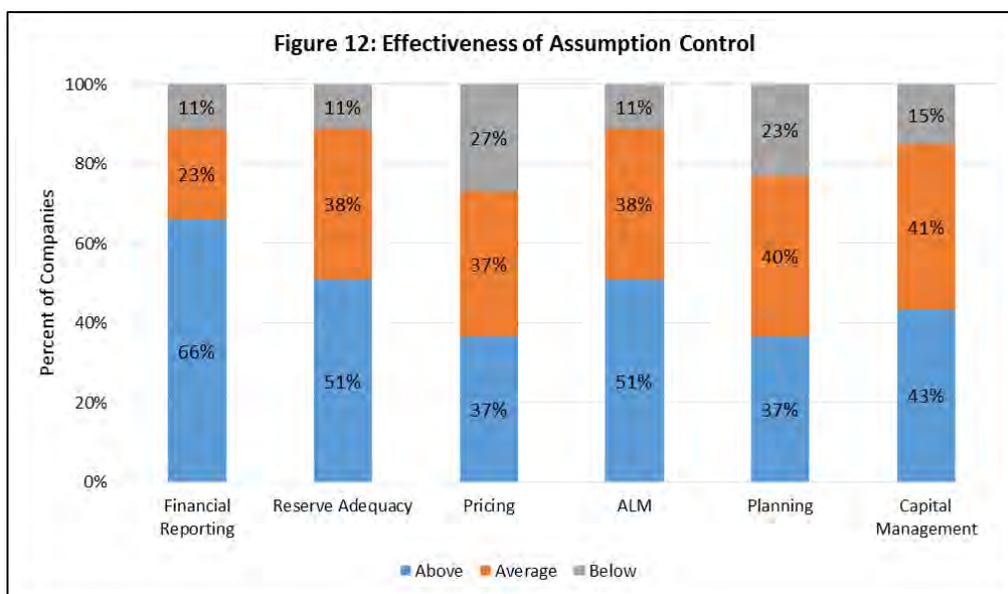
9.1.1 Assumption Review and Approval

The majority of survey respondents, 77%, which is up slightly from 2012, have a specific calendar review cycle. The most common frequency we heard was annually for key assumptions and less frequently for less material assumptions. Several companies considered in their schedule the criticality and materiality of each assumption to set the calendar review period.

Through our follow-up discussions, we learned a majority of companies handle the assumption review and approval process centrally through an assumption governance committee. The responsibilities of the committee varied by companies on the level of involvement. For example, some committees were responsible for the assumption-setting processes from experience study, analysis, recommendation and financial impacts. At other companies, the committees were more of a governing body that reviewed the assumption setting process and were responsible only for approval.

9.1.2 Assumption Storage

Of the survey respondents, 45% of companies have a centralized location that houses common assumptions, which is up slightly from the 2012 survey. For those with a centralized location for assumptions, a shared network folder or production databases with system access limitation were the most common storage locations.

In our follow-up discussions, we learned that companies use other solutions to manage assumptions when a centralized location for all assumptions has not been put into place. For example, an assumption steward role was developed so that one individual was responsible for tracking and maintaining all assumptions. This helps to address the controls around assumption management and ensuring the appropriate approved assumptions are being used for each modeling purpose.

The task of designing and implementing a central location for assumptions is not a trivial task. In our follow-up discussions, we learned several companies were in the process of defining and developing a central location. A large investment is required to appropriately define the architecture, system access requirements and change management controls for maintaining assumptions in a centralized location.

9.1.3 Inputting Assumptions into Models

After assumptions are finalized and ready for implementation, most companies follow the same change control processes used for other model development described above. This is imperative because we found most companies manually input at least some of their assumptions directly into the actuarial models. Roughly 75% of survey respondents manually input assumptions, which is consistent with the 2012 survey. Only about 20% of the respondents have scripts that automatically pull assumptions into the actuarial models.

The common types of controls we found in place to ensure accurate assumption input were peer review, waterfall analysis and results validation for reasonableness based on expectations of financial impacts.

9.2 Leading Practices

More emphasis has been placed on assumption management since the 2012 survey was conducted, but through our research we have found that only certain components of the overall assumption management process have been improved toward leading practices. The companies that have implemented an assumption governance committee have benefited from a thorough assumption control process to ensure proper implementation of assumptions. Through our research, we found the leading practices around the roles and responsibilities of an assumption governance committee should do the following:

- Include stakeholders from all modeling areas and purposes
- Monitor emerging experience across the company
- Prioritize and schedule experience studies and frequency of assumption reviews based on assumption risk ratings
- Standardize documentation of assumption reviews, including impact analysis
- Approve and communicate assumption changes
- Implement and test or include formal guidelines for the modeling area for testing protocol

The assumption management process should be the same for all modeling purposes, but we found that financial reporting versus projection-based models had different levels of controls effectiveness. Using the same assumption management process will help to promote internal consistency and controls of assumptions across models. Our research indicated that very few companies have proper controls in place to ensure the assumptions are consistent across product and/or modeling purpose.

Some companies utilized a single model for multiple purposes. The use of one model helps to force the alignment of assumptions, while at the same time also realizing other benefits such as consistency and efficiency.

