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Variable annuity hedging under the U.S. statutory framework

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There is a rising interest among U.S. variable annuity (VA) companies in formulating hedge strategies that directly address the need to protect U.S. statutory capital and maintain dividend-paying capacity. For some time, provisions have existed within this statutory framework for recognizing both the risk-reduction benefits and the costs that arise from projected profits and losses associated with clearly defined hedge programs; however, recent changes have reduced dissonance between valuation frameworks, making it easier to achieve stable earnings across frameworks. Key considerations when developing a sound VA hedge program and risk framework with a focus on statutory capital include:

1. Recent changes in U.S. statutory and GAAP frameworks have reduced dissonance between frameworks, with convergence toward a fair value framework for companies that project fair value hedging within their statutory capital calculation, making it easier to manage VA risks and achieve stable earnings across frameworks.
2. When formulating a hedge strategy, companies need to be cognizant of differences that remain between statutory and GAAP frameworks, including the underlying scenario framework, cash flows required to be included, general account asset treatment (market vs. book value), and the level of conservatism in assumptions. For managing risks associated with Guaranteed Minimum Death/Living Benefit (GMxB) riders, U.S. companies typically focus on fair value (similar to GAAP) and/or statutory capital.
3. There are material costs associated with hedging the full product, but these costs are also recognized in the statutory framework, leading some companies to seek out a middle ground between fair value hedge programs that are restricted to certain riders on the one hand, and programs that seek to stabilize the entire product value on the other hand. Tail risk under large equity down shocks is often a key consideration, and such strategies for tail risk protection need to be thoroughly evaluated in accordance with a company's risk framework.
4. The statutory framework has a conservative flooring mechanism adding convexity in the reserve/capital risk profile that does not align with the fair value hedge target, leading to mismatch between hedge gains/losses and reserve/capital movements, particularly under favorable market conditions for the more out-of-the-money businesses. It may be prudent for companies to explore approaches to manage or mitigate this convexity.
5. In cases where interest rate hedging is not included in the hedge credit modeling, statutory valuation will have different interest rate sensitivity than under a fair valuation approach, mainly driven by differences in the scenario frameworks such as equity/rate interaction and mean-reversion considerations.

When formulating hedge strategies with risk-return trade-offs in mind, it is essential to have a strong and clear risk framework in place, defining approaches for measuring residual risks, bounds on acceptable residual risk levels, and strategies for ensuring risk levels remain within these bounds, such as evaluating the protection levels on capital. The risk framework should be reviewed periodically and needs to be supported by adequate systems and tools for timely risk assessment, risk monitoring, as well as attribution of hedge strategy performance, which will allow companies to effectively communicate with internal and external stakeholders.

Section 1: Introduction

The U.S. statutory framework for VAs requires a long-term cash flow analysis under a set of "real-world" capital market scenarios, as a basis for setting required levels of risk capital. However, it also contains provisions for recognizing projected profit and loss (P&L) from hedge programs designed to mitigate capital markets risk. Companies employing such programs may see reduction in required capital, as well as a risk profile that is closer to a hedged fair valuation view of the business than to an unhedged real-world view.

Although fair value hedging of certain GMxB guarantee riders has been common industry practice for some time, driven in part by U.S. GAAP requirements that take a fair value ("risk-neutral") valuation approach to these guarantees, similar hedging for other GMxB guarantees and for the base product[1] has been less common historically. One driver was U.S. GAAP rules, which required certain rider guarantees to be reserved under the Statement of Position 03-1 (SOP03-1) framework that is closer to real-world valuation than risk-neutral valuation, such that hedging on a fair value basis could lead to GAAP earnings volatility for these riders. Another driver was that, until recently, the U.S. statutory framework contained a working reserve that could lead to a mismatch with respect to the fair value view of the balance sheet; this was removed as part of the National Association of Insurance Commissioners (NAIC) Valuation Manual 21 (VM-21) reform.

