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Session 93PD
Pricing and Managing Derivative Risk: An Integral Risk Function

Track: Product Development

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Summary: The trend for product features within equity-based products has been to introduce some level of guarantee on the returns of the associated subaccounts. Guarantees of this type, even within an insurance product, must be bifurcated and treated as derivatives for accounting purposes under SFAS 133. This session talks about the methods for pricing these risks and, more importantly, what techniques and products are available to help manage the risk to the insurance company.

MR. PAUL A. HALEY: I would like to welcome you to Session 93, "Managing Derivative Risk: An Integral Risk Function." Yes, the pun was intended.

As variable products spiked in popularity during the late 1990s, companies started competing on the basis of guarantees that they put into the products. It started with guaranteed death benefits, moved on to GMIBs, GMABs and now even GMWBs. Those guarantees are correctly considered derivatives. What we're going to discuss today is how people are pricing for that risk and how they manage it. We will take you through the life cycle of how to manage that derivative risk.

Howard Zail is going to start us off. Howard is a partner at Lotter Actuarial Partners, and he will lay the foundation by talking about some of the risk metrics that you

should look at as you go through the pricing of these products. You need to set that foundation on what the value is and what you're going to measure, or else you won't know what you need to get done. Prior to joining Lotter Actuarial Partners, Howard was a vice president at Centre Insurance. Prior to that, he was at Donaldson, Lufkin & Jenrette.

After Howard, we're going to have Novian Junus with us. Novian is a consultant with Milliman USA, and he's going to talk about the actual pricing of the derivative. So we're going to go from the metrics to the actual pricing of the guarantees. Before Milliman, Novian was the chief actuary at Northern Life. Before that, he led product development at Providian. Novian specializes in product management and risk management, and is on the Society of Actuaries' risk management task force.

Jim Greaton is going to follow Novian. Jim is the vice president of risk management for SunLife of Canada's U.S. operations. He's going to talk about what to do after you've actually priced and sold these products. How do you manage the risk once you've actually got it on the books? Prior to joining Sun Life of Canada, Jim was the corporate actuary at Keyport and, prior to that, he was the director of risk management for Providian.

Finally, Marshall Greenbaum, who is a senior vice president for Constellation Finance Management Company, is going to wrap the whole thing up for us. He is going to give us an overview of what the other three people have been talking about, and also talk about some specific examples of how companies are hedging the risk that they have on their books, now that they've sold these derivatives. Prior to Constellation Finance, Marshall was a senior consulting actuary with Ernst & Young, where he specialized in financial and actuarial risk measures, and prior to that, he was with Buck Consultants. With that, I'll turn it over to Howard.

MR. HOWARD A. ZAIL: Good afternoon, everyone. I'm a partner in a specialty life and health actuarial consulting practice called Lotter Actuarial Partners. I'm going to talk today about the risk metrics that go into pricing and managing derivatives in an insurance environment and how you might model them. This is a topical discussion in the insurance industry. Many of you have seen the high-profile disclosures from certain insurance companies that have large exposures to guaranteed minimum death benefits (GMDBs). There have been some serious losses in GMDB portfolios over the last few months. The question to ask is, was there a better way to measure the loss potential for these GMDB products before they were sold and, going forward, how do you recognize and measure how big these potential risks are?

I'm going to introduce two concepts to you that are fairly well known within the investment banking and banking industries. The first concept is a risk measure; the second concept is a performance measure. The risk measure is called "value at risk" (VAR); the performance measure is called "risk-adjusted performance measurement" (RAPM). To some extent, the concepts that are used to build up

these two measures are very well known to actuaries; they were based on actuarial principles. The methodologies used to create them are the models and the cash-flow techniques that are common to a lot of practicing actuaries.

On the other hand, they are quite new to our profession. Over the last 10 years, a lot of intellectual capital work has been put in by the investment banks and the financial academic community to make these measures much more user friendly, understandable and implementable in a complex derivative-type environment.

Before you get into any modeling, you need to determine the fundamental issues to consider. This includes your goals, what risks you're going to try and measure, and what risks you're not going to try and measure. I'll describe the VAR and RAPM metrics and I'll introduce a couple of others that are sometimes used as alternatives. Then I'll show you why they're very useful in the banking industry, but need some adjustment to get them to be readily applicable in the insurance industry. We'll talk about some of the necessary adjustments. Then I'll talk about some approaches to implementing them in a model and some of the things that you may want to look at, which may be a little bit different than what you are used to. Finally, I'll talk about the pitfalls. They are very strong measures, but there certainly are pitfalls in using these metrics.

To start this process, you have to establish upfront a number of business-oriented questions. They are the questions that your CEOs see in the investment community and that investors in your company ask. How much capital is required to support a particular business? How should we be investing our capital? What are the risks we should keep? What are the risks we should lay off onto others? How do we compare different types of risks? How do you compare the equity risk encapsulated in a GMDB to the mortality risk in a normal term insurance product? They are very different types of risks, but you want to bring them onto a comparable basis. Then obviously, what are the instruments that best hedge the risks in your portfolio?

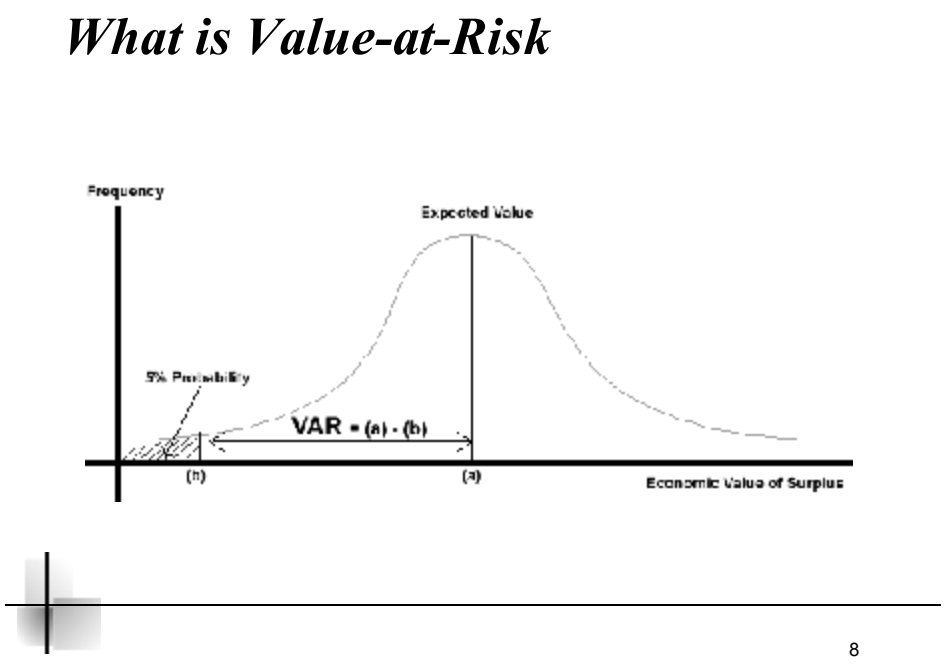
In terms of identifying the key risks, there are generally four major types. Financial market risks are defined to be the most important faced by an insurance company: interest rate risk, equity risk and liability-option risk. Next would be credit-type risks—that's not just investing in investment grade BBB or BB securities but also, if you have large exposures to reinsurance companies, what is their credit exposure? Operational risks include mortality-, morbidity- and health-care type risks. The final risk, liquidity, was rarely focused on from an insurance company's point of view. But when you actually look at some of the major insurance company failures over the last 10 years or so, they have been, in part, due to the inability of the company to liquidate assets when needed.

