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Capital Planning with SAS® Infrastructure for Risk Management and SAS® Risk and Finance Workbench

Minna Jin, Huina Chen, Juan Du, and Henry Bequet, SAS Institute Inc.

ABSTRACT

In this paper, we demonstrate how to integrate SAS® Infrastructure for Risk Management and SAS® Risk and Finance Workbench to perform efficient capital planning. On one hand, SAS Infrastructure for Risk Management serves as the execution engine to perform high-performance computation with great auditability and scalability. A script automatically turns worksheet-style data and formulas into SAS data sets and computational job flows, performing end-to-end calculation without intermediate manual data movements. On the other hand, SAS Risk and Finance Workbench provides a central hub to manage the various aspects of the process such as data preparation and validation, capital projection, stress testing, and regulatory reporting. The seamless integration of both software applications streamlines the capital planning process with ease of use, fast and scalable computation, and sound process control.

INTRODUCTION

Capital planning is an essential process for companies to project capital, assess business resilience, and guide risk-based decision making. Capital planning software excels with several capabilities that could also be challenges. Firstly, the software should monitor the data preparation and validation process. The input data plays an important role in producing accurate capital projection. Secondly, companies usually have different requirements in assessing capital expenditures. Therefore, the software should be flexible enough to take in user inputs such as risk appetite, scenarios, and management decisions. Using different parameters and risk factors, users could perform iterative scenario analysis and stress testing. Thirdly, as an iterative process, periodical capital planning and stress testing can be very time consuming. Capital projection needs to run as fast as possible. Furthermore, reporting is an important part of the capital planning process. An effective software needs to generate comprehensive and easy-to-understand reports. Finally, sound capital planning software should be a streamlined process that ensures ongoing consistency, transparency, auditability, and efficiency. Users should get easy access to all existing projects, and be able to create new projects/analysis without interfering with existing ones.

Bearing those challenges in mind, in this paper, we apply the integrated SAS Infrastructure for Risk Management and SAS Risk and Finance Workbench to the capital planning process. With the merits from both software applications, we address the challenges, and provide a user-friendly and high-performance solution for capital planning. To understand the power of the integrated environment, let’s first have a closer look at these two platforms.

SAS INFRASTRUCTURE FOR RISK MANAGEMENT

SAS Infrastructure for Risk Management is a modernized, high-performance risk platform based on the many-task computing (MTC) framework. It is designed to support data and code versioning, automation, and transparent processes while applying the power of parallel code execution at a low cost. In the capital planning process, the platform serves as the calculation engine.

Calculations in SAS Infrastructure for Risk Management are executed sequentially or in parallel with behind-the-scenes, optimally orchestrated processing—in other words, job flows. Job flows consist of tasks. Each task is a microservice that defines its inputs and outputs in terms of data objects and can be executed independently. Data objects are shared and reused to avoid unnecessary computations. A cache-aware scheduling algorithm allocates related tasks to the same server or thread to maximize disk caching benefits. To help users make effective use of the high-performance platform, SAS Infrastructure for Risk Management provides an efficient tool, SAS Scripting Client, to help them create parallel programs without worrying about synchronization. The SAS Scripting Client consists of a set of SAS macros and is used to create the job flow definition when given the tasks. This powerful tool plays a key role in our integration. It facilitates the automatic data driven generation of capital projection job flow in

SAS Infrastructure for Risk Management. Furthermore, the platform provides a visual representation of complex analytical tasks with clear dependencies. Users could monitor the progress of calculation as analysis is running. Finally, log files, documentations, input/output tables, and results of intermediate calculations are accessible from the user interface, which provides convenience for tracking and debugging.