The operating environment has changed in recent years, making it easier for insurers to hedge the VA capital markets risk exposures and achieve stable earnings across frameworks. First, the Long-term Duration Targeted Improvement (LDTI) changes that will become effective in 2023[2] will align U.S. GAAP more to fair value on all GMxB riders. Second, the NAIC VM-21 reform that became effective in 2020 allows companies to reflect higher credits for hedging within the principle-based reserving framework for reserve and capital. As such, it is easier to design a hedge program that manages the statutory capital and dividend payment capacity, which is constrained by capital requirements under the U.S. statutory framework.

Section 2: U.S. statutory capital methodology

The statutory capital for U.S. insurance companies is based on the Risk-Based Capital (RBC) framework. RBC is calculated according to the formula below. It uses separate distributions for material risk components, the capital risks within the formula below, that are aggregated with an allowance for diversification benefits. The total adjusted capital represents companies' statutory capital and surplus according to the U.S. statutory account principles.

$$\boldsymbol{RBC = C_0 + C_{4a} + \sqrt{(C_{1o} + C_{3a})^2 + (C_{1cs} + C_{3c})^2 + (C_2)^2 + (C_{3b})^2 + (C_{4b})^2}}$$

$$\boldsymbol{RBC\ Ratio = \frac{Total\ Adjusted\ Capital}{RBC}}$$

The minimum requirement is 100% of the RBC amount before regulatory intervention.[3] Companies typically target to hold at least 350% RBC as the statutory capital on the balance sheet. Holding additional "buffer" capital above the target is also a common approach for risk management.

The capital risks cover exposures associated with affiliates (C_0), assets (C_1), insurance (C_2), market (C_3), and business risks (C_4). The key risk components related to GMxB liabilities are C_{3a} and C_{3C}, which are the GMxB interest rate risk and GMxB equity risk, respectively. CTE 98 and CTE 70 are conditional tail expectations, and they represent the average of the worst 2% and 30% of outcomes, respectively, from the full set of stochastic results of future fund growth and interest rate paths. The CTE 70 is the reserve amount that the insurer must hold, and it is calculated on a pretax basis. The total C_3 is approximately 25% of the difference between CTE 98 and CTE 70 calculated per the requirements specified under the NAIC VM-21.[4] The C_3 is a posttax calculation and targeting total asset requirement (TAR) at 400% RBC is roughly equal to CTE 98 multiplied by the federal income tax (FIT) rate.[5]

The VM-21 framework involves a stochastic real-world valuation that incorporates both asset and liability cash flows. Asset projection reflects general account assets as well as derivatives used in hedging,[6] with potential credits for future rebalancing, and liability cash flows capture both rider and base product cash flows. The outcome for each scenario within the stochastic valuation captures the amount of additional assets that the company needs to hold

above the cash surrender value (CSV) to enable the company to meet all GMxB obligations along the projection path. When looking at GMxB on a standalone basis before any consideration for diversification among all RBC capital risk components, holding TAR at CTE 98 is equivalent to targeting 400% RBC, i.e., capital = CTE 98 – CTE 70 = 400% C_3. For the rest of the paper, the term CTE 98 TAR is used interchangeably as 400% RBC TAR as a simplifying assumption. For VA products, there is also C_1 risk associated with the general account assets backing the business and some diversification benefits between C_1 and C_3 within VA can be expected. Additionally, insurers who write both VA and non-VA products could recognize material RBC diversification benefits. Certain products, such as registered index-linked annuities (RILAs), can be valued together with VA products under the VM-21 framework and provide diversification benefits. For this discussion, RBC diversification is ignored, and the framework is simplified down to protecting the VA CTE 98 TAR. That is, to protect the statutory capital and maintain 400% RBC under stress scenarios, companies would need to always hold TAR at CTE 98.

The U.S. statutory framework requires inclusion of projected VA hedge program P&L within the cash flow projection. In the case of a fair value-based hedge program used to replicate certain cash flows, this approach will reduce differences between the statutory valuation of the hedged cash flows and the fair value of those cash flows.

Section 3: GMxB hedging objectives

GMxB liabilities are exposed to significant equity and interest rate market risks. There is a wide range of risk management strategies for these GMxB exposures, one of which is fair value hedging of rider cash flows.