Let's begin with VAR. The J.P. Morgan definition says, "Value at risk is a measure of the maximum potential change in the valuable portfolio financial instruments of a pre-set horizon." Another way to look at VAR is that it answers the following

question: How much money can I lose with X percent probability over a given time horizon? One example is, how much money can I lose over the next week with 95 percent probability? A lot of banks, in fact, look at periods even shorter than a week. They say, "How much money can I lose over the next day?" That is your VAR concept.

When you look at it in graph format, a company would take its portfolio of assets and liabilities, project them out over its horizon period and see what kind of distribution it gets for those values at the end of that horizon period (Figure 1). I have gotten a symmetrical distribution here, but it might not be the case. The company will first ask where it expects its surplus, its net assets, to grow to, and then ask what the worst-case loss is that can occur, say, for example, the 95th percentile. VAR is simply the difference between the expected case and your Xth percentile worst-case loss. It's a straightforward measure, but it incorporates a number of important concepts. The most important concept is that both the assets and liabilities should be marked-to-market. You can't use a statutory basis for determining the value of the liabilities; you should use something that you typically use in an embedded value calculation.

Figure 1



In this example, there is a five percent probability downside risk that is not in the value at risk. The choice of a five percent tail, or a one percent tail, is an arbitrary one. A little bit later, we'll get to how to make it a little less arbitrary. Most companies just choose a level, stick to that level and then use the VAR to compare the value at one point in time to another.

The next thing about value at risk is that it's the change in value over a time horizon. That's important. The banking industry uses very short horizons—like one day, one week or maybe one year. That is not very applicable for insurance companies, where your liabilities go far out; looking at your risk over just one year is not that helpful. You typically look at a period of time over which you believe you could liquidate your assets and liabilities. For insurance companies, one year is not enough.

What is value at risk used for? It was originally developed as a risk-reporting mechanism. It evolved in the early 1990s when the CEO of J.P. Morgan said to his staff, "I want to know at the end of each day what my risk exposure at my bank is and how it changes from day to day." That's how value at risk got off the ground and why I gave you the J.P. Morgan definition earlier. It can be used as a component of portfolio optimization and choosing the best risk return for both your assets and liabilities. It can be used to allocate capital between different units. If you're selling business at a 12 percent return on one side of the company, and you're selling business at a 15 percent return on another side, it gives you another technique of deciding where you should focus your efforts. It can also be used to help you set your reinsurance limits and the limits that you offer your policyholders. Maybe that's more important in a property and casualty setting. Finally, it can be used as a methodology for determining economic capital(I'll define that later).

Last year's Goldman Sachs annual report shows Goldman's calculations of value at risk. At a 95 percent probability, Goldman can lose $52 million dollars in a day. The report shows the sources of how it could lose that money, and the diversification effect, which is very large and very important. It can certainly diversify between the different types of risks. In an insurance environment, it's difficult to determine how you measure diversification between types of insurance. But that's one of the things to think about when implementing this model.

Let's talk about the pros and cons. On the pro side, value at risk is fairly simple to understand. More of the rating agencies are beginning to use it. A.M. Best is considering implementing it into their rating process. Standard and Poor's has already implemented it to some extent. It's a concept that is widely known throughout the banking industry, and regulators, in certain instances, will use it as a guide to help them determine how much capital a broker-dealer should have.

On the downside, even though it looks very simple, there's a lot of work in getting it implemented. It's new to the insurance industry. There are some companies that currently use value at risk or similar methodologies. But at the moment, they are just a handful. I think that will increase as it becomes more important for the credit agencies. The real downside is that your state insurance commissioner is not going to use that to allow you to determine how much capital your company should hold.

The next concept I want to introduce, because it gets into performance measurements, is that of economic capital. Economic capital is simply the amount

of capital that an institution would devote to support its financial activities in the absence of regulatory constraints. It's a measure of the true risk associated with your business. You can get that figure by looking at your VAR with certain adjustments. You extend the time horizon; you may use a higher confidence interval appropriate to your credit rating. Value at risk doesn't include present value concepts, but when you're looking at economic capital , you should look at everything on a present value basis.

Why analyze economic capital? The second measure that I look at is risk-adjusted performance measurement. That's taking your expected profits and dividing it by your economic capital. It's a simple ratio that gives you a sense of how much money you're earning on your true capital, where economic capital is based on a VAR-type methodology.

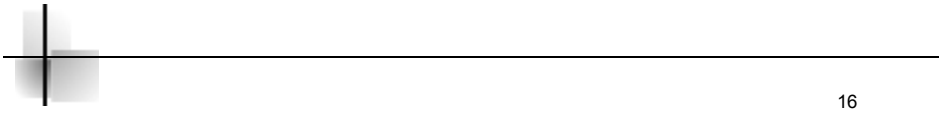
Here's a simple example looking at two strategies: hedged and unhedged (Figure 2). The typical actuarial approach would calculate two things: net present value (NPV), which is your expected profit, and internal rate of return (IRR). The decision would be based on the strategy with the higher NPV and IRR Say the unhedged strategy wins out in both cases.

Figure 2

An Example of RAPM

Should we hedge a portfolio of 1-year GIC's?

Strategy	Notional	E[Profit]	IRR	Standard Deviation	VaR
Unhedged	$400 m	$ 5 m	15%	8	16
Hedged	$400 m	$ 2 m	10%	2	4



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Now let's look at value at risk and RAPM. Using the same example, we get you a value at risk of 16 for unhedged and four for hedged. For RAPM, you get 31 percent RAPM on unhedged and 50 percent on hedged. This suggests that, for your hedge

strategy, you're getting a better risk-return profile. This is different from what you would get under your traditional NPV calculations.

In summary, VAR has a place in the insurance industry. Your time horizons have to be longer. Because you're looking at longer time periods, your volatility in your assumptions changes over time and you have to adjust for that. Measuring correlations among different risks is difficult due to lack of data.

The biggest pitfalls are modeling or assumption error. Using VAR to make decisions is useless if the data is no good. Finally, it's most important that you put it on a basis that is easily understood by senior management and outside investors. VAR and RAPM are good methodologies for helping you understand what your sources of risks are and how they interact. They provide a basis for comparing to see if you're being rewarded appropriately

MR. NOVIAN E. JUNUS: Good afternoon. I'm going to talk primarily about the design and pricing issues that you need to take into account. I'm not going to go into the details in terms of how you would set up your scenario generators or what assumptions you need. I'm going to leave some thoughts with you about how to derive those assumptions, how to look at the analysis and how to look at your pricing results to make sure that the model is giving you some numbers you can believe in.