SAS RISK AND FINANCE WORKBENCH

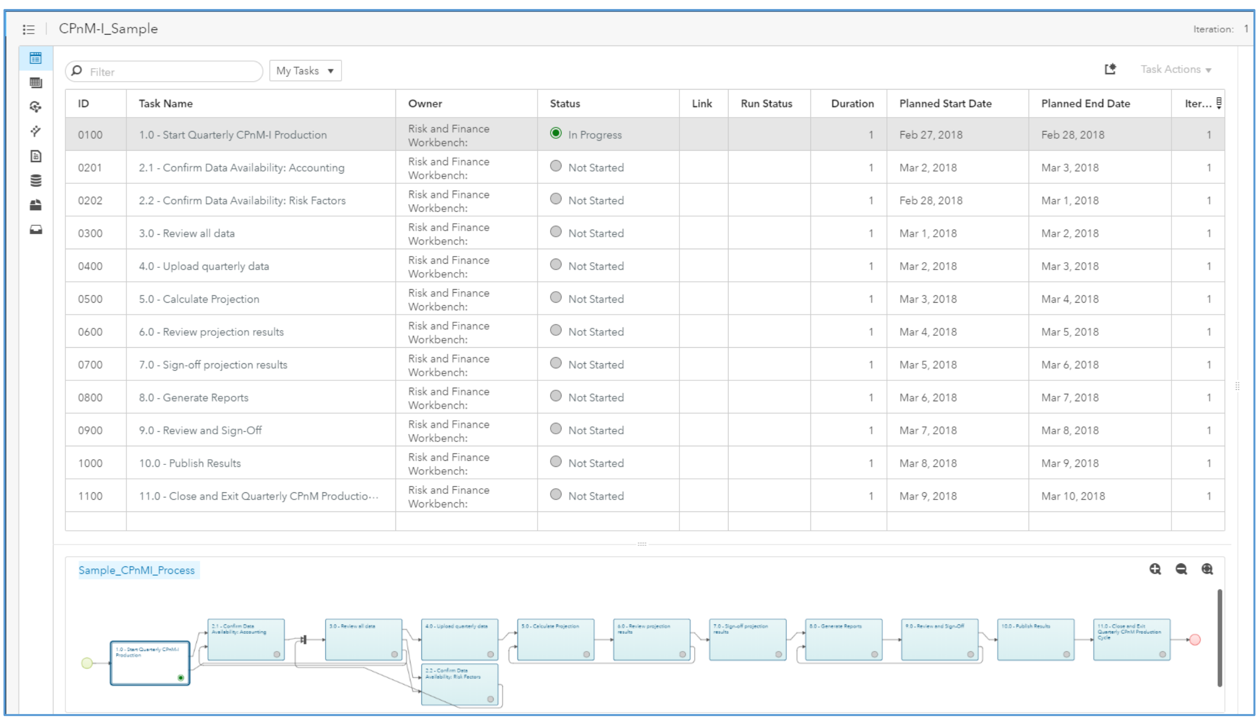
SAS Risk and Finance Workbench is an integrated environment for managing risk and financial data to perform various analytic activities. It can be easily integrated with other SAS solutions and third-party systems through a centralized inventory of models, scripts, and a repository for risk and finance data.

SAS Risk and Finance Workbench provides a web-based interface to manage the end-to-end capital planning process. The user- defined process workflow serves as a controller to orchestrate various work tasks. Each task is clearly labeled with name, owner, status, and timelines. Users could easily track the progress and take necessary actions in a timely manner. For example, the projection task sends requests to SAS Infrastructure for Risk Management to trigger capital projection job flow execution. Furthermore, users define hierarchies, time horizons, filters, and other properties in SAS Risk and Finance Workbench. Capital planners could view input data and output results from multiple perspectives by selecting different x, y axes, and filters when creating worksheets. This helps them better understand the company's financial status and make wise decision in business operation. Last but not least, the platform provides flexible regulatory reporting functionality for users to create customized reports.

FULLY CONTROLLED CAPITAL PLANNING PROCESS

Capital planning is a time-consuming and iterative process that budgets capital for business growth and other major expenditures. An effective planning process requires inputs from different departments including accounting, finance, and risk management. Therefore, coordinating work, consolidating inputs, and validating results are important factors for a successful capital planning process.

As mentioned in the previous section, SAS Risk and Finance Workbench enables users to define their own process workflows. Figure 1 defines a sample workflow for a basic quarterly capital planning cycle.



