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Representative Scenarios Method (RSM) Part 2: Field Testing the RSM

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This article is the second of two articles to address the RSM. Part 1 was published in the September 2015 issue of *Small Talk*. That article focused on the motivation and goals for this new reserve methodology, together with a description of how the methodology works and what key information can be derived from the analysis. The ultimate goal would be to develop and validate a consistent analytical framework that could be used for all long-tailed liabilities.

This article will focus on the field tests that have been undertaken to validate the accuracy and practicality of this methodology, describing refinements to the methodology together with next steps. Four product types have been tested: non-variable indexed annuities with guaranteed lifetime income benefits (FIAs with GLIBs), level premium term life insurance (term), universal life with secondary guarantees (ULSG), and variable annuities with guaranteed lifetime withdrawal benefits (VAs with GLWBs). Note that in the course of this testing, refinements have been made to the RSM methodology.

If the testing shows that a refined RSM analytical framework can be used for all long-tailed liabilities, then RSM could be used as an asset adequacy analysis methodology and also as an approximation method for principle-based reserves (PBRs) for all long-tailed product types. For example, Section 2G of VM-20 states:

> A company may use simplifications, approximations and modeling efficiency techniques to calculate the net premium reserve, the deterministic reserve and/or the stochastic reserve required by this section if the company can demonstrate that the use of such techniques does not understate the reserve by a material amount and the expected value of the reserve calculated using simplifications, approximations and modeling efficiency techniques is not less than the expected value of the reserve calculated that does not use them.

APPROXIMATING THE TARGET RESERVE

In reviewing the field tests, it is important to recall the target reserve that is being approximated by RSM. While there are several possible candidates, the Part 1 article states, "RSM approximates the results that would be derived from full stochastic modeling of all key risks associated with a block of business." In the development of RSM, this is our working definition of the "right-size reserve" that was the original goal of the principle-based approach (PBA).

If you had the computer power and the luxury of adequate time to run a very large number of fully stochastic scenarios, meaning that all the key risk drivers (KRDs) would be stochastically modeled at the same time, there would still be the question of the proper size of the statutory margin to be included in the reserve. As noted in the Part 1 article, there are two main methodologies for determining such an aggregate margin: the cost of capital (COC) method and the percentile method. The COC margin is similar to the concept of transfer value, wherein the margin represents the compensation that an arm's-length investor would require to accept the risks associated with a block of business. The percentile approach is more like the CTE 70 methodology of VM-20, approximating a percentile level in the distribution of the present value of future cash flows across all scenarios. One of the features of RSM is that it can provide an estimate of the aggregate margin on either basis; therefore, we will be presenting results using both aggregate margin methodologies.

FIXED INDEXED ANNUITIES WITH GLIBS

The Annuity Reserve Work Group (ARWG) of the American Academy of Actuaries (AAA) responded to the Life Actuarial Task Force's charge to develop Section 22 of the PBR Valuation Manual (VM-22) by setting the statutory reserve equal to the greater of a formulaic reserve (floored by the cash surrender value) and a modeled reserve. To support the development and testing of both the formulaic and the modeled reserves, the Kansas Insurance Department (KID) led by Commissioner Sandy

RSM could be used as an asset adequacy analysis methodology and also as an approximation method for principle-based reserves (PBRs) for all long-tailed product types.

Praeger sponsored a field test of these methodologies for the purpose of advancing PBR. A field test team of programmers and actuaries was assembled (Steve Strommen, James Kavanagh, Phil Colbert and Mark Birdsall), and two companies recruited to provide funding and actual product and policy information for the testing.

One of the challenges for both ARWG and the field test team was the lack of industry experience on GLIB utilization for FIAs.

As the result of extensive discussions, consideration of a Society of Actuaries (SOA) survey of pricing assumptions for FIAs with GLIBs, plus a review of information aggregated by KID from actuarial memoranda in support of asset adequacy analysis, ARWG developed a set of principles and a sample GLIB utilization function that was the initial basis of the field test. This sample function was applied for both the formulaic reserve and the modeled reserve calculations using RSM. The principles used in developing the GLIB utilization function included the following:

