OLIVER WYMAN

Consulting Actuaries

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GETTING THE MOST OUT OF AXIS™

MEETING MODELING STANDARDS IN 2020 AND BEYOND

Editor's words: Welcome to the Spring 2020 edition of our AXIS newsletter. This issue discusses implications of the forthcoming Actuarial Standard of Practice ("ASOP") 56, and runtime reduction considerations in a principles-based world. You will find helpful tips and tricks for navigating the system and highlights of new features in recent AXIS releases. We hope you enjoy the newsletter.

IN THIS ISSUE

Executive Corner
Alert to AXIS Users! ASOP 56, Modeling is Coming

In the Spotlight
Balancing Model Runtime and Accuracy in a Principles-Based World

Tips & Tricks

What's New in AXIS

Executive Corner

ALERT TO AXIS USERS! ASOP 56, MODELING IS COMING

After four exposure drafts and over 100 comment letters, ASOP 56[1], Modeling will be effective October 1, 2020. It is intended to cover an extensive list of modeling aspects including: design, development, modification, evaluation, selection, use or review of any type of model.

GIVEN ITS BROAD SCOPE, WHAT WILL BE THE IMPACT OF ASOP 56?

Time will reveal the degree to which ASOP 56 changes the way actuaries interact with models; however, it will certainly impact how we think about and articulate certain modeling decisions. The following discussion connects specific modeling tools and practices to passages in ASOP 56. Three examples act to highlight available AXIS capabilities that will assist actuaries in meeting their professional obligations.

Example 1: Models must meet their intended purpose via model structure

Product development and pricing models are used to illustrate new product profitability and adherence to the company's desired risk profile. A model producing only aggregate outputs may exhibit fantastic results under a range of scenarios while masking the subsidization of some pricing cells by others. As a result, there exists risk that the distribution of business sold differs adversely from that assumed in pricing. Thus, a pricing model lacking adequate granularity may fail to meet its intended purpose.

AXIS allows users to efficiently set up models to produce reports across different dimensions and levels of granularity. Exhibit 1 illustrates how two AXIS pricing Cells that are identical except for product feature 'A' vs 'B' may generate different profitability metrics X% and Y%. Individual Cells are aggregated into gender-distinct Subfunds in the level above. The Subfunds are further aggregated to Funds that distinguish policies with and without secondary guarantees. Finally, all Funds are aggregated at the Office level.

Further, the Generate solving functionality embedded in AXIS allows the user to target certain profitability levels by altering specified model inputs.

Finally, Exhibit 2 illustrates an out-of-the-box AXIS pricing report that summarizes key profit measures across the modeled pricing distribution.

"...whether the use of the model dictates a particular level of detail, for example, whether grouping inputs will produce reasonable output, or whether a certain level of detail in the output is needed to meet the intended purpose"

(ASOP 56, section 3.1.4.c)

1 ASOP 56 may be viewed here: http://lists.actuary.org/t/1284077/23691228/11011/2/

The industry's collective challenge is to make more deliberate modeling choices to better articulate how a model meets its intended purpose.

Exhibit 1. AXIS model hierarchy, depicting varying levels of pricing model granularity

