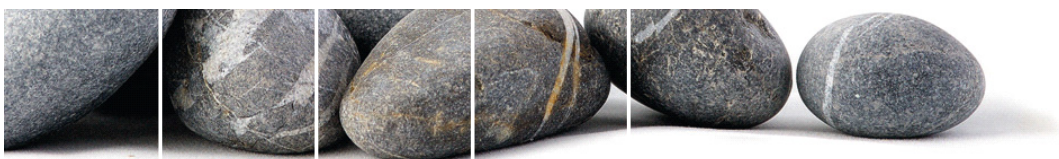


Working Paper

The Variable Annuities Dilemma:
How to redesign hedging strategies
without deterring rising demand.

Dr. Bernhard Brunner | Senior Vice President
Mikhail Krayzler | Analyst

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Contents

1	Executive Summary.....	3
2	Variable Annuities – An Overview	4
3	Risk Management for Variable Annuities	6
4	Impact of Recent Market Crisis on Variable Annuities.....	9
5	Conclusion	11

1 Executive Summary

Increasing life expectancy as well as reduction of the state retirement pensions in several countries has led to the rapid growth of variable annuities (VAs), products allowing guaranteed payments and participation in the financial markets at the same time. In the following we give an overview of the variable annuity (VA) market and describe typical products. We then discuss most common risks arising for VA providers and the possibilities of overcoming these risks. Different hedging strategies are compared with an accent on dynamic hedging. The last part is dedicated to the influences of the current financial turbulence on the VA business. While the crisis has underlined the value inherent in the products and resulted in increasing demand, it has at the same time exposed potential challenges in product design and strategy. In particular, the significant declines in equity values means many guarantees embedded in VAs have become “in-the-money” that is the guarantee benefit has greater value than the assets accumulated in policyholders’ account balances. The challenge for providers is to design variable annuity products to limit their liabilities and protect their income stream, but without raising the price of guarantees to a level that will choke demand. However, the most important implication of the financial crisis is applied to the risk management and hedging programs. It has become evident that a powerful hedging platform is almost a must for a successful business.

2 Variable Annuities – An Overview

Variable annuities have been available in the United States since the mid-1980s. In its basic form, a variable annuity resembles a package of mutual funds purchased by an investor or policyholder. However, compared to a classical mutual fund, a VA differs in several important ways.

First, a VA allows the policyholder to receive periodic payments for the predefined period, usually for the rest of their life (or the life of their spouse or other designated person). This feature protects against the possibility that, after retiring, the policyholder could outlive their assets. Second, a VA is tax-favored. Depending on the local regulations, VA contributions can be tax-deductible if the VA is held as a part of a retirement plan. Within a VA, money can be transferred from one investment option to another without being subject to taxes at the time of transfer. However, when money is withdrawn from a VA, it is taxed on the earnings at ordinary income tax rates rather than capital gains rates that might be lower.

In general, when a VA is part of a retirement plan, the benefits of tax deferral will outweigh the costs only if the tax rate in the decumulation phase is lower than in the accumulation phase and the VA is held as an investment to meet retirement or other long-term goals. Third and most important, VAs combine an investment in mutual funds with an insurance component in the form of a guarantee on underlying fund performance.

Over the years, the guarantees offered on VA products have evolved as the market has adapted to meet customer needs. While the vast majority of current VAs offer a death benefit rider as a default feature, more sophisticated designs include a variety of living benefit riders (see Figure 1).

Benefit	GMDB	GMAB	GMWB	GLWB	GMIB
Description	Lump sum on death to the beneficiary	Guaranteed lump sum after accumulation period	Guaranteed amounts via partial withdrawals over a specified period during accumulation and/or decumulation period with the possibility to surrender the guarantee	Guaranteed amounts via partial withdrawals during the whole life (policyholder retains control over the investment)	Guaranteed income via partial withdrawals after annuitization (policyholder loses the control after investment is converted to annuity)
Payoff Phase	Accumulation / Decumulation	Accumulation	Decumulation (occasional Accumulation)	Decumulation	Decumulation
Guaranteed Amounts	<ul style="list-style-type: none"> ▪ Initial premium ▪ Roll-up: premiums paid accumulated at guaranteed rate ▪ Ratchet: optional adjustments of guaranteed amount to the actual account value at specified dates ▪ Greater of fund value, ratchet and roll-up 		Annual withdrawals defined as maximum % of <ul style="list-style-type: none"> ▪ Initial premium ▪ Fund value ▪ Ratchet: optional adjustments of guaranteed amount to the actual account value at specified dates ▪ Bonus options: ability to increase the guaranteed amount if no withdrawals have been redeemed during predetermined periods ▪ Greater of fund value, ratchet and roll-up 	Minimum annual income defined as % of <ul style="list-style-type: none"> ▪ Initial premium ▪ Fund value at the time of annuitization ▪ Roll-up: premiums paid accumulated at guaranteed rate ▪ Ratchet: optional adjustments of guaranteed amount to the actual account value at specified dates. ▪ Greater of fund value, ratchet and roll-up 	