1. GLIB utilization begins at attained age 60.
2. Utilization peaks at key retirement ages, with modest rates in between. Utilization rates around key retirement ages are smoothed around those ages, reflecting changes to the normal retirement age.
3. Contract status (qualified versus non-qualified) impacts the pattern of GLIB utilization.
4. GLIB utilization rates must follow contract provisions, such as waiting periods.
5. GLIB utilization is influenced by the degree to which the benefit is "in-the-money" (ITM)—see the following detailed description of the ITM calculation. The GLIB utilization rate for a contract is zero when the GLIB benefit is not ITM.
6. GLIB utilization can be deferred, anticipating near-term increases in GLIB benefits, and then added back when the higher benefits are available.
7. GLIB utilization is influenced by the relative richness of joint- and single-life benefits, which may not be actuarially equivalent. For some FIA with GLIB products, the joint-life benefits are richer than the corresponding single-life benefits.
8. GLIB utilization is 100 percent after critical terminal ages (85 for non-qualified; 71 for qualified). If contracts are issued at these terminal ages or later, then all such contracts are assumed to utilize the GLIB at the end of the first contract year.

ITM-ness was calculated as a ratio of the present value of both GLIB income payments and death benefits, discounted at the current valuation calendar year Plan Type C interest rate, divided by the contract account value at the valuation date. The present value of the GLIB benefits was adjusted based on the relative

Figure 1
Comparative Reserve Levels ($millions)

	Company A		Company B	
Item	**Reserve**	**% of Account Value**	**Reserve**	**% of Account Value**
Account Value	5,139	100.0%	2,635	100.0%
Cash Surrender Value	4,608	89.7%	2,292	87.0%
CARVM (AG 33 & AG 35)	4,753	92.5%	2,542	96.5%
Modeled Reserves				
RSM (COC margin)	4,081	79.4%	2,911	110.5%
Fully Stochastic (COC margin)	4,018	78.2%	2,979	113.1%
RSM (percentile margin)	3,965	77.2%	2,681	101.7%
Fully Stochastic (CTE 70)	3,941	76.7%	2,741	104.0%
Aggregate Margins				
RSM (COC margin)	137	2.7%	418	15.9%
Fully Stochastic (COC margin)	107	2.1%	358	13.6%
RSM (percentile margin)	21	0.4%	189	7.2%
Fully Stochastic (CTE 70)	30	0.6%	120	4.6%

richness of the joint- and single-life GLIB benefits. More details regarding the GLIB utilization function and other modeling information can be found in "Phase 1—RSM Field Test Report to ARWG for VM-22," available by request to Nicole Boyd of KID at *NBoyd@ksinsurance.org*.

Referring to the two participating companies as Company A and Company B, it is worth noting that the FIAs with GLIBs that were included in the field test were of different benefit richness, with Company B's GLIB product generally richer. In addition, the policies valued were almost all in the first contract year, which will impact the COC calculation significantly due to the long length of the remaining liabilities.

The KRDs for this analysis were determined to be mortality, lapse, GLIB utilization, interest and expense. Following the RSM process outlined in the Part 1 article, the table in Figure 1 summarizes the results of the modeled reserve calculations using both the RSM scenarios and 500 fully stochastic scenarios, for which all the KRDs varied stochastically in each scenario.

The sizes of the modeled reserves relative to the account values reflect the relatively richer benefit for Company B's product. Note that the modeled reserves for Company A are within a narrow range and slightly higher than the respective fully stochastic reserves. For Company B, the results are lower than the respective fully stochastic reserves and further away as a percentage. While the current CARVM reserve also reflects the difference in the benefits, it does not fully reflect the difference in the relative riskiness of the product designs.

The higher margins shown for Company B reflect the greater risk due to the richer guaranteed benefits. For these blocks of business, the COC margin is higher than the percentile or CTE margin. This is typical for new business on long-term contracts with many years before expiry. The COC margin tends to reduce much more rapidly over time, and becomes less than a percentile or CTE margin in later years as the contract ages. The comparative behavior of these two margins over time was not calculated for this, the first product that was tested, but was calculated for the other three products that were tested later.

Other conclusions from testing FIAs with GLIBs include:

1. While RSM did not provide exactly the same numerical results as full stochastic testing, it did provide essentially the same comparative information for potential use by regulators. That information includes:

    a. Before adding a margin, the central estimate for both companies is less than the current account value. That means that if expectations are realized, both companies will realize a profit on this business.

While RSM did not provide exactly the same numerical results as full stochastic testing, it did provide essentially the same comparative information for potential use by regulators.

    b. Aggregate margins for Company B need to be much larger than for Company A due to the risk associated with the richer guaranteed benefits.

    c. When the aggregate margin is included, modeled reserves for Company A are still much less than the account value, while those for Company B are greater than the account value.

2. The KRD of investment returns should be split into two separate risk drivers: interest rates and equity returns. These separate risks are not fully correlated, but in the RSM scenarios generated for testing FIAs they were treated as fully correlated, thereby overestimating the risk. (This refinement has been implemented in the testing for VAs, which was done later.)