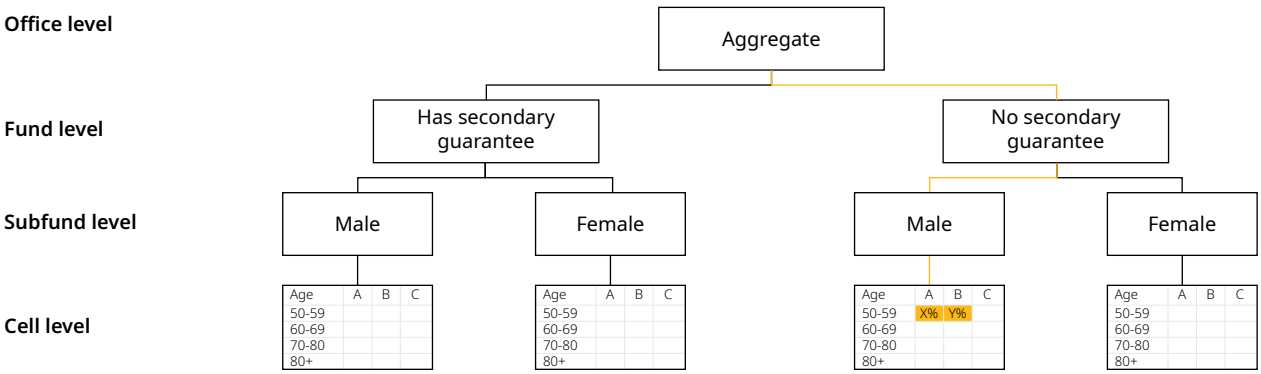
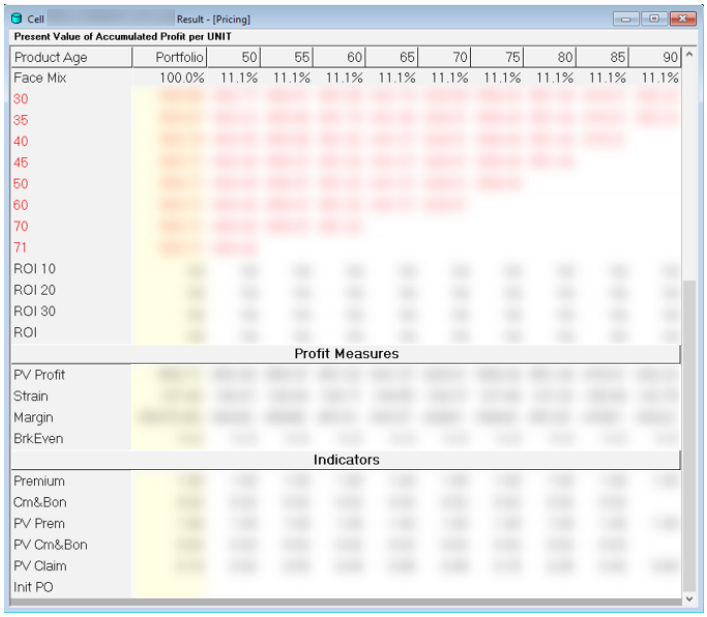


Exhibit 2. AXIS sample pricing report



Example 2: Models must meet their intended purpose via governance and controls appropriate to the model context

A common practice is to name new iterations of a model V1, V2, V3, etc., to aid in tracking model updates during the development process. However, model development is rarely linear: backtracking, discarding, branching versions, or restarting from a past version in the middle of the process may be required.

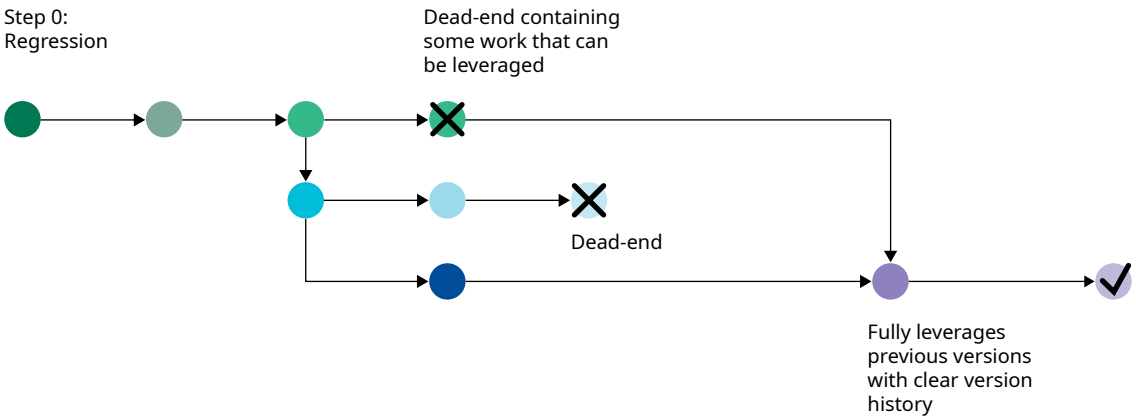
Exhibit 3 shows an illustrative model development path with some dead ends and other potential version control issues. Standardized naming conventions may not be sufficient to adequately trace the progression of such a model. AXIS possesses built-in version control functionality via the Version Control Projects section in EnterpriseLink. The ability to check-in and check-out AXIS Datasets allows users to memorialize changes and lock down discrete versions of the model. Consequently, it helps users ensure they are using the correct version of a model, avoid unintended changes, and mitigate model risk.