Figure 1. Variable Annuity Guarantees

The guaranteed minimum death benefit (GMDB) addresses the concern that the policyholder may die before all payments are made. If this happens, the beneficiary receives a payout, typically the amount of purchase payments made by the deceased policyholder, if at the time of the policyholder’s death the account value is less than a guaranteed amount.

In contrast, living benefits can be described as wealth-preservation or wealth-decumulation products as they enable the policyholder to preserve wealth during the drawdown period. They combine some of the advantages of traditional defined benefit and defined contribution retirement plans. There are three common types of living benefit riders: guaranteed minimum withdrawal benefit (GMWB); guaranteed lifetime withdrawal benefit (GLWB); and guaranteed minimum income benefit (GMIB).

The GMWB riders guarantee that a certain percentage (usually 5% to 7%) of the amount invested can be withdrawn annually until the entire amount is completely recovered, regardless of market performance. This means that if the underlying investments perform well, there will even be an excess amount in the policy at the end of the withdrawal period. Additional features may include, for example, a step-up that periodically locks in higher guaranteed withdrawals if investments do well.

Another type of withdrawal guarantee is the GLWB rider. It allows the policyholder to make withdrawals for the entire life. The actual percentage allowed to be withdrawn varies according to the person’s age and/or fund performance at the time of the first withdrawal.

A GMIB rider is designed to provide the investor with a base amount of lifetime income at retirement, which is at least as valuable as the account value of the investments at

the point of conversion. Triggering this guarantee is similar to purchasing an annuity in the traditional sense.

In addition to these three living benefits, which focus on the decumulation or payout phase of a VA, there is also a type of living benefit guarantee particularly designed as a wealth-accumulation product. The guaranteed minimum accumulation benefit (GMAB) rider guarantees that the final contract value at the end of the accumulation phase will not fall below a specified level regardless of the actual investment performance. This type of guarantee is particularly enticing to younger investors.

Over the last decade, VAs have been a major success story in the North American insurance market. They have even overtaken traditional fixed annuities to become the primary form of protected investment. This success has been repeated in Japan where since 2001, the VA market has grown from \$1.3 billion up to more than \$140 billion in March 2008.

Attention is now turning to Europe where VA products have been launched in a number of markets. The appeal of these products is that it addresses the long-term savings and retirement needs of Europe's rapidly aging population. As individuals also become more heterogeneous in terms of their demand characteristics, there is growing recognition in the industry and by governments that existing retirement models have to be improved to better meet consumer needs. In particular, consumers require access to market returns in order to keep pace with the rising cost of living, but they also need to protect their assets and lifestyle from negative economic trends.

3 Risk Management for Variable Annuities

Because of increasing sales volumes and rising product profitability in the United States and Japan, VAs offer strong opportunities for providers. However, caution is needed because VAs can have a high negative impact on the VA provider's balance sheet. Proper risk management is still the main requirement for a successful product. In addition, issuers gain a competitive advantage in the market if they clearly understand and can provide transparent demonstration of VA risks. Given the highly complex structure of VA products, risk management deserves special attention.

Risks associated with VAs can be divided into three main categories: market risks, insurance risks and operational risks. The most important insurance risks are: longevity, mortality, lapse risk and policyholder behavior. Insurance risks rarely can be hedged out. Just a few instruments have been developed to manage longevity and mortality risks, two examples are longevity- and mortality-linked derivatives. However, the corresponding market has not been established yet due to the number of different

issues one faces when trying to use these instruments. Companies launching longevity bonds have experienced several problems, such as high prices, basis risk between the underlying index and longevity risk faced by insurances or pension funds. In addition, the absence of comprehensive models to project life expectancy and a lower degree of standardization in the market for longevity bonds are further major problems in this field.