ID	Task Name	Owner	Status	Link	Run Status	Duration	Planned Start Date	Planned End Date	Iter...
0100	1.0 - Start Quarterly CPnM-I Production	Risk and Finance Workbench:	In Progress			1	Feb 27, 2018	Feb 28, 2018	1
0201	2.1 - Confirm Data Availability: Accounting	Risk and Finance Workbench:	Not Started			1	Mar 2, 2018	Mar 3, 2018	1
0202	2.2 - Confirm Data Availability: Risk Factors	Risk and Finance Workbench:	Not Started			1	Feb 28, 2018	Mar 1, 2018	1
0300	3.0 - Review all data	Risk and Finance Workbench:	Not Started			1	Mar 1, 2018	Mar 2, 2018	1
0400	4.0 - Upload quarterly data	Risk and Finance Workbench:	Not Started			1	Mar 2, 2018	Mar 3, 2018	1
0500	5.0 - Calculate Projection	Risk and Finance Workbench:	Not Started			1	Mar 3, 2018	Mar 4, 2018	1
0600	6.0 - Review projection results	Risk and Finance Workbench:	Not Started			1	Mar 4, 2018	Mar 5, 2018	1
0700	7.0 - Sign-off projection results	Risk and Finance Workbench:	Not Started			1	Mar 5, 2018	Mar 6, 2018	1
0800	8.0 - Generate Reports	Risk and Finance Workbench:	Not Started			1	Mar 6, 2018	Mar 7, 2018	1
0900	9.0 - Review and Sign-Off	Risk and Finance Workbench:	Not Started			1	Mar 7, 2018	Mar 8, 2018	1
1000	10.0 - Publish Results	Risk and Finance Workbench:	Not Started			1	Mar 8, 2018	Mar 9, 2018	1
1100	11.0 - Close and Exit Quarterly CPnM Productio...	Risk and Finance Workbench:	Not Started			1	Mar 9, 2018	Mar 10, 2018	1

Figure 1: Capital Planning Process Workflow

In this process workflow, 12 tasks are included to complete the capital planning process. Each task is defined by a unique Identifier (ID), a name, and the owner. The status column indicates whether a task is in progress, completed, or not started yet. A capital planner starts a planning task by clicking the icon “Take Action” on the top right corner. In the drop-down list, the planner can choose to start a new iteration, send the task to a department, approve or reject a task, and mark a task as complete.

Depending on the properties, some of the tasks can run simultaneously, while others run in sequence. For example, task 2.1 and task 2.2 require personnel from two different departments, accounting and risk management, to confirm data availability. They are independent of each other and can be done in parallel. By contrast, task 6, review projection results, needs to happen after task 5.0, calculate projection, is completed.

Among the 12 tasks, some tasks are pure process control tasks. For example, task 1.0 is to start a new planning process, while task 11.0 is to close and exist the cycle. The other tasks run scripts to perform certain jobs. For example, task 4.0 is a data uploading task. Once task 2.0 and task 3.0 for data availability are confirmed and reviewed, task 4.0 runs a script to upload the new input data into SAS Risk and Finance Workbench. Task 5.0 runs a script to do capital projection, where the platform sends a request to SAS Infrastructure for Risk Management to trigger capital calculation in the high-performance MTC platform. Specifically, the script in task 5.0 first creates a new folder named by the project base date in the SAS Infrastructure for Risk Management input area, and puts the new input data into the folder. This triggers live ETL to load the data into the SAS Infrastructure for Risk Management landing area. Then the script triggers capital projection job flow execution in SAS Infrastructure for Risk Management while the results are loaded back to SAS Risk and Finance Workbench. After all, task 5.0 is marked as complete.

The generation of the capital projection job flow and its execution in SAS Infrastructure for Risk Management is data driven and fully automatic. A generating script transforms user-provided formulas into a job flow, loads user data to the SAS Infrastructure for Risk Management landing area in form of SAS data sets, and triggers projection in SAS Infrastructure for Risk Management, which, in turn, loads the calculation results back to SAS Risk and Finance Workbench database. Figure 2 shows an example of a dynamically generated four-task job flow.