9.3 Industry Assessment and Next Steps

Next steps for the industry to focus efforts related to model assumption management are the following:

- Consider the assumption management process holistically
- Establish central storage of assumptions and automated feeds into actuarial models

The effectiveness of assumption management controls is rated higher when compared to model input or model output, and through our follow-up discussions we learned that companies are focusing more of their time on controls around assumptions. It is expected this trend will continue with the upcoming regulatory changes. Companies should consider the complete end-to-end process of assumption management—from experience monitoring, studies, approval and implementation—instead of focusing narrowly on the tactical implementation of assumptions into the model. The need for experience study, impact analysis, and assumption documentation and justification is going to become even more important with the new regulatory requirements.

The path toward automation of assumptions will help to implicitly build into the process necessary controls to lock down the assumption management process. This is also an area where actuarial resources can get support from IT to use automated scripts to upload the assumptions directly to production models.

Section 10: Model Input and Output Management

Model input includes data files, model settings and other front-end user aspects of actuarial modeling. On the other end of the modeling process, model output covers the process by which results are extracted from models, templates are populated, and results are reviewed and validated. Through our observations and follow-up conversations, it became apparent that model input and output management boiled down to the following "buckets" to try to avoid models with "garbage in, garbage out" and to avoid wasted time and effort:

- What processes exist before and after a given model task?
- How are data manipulated, fed and stored?
- What validation processes are completed and how often?

10.1 Current State and Recent Developments

Survey participants have rated themselves overall to be adequate with respect to controls around the input and output processes for all modeling tasks. The common theme of more robust and/or effective controls for financial reporting continues to hold true (Figure 13). This jeopardizes the projection modeling process, because the sustainability and repeatability of the model review process can be compromised.

Figure 13: Effectiveness of Model Input Controls
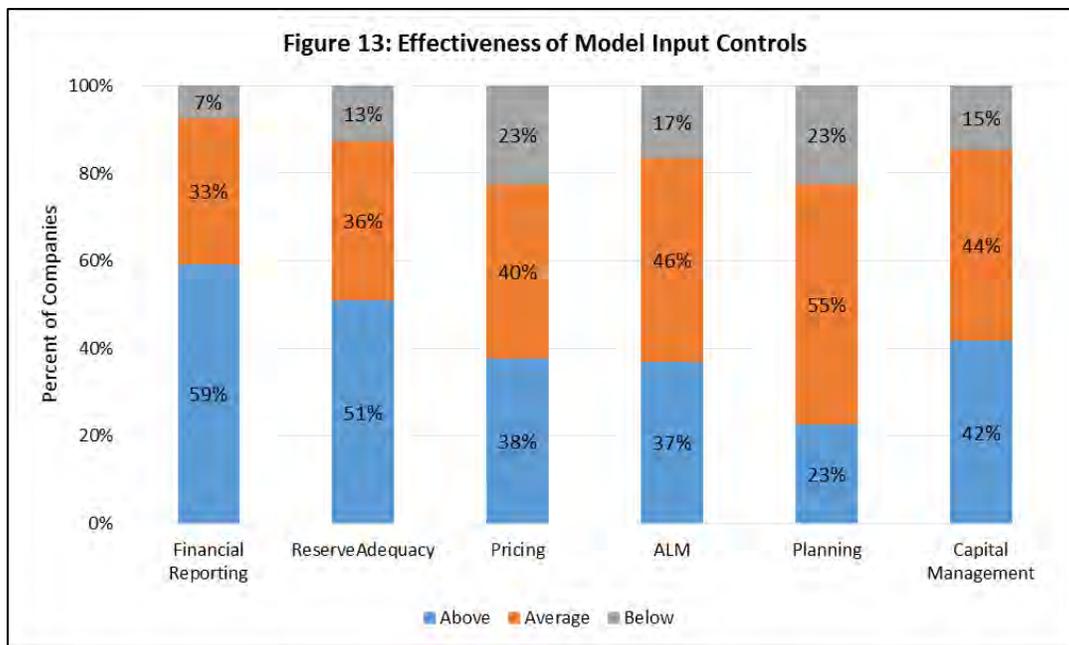
A key theme in the 2012 survey was automation of model input and output and moving away from time-consuming, error-prone manual processes. For each manual process, additional controls are required to ensure the process was appropriately executed. This takes time away from actuarial specialists to produce results and complete analyses.

As seen in Figure 14, overall, the survey data show an improvement in this area for model input management.