Another type of insurance risk is caused by unexpected policyholder behavior and unanticipated rate of policy terminations (lapse risk). This has become an important issue for many insurance companies and pension funds. Recently, we have seen an increased demand on the VA products by professional investors and hedge funds. These professionals can make more effective decisions than individual policyholders regarding optimal allocation between underlying funds or time points when to sell the products. If the policy issuers are not prepared for this policyholder behavior high losses might arise. This and other types of insurance risks can be also outsourced or partly eliminated by increasing the size of the VA portfolio – as most of these risks follow the law of large numbers (pooling of risks).

In contrast to insurance risk, market risk, which primarily includes equity, interest rate and volatility risk, will not decrease by enlarging the size of the VA portfolio. However, these risks can be controlled by appropriate hedging strategies. Finally, insurers should be aware of the so-called operational risks. These consist of model risk, legal risk, wrong implementation of risk management framework, IT breakdowns, and similar risks. Unfortunately these risks cannot be easily hedged, so they need to be monitored closely. In the following we will concentrate on the market risks and examine how the VA issuer can manage them. While the entire risk monitoring system and some hedging programs play an essential role in the success of the product, actual risk management starts even earlier – during pricing and product design. There are several options that can be implemented in the design phase that give more flexibility to insurers. The following measures help to eliminate some potential risks:

- possibility to change the guarantee costs;
- restrictions on fund investments to reduce volatility and diversify portfolio;
- incentives to defer the option (such as a bonus for not withdrawing funds); or
- callable features (such as the right of the issuer to buy back the guarantee from the guarantee holder, which means to cancel the guarantee).

Caps on benefit levels in addition to some of the above-listed options help to reduce costs of expensive guarantee riders.

The factors to consider when pricing products, which is the next phase, should include the potential costs of hedging, risk capital and unknown policyholder behavior.

In addition, market data should be used to calibrate the pricing models. For all this, a comprehensive pricing framework is necessary.

After products are designed and priced the so-called hedging programs come into play. There are four basic approaches to hedge VAs: run naked, reinsurance, static and dynamic hedging.

Run naked means an absence of any hedge. This approach is often applied if the provider's VA business is small; the expenses combined with a hedge program are too high; or the instruments needed to hedge are not available at reasonable costs. The advantage of this approach is that it provides the ability to participate in the full upside potential. In addition, there is no need for special risk management and/or asset-liability management (ALM) expertise. However, the absence of downside protection and high earnings volatility mean that only a few VA providers now employ this type of hedging strategy as a stand-alone approach.

Another approach is to transfer the risk to a reinsurer and pay a premium. The advantage is having well-structured, customized global protection as well as the possibility to outsource some insurance risks. Again, no special risk management expertise is required. However, this hedging approach is expensive and illiquid. A separate problem with this strategy is that it can be difficult to adjust the designed reinsurance protection to meet changing market conditions or other requirements. Like any strategy that includes a third party, reinsurance leads to some additional risks due to counterparty credit and operational risk.

The last two concepts are in-house hedging strategies. Applying the static approach, at the beginning of the product's lifetime, the writer of the VA purchases over-the-counter options, or, if possible, exchange-traded options, to hedge potential risks arising on the liability side. In addition to the counterparty risk, a major disadvantage of this strategy is that underlying liabilities might be over or under hedged unless they are rebalanced frequently during the term of the investment. To overcome this, insurers often buy a specific over-the-counter instrument that allows them to keep the same hedge level over time. However, these protections are expensive and again involve counterparty risk.

In contrast, a dynamic hedging program dynamically manages a portfolio of derivatives with sensitivities (in industry parlance, these are referred to as "Greeks") that correspond to VA liabilities. Depending on the type of sensitivities or risk factors to be hedged, the following subtypes of dynamic hedging are common:

- Delta hedging: insurance against movements in the underlying fund price;
- Rho hedging: protection against negative movements in risk free interest rates;
- Vega hedging: taking into account changes in volatility;
- Gamma hedging: insurance against changes in delta due to a change of the underlying fund price.

The so-called “higher order Greeks” or “cross Greeks” are mainly used in more comprehensive hedging programs. The final hedge portfolio is expected to match movements in liabilities over a short period of time. As a result, the portfolio is adjusted frequently. The rebalancing period should be defined so that it provides an acceptable trade-off between transaction costs and hedge accuracy.

As a consequence, dynamic hedging programs often use exchange-traded derivatives, which are generally less expensive and more liquid than over-the-counter instruments. This makes it easier and cheaper to unwind positions and leads to more flexibility in product design and pricing. In addition, the credit risk from third-party instruments is less than it is with static hedging or reinsurance as the exchanges use the mechanism of clearing houses that guarantees fulfillment of the contract. That means the VA writer is no longer linked to one bank or one reinsurance company.