I'll start with a brief description of the derivatives that are in insurance products. I'll go over some of the competitive landscape and the trends happening right now, particularly in variable annuity product designs and features. I'll also go over some considerations you want to take into account when you're designing and pricing the products.

I would characterize derivatives in insurance products as any kind of guarantee you have (Figure 3). That includes minimum-rate guarantees in fixed annuities, return of premium provisions and no-lapse guarantees in variable universal life (VUL) or universal life products. My focus is on equity-related guarantees: guaranteed minimum death benefit (GMDB), guaranteed minimum income benefit (GMIB), guaranteed minimum accumulation benefit (GMAB), guaranteed minimum withdrawal benefit (GMWB) and guaranteed payout above floor (GPAF).

Figure 3

These guarantees developed due to insurance companies' need to differentiate their products versus other financial institutions. It started with the unbundling of the traditional life product into universal life. That was a response to the competition from "buy term and invest the difference." Growth of the accumulation business, and less emphasis on protection, is how you get to the variable annuity versus a mutual fund product.

The current rationalization of product designs and features is being driven by dwindling reinsurance capacity. A few companies are holding back from developing these guarantees on their products because they cannot see how to price it adequately and competitively. In Canada, RBC and reserving requirements for these kinds of guarantees are increasing. People are becoming more aware of the cost of the tail event and increased earnings volatility.

People characterize the GMDB guarantee cost as being great, but your deferred acquisition cost (DAC) volatility is even greater due to lower equity returns.

Figure 4 shows what's happening right now in the industry. The points in yellow indicate the rationalization of pricing and designs in the market place. Companies are removing benefits, like dollar for dollar, and increasing charges. On GMIB riders, we are seeing lower guaranteed annuity factors (GAF), longer waiting periods before the option can be exercised, fund allocation restrictions and, again,

increasing charges.

Figure 4

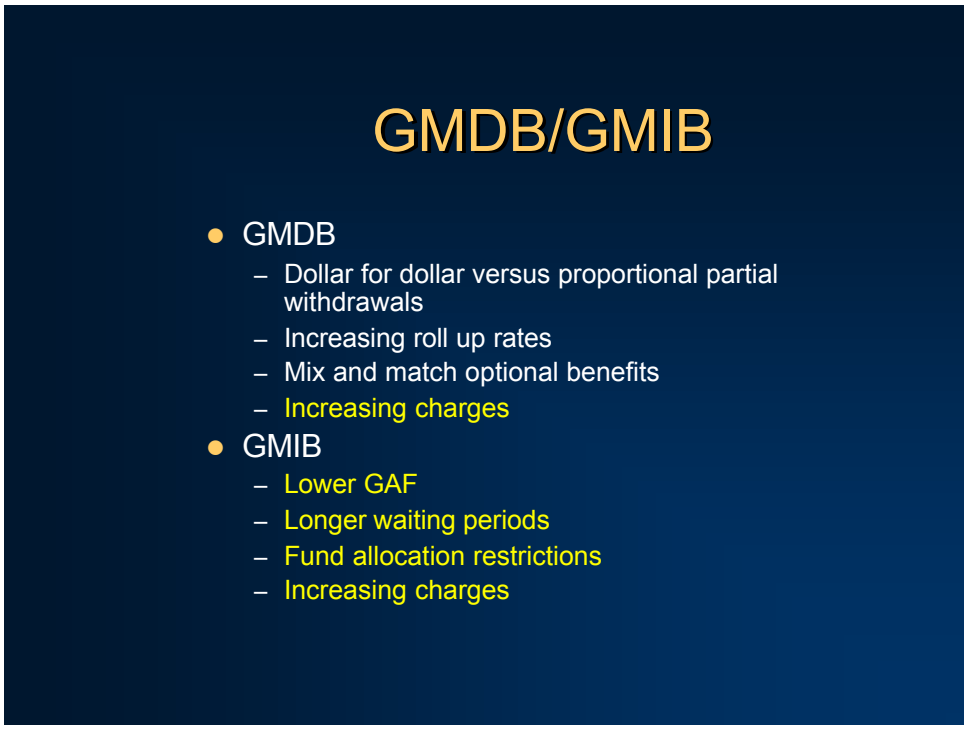
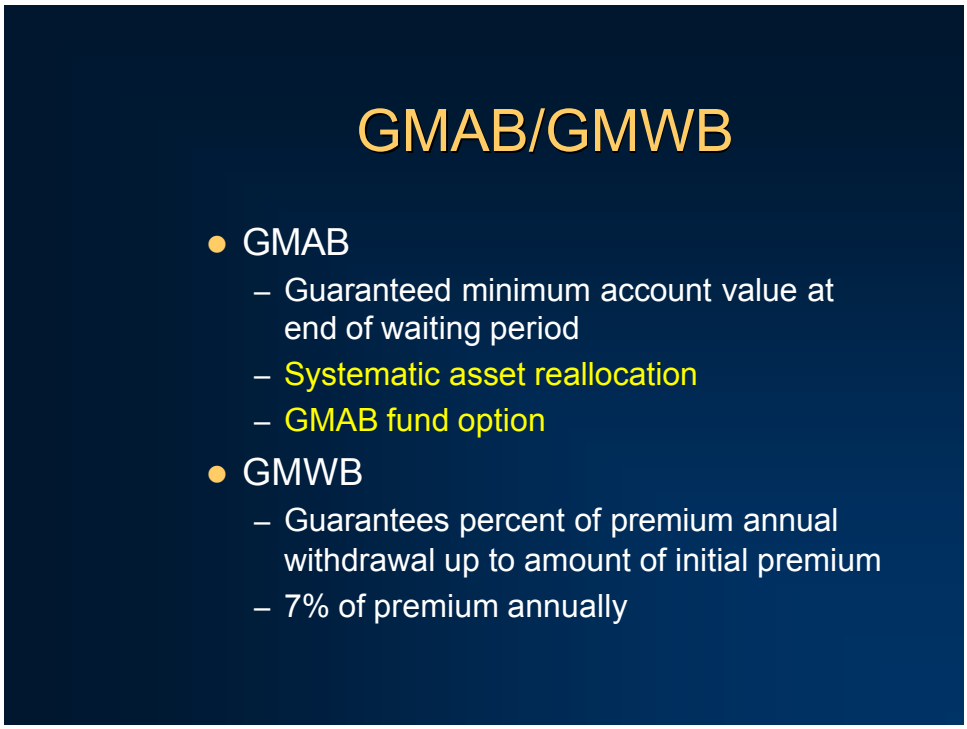


Figure 5 shows what is happening with GMAB. Companies came out with the basic products early and then they started increasing the charges. Now they are coming out with different kinds of GMABs, which employ a systematic asset reallocation between fixed and equity. Another innovation is a GMAB fund that will guarantee a return of principal at the end of a certain time period. That fund is being managed by the insurance company.