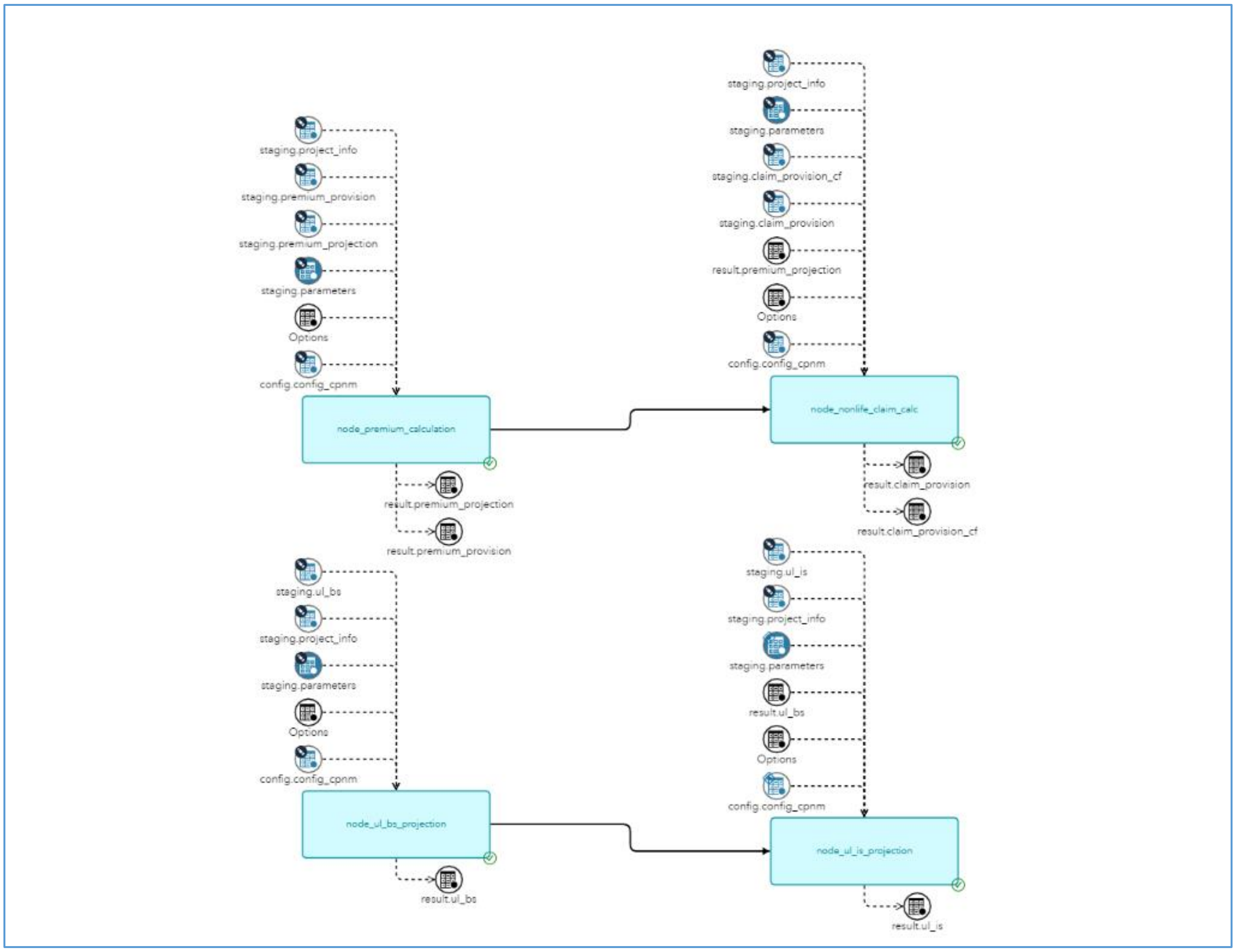


Figure 2: Simple Four-Task Job Flow in SAS Infrastructure for Risk Management

The job flow in Figure 2 is created automatically using user-provided formulas and a few configuration files. In this simple example, the user provides formulas in an Excel file with four worksheets: property and casualty premium provision, property and casualty claim provision, life unit-linked income statement, and life unit-linked balance sheet. Each worksheet has line items related to one or a few aspects of capital projection. Every aspect is called a hierarchy in SAS Risk and Finance Workbench. Table 1 shows a formula definition worksheet related to calculating the income statement of the life unit-linked business.