Prior to the global financial crisis in 2008, a prevalent trend was for companies to manage GMxB on a fair value basis but with a GAAP focus. The fair value hedge target involves a risk-neutral valuation on the GMxB rider claims and fees, and the hedging program is usually a dynamic hedging approach that involves a replicating portfolio of derivatives providing payoffs closely matching the movement of the fair value hedge target. Companies that manage to GAAP earnings volatility hedge less than the full rider cash flows because certain riders fall under a real-world valuation approach that reduces the overall market sensitivity of the valuation compared to a risk-neutral framework. However, after the transition to LDTI, any risk management program still targeting GAAP earnings volatility may need to be revisited.

Following the global financial crisis, a trend of companies moving toward managing the statutory capital exposure has been observed. Statutory capital is managed via the RBC framework, and for VA GMxB, the requirement is mainly tied to a real-world valuation that captures both base product and rider exposures in tail scenarios. When undergoing significant equity market downturn during the global financial crisis, companies that only hedged the riders experienced capital erosion due to a substantial decrease in the base product cash flows that ultimately increased statutory capital requirements. The table in Figure 1 is a summary of the valuation differences between statutory valuation and fair value calculation of VA blocks.

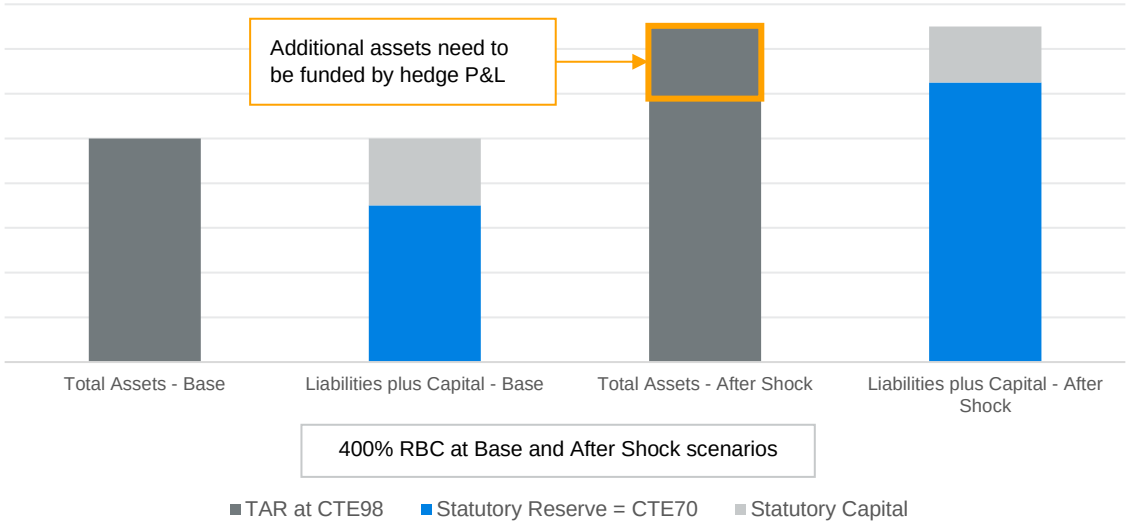
FIGURE 1: FAIR VALUE VS. STATUTORY VALUATION

ASSUMPTIONS	FAIR VALUE	STATUTORY CAPITAL
Scenarios	Risk-Neutral	Real-World CTE
Mortality/Policyholder Behavior Assumptions	Best Estimate	Reflects Provision for Adverse Deviations (PADS)
Asset Assumptions	Market Value	Book Value
Base Product Cash Flows	Optional; dependent on the usage of the metric/hedge target	Included
Flooring	No flooring	Requirement cannot be negative (below the CSV)[7]

The U.S. statutory valuation is considerably more complex than a fair value calculation so a statutory-based hedge target can be more challenging to execute and attribute changes throughout a period. Implications of any diversification benefit from non-VA businesses are also an important part of the statutory capital management, but they are not included in the discussion of VA risk management in this paper. There are various ways of structuring a program that protects statutory capital, such as through an overlay to a fair value hedging program or setting the program to target statutory sensitivities directly.