Figure 14: How Input Data Are Fed into Actuarial Models
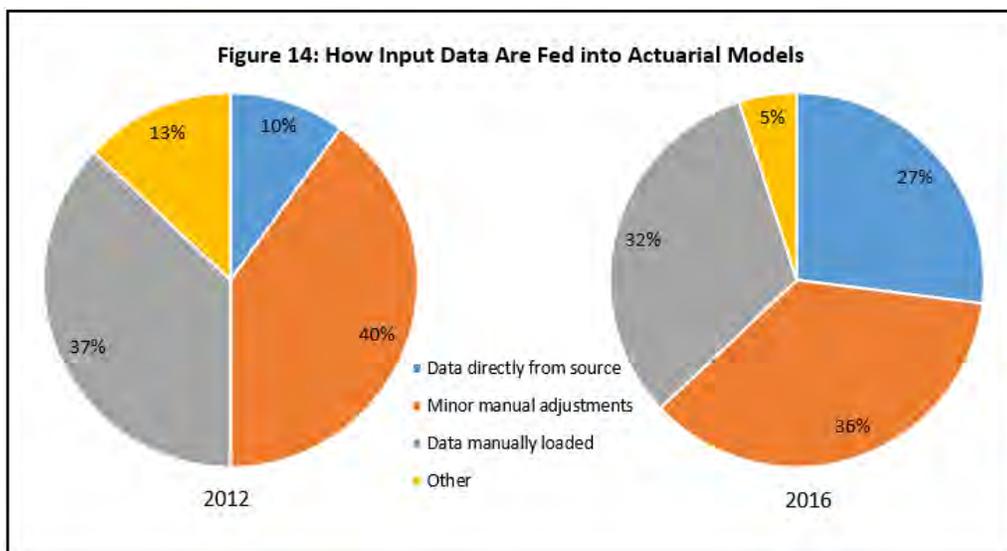
Complex pre-modeling processes such as compression routines are becoming more automated, but there continue to be diverging practices across the industry as a significant number of participants continue to make manual adjustments or manually load data into models.

For model output management, a similar trend is seen. More than half of survey participants noted there are manual adjustments and processes after the model produces results (Figure 15).

Figure 15: How Model Outputs Feed into Reporting Tools
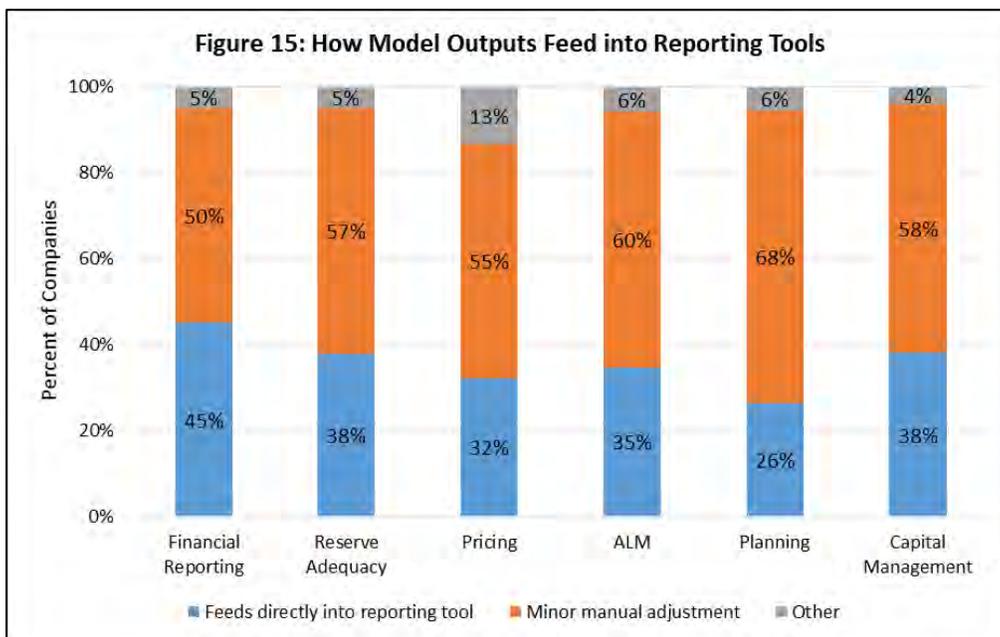
A consideration would be to have predefined reports built in the modeling software that are generated with each model run, thereby eliminating the risk associated with data transfer from software results into other platforms. Among the most tightly controlled results extraction process identified in 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. This arrangement allows the user 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 existing controls structures 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 would need to be controlled, 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).

10.1.1 Controls and Validation

The most common input control is static validation—reconciling policy count, amount inforce and other data fields to the source. This control specifically addresses the completeness of the inforce file. For other inputs (e.g., assumptions, model switches), survey participants noted the use of software comparison tools to see changes between the previous model version and the current model version. Although this control has merit because it would require an investigation of every difference, it is not very practical in an industry that is feeling the constraints of time and resources. Otherwise, controls surrounding model inputs fall into two areas:

- Significant peer review processes in advance of running the model or task. Although 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 because 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. 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, because 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.

Analysis of model results is a control that is more suitable to model output management—in particular, model validation. Although common practices are found such as peer review and single- and cohort-level analytics, the industry's main challenge is allocating time and resources to complete an independent validation. This is particularly true for smaller companies. Generally, larger companies have more staff to complete these procedures, but the procedures are still time consuming due to the sheer size of their business and number of their models. To combat this, companies have developed model inventories with a model risk rating that may be based upon complexity, materiality and other factors referenced above in the Model Governance section. The risk rating determines how often validation procedures are completed as they are crucial for business decisions.