3. The yearly projections of capital for the COC method should be in proportion to some base, such as the present value (PV) of the remaining benefit-only cash flows, some measure of the remaining in-force block, or some other projected base, depending on product type and the likelihood of future premiums. If the same base is to be used for all product types, a generic measure that would apply to all product types—such as projected policy count or benefit count—would need to be used. For purposes of this testing, the base used to project future capital requirements was the PV of remaining benefit-only cash flows.

4. While not shown in this summary, the various scenario amounts produced using the RSM provide substantial information about the size of various risks, and could feed readily into a company's risk management program. The interest KRD reflects the impact of both dynamic lapse and dynamic GLIB utilization in response to interest rates and tends to have the largest impact for the products studied, while expenses tend to have the smallest impact and may in fact not be considered a KRD. To increase understanding of the components of risk, it may be desirable to separate out the impact of dynamic lapse and dynamic GLIB utilization from the interest KRD. This would not change the result of the reserve or margin calculation because all the separated components would be perfectly correlated with changes in interest rates.

But it might be useful for risk managers to understand how much of the interest rate risk is due to policyowner behavior changes in response to interest rate changes.

LEVEL PREMIUM TERM LIFE INSURANCE

KID made four changes in preparing for the testing of the next product types:

1. A case study approach employing prototype products was used to help make the testing more efficient.
2. A peer reviewer knowledgeable in each respective product type was recruited to help establish the appropriate product designs, modeling assumptions and product pricing, and provide other review.
3. The COC margin for FIAs with GLIBs was based on a 6 percent after-tax COC factor. Due to the high level of COC aggregate margin produced by that factor relative to the percentile margin, it was determined to use a 4 percent after-tax COC factor for the remaining products.
4. KID funded the testing rather than the participating companies. We thank Kansas Insurance Commissioner Sandy Praeger for her support!

One key fundamental of RSM is using current (best) estimate assumptions. The RSM aggregate margin, whether calculated by COC or percentile method, is explicit and varies with risk, as shown in the work for FIAs with GLIBs. One complication in evaluating RSM for life insurance products (such as term and ULSG) is that mortality improvement is currently not recognized in calculating statutory reserves, though such improvement is allowed and prudent in the calculation of reserves for other types of long-tailed insurance products. In the analyses of term and ULSG, we assumed that this regulatory constraint would be lifted and some recognition of the trend of mortality improvement would be allowed, subject to the inclusion of reserving margins that reflect the possibility that it may not happen.

For the field test, five variations of level premium term were priced for purposes of the case study:

1. 10-year term, issue age 35
2. 10-year term, issue age 55
3. 20-year term, issue age 35
4. 20-year term, issue age 55
5. 30-year term, issue age 35

All contracts are issued to males, and the amount of insurance is $500,000 per contract. Full details of assumed experience and other pricing assumptions are in the Phase 2 report on term life insurance at *www.blufftop.com/RSM/Kansas.html*. The KRDs were determined to be mortality, mortality improvement, lapse, interest, default costs and expenses.

From the testing, the reserves under RSM and the fully stochastic reserves were very similar, as shown in Figure 2 (note the reserves are projected in this work).

Figure 3 compares the aggregate margins under the two methods over time. A log scale is used for the vertical axis so that proportional differences remain visible even as both margins get much smaller in dollars as the business runs off the books.

The main difference between these two margin methodologies is apparent from this graph. The COC margin tends to be larger when the business still has a long period to run. However, the COC margin is released faster, crosses over and becomes lower than the percentile margin.