After a statutory valuation stress, the TAR needs to be either funded by a hedging program that provides matching gains/losses as the CTE 98 moves, or through holding a capital buffer to support any increase. Figure 2 shows a hypothetical case of an in-the-money block where the company starts with 400% RBC (i.e., CTE 98 TAR without considerations of diversification benefits) at the base scenario. Additional assets for meeting the 400% RBC target requirement after an equity down shock need to be funded by payoffs from a hedging program.

FIGURE 2: HYPOTHETICAL ILLUSTRATION OF 400% RBC

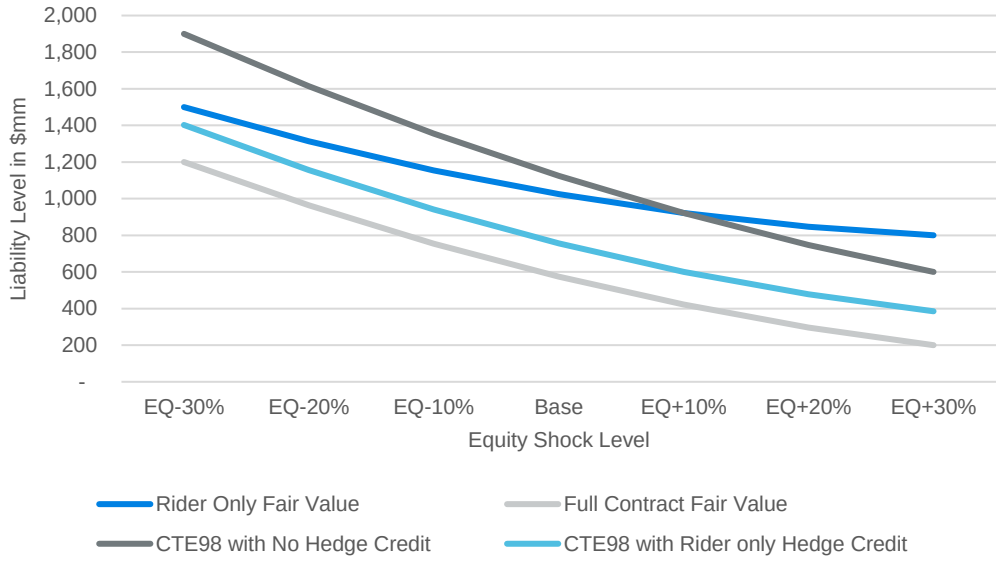


Section 4: Equity sensitivities

Protecting statutory capital requires constructing a derivative portfolio that provides payoffs matching the movement of the CTE 98. For hedging equity market movements, an insurer needs to focus on equity sensitivities. Fair value equity sensitivities for the rider only are typically lower compared to the statutory CTE 98 due to the exclusion of base product cash flows, among which M&E fees and revenue sharing are the main items sensitive to equity movements.

Figure 3 illustrates the liability outcomes of a sample $5 billion standalone VA block that is out of the surrender charge period under four lenses: rider-only fair value, full contract fair value, CTE 98 without hedge credit, CTE 98 with hedge credit for rider-only fair value hedging.[8] Figure 3 captures the level of liability above the cash surrender value under each lens for a block that is 20% in-the-money (where 20% is the ratio of the aggregate gap between guarantee level and account value, divided by account value). When comparing the CTE 98 to the full contract fair value,[9] the higher sensitivity is driving the calculation reflecting on average more adverse fund returns than a risk-neutral framework.

FIGURE 3: HYPOTHETICAL ILLUSTRATION OF AN IN-THE-MONEY GMXB BLOCK



The table in Figure 4 shows equity deltas and gammas for these various valuation lenses. Delta refers to the change in the valuation reflecting an instantaneous +1% movement of the underlying equity funds, and gamma is a second-order calculation that reflects the change in delta with an instantaneous +1% movement of the underlying equity funds. Figure 4 captures the Greeks of the liability only. For example, after a +1% equity movement, the CTE 98 TAR is expected to move by $21.7 million if there is no hedging program in place. If the rider is hedged, then the CTE 98 TAR is expected to be reduced by $17 million but the reduction would be offset by a reduction in assets of $11.7 million due to hedge losses in such a market movement.