10.2 Leading Practices

The following leading practices were found:

- Automated data feed into a model (inforce, product specifications, actual financial data) obtained from a centralized data warehouse that also supports the finance function

- Automated processes that were previously manual in nature (e.g., updating file names, changing dates) as part of a controlled IT process

- Model output feeds into a centralized data warehouse, and reporting tools are used to create standard and custom reports
  - In cases where this construct is not practical, controls can be put around the result extraction process to ensure completeness, accuracy and consistency. Consideration should be made to allow for some degree of flexibility to be reactive to requests to evaluate data differently.
- Controlled standardized reports are used that read directly from a data warehouse with complete roll-forward from previous results for models that impact financial statements

10.3 Industry Assessment and Next Steps

Next steps to evolve toward leading practice in model input and output management are the following:

- Eliminate manual processes
- Automate data verification processes
- Centralize model input and output

The industry should continue to push automation and eliminate manual processes for both model input and output management. This will allow additional time for analysis and relieve the burden of actuaries completing the modeling process from start to finish. Optimally, all data fed into the model (inforce, product specifications and actual financial data) are obtained from a centralized data warehouse that also supports the finance function. Model output is fed into an environment that is flexible enough for deeper analysis and also has standardized reports that help explain results. For management to have confidence in model results, validation must be a top priority—especially for models that impact financial statements and business decisions. Companies should inventory all models and develop an internal risk rating that will reflect the rigor needed with respect to controls.

Section 11: Organizational Design

As the industry continues to enhance governance surrounding actuarial models, companies must adapt to the demands by making changes to their organizational design. These demands are creating additional responsibilities and new roles within companies. Companies will need to embed governance requirements into future business plans and strategies to ensure they develop and acquire resources to accomplish their governance goals (Figure 16).

Figure 16: Increased Time and Effort of Actuarial Modeling Due to Modeling Governance
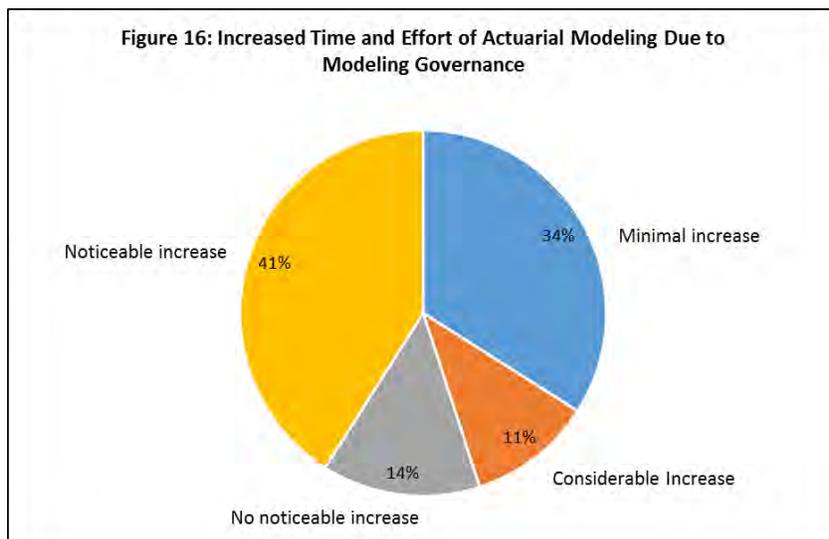
11.1 Current State Assessment

For model governance to be effective, it is important to understand who or what is instigating change within the organization to develop the appropriate culture. As noted above, the industry is recognizing the value of model governance with management noted as the top driver, along with support from regulatory and external requirements. More than half of the companies noted that enhancing model documentation was one of their two top priorities for model governance, which can be correlated with upcoming regulation and external auditor requirements. Over the past four years since the 2012 survey, all but 5% of survey participants enhanced governance at their organization (Figure 17).