Figure 2
RSM vs. Stochastic Reserves Over Time

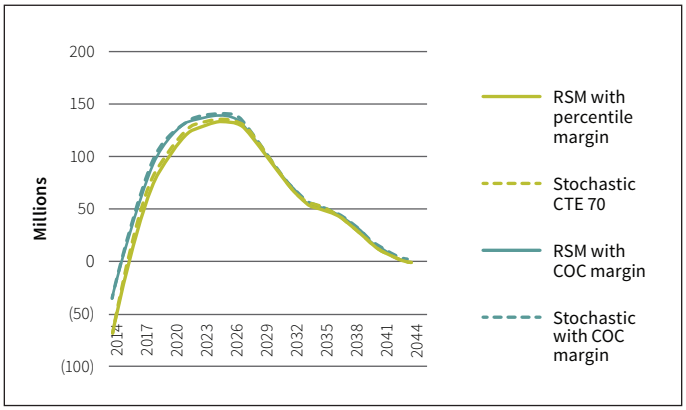
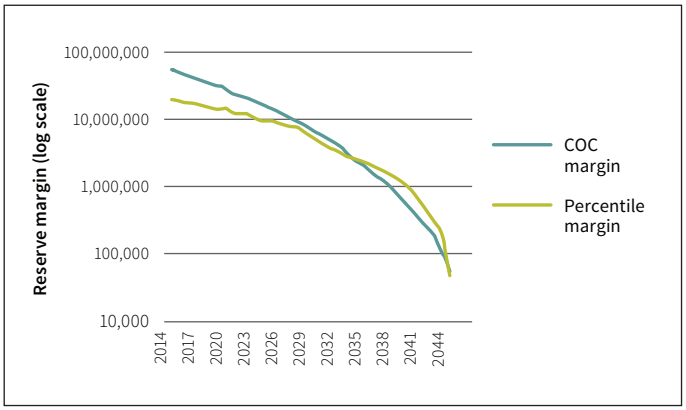


Figure 3
Margins Over Time



In reviewing the breakdown of risks over time, we reached the following conclusions:

- The largest risk is the mortality trend, at over $70 million initially. As time passes this risk declines rapidly. As noted earlier, we assumed that some recognition of the future mortality trend would be allowed in RSM. The effect of this single assumption explains most of the difference between reserves under RSM and VM-20.
- The second largest risk is mortality fluctuation. Since claims are heaviest in later years, this risk remains significant as long as business remains on the books.
- The lapse risk for this block of business is surprisingly small in 2014–2015. This is because the direction of this risk changes over time. Before 2015, high lapse rates are adverse due to the loss of renewal premiums and the expense recovery that they provide.[1] After 2015, high lapse rates are favorable due to the elimination of future claims liabilities. In 2014–2015 these risks largely offset so the total risk due to lapse rates is minimal at that time.
- Default cost risk is comparable in size to interest rate risk. This is dependent, of course, on the assumed quality of the investment portfolio, which in this example is on the low end of investment grade.
- Expense risk is not material. Therefore, as with FIAs with GLIBs, it would not need to be included as a KRD.

UNIVERSAL LIFE WITH SECONDARY GUARANTEES

ULSG provides a fixed benefit amount upon death at very low cost. The basic contract takes the form of universal life insurance with flexible premiums. A secondary guarantee ensures that coverage will remain in effect even if the contract's account value declines to zero, as long as a shadow fund remains positive. The premium level needed to keep the shadow fund positive is much lower than that needed to keep the account value positive. This leads to the two main characteristics of a ULSG contract: a low premium for lifetime coverage and a small or zero surrender value.

The ULSG contract used for this testing was meant to represent the competitive low-premium end of the estate protection market. When the minimum premium is paid, the account value never accumulates to a large amount and goes to zero fairly quickly. For purposes of this testing, all policy owners were expected to pay the minimum level premium. Two different ULSG contracts were priced for this study: male issue age 50 and male issue age 70. Full details of assumed experience and other pricing assumptions are in the Phase 2 report on ULSG at *www.blufftop.com/RSM/Kansas.html*. The KRDs were determined to be mortality, mortality improvement, lapse, interest, default costs and expenses.

Figure 4
Comparative Reserve Levels ($millions)

	RSM with Percentile Margin	Stochastic CTE 70	% RSM-CTE 70	RSM COC margin	Stochastic margin	% RSM-CoC	VM-20 Deterministic	VM-20 Stochastic
2014	204	189	8%	403	429	–6%	942	981
2019	2,112	2,061	3%	2,252	2,231	1%	2,732	2,766
2024	3,864	3,782	2%	3,913	3,808	3%	4,344	4,367
2029	4,964	4,883	2%	4,943	4,857	2%	5,313	5,334
2034	4,921	4,845	2%	4,867	4,800	1%	5,143	5,170
2039	4,089	4,028	2%	4,031	4,001	1%	4,227	4,254
2044	3,487	3,436	1%	3,430	3,402	1%	3,562	3,587
2049	3,074	3,046	1%	3,023	3,009	0%	3,108	3,123
2054	2,430	2,414	1%	2,392	2,383	0%	2,434	2,442
2059	1,360	1,352	1%	1,340	1,336	0%	1,353	1,356
2064	497	496	0%	491	491	0%	494	494

