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IAA Risk Book Governance of Models

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Introducing the IAA Risk Book

The actuarial profession has contributed significantly to the development of risk management tools and processes, in insurance, pensions and related industries. Actuarial skills are also increasingly being applied in new and developing areas of knowledge.

Actuarial practice continues to improve the understanding, measurement and communication of risk and risk events and their implications through the development of tools and increasingly processes to manage the future uncertainty of risks in a sustainable and transparent way. These tools and processes trace, manage and mitigate the acceptance and transmission of the uncertain outcomes of risks.

The Risk Book is intended to provide high-quality reference materials to support a better understanding of the risks and inherently uncertain future outcomes that need to be managed when delivering financial services products – whether they involve insurance, investments or retirement incomes, or more broadly. The Risk Book is written to be accessible to a wide range of readers, many of whom may not be actuaries or experts in the areas discussed but may be decision-makers in those areas. Consequently, the Risk Book should provide insight into the ideas and concepts behind actuarial topics and concepts. It is therefore focused on being descriptive rather than being formal and mathematically precise.

All the Risk Book chapters are publicly available on the IAA website and are periodically updated. See www.actuaries.org and follow the path to '*Knowledge / Publications / IAA Risk Book*'. A discussion of their structure and relationships is provided in the chapter *Introduction – Using the Risk Book*.

The Risk Book is intended to be a dynamic and evolving resource, updated over time, reflecting new areas where actuarial expertise can add value, experience and advances, and topics of current interest and importance. It is electronically distributed to support ongoing updates. Risk Book chapters will be reviewed periodically at least every five years, and more frequently if significant changes or developments occur.

The development and maintenance of the Risk Book is managed by the Risk Book Editorial Board of the IAA Insurance Regulation Committee.

Many people, mostly actuaries, have contributed to the Risk Book. Contributors are listed on the website.

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1 Introduction

Models have become increasingly important for the financial reporting, management and regulation of insurance enterprises and for their effective risk management. This chapter explores the meaning and function of model governance as it relates to insurance enterprises, and describes the fundamental concepts behind, and main components of, effective model risk management and model governance.

Model governance is essential to all who rely on the information produced by models, directly or indirectly, either to carry out their function or because they are concerned with the continuing health and solvency of the entity being modelled (such as management, boards and regulators of insurance enterprises and pension funds). Indeed, in some jurisdictions, regulatory approval is needed for an insurer's own models to be used to determine their capital requirements; in which case, the quality of model governance, including documentation and validation of the model, is usually part of the approval process.

1.1 Aims of Chapter

This chapter touches on several key elements of model risk and model governance. Key messages of this chapter include:

1. Models are critical to the financial and risk management of insurance enterprises. This requires a governance structure to manage their limitations and weaknesses so that the results of the model can be relied upon by its users.
2. Model governance is an ongoing process, not an end point.

There is a large and growing library of material developed by a variety of interested parties, which provides more detailed information and guidance. The Bibliography at the end of this chapter provides a selected set of references for readers who wish to expand their knowledge of model risk and model governance.

1.2 Relevance to Actuaries

Actuaries and other modelling professionals serve a vital role in governance of insurer financial models.

In addition, actuaries are usually responsible for the assessment of insurance risks. The nature of insurance risks and their level of complexity are such that actuaries should specifically consider these both in the design and application of the model risk management policy, and in designing appropriate model governance.

2 Executive Summary

Model governance and the management of model risk are critical considerations within the insurance industry. A formal governance structure is necessary to mitigate both operational risk and reputation risk which might arise from financial misstatements, or inappropriate reliance on model results for both strategic and operational decisions. Further, the quality of model governance is often an important part of model approval for use in determining an insurer's own basis capital requirements in jurisdictions that allow this. The financial crisis of 2008 intensely focused regulators' and shareholders' attention on inappropriate model reliance and the need for more formal governance and validation practices.

Model governance is both complex and broad. It should be proportional to the potential risks of the models. It has to address models (many of them highly sophisticated) that support internal capital, reserve, valuation, and design and pricing of insurance contracts. Its scope extends beyond the realm of purely actuarial models to enterprise models such as asset allocation models and general financial models used by insurers.

The level of complexity of insurance models used, including all the components, levels, sources and uses described above, should be considered both in the design and application of the overall model risk management policy, and in the model governance that is most appropriate.