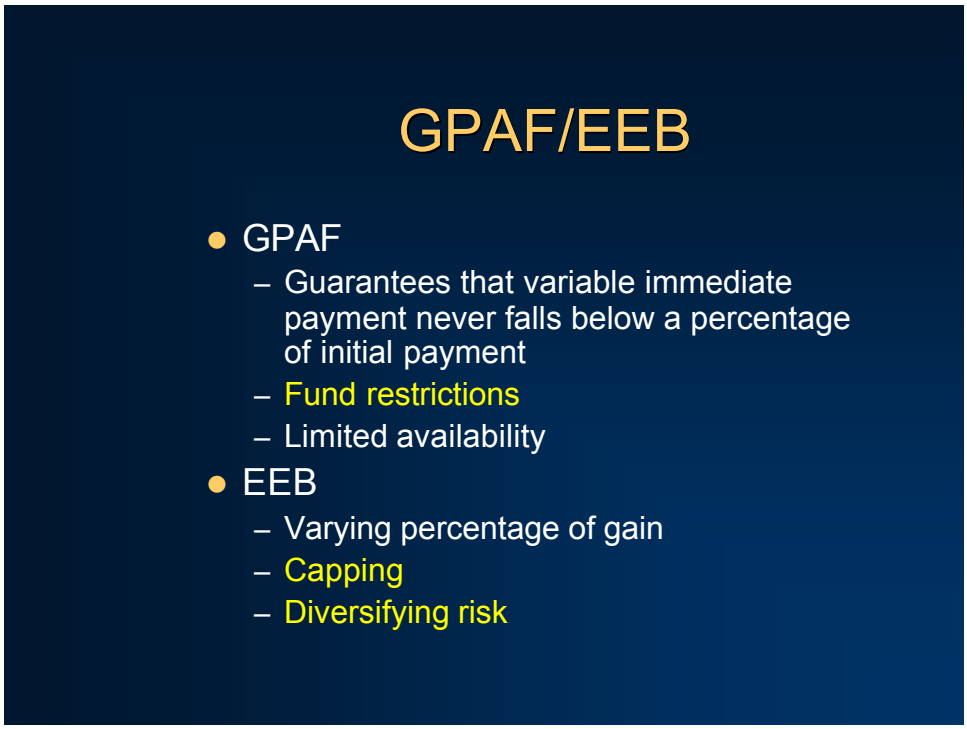
Figure 5



GMWB, which guarantees the return of premium in the form of annual withdrawals, is a lot less expensive than GMAB. A few companies have started reintroducing that or coming up with variations of that.

GPAF is new; there are only about four or five companies that have it (Figure 6). Fund restrictions are key, but there is limited availability right now. I think there may be more rationalization coming soon. For earnings and enhancements benefit (EEB), companies are including more caps. One of the selling points of EEB is a diversification of risk versus the GMDB.

Figure 6



This is what you want to consider when you design these products. You can have limiting features, but the danger with limiting features is that they can be misleading. Market-conduct issues can come back to haunt you later. You need to make sure that you're up front with what kind of limitations you have. The cap on roll ups and ratchets is very visible. Fund restrictions are very visible. Issue-age-based fee structure and design are very visible, too, unless you hide that in the prospectus.

Another design consideration may be sophistication of distribution and target market. You may want to offer different designs to more sophisticated channels because they have the ability to anti-select.

Where should you position yourself within the competitive landscape? This is very capability- and competency-driven, unless you can reinsure the risk away. If you don't have the capability to manage a hedge portfolio properly, then you have to be careful in your design. Otherwise, how are you going to control the risk. If you're big enough, and you can manage your own hedging, that's great. If not, be careful how you design it and how you price it. There may be alternative design options out there.

You don't necessarily need to develop all of these guarantees. You can mix and match, or analyze the different design options for each guarantee. An example is guarantee payout annuity floor. You can either attach the guarantee payout annuity

floor to a variable annuity or you mix and match with a fixed annuity providing the floor and stick the variable portion in a variable annuity. It's like replicating a portfolio when you do arbitrage-free pricing of an option. Do the analysis and rationalize your pricing that way.

Let's go to some practical techniques. There was a session I went to today about Markov Chain Monte Carlo that was very technical but very good. It gave a good background of the theoretical aspect behind scenario generation. We learned of the regime-switching model, used in Canada to determine reserve and capital levels.

When you generate the scenarios, make sure they replicate expected fund performance. Otherwise, you have some basis risk. In Canada, they force companies to calibrate the tail so that it's fat enough for reserving purposes. Do you want to take that into consideration when you're pricing?

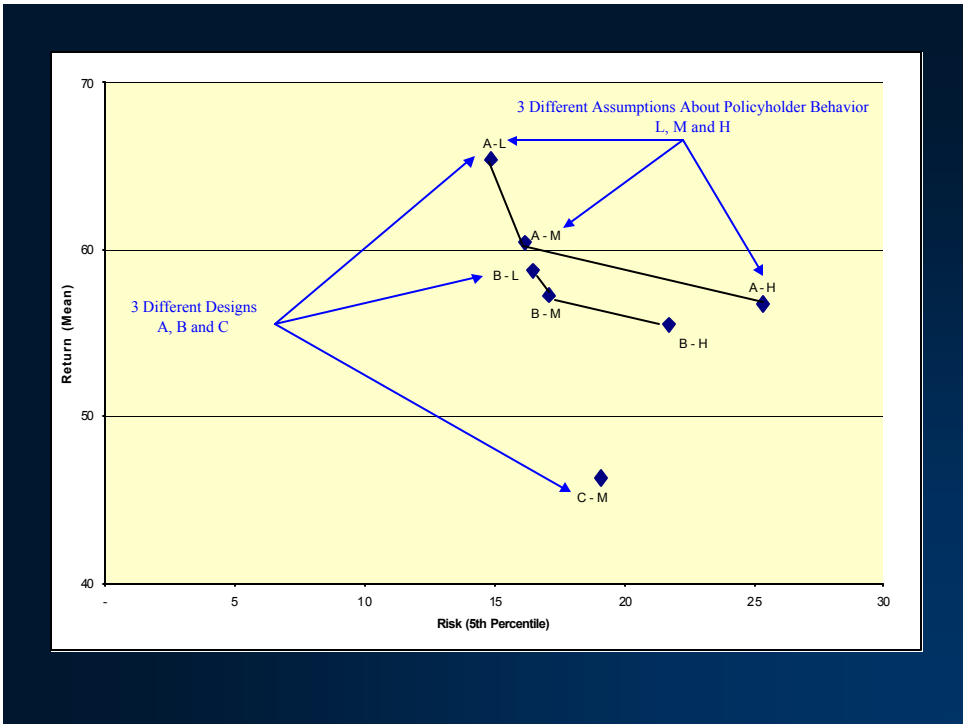
You want to tie your interest rate and equity returns together. When you're pricing a GMIB, the cost depends on what interest rates are at the point when the person can exercise the option. There are various theories about how to relate equity returns to interest rates. It's not just generating scenarios. You have to generate the right scenarios.

Consider the use of stochastic and Monte Carlo pricing. In Canada, I know of a company that prices on a stochastic basis. It also sets up stochastic reserves when it's pricing. So 10 years from now, the company has to stochastically determine the reserve at that point in time. That's making it really hard, but that's the kind of reserving standard that's being enforced in Canada and may happen in the United States.