Figure 5
Margins Over Time

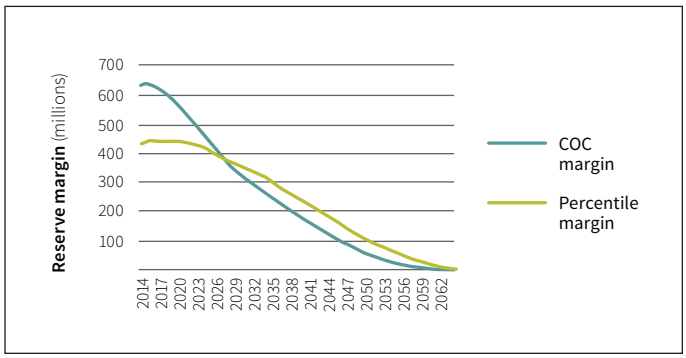
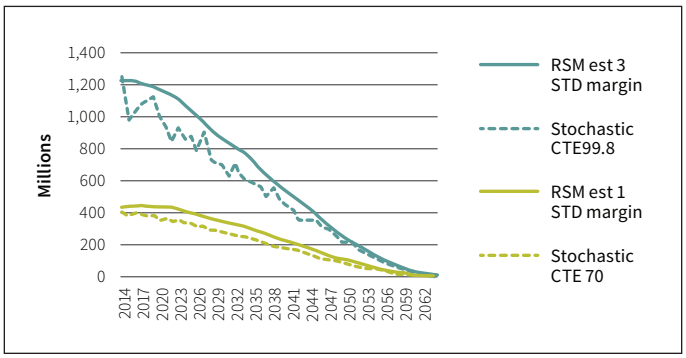


Figure 6
RSM vs. Stochastic Margins



From the testing, the reserves under RSM and the fully stochastic reserves were not as similar as for level term insurance, as shown in Figure 4. The reserves under RSM were slightly higher than the fully stochastic reserves, with the percentage difference generally declining with duration.

Note in this case we also estimated two VM-20 reserves, shown in the last two columns of Figure 4. A comparison of the VM-20 reserves with the RSM and stochastic reserves makes it clear that the VM-20 reserves are materially higher in the early durations. The difference between RSM and stochastic reserves is tiny compared to the difference between RSM and VM-20 reserves. Most of that difference between RSM and VM-20 is attributable to the treatment of mortality improvement. The VM-20 reserves cannot reflect mortality improvement beyond the valuation date, but for RSM and stochastic reserves we allowed reflection of mortality improvement.

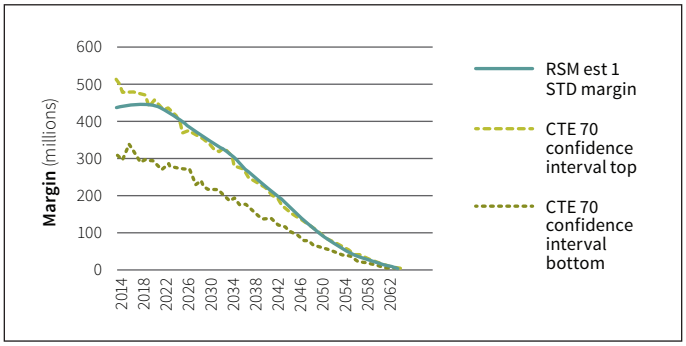
While the RSM estimates become better over time, the early durations are not as close as a percentage of the fully stochastic reserves. Note that the crossover point for the RSM with the two different aggregate margins is just beyond the 10th duration in this projection.

Figure 5 compares the aggregate margins under the two methods over time. Unlike the graph for level term, a log scale is not used, resulting in a somewhat different shape as compared with term.

The main difference between these two margin methodologies is again apparent from this graph. The COC margin tends to be larger when the business still has a long period to run. However, the COC margin is released faster, and crosses over and becomes lower than the percentile margin. The crossover point for the two different aggregate margins is just beyond the 10th duration in this projection.

The results in Figure 6 show that in the case study of ULSG the margins estimated using RSM are a bit more conservative than

Figure 7
RSM Percentile Margin vs. CTE 70 Confidence Interval (100 Scenarios)



those estimated using full stochastic analysis. This contrasts with the results previously obtained for level premium term, where the margins estimated using RSM were closer to those from full stochastic analysis.

While the RSM estimate of the percentiles is higher than estimated using full stochastic modeling in this study, it is worth bearing in mind that the stochastic results are subject to estimation error. Figure 7 illustrates the 95 percent confidence interval for the CTE 70 based on a sample of just the first 100 scenarios out of the 1,000 scenarios that were used. One hundred scenarios is a much larger number of scenarios than were used to obtain the RSM figure. Nevertheless, the RSM estimate appears to be on the edge of the confidence interval for the stochastic CTE 70 estimate using 100 scenarios.