"The actuary should evaluate model risk and, if appropriate, take reasonable steps to mitigate model risk. The type and degree of model risk mitigation that is reasonable and appropriate may depend on the following: ...the operating environment and governance and controls related to the model..."

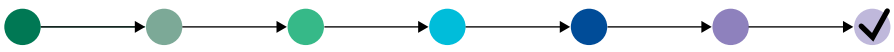
(ASOP 56, section 3.6)

Exhibit 3. Visualization of AXIS Version Control supporting transparent model development

AXIS developer experience



AXIS version control



Example 3: Models must meet their intended purpose via assumptions consistent with one another and in aggregate

AXIS has a variety of output reports that can be leveraged to assess the reasonability of model output. For example, for assumption validation, AXIS has Fund Movement and Inforce Movement reports that, respectively, attribute the fund value rollforward and policy decrements over time. When assessing the impact of a set of liability assumptions on model outputs, Inforce Movement reports allow the reviewer to assess both aggregate and individual decrements at different levels of granularity, such as those outlined in Exhibit 1.

Exhibit 4 illustrates how the reasonableness of decrements for a flexible-premium Universal Life product with Secondary Guarantees ("ULSG") can be driven by the interplay between voluntary lapses (i.e., surrenders) and fund lapses, where fund lapses are determined by the interplay of the premium funding assumption and secondary guarantee mechanics.

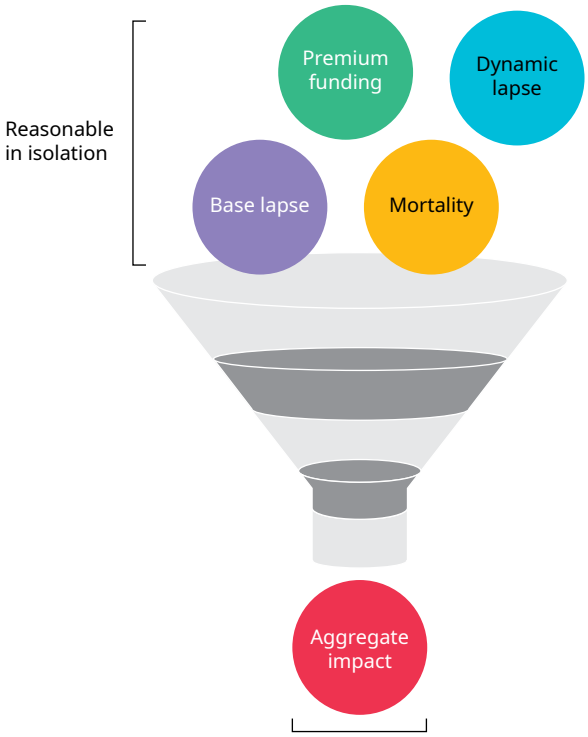
"Where appropriate, the actuary should use, or confirm use of, assumptions for the model that are reasonably consistent with one another for a given model run"

(ASOP 56 – 3.1.6.c)

"The actuary should assess the reasonability of the model output when determining whether the assumptions are reasonable in the aggregate. While assumptions might appear to be reasonable individually, conservatism or optimism in multiple assumptions may result in unreasonable output"

(ASOP 56, section 3.1.6.e)

Exhibit 4. Individual versus aggregate view of assumption reasonableness: ULSG model



CONCLUSION

The three examples above illustrate the application of a range of basic AXIS functionality. Together, they provide inspiration for how an AXIS modeler might leverage out-of-the-box tools to satisfy the standard of care required by ASOP 56.