Policyholder behavior also needs to be taken into account. The biggest thing is you have to stress all of the assumptions, including policyholder behavior.

In Figure 7, mean return is on the Y-axis; and risk is on the X-axis. This is a risk-return profile for different designs and different policyholder-behavior assumptions. Design C is inefficient; it's low return/high risk. Design B makes you relatively indifferent to policyholder behavior. With design A, however, if you are wrong on your assumptions on policyholder behavior, you can be really wrong on expected return. This approach is akin to what people do with efficient fund analysis for investment strategies. For pricing, of course, you have to reconcile and calibrate to what is being charged in the market place.

Figure 7



Reality says that you have to calibrate to all three pricings. But if you're determining your own price, using your own assumptions, you have to understand the impact of those underlying assumptions. They do include some underlying assumptions in terms of policyholder behavior and utility function. Another, simpler way to price it is to have your reinsurer or investment bank price it for you.

In pricing you have to understand your bet. You can only manage well that which you are able to manage. You can't manage interest rates. You can't manage equity returns. So know which levers you can manage, then manage them. If you can't manage policyholder behavior, you need to know how varied the results are if you make wrong bets. Beware of modeling areas and tail risk; if you can't price it, don't introduce it. The interaction of sources of revenue can be something to consider in the overall pricing of your product. Then when you're trying to price based on your actuarial projections, at what level of certainty do you want to price? There are competitive considerations. You don't want to be the ones that are sticking out like a sore thumb. Another thing to consider is that most times, on a GAAP basis, you can't reserve this unless you hedge it. You're going to have earnings volatility on these kinds of products. You have to take that into consideration when you are pricing these products.

MR. JAMES P. GREATON: I'm going to address one of the follow-up questions from pricing. What do you have to do to manage the risk once it's in house?

You don't get a reward without taking some risk. We've written a lot of derivatives on our liability side, the balance sheet, especially around variable annuities and the guaranteed benefits associated with them. You have to take some of that risk to get reward. Having the derivatives on your liability side is one thing. If you have them on the liability side, you better also put them on the asset side to manage them and to match them. We as actuaries are more comfortable with managing risks that we are familiar with—mortality, morbidity, credit or perhaps asset/liability mismatch risk. We've developed an expertise in these over the last few years. Hopefully, we can develop an expertise in managing derivative risk. We still need an intelligent framework in which to do that.

The basics of a risk management framework can be boiled down to five steps.

1. Identify and assess the risk;
2. Select a risk management strategy;
3. Implement the strategy;
4. Set up a reporting regime; and
5. Monitor.

There is a feedback loop into identifying what other risks you've taken if you properly set up your strategy. I'm going to walk through each portion of this cycle.

To identify the risk, you need a clear picture of the option that you've written. You need to understand the exposure to the underlying instrument, but you may also need to understand exposure to other key factors in the risk. When people talk about the Greek letters, what they are talking about is exposure to not just the underlying instrument, but also to potential movements in interest rates, volatility or other parameters.

When you're talking about liability-side risk, you need to understand policyholder behavior dynamics. Changes in policyholder behavior impact your potential payoff, but also changes the risk.

I found it quite useful to involve the investment professionals up front in these processes. They have insights into what a derivative is and how to manage it. If you have a good derivative person in your investment department, make sure he or she is involved in both the product-design process and the risk management process. If you decide to keep the risk in house, the major responsibility is going to be on his or her shoulders.

Once you've identified your risk, you need to come up with a strategy. You can avoid the risk by not writing the product. You could transfer the risk or come up with some other mechanism to eliminate the risk. You are probably either going to accept it out flat, which a lot of people have been doing implicitly without understanding that they are accepting the risk, or you can try and come up with a strategy to reduce the risk. If you choose to reduce the risk, you need to determine

how you are going to manage the strategy. You should explore all the alternatives. Talk to reinsurers to see what they could offer you. Talk to investment banks to see what they could structure for you. Compare the cost of each of these strategies to accepting the risk yourself.

The fact of the matter is that the future is a single scenario. We just don't know what it is. You have to test what level of loss you'd be willing to tolerate, how probable you think that is and then decide which of these alternatives you want to go with.

In helping you to choose that strategy, you need to properly quantify your risk. Some ideas include VAR, embedded value or a measurement that Sun wants to implement, embedded value at risk. You could look at maximum loss, or potential volatility in some earnings measure. You need to have a viable model. In other words, once you've chosen your framework, you need to have a model that can measure that framework in. If you can't turn around an embedded value calculation in less than three months, you're going to have a tough time using that as your framework for decisions.

You then have to select the strategy that's going to fit the criteria in your framework. The strategy could be reinsurance, it could be hiring a professional investment bank to do the hedging for you or it could be doing the hedging in house. Another key item is realistic assessment of your company's ability to execute the actual strategy. You just can't have one person in the investment department who wants to play with derivatives. You need the supporting infrastructure to implement the strategy.

Assuming that your strategy isn't to hand it over fully to a reinsurer or an investment bank, you need to consider the cost of putting up the infrastructure to manage the risk. That includes developing the systems you'll need to dynamically hedge a derivative exposure. You will need to be able to measure your exposure real-time in the market place. You'll have to develop sophisticated systems to populate it with liability data, real-time, at least once a day. You'll also need to set up processes to measure the risk and give information to the investment professionals so that they can pull the triggers and make the trades. The people are the key. You must have sharp people in the investment, actuarial, administrative, accounting and audit areas to get the processes up and running.

The next key item that you need is some sort of reporting mechanism. You need to define, beforehand, what kind of reports you need for each area (investment, actuarial, accounting, and so on); their information and timing needs will be different. You will need to prove your hedge effectiveness and fill out an income statement and balance sheet. If this process is going to work well, you will need to inform management about how the system in place is performing and give them feedback on whether the strategy is meeting the defined goals. If you get a climate like the last six months where the market is volatile, you may need more frequent

reporting.

Once you've defined your reports, the key is to have a clearly defined strategy and have individuals accountable for implementing that strategy. If you don't have individuals that are held accountable, you're going to fall short. That strategy may be different for different companies. It's okay to have different strategies; you just have to make sure everyone understands what your strategy is. You then have to measure your execution against that strategy and measure the effectiveness of the strategy for actually obtaining your goals. This monitoring needs attention at the top of the company, so it can get the proper attention further down in the company.

There are some other considerations. You need backup plans. If you lose key people or key systems, you must have a disaster recovery plan. You need to have trained people two or three deep in the organization. It helps to have a good audit team, both internal and external, in order to be able to test the effectiveness of your strategy. They can help you set up the strategies and build an effective process.

You'll need standard reports for regulators and appointed actuaries, and you'll need enhanced modeling capabilities, especially for asset adequacy analysis.