In reviewing the breakdown of risks over time, we reached the following conclusions:

- The largest risk is the interest (i.e., reinvestment) risk. Since most of the premium will be received many years in the fu-

ture, uncertainty about interest rates available in the future is a major contributor to total risk.

- Mortality improvement and lapse rates compete to be the second-largest risk. Lapse risk is surprisingly large given the low level of anticipated lapse rates on ULSG. It is the extreme case where lapses decline to effectively zero that creates this risk.
- Default cost risk is substantially smaller than interest rate risk.
- Expense risk is not material. Therefore, it would not need to be included as a KRD.

VARIABLE ANNUITIES WITH GLWBS

For testing this product type, we focused on a single-premium deferred VA with the following design characteristics:

- Death benefit = account value
- Blended fixed/equity fund only. Investment purely in equities is often disallowed with GLWBs.
- Free withdrawals equal to 10 percent of account value
- Surrender charges applied in first 10 years
- GLWB rider
  - Guaranteed minimum withdrawal payments equal to percentage of GLWB shadow fund when withdrawals start. Shadow fund is original single premium projected at 5 percent per annum for 20 years, 0 percent thereafter.
- Rider charges
  - Rider charges are percentage of account value and continue after start of withdrawals.

Due to the underlying variable nature of the account value mechanics, certain adjustments were made to the utilization function for GLWBs, but the function was similar to that used in the testing of FIAs with GLIBs discussed earlier.

VAs with GLWBs pose significant market-related risk to the insurer. Therefore, it is common practice to use a hedging program to reduce these risks. Through hedging, the capital requirements can be significantly decreased. However, hedging can be expensive, and the cost of hedging must be balanced against the savings from reduced capital requirements.

In practice, very refined hedging programs are often used. For purposes of this testing, a simple strategy has been used in order to illustrate how hedging can reduce reserve and capital requirements, with the understanding that more refined hedging might increase that effect.

The hedging program used in this case study involves the purchase of a specified package of options at the beginning of each year, with settlement of those options (and purchase of new ones) at the end of the year. The package of options represents a simple delta hedge on stock market movements that protects against severe downside risk. The cost of downside protection is reduced by giving away some upside. More specifically, the package includes:

- For downside risk: a put option that covers losses from a stock market return that is more than 12 percent below the risk-free rate
- For upside: a pair of call options (long and short) that give away 25 percent of stock market returns in excess of 5 percent over the risk-free rate, but not past 15 percent over the risk-free rate

The notional amount of the hedges at time of purchase is 60 percent of the account value on the VAs at that time. That represents the portion of account value of the blended investment fund that is invested in the stock market.

This simple hedging program could be refined in many ways in practice, but such refinement was not modeled for this study. Potential refinements include:

- Add some sort of hedging on interest rate movements.
- Change the delta hedge over time based upon stock market returns in previous periods. For example, if the stock market rises, the downside risk gets more remote and the strike price of the put option could be reduced.
- Make the hedge program dynamic. This would allow inclusion of options for terms longer than one year, with dynamic management of the option portfolio (settlement of some options and purchase of others) as conditions change.

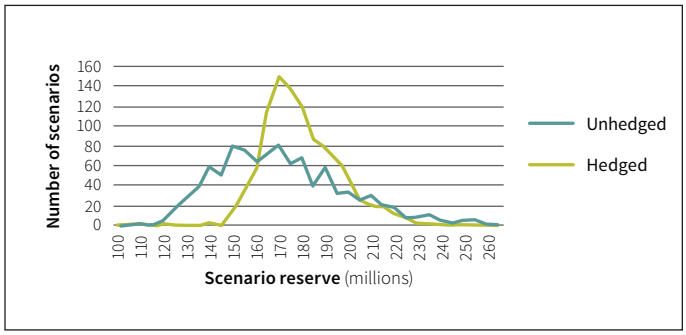
Such refinements could reduce overall risk further, thereby reducing required reserve margins and capital requirements below those illustrated here. Nevertheless all hedging has a cost that must be balanced against such potential benefits.

Figure 8 illustrates the cost/benefit trade-off of the simple hedging program used in this study. The distribution of 1,000 stochastic scenario reserves was determined both with hedging and without hedging.

Figure 8 shows clearly that the hedged distribution is different from the unhedged distribution in two significant ways:

1. The hedged distribution is narrower, with more scenarios in the center and fewer in the tails. Also, the extreme tails are not as far from the center.