AXIS Model Health Check

With the effective date of ASOP 56 less than six months away, companies should be ensuring models are robust and fit-for-purpose. For a complimentary AXIS model “Health Check”, please reach out to the Oliver Wyman consultants named on the back cover.

Oliver Wyman Actuarial Modeling Software Survey

In addition, Oliver Wyman will be releasing an actuarial modeling software survey in Q4 2020. Please reach out with any topics or questions of interest. We value your insights.

Tips & Tricks

USING SERIATIM OVERRIDE BATCHES TO DETACH OR PROCESS POLICIES SELECTIVELY

The following steps illustrate the procedure to set up a Seriatim Override Batch to process policies selectively in a Projection Batch.

1. Create a new Seriatim Override Batch
2. Include the new Seriatim Override Batch in the corresponding Override Set of the desired Projection Batch
3. Code the Seriatim Override Batch

   Example #1: Use the following formula expression and replace <list of policies> with the desired list of policy IDs in quotations separated by commas

```
IF INLIST( TRIM([Policy ID] ), <list of policies> ) THEN
       _SKIP = .F.
ELSE
       _SKIP = .T.
ENDIF
```

   Example #2: The "IF" statement can be replaced by other conditions. For instance, the condition can be "[Iss Year] > 2010" to selectively process policies issued after 2010

```
IF [Iss Year] > 2010 THEN
       _SKIP = .F.
ELSE
       _SKIP = .T.
ENDIF
```

Alternatively, policies can be detached and reattached from the model by substituting "`_SKIP`" with "`_ATTACH`" and swapping "`.F.`" and "`.T.`". When a policy is detached, it is removed from the Seriatim model and cannot be seen or processed until it is reattached.

1. A Seriatim Override Batch using the "`_ATTACH`" functionality must be executed as a standalone Batch. Adding it to an Override Set will not impact the Projection Batch
2. The current state of the Seriatim model should be considered when applying these Seriatim Override Batches. The functionality does not automatically reattach policies unless specified. Thus, including an "`_ATTACH = .T.`" statement in the beginning of the Seriatim Override Batch formula will reattach all records and help ensure that no policies are inadvertently left out

Tips & Tricks

APPLICATION OF GLOBAL PARAMETERS TO STREAMLINE MODEL RUNS

The Global Parameter is a very flexible feature in AXIS that can help streamline model runs and report creation. The example below highlights how this functionality can be utilized to produce a series of model runs with dynamic report names via a single Batch run.

Define the Global Parameter in Dataset Parameters and assign to the AXIS report output

1. In Dataset Parameters, select Global Parameters and populate the three required fields.
   Example:
   - Name: **Report_Year**
   - Value: 2020
   - Description: Current study year
2. Append the Global Parameter to the report name in the desired Projection Batch.
   Example: Update output name to "`AXIS_CY_Report_$(Report_Year)`"

Apply a Dataset Formula Batch to produce multiple model runs and reports

1. Create a new Batch under the Macro tab → Dataset Formula.
   Example: The Dataset Formula Batch formulas below will cycle through study years 2010 through 2020 and output distinct reports for each study year

```
Dim Study_Year as Integer

For Study_Year = 2010 to 2020

    SetGlobalParameterValueDataset ("Report_Year", Study_Year)

    Call RunBatch("ImportInforce")    'Load study year in-force data

    Call RunBatch("RunProjections")   'Run projections Batch

Next Study_Year
```

In the Spotlight

BALANCING MODEL RUNTIME AND ACCURACY IN A PRINCIPLES-BASED WORLD

INTRODUCTION

With the optional implementation period behind us, principles-based reserving ("PBR") under VM-20 is now the required reserving standard for individual life business issued on-or-after January 1, 2020. Determining reserves under PBR requires modeling assets and liabilities across a range of scenarios to assess the sufficiency of assets, representing a huge shift from the previous formulaic reserve framework.