As the discipline of model governance and model risk management matures and is further codified, further tightening of both the language and the expectations concerning the approach to the subject can be expected. It is incumbent upon insurers to keep abreast of developments and to update frameworks and processes accordingly.

3 Definitions

The terms “model”, “model governance” and “model risk” mean different things to different people. In this chapter they have the following meanings:

- **Model** – a practical representation of relationships among entities or events using statistical, financial, economic or mathematical concepts. A model uses assumptions, data and algorithms that simplify a more complex system, and produces results that are intended to provide useful information on that system.
- **Model governance** – a comprehensive set of principles, roles, responsibilities and processes that provide comfort to the intended users of the model results that model risk is understood and being effectively managed.
- **Model risk** – the risk of adverse consequences from reliance on a model which is flawed or misused.

4 Background

Models are used extensively within insurance enterprises for critical purposes, including pricing, financial reporting, risk analysis and capital assessment, planning and general decision-making. Some insurer models are simple in their construct and purpose, but some insurer models have evolved from simple spreadsheets to complex systems designed, maintained and operated by many professionals, including actuaries, accountants, economists, statisticians and software engineers.

As the business and external environment evolves, models must be continually refined and improved so they continue to meet the needs of management and external stakeholders.

This reliance on models also brings exposure to model risk and thus management of model risk is a critical issue. Insurance enterprises and their governing bodies need a proportionate and effective system of governance over such models to ensure that results from the use of models can be relied upon for their purposes on an ongoing basis.

Historically, within insurance companies the actuary was considered as the model expert and users assumed that the results of the actuaries’ models could be relied on. But, in today’s environment, there

is a need to demonstrate formally to boards, regulators, rating agencies and other users that model risk is being actively managed throughout the insurance company. Actuaries have recognized a professional obligation to consider, manage and disclose model risk where appropriate in the models they use and to work collaboratively with other professionals as models get more complex and their value, scope and use increase.

5 Introduction to Models and Model Risk

Models are pervasive and critical to financial institutions in general, and insurance entities in particular. What is a model? A model is defined as a practical representation of relationships among entities or events. While the conceptual aspect of models is fundamental to their selection and use, models are used to simplify, and in some cases enable simulation of, complicated real-life systems. This simulation may be enabled through complex software and multiple component computer-based systems that attempt to accurately reflect the conceptual definition and provide answers to difficult questions. The twin aspects of models – conceptual representations vs. system-based tools – must be understood whenever the word “model” is used in this chapter.

In insurance enterprises, many different models may be needed according to the system which the model is attempting to represent and the function of the model:

- Some models address a specific risk, insurance feature or assumption, or environmental element impacting the business. For example, a model may be needed to simulate future patterns of gains and losses from a given insured risk, or economic variable such as interest rates.
- Other models, including financial models, attempt to simulate the financial operation of some portion of the business itself at various levels from a single policy contract or invested asset up to the entire insurance entity. Financial models thus tend to incorporate and aggregate a number of component risk models and other financial models as sub-models. Risk management actions should address both relevant sub-models and the models themselves in a proportionate way.
- Model risk arises from reliance on model outputs in situations where the model is flawed or is used inappropriately. Consequences can include material misstatements, poor business decisions, and failure to seize opportunity or prepare for adversity, with all the associated financial and reputational implications that may arise. Sources of model risk include:
 - Use of inappropriate model parameters;
 - Bad data;
 - Data manipulation errors;
 - Inappropriate assumptions;
 - Flawed or inappropriate methodology;
 - Calculation errors in the model;
 - Failure to present the model results clearly including their uncertainty;
 - Biased results and disparate impact on minority groups; and

- User error in the choice or operation of the model. An important type of user error is the use of a model beyond its limitations, whether these limitations may have been known but ignored or not fully appreciated. An example of this is relying on model results dependent on extreme tail events where the model parameterization may be based on assumed distributions rather than observed data.

While there are many excellent references available addressing model risk and its management in general, the nature and characteristics of insurance models justify a careful and appropriate application of model risk management theory within an insurance enterprise that appropriately reflects both the models themselves and the resources available to manage the models and their risks.