Figure 17: Model Governance Changes over the Last 4 Years
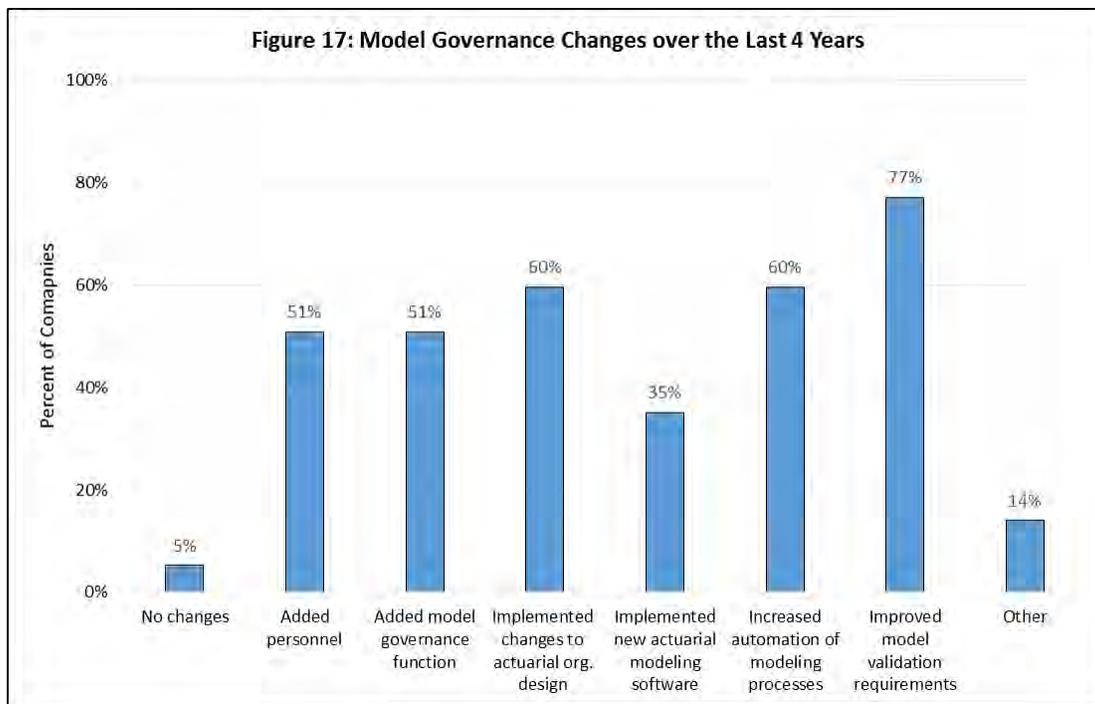
As seen in this table, companies noted a variety of changes within their organizations such as adding personnel, adding a model governance function or specialty group, and reassigning roles and responsibilities. More than half of the companies added personnel to assist with the development and execution of their model governance framework. Even with additional resources, many companies noted that they felt constrained and overwhelmed by the amount of effort required for a robust governance framework.

The second highest priority noted was increasing the automation of modeling process. This aligns directly with optimizing the modeling process. Our expectation would be heavier involvement of other areas in the organization such as IT. The survey data contradict our expectation, because IT is mainly used to maintain the modeling grid and install software, and it is used sparingly in other areas.

11.2 Leading Practices

In our follow-up discussions, it was clear this is an emerging area of focus. As organizations better understand what actuarial model governance entails, they are modifying their organizational design to implement the new roles and responsibilities required. Companies that are leading in this area have the following characteristics:

- They have created a corporate culture in which employees understand the value of and seek to improve governance and controls across all functions, and model governance is a component of roles and responsibilities throughout the organization.

- They have established a working group that specializes in model governance. This group establishes standards and implements model governance throughout the organization, and it can either be stand-alone or sit within a broader risk group.

  o They have strengthened the partnership between IT and actuarial resources. Leading companies either have IT involved within their process or have someone from IT within their business unit.

- They have implemented a model steward role serving as gatekeeper for the production models. Some companies have this role in a single person, but others split the role across multiple people.

- They have separated duties between model builders, model testers and model validation.

11.3 Industry Readiness Assessment

Next steps to evolve toward leading practice related to organizational design are the following:

- Partner with IT to augment resources for actuarial model governance
- Align skills with roles and responsibilities
- Revisit roles and responsibilities as model governance standards mature

As actuarial model governance becomes more streamlined within organizations, accompanying changes should be made to roles and responsibilities. Companies should look at what needs to be done and the skills required to complete those tasks, rather than starting with "how things have always been done." More strategic partnerships of IT and Actuarial, whether it is embedding IT professionals within the actuarial organization or aligning IT professionals with actuarial functions, can provide additional resources and better align skill sets with the types of tasks being performed. This process will be iterative because model governance in the life insurance industry is still maturing.

Although it is apparent from the survey that organizations are changing and adapting to handle governance demands for actuarial models, many companies have informal plans in place to achieve their future model governance states. Through our follow-up discussions, we found many companies have goals but look to accomplish these goals only as time permits and they are not formalized. Without a formal plan, companies run the risk of not accomplishing their goals because they did not plan for enough resources or push them aside for other responsibilities.

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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Jan Schuh, SOA senior research administrator

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Sally Shi
Darryl Wagner
Frank Zang

Appendix B: Actuarial Modeling Controls Survey

2016 SOA Actuarial Model Governance Survey – RSVP 3/31/16

Welcome to the Actuarial Model Governance Survey.

As the life insurance and annuity industries move toward model-based approaches to reserve and capital valuation, as well as management reliance on models for additional purposes, 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 model governance practices and the effectiveness of model controls when compared to the requirements of a model-based framework. Thank you for your participation.

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

- The survey is expected to take 45 minutes to complete, and all respondents are encouraged to answer all 52 survey questions if possible. We recognize this survey is lengthy, but the information contained will provide valuable insights for participants and the industry as a whole for enhancing actuarial model governance.

- It is requested 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 at the end of the survey and provide detail on key differences.

- All responses will be kept confidential and not disclosed or deemed identifiable in any way to anyone other than SOA and Deloitte Consulting LLP staff directly involved with this project. Results shown in the final report will not be attributable to any one participating company.

- The survey requests your contact information for the purposes of contacting you to schedule a follow-up telephone interview if you elect to participate, following up with you for additional information or clarification about a response and distributing the final report to you prior to releasing to the public.