FIGURE 4: SUMMARY OF GREEKS FOR THE IN-THE-MONEY GMXB BLOCK

UNIT $ MILLION	RIDER-ONLY FAIR VALUE	FULL CONTRACT FAIR VALUE	CTE 98 WITH NO HEDGE CREDIT	CTE 98 WITH RIDER-ONLY HEDGE CREDIT	NET EXPOSURE (LIABILITY MINUS ASSET) WITH RIDER-ONLY HEDGING
1% Delta	-11.7	-16.7	-21.7	-17.0	-5.3
1% Gamma	3.5	3.5	3.5	3.8	0.3

Notably, going from rider-only hedging to full contract hedging would have an expected cost of approximately $30 million annually, which is a significant offset to any reduction in cost of required capital for moving from rider-only to full product fair value hedging.[10]

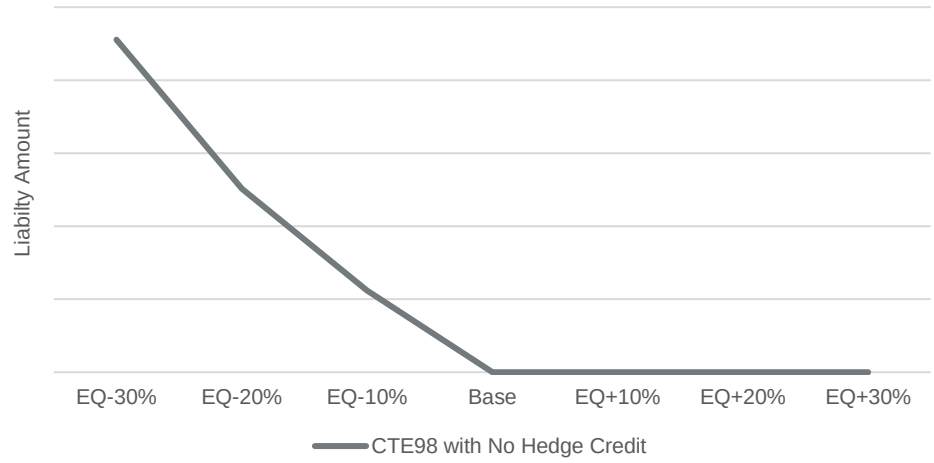
In practice, companies often stake out a middle ground between rider-only and full product hedging, for example using options to hedge a certain amount of the base product tail risk associated with large equity drops. In this case, the best estimate real-world hedge cost takes the form of option premium rather than expected payoffs from linear instruments and may be significantly less than the $30 million per year noted above. Furthermore, the "delta" contribution from such hedges will be smaller, reducing the impact on projected hedge P&L, at least as viewed through the lens of the "safe harbor[11]" approach under the VM-21 guidelines for reflecting hedge credits within the stochastic CTE calculation. Companies need to determine an optimal option hedging strategy to achieve the target mix of hedge cost versus risk reduction.

Section 5: Equity sensitivities for out-of-the-money VA blocks

When managing the TAR at CTE 98, companies can face challenges driven by a constraint within the VM-21 framework where the CTE calculation involves a floor at CSV. Companies must always hold assets in the amount of the CSV as a minimum, even if the projection suggests surpluses are expected in the future. Typically, the CSV floor is approached as the underlying GMxB becomes more out-of-the-money, which increases the possibility of surpluses being projected in the VM-21 valuation. When the CTE is floored, there's muted sensitivity as equity increases and hence gamma is elevated in the vicinity of where the floor is binding.

Figure 5 shows a hypothetical illustration of the equity risk profile for a VA block that is out of surrender charge period, far out-of-the-money (OTM), and already subject to CSV flooring in the baseline valuation. When the CTE 98 calculation is already floored at CSV, it becomes insensitive to any further favorable shocks and hence adds convexity to the risk profile of CTE 98 as shown in Figure 5. For this reason, hedging based on the statutory view can be as or more concerned with gamma as delta, providing further reason to augment use of linear instruments with option positions. One approach would be a tail hedging program with equity put options for protecting the downside exposure, but it can be challenging to manage when the CTE 98 is oscillating around the CSV floor. A dynamic hedging program could drive large mismatch in hedge losses and CTE 98 movements as the market goes up, because any fair value calculation does not have a constraint on capturing future surpluses.