A useful description of models is found in the guidance issued by the Federal Reserve Board to banks (see Bibliography, reference SR 11-7):

All models consist of three components: an information input component, which delivers assumptions and data to the model; a processing component, which transforms inputs into estimates; and a reporting component, which translates the estimates into useful business information. In practice the various model components may be implemented through a single platform or a complex system of connected processes.

This observation is especially relevant to financial models of insurance enterprises, where the selection and manipulation of source data, both for purposes of creating assumptions and for actual model input, may require extensive, detailed and frequently updated processes. These can include independent systems and computing platforms and can rely on manual interventions and judgment of modellers. Similarly, the presentation of meaningful results from more complex models usually requires further analysis and rearrangement to produce useful information. Accordingly, model risk should be considered throughout the entire scope of a model, including the assumption development, data extract and transformation, and report-generation processes.

There are three different aspects of models which may contribute independently and in combination to model risk: (1) **specification**, (2) **implementation** and (3) one or more **model runs**.

The model specification is the full conceptual description of the input, processing and output components of a model as described above and the interrelationship of those components with each other and with other models. (A model may provide input to, or use the output from, other models.) The interrelationships between components will include methods, algorithms and data transformations that in total produce outputs from the inputs. Output specifications will detail the granularity and format of the information available from the model processing that can be used to produce reports of the results of the model.

Specifications should be documented to:

- Provide an accessible picture of the capabilities and weaknesses, limitations and intended purpose of the mode; and
- Allow an informed assessment of the potential fitness of the model for actual use for a specific purpose.

The implementation of a model is the creation of a working system or process based on the specifications. The implementation must accept, store and process input data, execute the processing methods and algorithms to generate more information up to the maximum time horizon of the model,

and produce the output data in the specified forms and formats. The implementation could involve one or more computer programs, spreadsheets and databases, and may require a specific technology infrastructure to support its operation.

Model implementations therefore rely on technical expertise and skill to accurately reflect the approved model specifications and to fulfil the model's intended purpose. That expertise may be applied, where appropriate, to design a system that accepts, manages and processes large volumes of input data, and potentially even larger volumes of results being generated while supporting the necessary validation work to prove its quality.

A model run consists of the execution of the model using a set of data together with assumptions. The assumptions should be appropriate to those data, and to the date and circumstances of the run. The model run will also probably be controlled by model run parameters that allow flexibility as to specific assumption, processing and output choices for the given run.

A model that is run repeatedly over time will almost certainly involve new input data and changes in the assumptions and parameters input to reflect the ongoing changes in the asset and liability portfolio of the enterprise, the external environment and new management demands for information. This requires additional control steps to verify that the model implementation retains its integrity.

Finally, insurance models, and particularly the complex computer systems that may result from their implementation, may be sourced and/or maintained either internally or from external third parties, which will impact the ways in which model risk can be investigated, documented and mitigated, but does not necessarily change the fundamental nature and extent of that risk.

The nature of insurance models, including the components, levels, sources and uses described above, needs to be considered in the design and application of the overall model risk management policy and in the model governance that is most appropriate, taking into account the materiality and complexity of what is being modelled.

6 Model Governance Framework

Model governance is a critical oversight function. It provides a framework through which an insurer can effectively oversee the development, implementation, maintenance, enhancement, use and retirement of models, understand model risk throughout this model lifecycle and provide those who use the results of the model with the confirmation of fitness and quality needed. Model governance provides structure, authority and direction for the needed model risk management. A well-designed and operating governance framework provides comfort to users that model output can be relied upon for an intended purpose and highlights its limitations.

An effective model governance framework will include three essential components: (1) a **model governance owner**, (2) a **model governance structure** and (3) a **model governance policy**.

The documentation of the model governance owner identifies roles and responsibilities. It outlines who will own model governance activities and where they will sit in the organization; it should be clear on expertise required, authority, reporting lines and continuity.

The model governance structure refers to the specific duties of the board and/or senior management, its various committees and management forums that oversee the management of model risk within an

organization. The model governance structure should be reflective of the organizational structure and business activities. This should include roles and responsibilities of the board and/or senior management, committees and working groups, and the reporting processes between each of them.

The model governance policy sets forth the guiding principles for the various governance activities that apply to models and related systems and processes. The model governance policy defines roles and responsibilities for the execution of model governance, and establishes conditions on the use of newly developed or modified models and required actions and limitations on model use when those conditions have not been met.