The transition to PBR introduces added complexity to actuarial projection and reserving models, including multiple scenario processing, asset-liability modeling, and nested projections, which all come at the expense of model runtime. As further described in Exhibit 1, AXIS PBR model runtime[1] is a function of the number of underlying model points, revaluation points, iterations, and scenarios being processed.

Exhibit 1. Common drivers of AXIS PBR model runtime

Number of model points	Number of future valuation dates ("revaluations")	Number of iterations	Number of scenarios
Runtime will vary with the number of liability model points and Asset and Reinvestment Cells modeled	Projection of PBR reserves requires inner/outer loop functionality and runtime is dependent on the number of revaluations	Segment earned rates are calculated through an iterative approach. Stochastic reserve ("SR") starting assets are iterated to be within 2%	The full SR scenario set contains 10,000 scenarios

1 For the purposes of this article, runtime is defined as the number of core hours required to complete a model run. The actual duration of a model run will depend on the number of CPU cores dedicated to the job.

Given the level of calculation complexity, VM-20 directly addresses the use of runtime reduction techniques to meet PBR reporting requirements, stating that "...a company may use simplifications, approximations and modeling efficiency techniques". However, there are two caveats: (1) companies should be able to demonstrate that these techniques do not materially understate the reserve and (2) companies are required to disclose these techniques in their PBR actuarial reports.

The remainder of this article focuses on the drivers of runtime depicted above and provides details on how to analyze and optimize the runtime of PBR models in AXIS.

MAIN DRIVERS OF RUNTIME AND MITIGATION TECHNIQUES

Number of model points

Model points are the number of liability and asset records contained in the model. In this section, we will dive deeper into the runtime savings achieved in an AXIS PBR model under different levels of in-force data compression.

Compression was performed on an illustrative block of universal life business in AXIS using a range of compression ratios and compressing on key risk drivers. The following charts show the resulting Deterministic Reserve ("DR") under a range of compression ratios along with the model runtime impact.

Exhibit 2. Model runtime and difference in average projected DR under a range of compression ratios

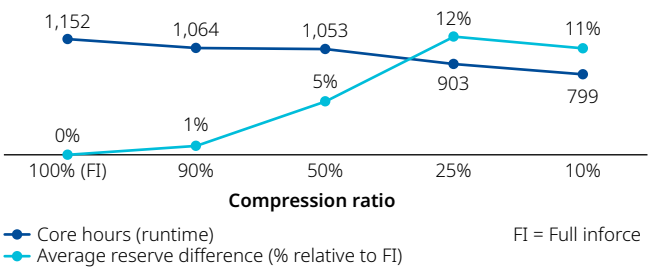


Exhibit 3. Starting DR under a range of compression ratios

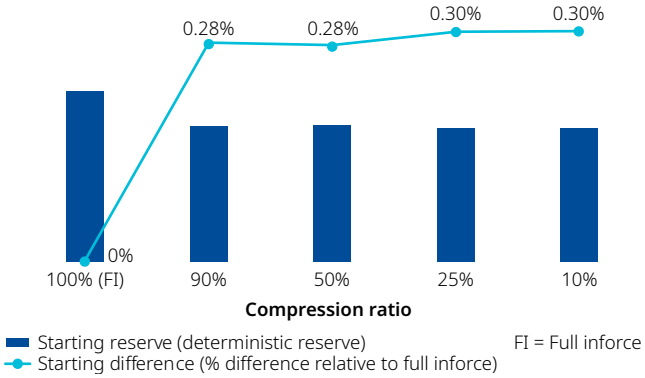
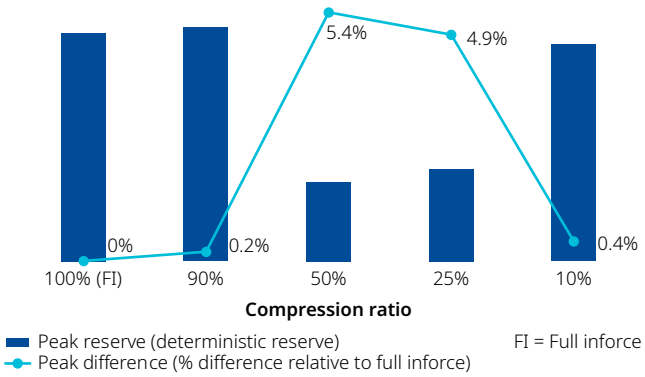