	A	B	C	D
1	HIERARCHY_LI_KEY	CALCULATION_LOGIC	HIERARCHY_NAME	EXTERNAL_INPUT_HIERARCHY
2	IS_TOTAL	IS_TOTAL=SUM(IS_INC,-IS_EXP,-IS_ITE)	UL_IS	
3	IS_INC	IS_INC=SUM(IS_FEEINC,IS_SURRCHARGES)	UL_IS	
4	IS_FEEINC	IS_FEEINC=BS_A_UL_FEES	UL_IS	ul_bs
5	IS_SURRCHARGES	IS_SURRCHARGES=BS_A_UL_RELSURR*R_SURRCHARGERATE	UL_IS	ul_bs,parameters
6	IS_EXP	IS_EXP=SUM(IS_GL_CLPAID,IS_PAE,IS_MGMTEXP)	UL_IS	ul_bs,parameters
7	IS_GL_CLPAID	IS_GL_CLPAID=BS_A_UL_RELDEATH*R_MORTCOVER	UL_IS	ul_bs,parameters
8	IS_PAE	IS_PAE=BS_A_UL_PREM*R_ACQEXPRATIO	UL_IS	ul_bs,parameters
9	IS_MGMTEXP	IS_MGMTEXP=BS_A_UL_ASSET*R_MGMTEXPRATIO	UL_IS	ul_bs,parameters
10	IS_ITE	IS_ITE=(IS_INC-IS_EXP)*R_TAXRATE	UL_IS	parameters

Table 1: Life Unit-Linked Income Statement Formula Definition

In Table 1, column A holds the line item keys. Each key uniquely defines a line item. Column B provides the calculation logic for calculating the line item in column A. Column C specifies the hierarchy that the line item in column A belongs to. The calculation of a line item could depend on other line items specified in the same hierarchy, or the ones from other hierarchies. If a depending hierarchy is not shown in column C, then it is listed in column D as an external input hierarchy. For example, the line item IS_ITE (Income Tax Expense) depends on line item R_TAXRATE (Tax Rate) from the hierarchy PARAMETERS, which is not listed in column C. Therefore, PARAMETERS is treated as its external input hierarchy.

In SAS Infrastructure for Risk Management, a job flow consists of tasks that run in sequence or in parallel to transform input data to output data. We create one task for each formula definition worksheet. Because there are four formula definition worksheets in our example, the job flow has four tasks. A task is defined by its input and output data, and the calculation logic. For the task corresponding to worksheet UL_IS in Table 1, we are calculating the line items belonging to hierarchy UL_IS in column C. Therefore, we generate an output data set called "UL_IS" to hold all calculated line items of this hierarchy. Since the inputs are the values of the line items from the external hierarchies specified in column D, the input data sets for this task correspond to the unique external hierarchies UL_BS and PARAMETERS. To calculate all the UL_IS line items in a SAS DATA step, the line items must be arranged such that a line item depending on others has to be computed after all the depending items are calculated. We use the dependency information conveyed by the formulas in column B to topologically sort the line items. Figure 3 shows a dynamically generated SAS DATA step to calculate line items with the right order.

```
data WORK.RESULT;
   set WORK.MERGE_ALL;
   if YEAR_DIF>0 then do;
      IS_FeeInc=BS_A_UL_Fees ;
      IS_SurrCharges=BS_A_UL_RelSurr*R_SurrChargeRate ;
      IS_GL_ClPaid=BS_A_UL_RelDeath*R_MortCover ;
      IS_PAE=BS_A_UL_Prem*R_AcqExpRatio ;
      IS_MgmtExp=BS_A_UL_Asset*R_MgmtExpRatio ;
      IS_lnc=sum(IS_FeeInc,IS_SurrCharges) ;
      IS_Exp=sum(IS_GL_ClPaid,IS_PAE,IS_MgmtExp) ;
      IS_ITE=(IS_lnc-IS_Exp)*R_TaxRate ;
      IS_Total=sum(IS_lnc,-IS_Exp,-IS_ITE) ;
   end;
run;
```

Figure 3: SAS Calculation Statements for Computing Life Unit-Linked Income Statement

The task created also performs input data enrichment, output data post processing, as well as loading the results back to SAS Risk and Finance Workbench database. All the related code is automatically generated for each task according to its input and output data. And the header code is also generated automatically for each task.

The SAS Scripting Client uses the header information of all tasks to automatically generate HTML-based documentation, and more importantly, to create the job flow that controls the order of calculation. By using the input and output object information, the SAS Scripting Client performs topological sorting of all tasks, determines the computational order, and produces a graphic representation such as the one shown in Figure 2.