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. Answers can be revised any time prior to pushing 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 click here for a print-friendly version of the survey

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

Interest in a Live Discussion

1. While the survey responses are the foundation for this analysis, live discussions further enhance our understanding of the responses and ability to compare across organizations. Would you be willing to participate in a one hour follow-up interview to provide additional context and clarity for your responses?

    ○ Yes
    ○ No

2. Please provide contact information if you are interested in a follow-up discussion.
    Name:
    Company:
    Work Phone:
    E-Mail:

Demographic Information

3. 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.)

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

4. 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 _____

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

    ○ Less than $1 billion
    ○ Between $1 and $5 billion
    ○ Between $5 and $25 billion
    ○ Greater than $25 billion

6. Is your company publicly-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 an individual user's machine, with the ability to update assumptions and/or formulas.

7. In what sort of environment are models currently run for each of the purposes below? For purposes with models in multiple environments, choose the answer that describes the majority of the models.

	Desktop Application	Network Server, but not formal production environment	IT-Maintained Production Environment	Other
Financial Reporting	○	○	○	○
Reserve Adequacy	○	○	○	○
Pricing	○	○	○	○
ALM	○	○	○	○
Planning	○	○	○	○
Capital Management	○	○	○	○

❑   If "Other" was selected, describe the environment _____

8. For each of the different model purposes, please categorize the models. (Please check all that apply.) Third-Party Open System is defined as a free-form model (out-of-the-box) with the ability to make unlimited formula changes. Third-Party Closed System is defined as a model which limits users' ability to make formula changes. Home-grown is defined as a specialized, internally-developed tool used in the execution of actuarial functions.

	GAAP Reserves	Loss Recognition	Statutory Reserves	Asset Adequacy	IFRS / CALM	Embedded Value	Capital Management	Pricing	ALM	Planning
Third-Party Open System	❑	❑	❑	❑	❑	❑	❑	❑	❑	❑
Third-Party Closed System	❑	❑	❑	❑	❑	❑	❑	❑	❑	❑
Home-grown	❑	❑	❑	❑	❑	❑	❑	❑	❑	❑
Other	❑	❑	❑	❑	❑	❑	❑	❑	❑	❑

9. Rate the level of risk associated with a "key" person leaving your organization on a scale from 1-5 for each of the following model purposes, 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
Financial Reporting	○	○	○	○	○	○
Reserve Adequacy	○	○	○	○	○	○
Pricing	○	○	○	○	○	○
ALM	○	○	○	○	○	○
Planning	○	○	○	○	○	○
Capital Management	○	○	○	○	○	○

10. How long are prior versioned models archived once these models are no longer active?

   ○ Less than 1 year
   ○ 1-2 years
   ○ 2-5 years
   ○ 5+ years
   ○ Until a new production model is approved
   ○ Other (May cover either an indefinite or undefined length of time) _____

11. How frequently is third party modeling software updated to a new release / version?

   ○ As available
   ○ Pre-determined calendar date
   ○ As needed for critical updates
   ○ Other _____

12. Who leads the process of updating software to a new release / version? If you feel there are certain processes which are led by each group, please select "Other" and describe.

   ○ IT
   ○ Actuarial
   ○ Model Governance
   ○ Each model owner
   ○ Other _____

13. How would you categorize the level of control on stand-alone Excel based models? (Please check all that apply.)

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

14. How would you categorize the level of control on spreadsheets that support models? Examples of how spreadsheets support models may include manipulation of model inputs or outputs, creation of model run files, extraction of model results, or back-end calculations based on model results. (Please check all that apply.)

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

Governance Standards

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

    ❑ Model structure
    ❑ Model development
    ❑ Model change management
    ❑ Model peer review
    ❑ Model validation
    ❑ Numerical thresholds
    ❑ Run logs
    ❑ Control compliance
    ❑ Results review
    ❑ Roles and responsibilities
    ❑ Documentation standards
    ❑ Governance standards are informal; no formal, written document available
    ❑ Other _____
    ❑

16. How does your organization use the governance standards? (Please check all that apply.)

    ❑ The standards are detailed and prescriptive
    ❑ The governance standards are high-level and provide guiding principles; application of the standards is determined by model owners
    ❑ The standards are created and rarely revisited; they are used primarily for reference
    ❑ The standards are part of a formal training processes for personnel
    ❑ The standards are regularly (such as annually) reviewed and revised (if needed)
    ❑ The standards are used by internal audit or other governance functions to confirm adherence to the model governance standards
    ❑ The standards are provided to fulfill requests from auditors, regulators, or other external parties
    ❑ Other _____

17. Describe the degree of centralization in your modeling organization for each model purpose. (A centralized modeling organization may include a shared services or center of excellence organizational design in which modeling responsibilities are centralized. Semi-centralization implies some modeling responsibilities are centralized, but many are still decentralized with model owners.)

	Fully Centralized	Semi-Centralized	Decentralized	Other
Financial Reporting	○	○	○	○
Reserve Adequacy	○	○	○	○
Pricing	○	○	○	○
ALM	○	○	○	○
Planning	○	○	○	○
Capital Management	○	○	○	○

   If other, describe the degree of centralization: _____

18. For centralized or semi-centralized modeling responsibilities, please indicate what responsibilities are centralized. (Select all that apply.)