Exhibit 4. Peak projected DR under a range of compression ratios



The example above demonstrates the significant runtime gains that may be realized through native in-force compression functionality in AXIS. However, it is important to assess the runtime gains against deviations in the reserve pattern when making a final decision on the level of compression.

Number of revaluations (frequency and projection horizon)

The number and horizon of revaluation points relates to the inner loop functionality required to project PBR reserves. Section 7. A of VM-20 indicates that cash flows must be projected "for a period that extends far enough into the future so that no obligations remain"; however, runtime reduction techniques are allowed if consistent with Section 2.G of VM-20.

In AXIS, the inner loop projection methodology is defined at the Fund level through an Embedded Block Monthly Revaluations Table. This object allows the user to set the frequency of inner loop reserve calculations as well as the resulting parameters (e.g., assumptions, scenarios) as further depicted in Exhibit 5.

Runtime optimization can be achieved by adjusting the frequency of revaluation points and the length of the inner loop projections executed at those revaluation points.

Revaluation points

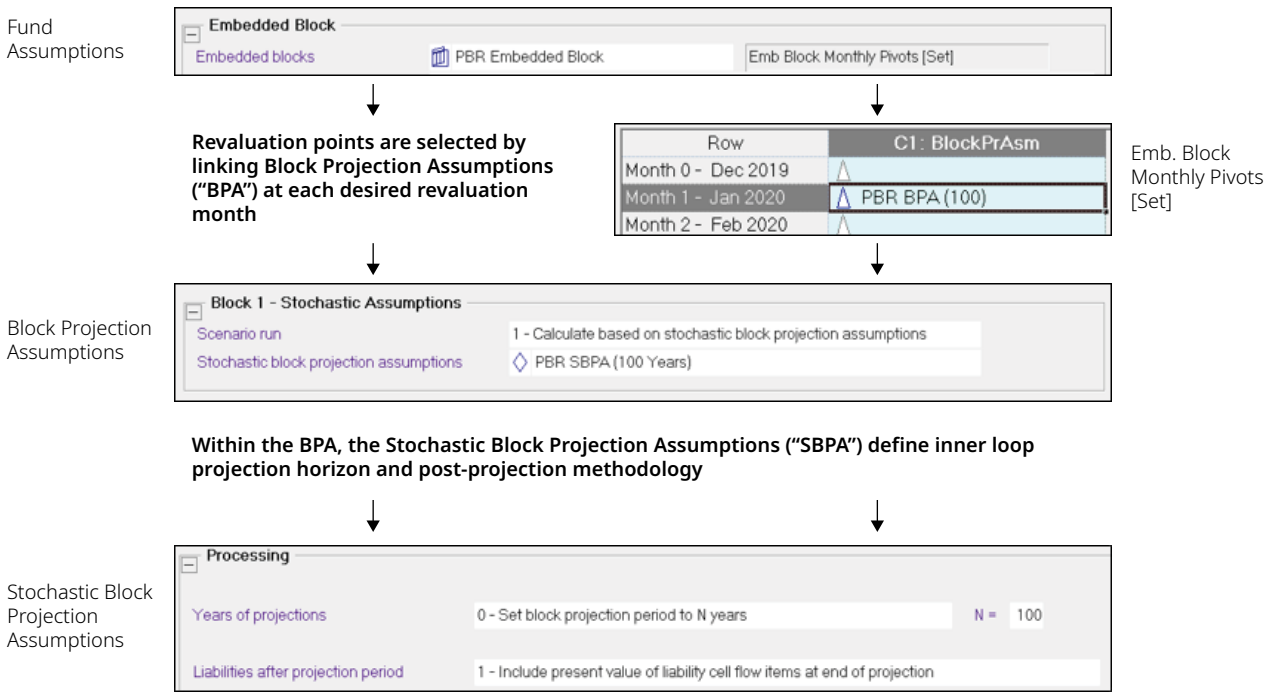
- Reducing the number of revaluation points decreases the number of separate PBR reserve calculations performed by AXIS
- AXIS will interpolate reserves between revaluation dates by default; however, the user can define other approaches in the Embedded Block Reserve Adjustment Formula Table
- Frequent revaluation in the first few projection years is recommended
- Product features that may have a significant impact on results, such as the end of the level-term period, should be considered when setting revaluation points
- Proper testing is recommended prior to modifying revaluation points, as precision may be significantly impacted by over-interpolating