Figure 8
Distribution of Scenario Reserves



2. The hedged distribution is shifted to the right, indicating a higher average or central value. This increase in the average reserve represents the expected cost of the hedging.

Numerically, these effects are illustrated by the mean and the CTE 70 of the two distributions:

	Unhedged	Hedged
Mean	$168.8 million	$177.2 million
CTE 70	$202.8 million	$197.2 million

Hedging increases the mean due to the added cost of hedging. But hedging reduces the CTE 70 because of the protection against downside risk.

More details regarding the modeling assumptions and other information related to the testing can be found in "Phase II—RSM Field Test Report for VM-21," available by request to Nicole Boyd of KID at *NBoyd@ksinsurance.org*. For this product design, the KRDs were determined to be mortality, lapse, GLWB utilization, expenses, equity returns and interest.

Figure 9 summarizes the results of the modeled reserve calculations using both the RSM scenarios and 5,000 fully stochastic scenarios, for which all the KRDs varied stochastically in each scenario.

Note that all the modeled reserves calculated more fully reflect the risks associated with this product design than does the Standard Scenario reserve, which in this case is less than the cash surrender value.

In this case, the RSM reserve with the percentile margin is not a good estimate of the fully stochastic CTE 70 reserve. The reason is that hedging changes the mapping between experience levels and investment returns so that investment returns in the

Hedging increases the mean due to the added cost of hedging. But hedging reduces the CTE 70 because of the protection against downside risk.

tail produce about the same scenario reserve as investment returns at, say, the one standard deviation level. Such a scenario reserve is at a very high percentile level in the full stochastic distribution.

Basically, RSM assumes lower investment returns lead to higher scenario reserves. But when hedging is in place that may not be the case, so the small number of RSM scenarios do not provide a good indicator of the full distribution. However, the RSM scenarios do still provide a good indication of where the tails are.

In looking at the aggregate margins calculated using the COC and percentile methods, the comparison we observed for this VA product was different from that observed for the life insurance

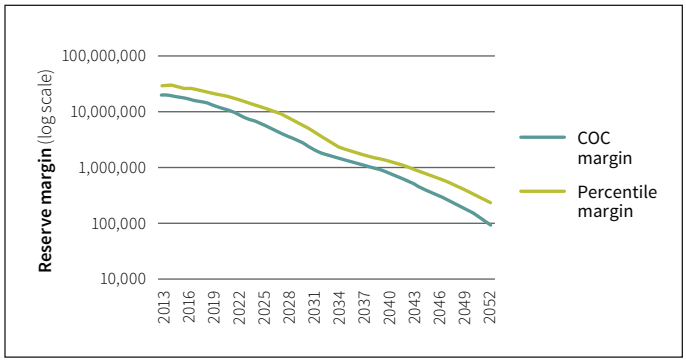
Figure 9
Comparative Reserve Levels ($millions)

Item	Reserve	% of Account Value
Account Value	206.4	100.0%
Cash Surrender Value	186.3	90.3%
Standard Scenario Reserve	178.2	86.3%
Modeled Reserves		
RSM (COC margin)	204.5	99.1%
Fully Stochastic (COC margin)	203.7	98.7%
RSM (percentile margin)	212.1	102.8%
Fully Stochastic (CTE 70)	197.2	95.5%
Aggregate Margins		
RSM (COC margin)	20.6	10.0%
Fully Stochastic (COC margin)	26.3	12.7%
RSM (percentile margin)	28.2	13.7%
Fully Stochastic (CTE 70)	21.7	10.5%

products. For VAs, the COC margin was consistently lower than the percentile margin as shown in Figure 10.

Two observations can be made regarding this comparison of margins over time for VAs with GLWBs:

Figure 10
Margins Over Time



1. The COC rate used to calculate the COC margin has not yet been set. For the VA case study we used 4 percent, but this could easily be calibrated to a higher value if the desire was to bring the margin under the two approaches closer together for this product.

2. For life insurance products, we observed a crossover by duration in the margin under the two methods. We stated that for products with a long remaining lifetime, the COC margin tended to be higher than the percentile margin, but it was released faster. For products with a short remaining lifetime, the COC margin would be lower. Actually, that remains true if one understands the measure of "remaining lifetime" in use. The "remaining lifetime" for this purpose is the ratio of the PV of the COC in all future years to the COC in the first projected year. When that ratio is high, the COC margin is greater than the percentile margin, and vice versa. In the case of the VAs with GLWBs we simulated, the relatively high assumed lapse rates and contract withdrawal rates made the capital requirement reduce more quickly over time and made that ratio much lower than for the life insurance products. In short, the "remaining lifetime" was shorter for VAs, and the relationship between the COC margin and the percentile margin reflects that.

