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The Actuary's Role in Risk Management

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Summary: The financial services industry has become increasingly interested in understanding and managing financial, as well as business, risks. While often perceived in terms of risk reduction or mitigation, today's focus has expanded to improve performance and to add value to the firm. Many banks and securities firms have built risk management areas to better manage their financial risks. Some insurance companies are moving in a similar direction. The panel discusses how the actuarial profession may contribute to the quantification and management of various types of risks that insurers and other financial service providers assume.

Mr. Ikwhan Oh: I'm vice president of Prudential Investments. I'm the moderator of this session. In this session we'll talk about risk management and the actuarial role in risk management.

Let me read one sentence from the description of this session. I think it's well-put: "While often perceived in terms of risk reduction or mitigation, today's focus of risk management has expanded to improve performance and to add value to the firm." I think there are two key themes. One is the risk reduction, and the other one is performance improvement. Let's focus on those two themes in this session. Since risk management is such a broad concept, we're going to focus on financial risk.

We have three distinctive speakers. Max Rudolph will give a broad overview of risk quantification models, asset/liability (A/L) management, and other financial risk quantification methods. Jean-Francois Lemay will talk about market risk, dynamic hedging framework, and the specific product level risk management in detail. Randy O'Connor, finally, will talk about enterprise risk management (ERM). He will talk about the corporate risk management from a very high-level point of view. At the conclusion of this session, I hope that you will get some exposure to what's going on in the industry, especially in the risk management field, and the actuary's role and the opportunities and challenges in that role.

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Note: The charts referred to in the text can be found at the end of the manuscript.

Max Rudolph is an FSA and a chartered financial analyst (CFA). Max is a first vice president and actuary with Mutual of Omaha, and is currently responsible for corporate A/L management. He has specialized in ERM, valuation, cash-flow testing, financial projections, and pricing of group and individual annuities. He has been published in the *Financial Reporter*, *PTS Perspective*, and *LOMA Resource*. He has spoken at numerous industry meetings and is a member of LOMA's Profitability Committee. He was recently elected to the Investment Section Council.

Mr. Max J. Rudolph: My role today is to set the stage for our other speakers. I'm going to talk about some general tools that we are either using at Mutual of Omaha or are hoping to leverage off our existing models to add in the next six months to a year.

Who is our customer? In my view, this can mean a lot of things. My customer, since I work at a mutual company, is my senior management. Your customer is also Wall Street, if you're a stock company, and your shareholders. It really is a broad question. You have to determine who your specific customers are and develop tools or methods of presentation that are based on what your customers' expectations are and what their knowledge base is. If you start talking about convexity risk to a bunch of accountants there are certain challenges. Anyone who has done it knows that their eyes kind of glaze over. Now, at our company we have accountants who are in senior positions. It has taken several years, but they're willing to listen and they ask good questions. You need a little bit of patience, but the end result is worthwhile. The concepts discussed here may be new to your senior management, even if you have actuaries in senior management positions. These concepts will be new to someone who took their exams a while back.

Probably the only thing I'm going to say, which may contradict what our other speakers are talking about, is in regard to the investment horizon. Whether it is your company or your personal investments, I feel it's very important that an investment horizon be long-term. Both with our personal investing and with companies, we tend to get locked into today's news, and we react up and down with the stock price or the value of a company. You want to avoid that.

Proactive actuaries can add value to the process if they take the time to learn the terms that the investment department uses for things. A lot of times they talk about the same things that actuaries do, but they just call it something different. That was one of the reasons why I went and got my CFA designation. I learned stuff while I was taking it, certainly, but a lot of times what I found was that it really helped me to get my point across to the investment department. I was able to speak in their language. But, again, you want to focus on what tools the actuary can provide to senior management so that good decisions can be made.

In my definition, as Ikwhan said, financial risk management is much broader than A/L management. A/L management, in my opinion, and I think everybody has their own opinion on this, focuses primarily on interest rate risk and is a subset of risk management. Risk management goes beyond financial risk management. I am

the first to admit that I have no ability to track down a fraudulent health claim. I just don't have those skills, so it doesn't make any sense for me to come in and say, "I'm going to be doing that as well."

I think it's really important that we utilize the tools that we already have and leverage off those tools. We already have cash-flow testing in place. We already have pricing models in place. Generally, we're using those models to do management projections, whether they be GAAP, statutory, or value-added. Many of us have extended those models to do duration studies as well.