FIGURE 5: HYPOTHETICAL ILLUSTRATION OF OUT-OF-THE-MONEY GMXB BLOCK



One alternative to reduce the gamma of the statutory liability when in proximity of the CSV floor is to adjust modeling of the hedge target used to achieve the hedge credit. The CSV flooring mechanism can be viewed as a prudent assumption for preparing for the extreme case of mass lapsation as the GMxB becomes far OTM. Companies can explore the interplay between dynamic policyholder behavior models within the hedge target valuation and the impact of the CSV floor on Greeks. Any gamma reduction from this approach comes at the cost of holding additional required capital.

Reinsurance or other transactions can be a helpful means of managing VA statutory capital. When tackling the case of CTE 98 being floored at CSV, companies can consider how reinsurance of certain cash flows would change risk profiles and help mitigate the CSV flooring issue for overall risk management. There can also be advantages from changes in business mix from acquisition, divesture, or new sales, such that the profile of aggregated business may present fewer challenges for risk management.

Finally, holding excess capital and targeting a range of RBC ratios allows companies to be less concerned about the increased gamma when approaching the CSV floor. However, defining an appropriate range to satisfy all stakeholders can be challenging.

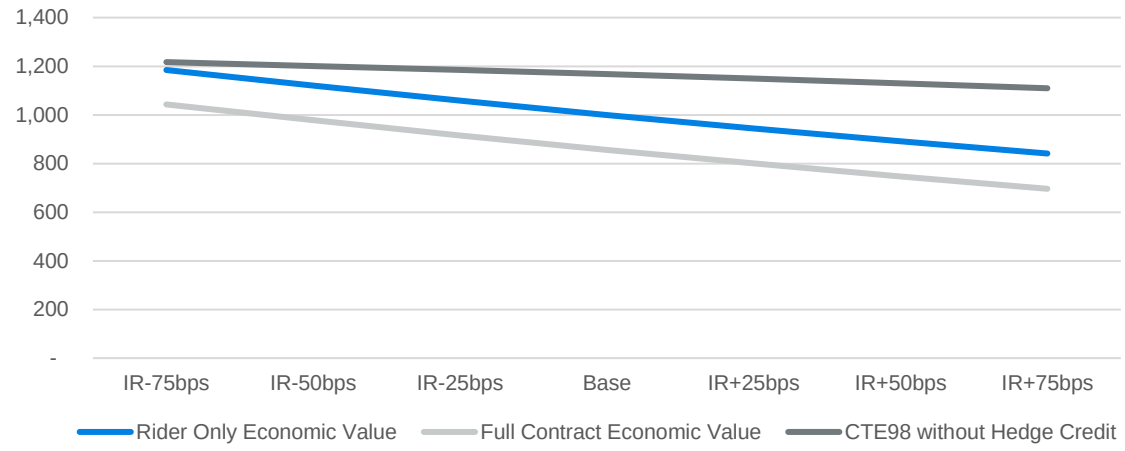
Section 6: Interest rate sensitivities

VA GMxB risk management focuses both on equity and interest rate risk exposures. Similar to managing statutory capital on equity risk exposure, companies need to focus on the CTE 98 interest rate sensitivities.