The model governance policy may also outline and mandate the organization's use of important risk management tools such as inventories of all models used in important processes (e.g., financial statement preparation) and may direct that a proportionate process of model validation be performed. However, these important tools are typically not specified in detail within the governance policy but rather within the model risk management function itself.

It is important to differentiate model governance from model management. Model governance consists of ensuring the necessary processes are in place so that model risk throughout the insurance entity can be understood and appropriately managed. Model management is the day-to-day operational activities of creating, implementing, adapting and using models throughout their lifetime, all with an appropriate strategy of comprehensive controls, including, for example, reviewing error logs, reconciling results and reasonability checks applied to model output before the results of the model are passed on.

Of primary importance, therefore, will be the development and application by the company management of a comprehensive process of model management that appropriately reflects and addresses model risk from the ground up, and ensures robust model development, implementation, modification and use.

7 Model Inventory

A critical tool in model governance is the model inventory, which should provide a clear, consolidated and accessible record of all models that are relied on by the company, with information as to their type and significance, their risk rating within the company, the status of validation exercises recently performed, and identification of any outstanding deficiencies that need to be understood and mitigated where possible. The model inventory should capture and reveal the current level of success in addressing model risk throughout the organization.

The overall governance process should also define who has authority to update the model inventory. The model inventory file itself should have sufficient audit controls attached to permit audits to ensure that the model inventory updates and maintenance have complied with model governance policy. Properly developed and updated, the model inventory can provide useful model risk exposure data on an enterprise-wide basis in a consistent manner.

The risk management significance of a given model will be driven by a risk rating approach that will generally utilize a combination of materiality, complexity and stability to assign a model risk rating. The risk rating in turn will trigger various levels of control procedures and determine the priority and frequency of validation and re-validation. The model inventory should support regular reporting and review of the status of model risk management within the company.

The level of complexity and sophistication of the model inventory will depend upon the needs of the users as well as the number of and complexity of the models and their significance to the management of the enterprise. The inventory can include:

- Model name and general description of function;
- Model risk rating;
- Model owner and purposes for which the model is approved for use;
- Individuals with the authorization to change the model;
- Reference to completed audit/peer review/technical reports and status of findings; and
- Summary of approved changes to the model.

In some instances, it is also useful to link model documentation, data sources and review reports back to the model inventory.

8 Model Validation

Model validation is the process of reviewing and examining all aspects of a model in order to confirm that the model is fit for its purpose. As such, validation is probably the single most important tool in the mitigation of model risk. Model governance does not define the approach to model validation. It is vitally concerned with the ongoing assessment of its effectiveness.

Model validation must focus on all stages of a model's life cycle, including the validation of the conceptual specifications behind the model, the implementation of those specifications, and the ongoing modification and operation of that model implementation to produce actual model runs. This is necessary to confirm:

- The appropriateness of the model's theoretical design for its intended purpose; and
- The accurate translation of that design in the working model.

These two separate objectives of model validation are equally important and relatively independent. In some instances, the confirmation of the accurate implementation of a model is referred to as "model verification" to distinguish it from conceptual validation. In addressing the conceptual validation, it is important to understand any weaknesses and limitations in the model so as to ensure that conclusions drawn from the model results are properly informed.

These two facets of model construction must further be examined in all of the components of the model: the input data and assumptions, the calculation engine, and the output and reporting of model results.

As insurance models are dynamic and must be updated to be repeatedly used, validation must be an effective combination of initial model validation along with periodic reviews and reconfirmations of continued fitness. Model validation must thus be viewed from the start as a continual and ongoing process, and not merely a part of implementation that may be occasionally revisited. This is particularly true where simple models are used for complex risks. A subtle change in the risk might render the simple model inappropriate.

Effective model validation depends on independence from the process of model development and modification in a variety of ways. For example, the people who perform validation tests should typically

be different people from those who created, selected, developed and maintain the model, in order to provide an effective and objective test of all aspects of the model. Verification of model calculations and results is usefully achieved by use of a fully independent model run in parallel, or if this is not practical, by performing independent calculations on isolated elements of the full model. While it may not be practical to use fully independent external resources, it is important to ensure independence of ownership and of financial interest in order to benefit fully from independent objectivity.