At Mutual of Omaha, we're very interested in setting a structure so that we make the right decisions given the current environment. As with anything, there are pros and cons to leveraging off the existing models. Your cash-flow testing model may be much more detailed than you would use for some other things, but if you use two models, somebody's going to ask you to reconcile them no matter what they are used for. If you use one model to do a monthly projection and you're being held to how close that monthly projection is against actual results and you use that same model to do a duration study, the same model can be used. You have to recognize that it's going to take longer to run that model than it would take with a quick and dirty model, but then you also know for sure that your results are consistent with everything else that you're doing. As machines get faster, every year it becomes easier and easier to run a big model in a short period of time.

It's clearly an iterative process. You already have your in-force models from cash-flow testing and other projects. The order doesn't matter. One company might focus on their interest-crediting process because it's a big single premium deferred annuity (SPDA) or universal life (UL) writer. We're a health company that also writes life and annuities, so we have different challenges than a pure annuity writer. We've focused a lot on durations and we're trying to figure out what's the right way to bring premium in on the health business.

One thing that we don't have in our current models, and some of the software vendors are talking about this now, is stochastic modeling of mortality, morbidity, expenses, and anything else you can think of. I don't know how to do that, but somebody does. Somebody will have ideas. Even if we do it as a sensitivity test, I think there's value to be added there. We present these projections to senior management and say, "Here's our one and only projection. It's a point estimate." What are the odds that anything is going to hit a point estimate? About zero. But if we show them the distribution of possible results, I think that's much more valuable.

How big is this project? I expect to be working on this project the rest of my career. Every year someone comes up with new tools and something new to look at. A lot of education needs to be done. One of the fun things about my job is that I'm always learning something new. I'll go to several sessions at an SOA meeting where somebody's doing something a little bit differently, maybe a topic like transfer pricing. I'll go and listen to that and think, "OK, how does that tie in with something that I'm working on?" And then maybe the transfer-pricing people will

make this jump, and we'll be able to leapfrog off that, and somebody else will be able to leapfrog off that. Seminars like this are important because they offer us an opportunity to share ideas. The profession as a whole will get better and better as we do that, but it is a long and iterative process. I think it helps us to be better actuaries. As more tools become available, we look at risk a little bit differently. Our paradigm shifts.

I can remember when we first started doing cash-flow testing for our New York subsidiary. We had four liability cells to model our entire annuity block because it took so long to run the liability side. It took two hours to run the assets and then we added the two together. Over time we've evolved to where we can do things a lot better than we could then.

Can risk management help us become better managers? For the people in this room that's a no-brainer or you wouldn't be here. It will help us to provide the information to make better decisions.

Can it help your career, either as an actuary or beyond that? For me, that remains to be played out, but I really think it will. I think the person who is able to provide tools to senior management so that they can make better decisions is going to visit the boardroom a lot more often than the person who's just doing what's always been done.

Do you need consultants? Yes and no. A lot of times a consultant can get you over the hump. You might have an idea but you might not be sure how to do it. Maybe one of the consulting firms has dealt with the issue before and can streamline your process so that you don't spend three years doing it. You can get it up and running a lot quicker.

Do you need to earn your CFA? Not necessarily. I think that getting my CFA helped me more as an intermediary between corporate actuarial, the pricing areas, the investment department, and the comptroller. Learning the language of other professionals helps a lot. I think the fact that I was willing to go through the exams that the investment department people went through provided some respect and opened some doors.

Is risk management a full employment act for actuaries? I'm going to give a plug here for the unified valuation system (UVS). A group has been working on UVS for a couple of years now, and, if it goes through at some point, that's just another iteration on this process. We'll already be doing it if we're doing risk management in this way. UVS will flow out of that, so I'm very excited about that.

What are the keys to success? The process needs a champion—somebody at the highest level of your company that's interested in this. If they have no interest, you can do it and say, "Yes, we predicted this was going to happen," but if nobody listens and no decision is made, it really doesn't matter.

What should an actuary do to succeed at risk management? We need to be open to new ideas. I do a lot of the recruiting at Mutual of Omaha as well, and the students who are coming out today are more well-rounded than they were when I came out of school 20 years ago. They're very open to new ideas. They're taking the investment track. They're looking at what can be done that hasn't been done before and they're excited about that. I think it's important for us as existing actuaries, as Fellows and Associates, to not discourage that but to really say, "Hey, you have new ideas; yes, let's hear them. Let's brainstorm periodically with whatever your ideas are and see how they fit in with other projects." You need a good relationship with a wide variety of areas: with your investment managers, chief actuary, comptroller, and your strategic business units.

I'm going to talk about a couple of tools that I'm either already using or planning to use in the near future that I think can help you make better decisions; they are duration, GAAP earnings-at-risk, and cash-flow-at-risk. This is not meant to be a complete list of the tools available.

An important definition to remember is that effective duration means the cash flows are dynamic across a range of interest rate scenarios.