With respect to financial reporting aspects, a key item involves whether you want to hedge the economics of the policy or hedge earnings. Those are not necessarily the same item. A statutorily defined reserve is not the same as the economic value or the market value of a liability. Do you want to design a hedge that is going to offset how your statutory reserves move, which will give you smooth reported earnings? Or do you want to come up with a full cash-flow projection of the underlying derivative and match that on an economic basis? If the latter, understand that you might have swings in earnings on both a statutory and a GAAP or a Canadian accounting basis. Consider the commissioner's annuity reserve valuation method–updated market value (CARVM-UMV) for equity index annuities, which have derivatives embedded within them. That certainly is not a market value of the liability. It's a conservative look at the options, taking the worst-case and holding that as the highest value. That's not necessarily what you want to hedge. But if you want to hedge those earnings, you better be hedging CARVM-UMV. AG 34 is going to have a drop and recovery. Do you want to hedge that one scenario so that your earnings are level? Once again, that is not going to be the market value. Guideline MMMM requires an adequacy analysis, which most people would take to mean cash-flow testing. What's going to be your investment strategy behind that? You're going to have to do that by year-end. Good luck.

U.S. GAAP, FAS 133—some forms of the embedded derivatives are covered and some aren't. GMDBs are not covered, so you can't reserve for them. If you decide to hedge, you will have a hedge on your balance sheet that will fluctuate with market values and nothing on the liability side to offset it. That will go straight

through earnings. Equity-indexed annuities (EIAs) in multiple-term options are required to hold multiple-term options. You'd be a fool to hedge multiple-term options. Therefore, you will definitely have a mismatch between your hedging strategy and your liability. That's going to come through earnings. No re-bifurcation means that at the end of the period, you can't re-bifurcate the policy. Therefore, two identical policies are going to be accounted for differently under FAS 133. You may be able to hedge the earnings, but you won't be hedging away your economic risk if you do that.

Canadian GAAP or cost accounting standards (CAS) have become near and dear to my heart over the last year or so. CAS has some tough scenarios that you have to test. But, once again, those are not market-value scenarios. To some extent, Canadian GAAP is a bit easier because it's on a cash-flow-testing basis. If you have a derivative that works to offset the majority of your risks, you get to account for that in your cash-flow testing. Then when you mark that to market, it's just going to flow right through onto the liability side of the balance sheet as well. But once again, the regime-switching lognormal process that you're calibrating to is not a risk-neutral, or market-value valuation. You might have a slightly different valuation basis for the hedges that you buy than you would if you were to try and hedge the economic value.

MR. MARSHALL C. GREENBAUM: Good afternoon. I'm going to be giving my presentation in the context of variable annuity products. I've been asked to touch on all the subjects that my co-panelists have talked about. My comments are equally valid to just about any accumulation product. I'm going to focus a bit more on viable hedge solutions as opposed to some of the other pricing criteria and design motivations.

It should be clear that variable product cash flows are derivatives. We talked a lot about GMDBs, GMABs and GMIBs, but let's not forget the mortality and expense (M&E) fee. The M&E is also a derivative; its value is contingent upon the policyholder's account value. Novian talked a little about substantially increasing RBC requirements. For those of you not familiar with what's in progress, I strongly suggest you get a copy of the latest report and take a look at it. We're looking at increasing capital requirements in the neighborhood of five to 10 times for an at-issue policy that has an enhanced death benefit.

I'm going to talk about hedging the tail exposure given these capital requirements, which are all driven by tail scenarios so that you cover somewhere between 95th and 100th percentile loss scenario. If you're going to do any amount of hedging, start with the tail and work your way up. We'll talk about dynamic hedging and active hedge programs. It's a theoretically interesting process, however, it's a very daunting task and there are certainly a lot of hiccups along the way.

Regulators are taking a look at these hedging programs. Canada will not necessarily give you full credit for dynamic hedging programs. If so, it will be sub-optimal for

an insurer to have its own dynamic hedging or active hedge program.

I think we're in a situation where we've exhausted institutions that are willing to take on this very large exposure, which I'll call an unhedged business model. If you're looking to transfer the risk, you're in a situation where you need to pay the capital market price for the embedded risk. When I talk about risk-neutral, fair market value, or market value, I'm using all these terms as synonymous with what the actual market price is to hedge out the risk.

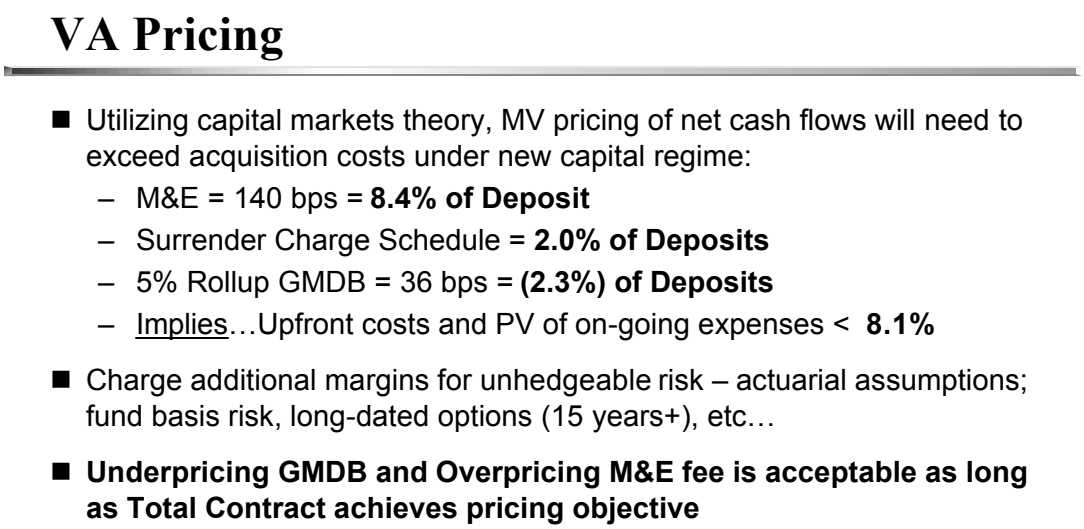
In a variable annuity product, there are two main sources of risk. I mentioned the M&E fee; the M&E fee is charged as a percentage of account value over time. It's essentially a forward commitment. Someone has promised to pay you if he or she is in the policy 100 basis points, one year from today, two years from today, three years from today. A forward commitment is essentially a derivative that could be hedged with futures contracts. You could hedge out the risk of the underlying assets portfolio using indices. The M&E fee varies. It's a one-for-one movement with the underlying account value, and so it essentially has the risk profile of owning stock. There's a guaranteed minimum death benefit through a non-linear exposure. If the markets go up, there are no claims. If the markets go down, there can be significantly substantial claims. In financial jargon, that's referred to as a "put option." Because of the various designs, it's a very exotic put option. The policyholder has the ability to put the contract back to the insurer upon death or upon annuitization.

I'm just going to mention briefly the pending capital regulations. They are all being driven by tail scenarios. They're looking at piggybacking what's been done in Canada, what the Office of the Superintendent of Financial Institutions (OSFI) has put out in the guidelines. There's a lot of talk about conditional tail expectation calculations, which is the result of running a Monte Carlo scenario set, looking at your worst X percentile of results, and ensuring that you have capital to cover your claims over that basis. There are some differences in where the United States is headed. The United States is headed in terms of looking at it more on a statutory income basis as opposed to a cash-flow basis and looking at a conditional tail expectation (CTE) 90 calculation—the worst-10th percentile—as opposed to in Canada, CTE 95, which is the worst-fifth percentile. There's guidance as to how to calibrate the scenario set, as well as how to calculate that CTE calculation.