As noted above, where possible, validation should be done by an independent team. This can be a challenge for a complex insurance model requiring many person-hours of development and possibly incorporating numerous sub-models. Proper validation requires expertise in all facets of the model (understanding the business written by the insurer over a long period, the market forces impacting on the insurer, and the model framework and technology used for its implementation), which may only be found within the insurance company itself. However, the judicious use of:

- an independent team that designs and oversees the validation process while the actual testing is done by people who are not independent; or
- independent employees or advisers conducting thorough reviews of calculation accuracy and reasonableness of results; or
- external experts examining the documented internal reviews

can still provide sufficient comfort without compromising the independence principle.

The goal of validation is to demonstrate to the stakeholders that the results of the model can be relied upon (subject to identified and disclosed limitations). Use of external or vendor models may bring additional challenges pertaining to validation since critical model elements including conceptual design, software coding and/or assumptions may be inaccessible to the users. Therefore, other approaches are needed to ensure that the results are fit for purpose. Actuarial Standard of Practice (ASOP) 38 from the U.S. Actuarial Standards Board (see Bibliography) addresses this issue for property/casualty cat models, but the concepts may have wider application.

Good model validation enhances the transparency of the model’s uses and limitations for all those who may rely on, or be affected by, the results of the model. A sole focus on validating the correctness of numerical results will miss the most valuable part of this exercise.

Some people would also add the concept of “auditability” to model governance – this is particularly important when model results are used in the audited accounts, but is also important for regulatory purposes. Key parts of this are being able to ensure there are versioning processes used as models and assumptions are updated, and being able to go back and replicate model results if desired.

9 Bibliography

Reference Document	Author/Source	URL
ASOP 38 – Using Models Outside the Actuary’s Area of Expertise (Property and Casualty), June 2000	Actuarial Standards Board (USA)	www.actuarialstandardsboard.org/asops/using-models-outside-actuaries-area-expertise-property-casualty/

Reference Document	Author/Source	URL
ASOP 56 – Modeling, December 2019	Actuarial Standards Board (USA)	www.actuarialstandardsboard.org/asops/modeling-3/
<i>Black Swan: The Impact of the Highly Improbable</i> , April 2007	Nicholas Taleb (Random House)	
Educational Note – Use of Models, January 2017	Canadian Institute of Actuaries Modelling Task Force	www.cia-ica.ca/docs/default-source/2017/217007e.pdf
Final Standards – Revisions to General Standards to Reflect the Use of Models, January 2017	Actuarial Standards Board (Canada)	www.cia-ica.ca/docs/default-source/2017/217005e.pdf
International Standard of Actuarial Practice 1 General Actuarial Practice, December 1, 2018	International Actuarial Association	www.actuaries.org/iaa/IAA/Publications/ISAPs/IAA/Publications/05ISAPs.aspx?hkey=334b21a7-a3ac-4e0e-8294-3cbc755ab14a
Model Governance – Some Considerations for Practicing Life Actuaries, April 2017	American Academy of Actuaries	www.actuary.org/sites/default/files/files/publications/Model_Governance_PN_042017.pdf
Model Risk – Daring to Open up the Black Box, 23 March 2015	Institute and Faculty of Actuaries (UK) Model Risk Working Party	www.researchgate.net/publication/277138848_Model_Risk_Daring_to_Open_the_Black_Box
Model Validation for Insurance Enterprise Risk and Capital Models, April 2014	Society of Actuaries Research Report, sponsored by CAS, CIA, SOA Joint Risk Management Section	www.soa.org/resources/research-reports/2014/research-2014-model-valid-ins/
Note on the Use of Internal Models for Risk and Capital Management Purposes by Insurers, November 2010	International Actuarial Association	www.actuaries.org/CTTEES_SO LV/Documents/Internal_Models_EN.pdf
<i>Plight of the Fortune Tellers: Why We Need to Manage Financial Risk Differently</i> , November 2010	Riccardo Rebonato (Princeton University Press)	



Reference Document	Author/Source	URL
SR 11-7 Attachment – Supervisory Guidance on Model Risk Management, 4 April 2011	Board of Governors of the Federal Reserve System	www.federalreserve.gov/bankinforeg/srletters/sr1107.pdf
Use of Models for the Supervision of Regulatory Capital, 6 May 2015	American Academy of Actuaries	http://actuary.org/files/RMFRC_IAISICS_Modeling_Presentation_050615_0.pdf



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