Although capital management is conceptually the same when dealing with equity and interest rate risks, the relationship in sensitivities between statutory valuation and fair value measures is distinctly different between the two risk factors. The equivalent of delta on the interest rate risk is rho, which represents the change in the valuation reflecting an instantaneous 1 basis point (bp) movement of the underlying interest rate curve. In fair value, there is little rho associated with the base product due to the offset between growth and discounting of these cash flows when applying shocks to the risk-free rate curve.[12] As such, the rho of a rider-only fair value and a full contract fair value are similar. On the other hand, the rho of base product cash flows is more significant in a statutory valuation underlying the CTE 98 measurement. The rho sensitivity is mostly due to discounting the projected base product cash flow at a different rate from separate account growth, as the VM-21 regulation specifies discounting at the net asset earned rate. When interest rates increase, the actuarial present value of these base product cash flows decreases, increasing the asset requirement. This sensitivity is the opposite of the GMxB rider rho where the rider liability decreases in higher interest rate environments, and as a result the CTE 98 rho is generally lower than that of the rider-only/full contract fair value. Another contributing factor to the dampened interest rate sensitivity within the CTE 98 metric is that the current NAIC prescribed scenario generator reflects interest rate mean reversion, as well as a floor on the interest rate level. These mechanisms are unique to the statutory valuation under the VM-21 guidelines and are not present in the risk-neutral valuation framework. Like the case of equity, the more a company hedges fair value rho and reflects projected hedging for hedge credit, the less disconnect it will see between the fair value and statutory views of the interest rate risk to the balance sheet.

Figure 6 shows a comparison of fair value and CTE 98 interest rate sensitivities. The rider-only and full contract fair value have a similar response to rate movements. The CTE 98 metric is less sensitive as discussed above. However, reflecting a fair value hedge credit in CTE 98 would add interest rate sensitivity due to the cost of hedging as discussed above. For hedging the interest rate exposure within the GMxB products, there's overall less consensus in the industry compared to equity risk management. Companies can choose to manage interest rate risks on an enterprise level as a broader asset-liability management (ALM) effort. Many companies account for the rho provided by the general account assets backing the business when managing interest rate risks.

FIGURE 6: GMXB INTEREST RATE SENSITIVITIES ILLUSTRATION



The above discussed rate sensitivity profile is applicable to companies using the current NAIC prescribed scenario generator, which does not reflect correlation between equity and interest rate movements. An anticipated update in the NAIC prescribed scenario generator will address the lack of interest rate response to equity movement. As such, some companies will have to update their interest rate risk management perspectives.

Section 7: VA risk management under U.S. statutory capital requirements

Companies managing VA statutory capital will need a risk framework that includes risk limits that constrain the derivative positions used for hedging and an approach for reviewing the effectiveness of the risk framework.

In particular, it is common to put constraints on the potential decrease in RBC capital under capital markets stress scenarios, accounting for movement in the liabilities and the hedge gains/losses. The time horizon considered typically ranges from a quarter to a year, and all asset and liability cash flows that occur during the time horizon under analysis are considered. The stylized market stress scenarios are typically calibrated based on historical market movements, and typically reflect tail measures at a certain confidence level such as a 90^{th} or 99^{th} percentile event.

It is also appropriate to define limits on the net fair value change between assets and hedged liabilities, under stress scenarios, consistent with how future hedges are modeled for hedge credit purposes within the statutory framework. This element of the risk framework relates to governance goals for the hedge program.

Determining liquidity needs and placing risk limits accordingly is another key element of the risk framework. A key driver of liquidity needs in VA hedge programs is the need to post collateral on derivative positions, which will affect overall asset management.

Once a framework is set, it is important to periodically review the hedge program and risk framework to ensure it conforms with the needs of stakeholders and any change in the operating environment. Such a review could consider the appropriateness of risk limits and outcomes under scenarios not explicitly considered in the risk framework. For example, in some tail hedging strategies, protection does not come into play until equities decrease significantly, and it is important to assess all the implications of limited protection under smaller market movements. Within the review, basis risks and hedge effectiveness are also crucial elements to incorporate when assessing the degree of RBC capital protection achieved. Furthermore, it is important to carry out projections under longer-term scenarios, to understand deficiencies in the risk framework that could arise at future times when the state of the products has evolved and market conditions may have changed more dramatically than is anticipated in short-term projections. The projections would further inform decisions with regard to dividend payout capacities.

Besides setting up the key metrics for establishing the risk management target and the ability to monitor risk exposures, it is also important to establish clear and effective approaches for hedge program performance attribution, which can be especially challenging for programs that don't purely hedge fair value. Transparent performance attribution allows companies to show internal and external stakeholders the effectiveness of a risk framework given the costs of the program.