It is hard to see how the regulator frustration with life insurance reserve work-arounds such as lines of credit and captive reinsurers will be resolved without some recognition of the trend of mortality improvement.

In reviewing the breakdown of risks over time for VAs with GLWBs, we reached the following conclusions:

1. In the early contract years, equity return risk is the most significant risk by far followed by interest, increased by the impact of dynamic surrenders and GLWB utilization related to ITM-ness.

2. Over time, mortality becomes the dominant risk.

3. As with the other product types, expenses could be left out as a KRD.

MAJOR CONCLUSIONS AND NEXT STEPS

1. Based on the results of these tests, two refinements to RSM have been made. The first is to separate the investment risk drivers for interest and equity risk. The second is to change the COC rate used in calculation of the COC aggregate margin from 6 percent to 4 percent.

2. Initial RSM results can lead to paring down the number of KRDs. In these tests, the small impact of expense variations suggested removing expense as a KRD.

3. Mortality improvement is a significant issue in the analysis of the two life insurance products tested. We believe that realistic central estimates would reflect some degree of future mortality improvement, but that reserve margins and minimum capital requirements for life insurance must be adequate in the case of no improvement. It is hard to see how the regulator frustration with life insurance reserve work-arounds such as lines of credit and captive reinsurers will be resolved without some recognition of the trend of mortality improvement. Note that when mortality improvement is a KRD, the variation around the current (best) estimate assumption for mortality improvement is included in the calculation of the aggregate margin using either the COC or percentile method. If regulators required, these variations could include a scenario where there is no mortality improvement, building that requirement into the aggregate margin.

4. The accuracy of the RSM approximation of the percentile margin is impacted by factors significantly affecting the shape of the distribution of the fully stochastic scenario amounts, such as hedging and possibly reinsurance and other

factors. Hedging had a significant impact on the shape of the stochastic distribution of scenario amounts for the VAs with GLWBs that were tested, so for this product type RSM did not provide a good estimate of the percentile margin (see point 7). The accuracy of the RSM approximation to the extreme tails of the distribution seems less affected by this issue. RSM with a COC margin (where capital is based on the tails of the distribution) seems to be a good approximation to fully stochastic reserving if the COC approach to the margin is accepted.

5. If the percentile approach to the aggregate margin is strongly preferred over the COC approach, a fully stochastic reserve employing scenario reduction methods may be a better approach than RSM in some situations, such as VAs with GLWBs. In this case, the number of stochastic scenarios used can be reduced significantly if the resulting CTE measure is increased by a measure of its potential statistical error. The variance or standard error of the CTE can be calculated, and the CTE plus two standard deviations could be used (in place of the CTE itself) as the reserve level. In this way each company can choose a "sweet spot" that balances the number of scenarios with the level of the approximation of the fully stochastic reserve. The use of a larger number of scenarios would reduce the add-on to the CTE and, with a high degree of probability, reduce the reserve. Additional research of an approach that combines RSM and full stochastic scenarios may be undertaken for potential use if a percentile margin is preferred.

6. For all four product types tested, the modeled reserves (both RSM and fully stochastic with either the COC or percentile aggregate margins) better reflect the risks associated with the assets and liabilities than the statutory requirements currently defined in CARVM, VM-20 and the Actuarial Guideline (AG 43) Standard Scenario.

7. As of this writing we are working on a case study applying RSM to long-term care insurance, using all the lessons learned so far and building on the previous work of the AAA's Long Term Care Work Group (LTCWG). An additional refinement to RSM, increasing the number of RSM scenarios somewhat for the KRDs contributing to the largest variations from the result of the anticipated experience scenario, will be tested as to whether this refinement improves the approximation of the fully stochastic CTE 70 reserve.

8. Develop sample demonstrations that would allow RSM to qualify as an approximation method for PBR reserves per VM-20, AG 43, VM-21 and other relevant VM sections, including VM-22, currently under development. ■

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ENDNOTE

[1] The measurement we used for whether a change in lapse rates was favorable or unfavorable was the effect on the present value of future cash flows. This is different from measuring whether the change in lapse rates creates a statutory gain or loss. The statutory gain or loss is often dominated by the release of statutory reserves, which is not a cash flow but does increase the statutory gain associated with an increase in lapse rates. If measured by whether there is a statutory gain or loss, high lapse rates on term are almost always favorable to the company.