Given where the capital regulations are going and where the cost of hedging is going, it's prudent to take a look at the product and do what I call an "acid test." Take a look at the market value of those cash flows—forgetting accounting, forgetting GAAP statutory financial reporting. Just take a look at the cash flows and ask, "What would be the cost for somebody else to purchase this risk?" Look at the example in Figure 8. M&E fees are 140 basis points annually. If you present value those cash flows on a risk-neutral or market-value basis, they may be worth something like 8.4 percent of the policyholder's initial deposit. The surrender charge schedule is a declining percentage of account value upon lapsation.

According to expected cash flows, as you predict policies lapsing, that may have a market value in the neighborhood of two percent. If the product includes a five percent roll-up death benefit, the market price of removing that risk may be in the neighborhood of 36 basis points annually or 2.3 percent of the initial deposit. The net cash flows suggest your acquisition expenses plus the present value of maintenance expenses should be less than 8.1 percent. That would be the cost of theoretically moving the capital markets risk out of the product.

Figure 8



In addition, you want to think about all the unhedgable risk that you have in the product, such as your actuarial assumptions that can't be hedged via the capital markets. That includes fund-basis risk, the risk that the actual subaccount net asset values do not vary one to one with the indices that you used for hedging and the notion that you sold long-dated options that go much beyond what the capital market is liquid for. You are actually selling put options that go out 15+ years until the ultimate policyholder's death.

On the pricing side, it's okay if you underprice a feature as long as the total contract achieves the pricing objective. What are the viable hedge alternatives? Going naked really isn't a hedge alternative, but it's a baseline comparison measure of your hedging activity. Certainly you can choose to not hedge away any of the market risk embedded in the products. But if new capital regulations go into place, you may be looking at holding a substantial amount of capital, which would significantly lower the expected returns on your product.

Reinsurance is an alternative, although not readily available. There may be one or

two parties interested in working with you. Another potential solution for transferring the risk is to swap the M&E fee risk. There is a market for taking your M&E fees and swapping them into a known, predictable revenue stream over time, or having them fully collateralized to a lump sum at point-of-sale. There are also structures that would remove the deferred acquisition cost (DAC) from your balance sheet going forward on a new sales basis.

Dynamic hedging is an option. It requires an extensive infrastructure and a very tight framework. I'm also going to go through a case study that demonstrates how the economics under it are suboptimal.

That leaves a static-option hedge strategy, where you would buy a long-dated option structure and hold that to maturity. The intent would be for very little rebalancing of that structure.

If you want to do dynamic hedging or an active hedging program, this is a laundry list of the things that you need to do (Figure 9). Before you enter into the hedge program, you certainly need to set up your objectives, your risk tolerance and understand your trading limits. You really want no trading limits; you only want to monitor the program to the objectives and the risks that you set up and then have a fully documented program. The actual execution of the hedge program is fairly straightforward. The difficult part is coming up with the calculations of your risk, your risk exposure and what you need to hedge your exposure. You should generate risk reports with respect to different indices, with respect to your different funds underlying your variable product and your exposures to currency risk, interest rate risk, etc. The list goes on. You also need to calculate your multiple exposures—what we call your Delta exposure, your Greeks, and not only those Greeks, but also all your cross-risk exposures. It's quite an extensive process of running numerous Monte Carlo scenarios and sensitivity analyses to get all your Greek positions. The computing time required can't be done in a night's timeframe.

Figure 9

Active Hedge Program Requirements

- Set objectives/risk tolerance levels; trading limits; documented program
- Risk report generation
  - Fund/index/stocks/currency/interest rate risk positions
  - Delta, gamma, vega, cross-risks exposures, etc…
- Requires Monte-Carlo processing, simulation analysis, back-up facility
  - Multiple processors; distributed processing
  - Constant monitoring of underlying subaccount investments
  - Monitoring of policyholder behavior
- Rebalance/monitor asset hedges continuously with live markets
- **Not a typical insurer's core business model!**
  - **Operational, execution risks are large**

[6]

In addition to monitoring what's happening on your asset side, you need to monitor what's happening on the policyholder side. The calculations you get on the liability side are only a snapshot of when you last analyzed that risk. You need to be constantly monitoring your liability exposure. Once you've got all the analytics and the hedge program documented, then you need to continually execute the trades and monitor the markets. At the end of the day, this all boils down to what is not an insurer's core business model. It exposes the insurer to a lot of operational and executional risks. I'm now going to go through a case study which demonstrates that if you don't get the full capital relief, you'll lose all the benefits of saving on the economics cost.

Comparing and contrasting dynamic versus static hedging, what you would expect under dynamic hedging is lower economic hedge costs. There are a number of reasons for that. You'd expect to pay lower implied volatility cost over time; you'd also expect to incur lower bid transaction spreads over time. But you do this at a price of higher volatility around that expected cost. Anytime you're doing something dynamic, you're not necessarily going to have the exact hedge targets that you're looking to protect against. So, you have some variation as well as all the operational and execution risk.

For dynamic hedging strategy, it appears that the United States is also in discussions about the capital implications. I hear that they are looking at not giving you 100 percent credit, but something in the neighborhood of 50 percent credit. You'd run the calculation without the hedge program, then with the hedge program, and you get credit for half of that differential. It appears that they're much more

comfortable with static hedging, which could get capital relief potentially in the neighborhood of 100 percent.

The case study will show that if you believe that the equity markets over the long horizon will perform in excess of risk-free rates, then hedging the tail will actually maximize your return on capital.

In the case study, we're going to hold capital at the proposed CTE 90 approach. At every point in our scenario, we're going to do another Monte Carlo model calculation. We're going to look at our worst 10 percent, take the average of them and hold capital at those levels. Note that this is, in concept, a risk-adjusted return on capital methodology. It's what Howard talked about earlier—RAPM. The statutory capital is now approaching something of an economic capital calculation. We can now look at the results using the new statutory capital standards, as a way to isolate perhaps what you feel would be preferable, given your assumption set of how you would expect the market to perform over the long run. (Figures 10, 11 and 12).