Once the projection in SAS Infrastructure for Risk Management is finished and the results are loaded back to SAS Risk and Finance Workbench, the capital planners could review and sign off on the results in task 6.0 and task 7.0.

The report is an indispensable component in the process of capital planning. A good report conveys accurate and clear messages about the financial status of the organization. It facilitates communications among stakeholders and enables decision making based on solid analysis of business prospects. In SAS Risk and Finance Workbench, users can produce multiple reports and organize them in a logical and coherent way. The user specifies a report template including headings, layout, and data structure to create a report. Figure 4 shows a sample report for a life unit-linked income statement projected out for three years.

Report: Life Unit-linked Income Statement for Bank 1, Universal Life Insurance, Projected Base and Scenario Base						
Lev1	**Lev2**	**Lev3**	**likeys**	**2017**	**2018**	**2019**
Income Statement			IS_TOTAL3	3,602,739.15	-605,899,809.00	-427,426,080.00
	Income		IS_INC3	15,490,835.50	1,169,345,775.00	2,231,143,431.00
		Fee and commission income	IS_FEEINC3	14,566,828.50	1,083,987,344.00	2,068,065,956.00
		surrender charges	IS_SURRCHAR	924,007.00	85,358,432.00	163,077,475.00
	Expenses		IS_EXP3	10,750,389.25	1,966,582,366.00	2,793,546,168.00
		Gross Claims Paid	IS_GL_CLPAID	11,000.00	10,777,580.00	20,590,590.00
		Policy acquisition and other underwriting expense	IS_PAE3	1,059,490.00	1,070,084,900.00	1,080,785,749.00
		Management expenses	IS_MGMTEXP	9,679,899.25	885,719,887.00	1,692,169,829.00
	Income tax expense		IS_ITE3	1,137,707.10	-191,336,782.00	-134,976,657.00

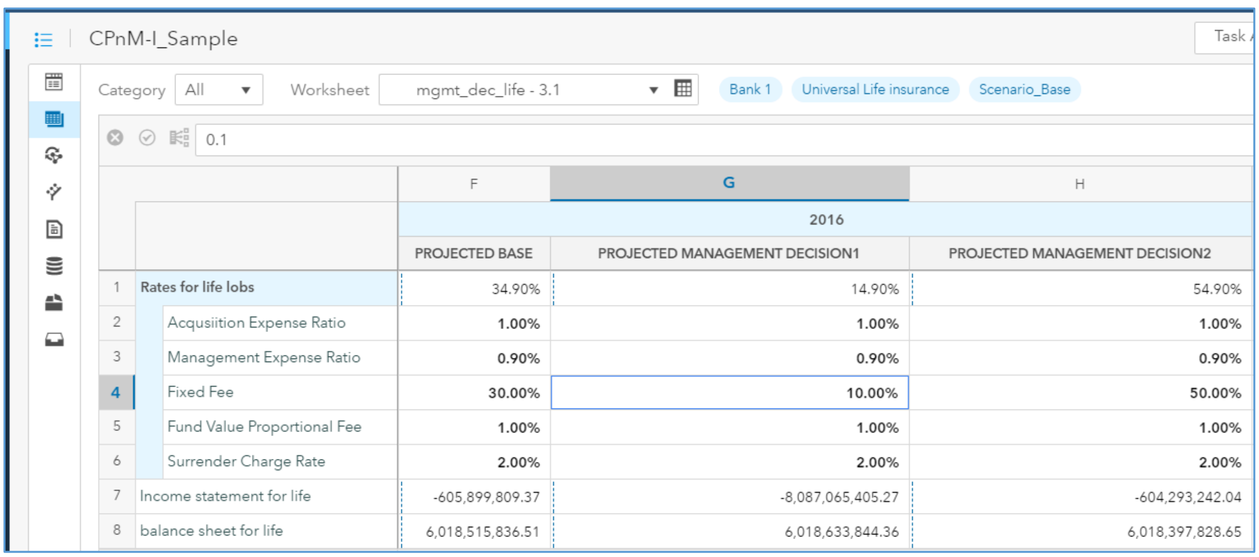
Figure 4: Report for Life Unit-Linked Income Statement

After the reports are generated in task 8.0, reviewed and published in tasks 9.0 and 10.0, capital planners could conclude the quarterly cycle by marking the final task 11.0 as complete.