Companies vary in their business strategies, business mix, investors, and risk tolerances, leading to some reasonable variation in hedge programs throughout the industry. In all cases, a robust risk framework coordinated across the company is essential, as well as having adequate supporting systems and tools in place to effectively quantify and monitor risks and carry out effective performance attribution to explain realized and prospective outcomes to key stakeholders.

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ENDNOTES

[1] Base product refers to the non-rider product income/expenses associated with the VA contract: mortality and expense (M&E) fees, revenue sharing, policy charges, surrender charges, maintenance expenses, and trail commissions.

[2] LDTI becomes effective in 2023 for public companies that are U.S. Securities and Exchange Commission (SEC) filers, but excluding smaller reporting entities. All other companies have until 2025 for LDTI adoption.

[3] The framework specifies four different levels of regulatory action.

[4] This is applicable to companies domiciled outside of New York. For the case of a company domiciled in New York, the valuation would follow Regulation 213 (Reg 213), which involves a deterministic real-world projection based on a set of prescribed fair value and actuarial assumptions. There are very distinct risk profiles when a company's reserve or TAR is floored at the Reg 213 requirement. This special case is ignored in this paper.

[5] There are two different approaches for calculating the posttax CTE 98. One of the approaches is deriving a pretax CTE 98 based on the same distribution as that used for the CTE 70 and then applying a high-level tax adjustment at the end, the Macro Tax Adjustment (MTA) approach. The alternative is to build all tax attributes within the stochastic calculation itself, the Specific Tax Recognition (STR) approach. When using the MTA approach, for companies not subject to an additional standard projection amount (ASPA) and not capped at the non-admitted deferred tax assets, the C3 is equal to CTE 98pre-tax x FIT – CTE 70 x 0.9281 x FIT. Total asset requirement at 400% of the C3 is then approximately equal to CTE 98pre-tax x FIT. The ASPA is a separate stochastic calculation based on prescribed mortality/policyholder behavior assumptions. Nonzero amounts arise when the prescribed assumptions are more conservative.

[6] The 2023 NAIC Valuation Manual requires companies to reflect all future hedging strategy. The term "future hedging strategy" is a derivative program undertaken by a company to manage risks through one or more future hedging transactions, including the future purchase or sale of hedging instruments and the opening and closing of hedging positions.

[7] An additional requirement arises when the company is subject to holding additional reserve associated with the Standard Additional Projection Amount, which is a separate stochastic calculation based on prescribed mortality/policyholder behavior assumptions. Nonzero amounts arise when the prescribed assumptions are more conservative than company assumptions.

[8] The rider hedge credit reflection within the CTE calculation is captured through a simplistic approach that replaces the real-world rider outcome with the risk-neutral realization for the rider cash flows, rather than an explicit stochastic on stochastic simulation of hedge credits.

[9] Full contract fair value is a risk-neutral valuation of both the base product and rider. The term "full contract" denotes that this calculation reflects cash flows associated with the entire contract.

[10] The $30 million/year hedge cost is estimated from the product of the expected equity risk premium, assumed to be 6% per year, and the $5 million additional delta going from hedging rider-only (-$11.7 million delta in Figure 4) to hedging full contract fair value (-$16.7 million delta in Figure 4). In practice, the expected equity risk premium can depend on market conditions, to the extent they affect the estimates of risk-free rate and the expected total return on equity. The annual cost of capital savings is estimated as the product of the annual cost of capital rate, assumed to be 10% per year, and the reduction in capital requirement going from the CTE 98 with rider-only hedge credit requirement to the full contract fair value liability, approximately $200 million as illustrated in Figure 3 above.

[11] The safe harbor approach allows companies to model nonlinear instruments, such as options, as purely linear derivatives. Such a modeling approach ignores potential benefits from the convexity within nonlinear instruments in scenarios with adverse fund movements.

[12] To the extent expected decrements change with the optionality of the rider at different interest rate environments, the base product cash flows do get impacted. However, such rho impact is expected to be second-order and relatively small.