Inner loop projection horizon

- Reducing the inner loop projection horizon decreases the period over which assets and liabilities are projected in support of the reserve calculation (Note: This can be a shorter period than the outer loop projection)
- In the SBPA, the "Liabilities after projection period" parameter should be set to "1 – Include present value of liability cell flow items at end of projection" to ensure reflection of cash flows past the end of the Block projection period

"Rigorous testing should be performed to ensure that the optimized methodology does not produce significant deviations from a more robust model run"

Exhibit 5. Embedded Block revaluation assumptions



Number of iterations

PBR calculations are iterative in nature, capturing interdependency between assets and liabilities. The DR requires solving for a vector of earned rates to be used to discount cash flows. Further, the SR starting assets need to be iterated to meet the asset collar requirement.

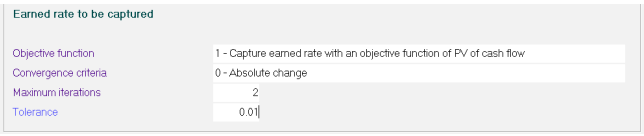
Net Asset Earned Rate capture

In AXIS, interdependency between assets and liabilities is typically modeled using a Portfolio Rate Capture.

- The Objective Function defines the underlying function being solved
- The Convergence Criteria and Tolerance inputs set the conditions for convergence to be considered achieved
- A minimum of two iterations is needed in AXIS; the first iteration will use the default reference rate while the second iteration will attempt to converge by using the results from the first iteration

Exhibit 6. Illustrative Earned Rate Capture parameters

Block Projection Assumptions



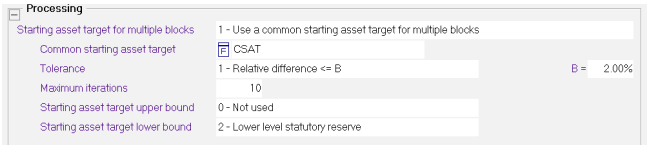
Common Starting Asset Target

Starting assets are solved for using the Common Starting Asset ("CSAT") Formula Table and associated parameters, defined in the Processing section of the BPA.

- The CSAT Formula Table sets the starting asset target and floor
- The Tolerance inputs set the conditions for convergence to be considered achieved
- Upper and lower bounds can be used to enhance the robustness and efficacy of the process
- Maximum iterations cannot exceed 100

Exhibit 7. Illustrative CSAT parameters

Block Projection Assumptions



Runtime optimization is ultimately achieved by facilitating faster convergence or reducing the maximum iterations. While some gains can be seen by increasing the efficacy of the solving process, such as the inclusion of the 2% asset collar in the CSAT Formula Table, reducing the maximum iterations will generally result in reduced accuracy and increased volatility. As such, rigorous testing should be performed to ensure that the optimized methodology does not produce significant deviations from a more robust model run.