   ❑   Develops business requirements for models
   ❑   Prioritizes and communicates a list of all change requests
   ❑   Builds and develops models
   ❑   Reviews or tests production models
   ❑   Maintains production models (model steward role)
   ❑   Runs production models
   ❑   Provides scheduled software updates
   ❑   Monitors and communicates leading practices
   ❑   Ensures adherence to model governance standards
   ❑   Other _____

19. Do your governance standards include references to risk management "three lines of defense," where, for example, the first line of review is the model owner, second line is the risk function and third line is the internal audit function?

   ○ Yes
   ○ No

20. Rate the effectiveness of the model governance structure in place at your organization for each model purpose below using the scale 1 to 5, where 1 = leading practice and 5 = not effective.

For the ratings throughout this survey, leading practices 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
Financial Reporting	○	○	○	○	○	○
Reserve Adequacy	○	○	○	○	○	○
Pricing	○	○	○	○	○	○
ALM	○	○	○	○	○	○
Planning	○	○	○	○	○	○
Capital Management	○	○	○	○	○	○

21. Rate the effectiveness of model 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
Model input data management	○	○	○	○	○	○
Assumption setting	○	○	○	○	○	○
Process and controls	○	○	○	○	○	○
Model structure / design	○	○	○	○	○	○
Model development / changes	○	○	○	○	○	○
The use of expert judgment	○	○	○	○	○	○
Documentation standards	○	○	○	○	○	○
Excel stand-alone models	○	○	○	○	○	○
Spreadsheets supporting models	○	○	○	○	○	○
Other	○	○	○	○	○	○

22. In the last year, are there examples where following the governance standards has resulted in a model correction prior to reporting results?

○ Yes
○ No
○ Unknown

23. Indicate all items that are defined in the model validation standards at your organization.

   - ❑ Validation of inputs
   - ❑ Validation of calculations
   - ❑ Validation of outputs
   - ❑ Validation of "fit for purpose" uses of models
   - ❑ Validation of processes for setting or calculating inputs
   - ❑ Frequency of validation for models
   - ❑ Risk rating of models
   - ❑ Model validation is not included in our model governance
   - ❑ Other _____

System Access

24. 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

25. Does your company have separate locked-down development, test and production environments along with standards for advancing from one environment to another? (Please check all that apply.)

	Development	Test	Production	None
Financial Reporting	❑	❑	❑	❑
Reserve Adequacy	❑	❑	❑	❑
Pricing	❑	❑	❑	❑
ALM	❑	❑	❑	❑
Planning	❑	❑	❑	❑
Capital Management	❑	❑	❑	❑

26. 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
Financial Reporting	○	○	○	○	○	○
Reserve Adequacy	○	○	○	○	○	○
Pricing	○	○	○	○	○	○
ALM	○	○	○	○	○	○
Planning	○	○	○	○	○	○
Capital Management	○	○	○	○	○	○

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

    ❑ Different levels of access are not used
    ❑ Different levels of access are controlled by IT
    ❑ Different levels of access are controlled by Actuarial
    ❑ Formal protocols exist for granting and deleting access for users

Change Control

28. 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
Financial Reporting	❍	❍	❍	❍	❍	❍
Reserve Adequacy	❍	❍	❍	❍	❍	❍
Pricing	❍	❍	❍	❍	❍	❍
ALM	❍	❍	❍	❍	❍	❍
Planning	❍	❍	❍	❍	❍	❍
Capital Management	❍	❍	❍	❍	❍	❍

29. For models in production, describe the change request procedures in place for revisions to production models. (Please check all that apply.)

    ❑ No change request procedures exist
    ❑ Change requests are documented
    ❑ Change requests are prioritized across user groups
    ❑ Change requests are formally approved or signed off
    ❑ Change requests are communicated to and coordinated among the modeling function
    ❑ Other _____

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

    ❑ Standardized testing approach
    ❑ Peer review
    ❑ 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)
    ❑ Management approvals
    ❑ Formal, documented communication
    ❑ Other _____

31. 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

32. Does your company have a process in place to ensure that model-generated results are not based upon models changed in an unauthorized manner?

   ○ No
   ○ Yes (please describe the process) _____

33. Does your organization have a formal process for implementing model design and coding changes?

   ○ No
   ○ Yes (please describe the process) _____
   ○

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

   ○ IT
   ○ The modeling area from which the change originates
   ○ Corporate actuarial
   ○ Other _____

35. Which of the following model standards does your organization use when making model changes? (Please check all that apply.)

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

Model Assumption Management

36. 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.

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

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

　　○　Yes
　　○　No

37a. In general, where are the model assumptions stored? (Please check all that apply.)