STRESS TESTING

We described a typical periodical capital planning process using SAS Infrastructure for Risk Management and SAS Risk and Finance Workbench in the previous section. What if management's decision changes, leading to an input parameters and assumptions change, and then requires re-calculation of the projected capital? What if an adverse scenario happens, so the risk factors significantly change and will have a big impact on the capital projection? Thus, there is a need to examine the impact of alternative management decisions or adverse scenarios on capital projection. These analysis results provide guidance for risk control and management.

In our integrated environment, users could perform stress testing and scenario analysis as follows: first modify the input parameter worksheet in SAS Risk and Finance Workbench and save it; then trigger a model in SAS Risk and Finance Workbench to execute the job flow in SAS Infrastructure for Risk Management with modified parameters, while calculated results get loaded back to SAS Risk and Finance Workbench database. In SAS Risk and Finance Workbench 3.1, this is accomplished through the Model Group feature. The model is registered in the generating script. Figure 5 shows a side-by-side comparison of projection results between the base case and alternative management decisions.



		F	G	H
		2016		
		PROJECTED BASE	PROJECTED MANAGEMENT DECISION1	PROJECTED MANAGEMENT DECISION2
1	Rates for life lobs	34.90%	14.90%	54.90%
2	Acqusiition Expense Ratio	1.00%	1.00%	1.00%
3	Management Expense Ratio	0.90%	0.90%	0.90%
4	Fixed Fee	30.00%	10.00%	50.00%
5	Fund Value Proportional Fee	1.00%	1.00%	1.00%
6	Surrender Charge Rate	2.00%	2.00%	2.00%
7	Income statement for life	-605,899,809.37	-8,087,065,405.27	-604,293,242.04
8	balance sheet for life	6,018,515,836.51	6,018,633,844.36	6,018,397,828.65

Figure 5: Test Alternative Management Decision

In this example, user changes "Fixed Fee" for the management alternative columns "PROJECTED MANAGEMENT DECISION1" and "PROJECTED MANAGEMENT DECISION2", compared to the column "PROJECTED BASE". The Fixed Fee is changed from 30% to 10% and 50% respectively. Consequently, after the test alternative management decision run, the results in the last two rows related to "income statement for life" and "balance sheet for life" are changed accordingly, compared to the column "PROJECTED BASE". This kind of analysis provides quick reference for decision making.

CONCLUSION

In this paper, we have seen that the integration of SAS Infrastructure for Risk Management and SAS Risk and Finance Workbench provides a powerful tool for capital planning. The workflow process in SAS Risk and Finance Workbench streamlines the work tasks and facilitates collaboration among stakeholders. It also provides a simple solution for stress testing, iterative scenario analysis, and customized reports. The automatic data driven high speed calculation in SAS Infrastructure for Risk Management addresses the challenge of extensive computation.

Overall, the seamless integration brings flexibility, efficiency, auditability, and traceability to capital planning process. In fact, we have already seen the success of integration in several other SAS solutions such as SAS® Regulatory Content for IFRS 9. Along with the new features coming out from SAS Infrastructure for Risk Management and SAS Risk and Finance Workbench, we surely will anticipate greater potentials powered by the integration of the two platforms.

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RECOMMENDED READING

- SAS® Infrastructure for Risk Management 3.4 documentation
- SAS® Risk and Finance Workbench 3.1 documentation

CONTACT INFORMATION

Your comments and questions are valued and encouraged. Contact the authors:

Minna Jin
100 SAS Campus Drive
Cary, NC 27513
SAS Institute Inc.
minna.jin@sas.com
http://www.sas.com

Huina Chen
100 SAS Campus Drive
Cary, NC 27513
SAS Institute Inc.
huina.chen@sas.com
http://www.sas.com

Juan Du
100 SAS Campus Drive

Cary, NC 27513
SAS Institute Inc.
juan.du@sas.com
http://www.sas.com

Henry Bequet
100 SAS Campus Drive
Cary, NC 27513
SAS Institute Inc.
henry.bequet@sas.com
http://www.sas.com