A disadvantage here is the high level of expertise required by the risk management team and the advanced systems necessary for continuous checks, monitoring and execution. In contrast to other approaches, total costs cannot be determined in advance because of the frequent rebalancing required (which can involve potentially high transaction costs). Using this approach also requires a significant capital outlay for training and systems.

Finally, a hybrid approach combines static and dynamic hedging. The static hedging involves purchasing an over-the-counter hedge when market rates are low to mitigate some complex risks. Dynamic hedging is used to bridge the remaining gaps.

All hedging programs have their benefits and pitfalls. To find the optimal approach, a cost/benefit analysis has to be done and key factors such as the size of the VA product, the VA provider’s risk appetite and market conditions should be considered.

4 Impact of Recent Market Crisis on Variable Annuities

The recent severe market turbulence has resulted in significant declines in equity values. Because of this, most guarantees embedded in VAs have become in-the-money. This means that the guarantee benefit has greater value than the assets accumulated in the

policyholders' account balances. As a result, it is likely that the market downturn will boost demand for VA products as the customer perception of the value of guaranteed products has increased.

In contrast, insurance companies face new challenges in their VA business as a consequence of the dramatic market development. First of all, the considerable fall in equity prices implies that the profitability of the VA business will significantly reduce an insurer's income stream as fees are based on the actual account values.

Another consequence of the increased equity volatility will be higher guarantee costs, which will be reflected in higher rider fees in new VA products. Potential policyholders are not attracted by higher product fees. Insurance companies will need to revise their new VA products and rider designs to limit the risks of the underlying fund investments and to avoid expensive guarantee riders.

However, the most important consequence of the market crisis is related to risk management and hedging programs. As the guarantees from existing products become more valuable and the possibility that the guarantees will end up in-the-money has increased, insurance companies that provide the guarantees are forced to raise their risk-based capital requirement. As a consequence, hedging programs, which are used to counter this increase in liabilities or reinsurance arrangements for risk transfer, will gain more importance.

Most existing hedging programs have generally been effective at mitigating the increase in liabilities resulting from the recent capital market crisis. However, despite the dynamic hedging approach used by most of the companies, there are some differences in implementation (for example, some companies used "higher order Greeks" and "cross Greeks" rather than simple Delta hedging). This led to considerable differences in hedging performance.

The main sources of variations are the Greeks that are hedged and the frequency with which hedging is applied. The increase in market volatility has generated losses to hedging programs that do not guard against changes to market volatility (Vega hedging). Although it is often argued that these losses are not realized cash losses, the impact on the required risk-based capital can be significant. As a result of the market downturn, hedging activity will increase and hedging programs will be enhanced to cover more risk factors.

The current market environment also has implications for the underlying fund investments included within VA contracts. Generally, the funds cannot be hedged directly. Instead, they are mapped to hedgeable indices or risk factors. This mapping is often based on simple linear relationships determined by historical data. However, during extreme market fluctuations this simple approach has often caused basis

mismatches (deviations between funds and corresponding indices), which have contributed directly to hedge ineffectiveness.

What we see now is an increasing tendency to include investment funds that employ different risk mitigation strategies in VA policies. Examples of these types of funds are volatility target funds and funds with a built-in downside protection. These allow VA guarantee costs to be shifted to the fund level. To avoid further guarantee costs and to benefit fully from these risk management strategies, it is essential to model these funds properly by using advanced mapping techniques and accounting for the current fund allocation.

5 Conclusion

The market of variable annuities has been growing very fast since its origin especially in the US and Japan. In recent years a similar trend was observed in the European market. VA providers have been offering new features and guarantees in their products, making them more attractive but at the same time often more expensive and more complicated to monitor and to hedge. In order to manage all types of risks arising in this business a powerful and comprehensive hedging platform is required.

The current market downturn has underscored the need for a proper risk management system. Many guarantees included in VA products become in-the-money because of significant decrease in equity values. This caused high losses for companies without appropriate hedging programs. At the same time, this market downturn showed the attractiveness of such guarantees for policyholders and led to increased demand for VA products, which we assume will continue. However, providers need to address potential problems in product design without the price of guarantees rising to a level that inhibits demand. New VA products must limit the risks of the underlying fund investments and avoid expensive guarantee riders.

To achieve this, providers are likely to enhance hedging strategies in order to ensure that more risk factors are addressed. There is a trend toward using funds with built-in risk management strategies, such as volatility target funds, and funds that include downside protection because, if modeled properly, they can help to reduce the costs of additional riders.