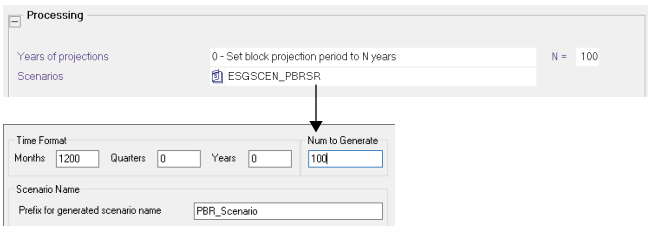
Number of scenarios

The VM-20 prescribed scenario generator produces 10,000 scenarios for use in calculating the SR; a common modeling simplification is to reduce the size of the scenario set used.

In AXIS, the number of generated scenarios for the SR is specified within the linked Scenario Generator in the SBPA.

Exhibit 8. Embedded Block scenario generation settings

Stochastic Block Projection Assumptions

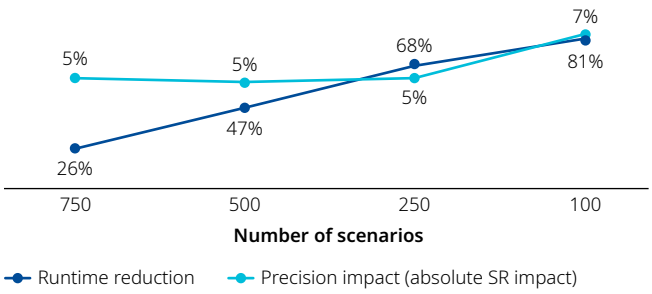


The transition to PBR introduces added complexity to actuarial projection and reserving models, including multiple scenario processing, asset-liability modeling, and nested projections, which all come at the expense of model runtime.

Model runtime reduction is not perfectly linear in relation to the number of scenarios and will vary based on overall model setup. The graph below illustrates the runtime and precision impact of varying the number of stochastic scenarios in a sample Dataset, relative to a baseline setup of 1,000 scenarios.

Significant testing must be performed to ensure that the reduction in scenarios does not cause understated reserves.

Exhibit 9. Runtime and precision impact of reducing the number of SR scenarios



CONCLUSION

As the volume of business being reported under PBR significantly grows in the coming years, the need to balance model runtime and accuracy will only become more essential. Making effective use of permitted simplifications, approximations, and runtime efficiency techniques will enable companies to significantly reduce the strain on systems and resources.

What's New in AXIS

NEW FEATURES IN RECENT AXIS RELEASES

US GAAP Link: Local database format for US GAAP History Database	Description • A new switch "Use Standard US GAAP database" has been added in US GAAP Link. By using this functionality, users can set up a local "US GAAP History Database" without a full SQL Server installation • The "US GAAP History Database" can only be used with data from the current Dataset; it cannot be loaded with data from other Datasets	Details • Version 20201201 Learn more • https://www.ggy.com/BugEnhance/UpdateDetail/28302/
DataLink macro: New features for updating DataLink Table options	Description • In DataLink Macro Batch, the following two options were added: – "Load from the following DataLink File for this Action only" in the existing Load Table step – "Update DataLink Table Options" • These new features will allow the flexibility to change the Source DataLink File and/or DataLink Table Options when running the DataLink Macro Batch	Details • Version 20200901 Learn more • https://www.ggy.com/BugEnhance/UpdateDetail/28010/
US GAAP Link: Gross DAC calculations	Description • In US GAAP History Tables, Optional Fields were modified, impacting multiple AXIS Modules • For DAC, SIA and URL calculations, "Expected Amortization Base", "Sum of Future Amort Base" and "Expected Basis for Experience Adjustment" Optional Fields will now be read from the prior period instead of the current period	Details • Version 20200301 Learn more • https://www.ggy.com/BugEnhance/UpdateDetail/27766/

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The Actuarial Practice of Oliver Wyman has life, health, and property & casualty actuaries that advise financial institutions, insurance companies, regulators, and self-insured entities across a broad spectrum of risk management issues. With almost 375 professionals in over 20 offices across North America, the Caribbean and Europe, the firm's consulting actuaries provide independent, objective advice, combining a wide range of expertise with specialized knowledge of specific risks.

Moody's Analytics shall have no liability in respect of the views and opinions expressed in this report.

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