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

38.   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, Access or other platform and fed into models
　　❑　Scripts pull assumptions automatically
　　❑　If other, please specify. _____

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

　　○　Yes
　　○　No

Model Input

40.   Many companies have controls in place to validate model input for completeness and accuracy. Model inputs are considered to be administration system data and model parameters (assumptions are covered separately). 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
Financial Reporting	○	○	○	○	○	○
Reserve Adequacy	○	○	○	○	○	○
Pricing	○	○	○	○	○	○
ALM	○	○	○	○	○	○
Planning	○	○	○	○	○	○
Capital Modeling	○	○	○	○	○	○

41. Which best describes how input data is fed into your actuarial models? (Please check all that apply.)

   ❑ 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 _____

42. What model input controls are utilized? (Please check all that apply.)

   ❑ Static validation
   ❑ Dynamic validation
   ❑ Peer review of model inputs
   ❑ Automated queries summarizing inputs
   ❑ Other _____

Model Output

43. 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
Financial Reporting	○	○	○	○	○	○
Reserve Adequacy	○	○	○	○	○	○
Pricing	○	○	○	○	○	○
ALM	○	○	○	○	○	○
Planning	○	○	○	○	○	○
Capital Management	○	○	○	○	○	○

44. For third-party modeling software, does your company maintain independent validation spreadsheets or other independent calculations as a control to verify the appropriateness of the model calculations and provide transparency?

   ○ Yes
   ○ No
   ○ N/A
   ○ Other

44a. If yes, which of the following apply to the validation spreadsheets or other independent calculations? (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 or new product features or calculations
   ❑ Used regularly to validate the model per model governance standards
   ❑ Other _____

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

	Feeds Directly into reporting tools	Minor Manual Adjustments	Other
Financial Reporting	❍	❍	❍
Reserve Adequacy	❍	❍	❍
Pricing	❍	❍	❍
ALM	❍	❍	❍
Planning	❍	❍	❍
Capital Management	❍	❍	❍

❍ Other (please describe)_____

Organizational Design

46. What changes has your organization made in the last four years to meet the increased requirements for model governance? (Please check all that apply.)

- ❑ No changes
- ❑ Added personnel
- ❑ Added model governance function
- ❑ Implemented changes to the organizational design (roles and responsibilities) for actuarial modeling
- ❑ Implemented new actuarial modeling software
- ❑ Increased automation of modeling processes
- ❑ Improved model validation requirements
- ❑ Other_____

47. How has model governance increased the time and effort required to perform actuarial modeling activities?

- ❍ No noticeable increase
- ❍ Minimal increase that was absorbed by regular modeling processes and functions
- ❍ Noticeable increase, leading to additional personnel and/or processes
- ❍ Considerable increase, leading to additional personnel and/or processes, as well as concerns about the financial implications of these additional resource needs

48. How many new personnel has your organization added in the last four years to perform enhanced model governance functions?

- ❍ No new personnel have been added
- ❍ 1-3 new personnel
- ❍ 4-6 new personnel
- ❍ More than 6 new personnel

49. How would you characterize Technology area (IT) involvement in actuarial modeling? (Please check all that apply.)

- ❑ None
- ❑ IT maintains the grid
- ❑ IT maintains network installations of software
- ❑ IT maintains production models
- ❑ IT maintains production environment
- ❑ IT runs production models
- ❑ IT updates production models
- ❑ IT develops models
- ❑ Other _____

50. What are your top two priorities related to actuarial model governance over the next two years? (Please select two.)

- ◯ Defining model governance standards
- ◯ Training on model governance standards
- ◯ Adding personnel for model governance
- ◯ Implementing changes to the organizational design (roles and responsibilities) for actuarial modeling
- ◯ Implementing new actuarial modeling software
- ◯ Increased automation of modeling processes
- ◯ Implementing model validation requirements
- ◯ Enhancing model documentation
- ◯ Other_____
- ◯ Other_____

51. To what extent are each of the following areas driving your model governance initiatives? Using the scale 1 to 5, where 1 = Key Driver and 5 = No Impact.

	Key Driver 1	2	3	4	No Impact 5	N/A
Regulatory Developments (e.g., PBR)	◯	◯	◯	◯	◯	◯
SIFI Designation	◯	◯	◯	◯	◯	◯
Historic Errors or Deficiencies	◯	◯	◯	◯	◯	◯
External Audit Requirements	◯	◯	◯	◯	◯	◯
International Regulations	◯	◯	◯	◯	◯	◯
Management	◯	◯	◯	◯	◯	◯
Other	◯	◯	◯	◯	◯	◯

Other_____

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

_____

Appendix C: Survey Participants

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

Allstate Life and Retirement
American Fidelity
Ameriprise
Ameritas Life Insurance Corp.
AXA US
Blue Cross Life Insurance Company of Canada
Columbian Mutual Life Insurance Company
CUNA Mutual Group
EMC National Life Company
Everence Association
Fidelity Investments
GE Capital NAL&H
Great American Insurance Group
Great West
Guardian Life Insurance Company
Guardian Mutual
Guggenheim Insurance
Indiana Farm Bureau
Jackson National Life Insurance
Liberty Mutual
MassMutual
Mutual of Omaha
Nationwide Insurance
New York Life
Northwestern Mutual
Ohio National Financial Services
OneAmerica
Pacific Guardian Life Insurance Company, Ltd.
Protective
Securian Financial Group
Sun Life Financial
Thrivent Financial
TIAA
USAA Life
Voya Financial
Western & Southern Financial Group
Woodmen of the World Life Insurance Society

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