Figure 10

Hedged VA Case Study

- Hold capital at proposed CTE90 approach
  - Risk-adjusted returns
  - Stochastic capital valuation within a stochastic valuation
  - Hedge program receives capital credit offset
    - Dynamic programs at 50% credit
    - Static programs at 100% credit

- Run simulation model with "real world" assumptions
  - Evaluate hedge alternatives

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Figure 11

Case Study Key Assumptions

Product Design

- M&E Fee: 1.40% of account value (AV)
- Investment Management Fees: 0.85% of AV
- Surrender Charges: 8%/7/6/5/4/3/2 of purchase payments
- Guaranteed Minimum Death Benefit - 5% Roll-up with a add'l fee of 0.10% of AV

Capital Market Assumptions

- Interest Rates: Flat 4% yield curve
- Expected Gross Return of Policyholder Account Value: **9.25%**
- Volatility of Account Value: **16%**

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Figure 12

Case Study Key Assumptions (cont'd)

Behavioral/Actuarial Assumptions

- Lapse: 2%/3/4/6/8/10/12/25/15+ of AV
- Free Partial Withdrawals: 2.5% of AV for 7 years
- Deaths: 0.5% grading up 0.1% per annum

Company Specific Assumptions

- Capital Held at 200% of pending RBC requirements
- Product Expenses: 8.0% up-front and 0.25% of AV ongoing
- Tax Rate: 35%
- Hurdle Rate: 12%

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In this study, we're going to do dynamic programs at 50 percent credit, a static program at 100 percent credit, and then we're going to evaluate the different hedge experiments.

I've run a generic variable annuity: base 140 M&E fee, management fees of 85 basis points, a seven-year surrender charge schedule, five percent roll up with a 10 basis-point charge , and interest rates approximately where they are today, a four percent yield curve. The underlying subaccounts have an expected return of 9.25 percent with a volatility of 16 percent. Behavioral assumptions are static, with two percent lapses starting out, a 25 percent shock-lapse, and free partial withdrawals of 2.5 percent. We're going to hold capital at 200 percent of the pending RBC requirements.

We will look at different options. First, do nothing (go naked). Next, dynamically hedge, where we actively manage an index futures program against their GMDB exposure, but because we're using index options we're going to retain what we call a 5 percent residual volatility. That five percent is the volatility around the market value of the GMDB exposure we're trying to protect. Third, we're going to look at some static hedging examples, a full risk cover where we isolate the risks that are driven by capital markets event for a 12-year period, for a cost close to two percent of deposit, which would be equivalent to a 32-basis point annual charge. Finally, we're going to look at what we call a tail hedge, which would cover your 10th percentile loss or present value of claims that would be in excess of two percent.

The insurer retains the first two percent on a present value basis of claims, and then the structure would pay excess claims after they've experienced a two percent loss for something like an eight-basis point annual charge.

What I'm referring to is shown pictorially in Figures 13 and 14, to show the tail hedge. What I have here on the Y-axis is the present value of GMDB claims expressed over a 20-year horizon as a percent of initial account value. Then the X-axis is a rank ordering of the scenarios from the worst percentile to the best. You can see there's a 20 percent chance that you'd have absolutely no claims, which is if the market returns above five percent. But you can also see on a probabilistic basis that the 10th percentile yields something like a two percent present value loss in GMDB claims. For this hedge, we tailor a structured out of the money put that would limit your exposure to that two percent level as a stop loss.

Figure 13

Static Tail Hedge – Tailored Put

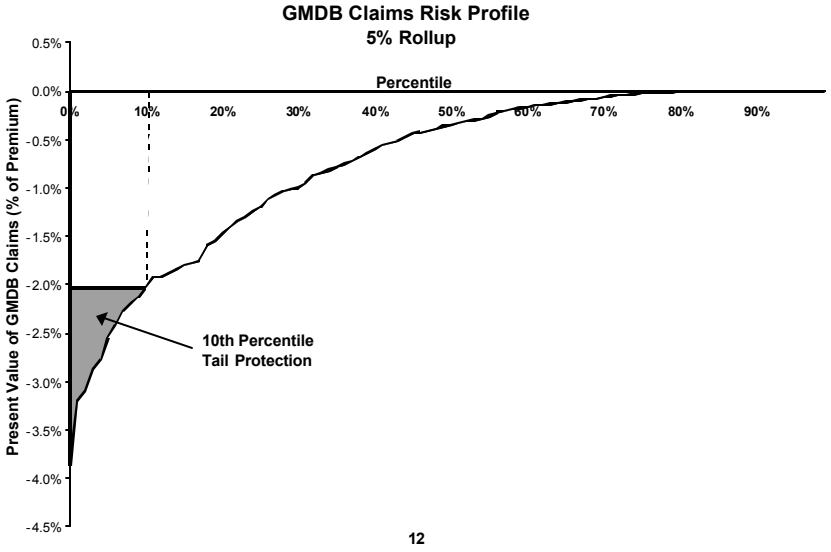

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Figure 14

Results - (Based on $1,000,000 in Premium)

Distributable Earnings (DE) Impact

	Naked	Dynamic Hedging	Full Static Hedge	Tail Static Hedge
Average $PVDE_{@12\%}$	$885	-$209	$76	$1,761
Initial Capital (% of Prem)	6.1%	5.0%	4.4%	4.8%

What you can see from the results is that when you go naked or you don't do any hedging, we're still earning something slightly in excess of our 12 percent hurdle rate, but we have to set up substantially more capital than we are today. We're at a 6.1 percent initial capital strength. When we move on to the dynamic hedging experiment, we have two effects going on. We're adding the cost of the hedge program versus the claims that we're getting from the hedge program. This comes through as a reduction in economics, because the markets now, on average, are returning that 9.25 percent. There's a perceived cost of hedging coming through, which is saying that on a present value basis, we're paying more in hedge costs then we're getting in actual present value claims. That's lowering the return on capital, and even though we're getting a capital offset, because it's at the 50 percent level that's not enough to offset that drag.

When we move over to the full static hedge, we have the same two effects happening. We're purchasing static hedge, perhaps at a higher expected cost than dynamic hedging, but we're getting 100 percent capital relief. So even though we're paying more in hedge costs, because we're getting a 100 percent capital relief, that is outweighing the additional cost that we just spent on the economic terms of the hedge.

When we move to the tail hedge, we actually have a result in excess of all the other calculations. Because we are getting 100 percent capital relief, we're holding capital in line with what we have in the dynamic hedging experiment. Because we feel that, on average, the equity markets are going to perform above the risk-free, we take advantage of that by doing complete, or what we call "full," hedging.

In summary, what I refer to as "static" tail hedging not only reduces the risk of the variable annuity product, but it also maximizes the return. It might seem like a counterintuitive result—reducing risk and maximizing returns—but under the new capital regime that's exactly what's going to happen. I'd like to open it up to questions for any of the panelists.

FROM THE FLOOR: Marshall, from what I understand, it's not a done deal about the hedging credit on the capital. I think if you can show you have a program, it's not going to necessarily be a 50 percent haircut . Also, I think Canada had a transition where it was going to do a 50 percent haircut, but I think it is now moving toward more credit if you can prove you have a track record in your hedging program. I don't think it's as black and white as what you're saying.

MR. GREENBAUM: I am just illustrating an example. I understand it's not black and white, but that's the concept. You now need to evaluate the haircut that you get, whether it's 50 or 70 percent, versus the additional savings that you have from dynamic hedging. I would find it hard to believe that you're going to get the same type of capital relief with a dynamic hedging program that relies upon people being there in the future to execute the trades as well as what the actual market value pricing of that program is going to be. I'm just getting feedback that the regulators

are much more comfortable with the static programs. I didn't mean for those values to be black and white—50 to 100.What's important is the concept and the relative magnitude of how those numbers lay out in evaluating how you go forward with any type of hedge solution.