I was scheduled to give a talk recently to nonactuaries, and I struggled when I got to convexity risk. With this group I can say convexity risk and you know what I'm talking about. It's the smile and frown stuff. Maybe we need to come up with a name that's not quite so threatening to people who aren't as math-oriented as we are.

In our projects we have defined cash flows as either cash in the door or cash out the door. That means premiums get included with asset cash flows. In a lot of cases it doesn't matter whether you net the premiums against the liabilities, but there are some cases where you get some really bizarre results, so it's a lot cleaner to include premium with assets. As we've talked to some of the software vendors, I think we've finally convinced them of that.

Most people are familiar with price behavior curves. If interest rates go down, with a typical SPDA product that is very convex, this tool shows the cost to the company, which is the value to the policyholder, of an interest rate guarantee. If you have a 4% or higher guarantee, those options are in the money in many of the scenarios that you run even in today's environment. In the fall of 1998, when rates fell so quickly, there were some big risks that were not recognized by companies. All of a sudden, floors became pretty expensive because that risk was recognized. There were a lot of people trying to buy at that time, but the time to buy a floor is now, not when the rate's at 2%.

Another tool that we have started to use recently is the first derivative of the price behavior curve, which, of course, is duration. A lot of times we talk about today's duration and we don't look at the duration if rates go up or down 100 or 200 basis points. This was interesting to me because I really hadn't thought about it this way.

For UL, it's hard to be matched because the duration changes so quickly. This tool forces us to ask whether duration is the right tool to use to manage UL products:

$$D_S = D_L + (D_A - D_L) \times MV_A/MV_S$$

I was first exposed to the concept of enterprise duration, also called duration of surplus or duration of the entire company (quantifying the sensitivity of the company to interest rates), through David Babbel, a professor at the University of Pennsylvania's Wharton School of Business, when I attended one of the SOA's seminars. The formula is in the *Financial Economics* textbook that many of us got last year. A company's sensitivity to interest rates is determined by the mismatch—the difference between the duration of assets and liabilities and the leverage. Do you have a lot of surplus or not? If you have a lot of surplus, that tends to dampen the impact of the mismatch. If you don't have a huge surplus a mismatch of just a few years can mean much greater sensitivity to the company than you realize. I think it's worth doing the exercise to calculate your enterprise duration just to make sure.

We first made these calculations in 1996 and really didn't know what we were going to get. At the SOA seminar, Professor Babbel talked about an example that he had worked on where a company found they had a duration of 40, which means that if interest rates increased 250 basis points, they wouldn't be worth anything anymore. They have zero value. I didn't expect to see that because I knew we had some good A/L management techniques already in place. We didn't get that result, and I was very pleased with that. Once you are sure you don't have this huge risk, you can start determining how to manage this risk. Is there a threshold for a company? Am I comfortable with it being five? Am I comfortable with it being ten? Am I comfortable with it being 20? Each company is going to have to decide that on their own, but it's always better to know what the issues are.

GAAP earnings-at-risk creates a distribution of GAAP results for the next year. I don't know what the distribution is and what an illustration would look like currently. It's a project that I want to work on, hopefully, by first quarter of next year. But my management team, and I think a lot of other management teams, are looking at GAAP results. Right now we give them a projection for incentive compensation and for other purposes that's a point estimate, but we don't tell them the range of possibilities.

This tool has limitations, as they all do. You don't want to go beyond 1 year, because if you try to run a 30-year GAAP earnings-at-risk, what do you do with the *Financial Accounting Standard 97* unlocking? The current modeling software doesn't support that. That might be an iteration in modeling software going forward.

If we can provide things graphically to our senior management, I think it will help them to understand the different risks that we actually have. Low discrepancy scenarios can help you to minimize the number of scenarios that you run.

Cash-flow-at-risk is another tool that I really like. I always get a chuckle out of cash-flow testing because we don't look at the cash flows—we look at the statutory income. The test is supposed to be based on cash flows. Do we have enough cash? If you send the insurance department just the cash results, they'll send it back to you and say, "What are you doing?" That's what the test should be, and cash-flow-at-risk can help you do that. It will help you to determine investment policy. For a health insurer, morbidity is an issue. What I want to do is go out there and say, "OK, what if I have 95th percentile morbidity? How much cash do I need available for that?" If that's at the same time that I have a lot of SPDA business that comes out of surrender charges and leaves, what's my risk? How big a deal is that? Each company will have its own issues. For liquidity requirements, how big should your short-term credit line be?

For General American, an interest-rate risk turned into a liquidity risk. We need to recognize the correlation between various risks.

The key is to use multiple tools. Don't just look at duration. Don't just look at GAAP earnings-at-risk, cash-flow-at-risk, or anything else; try to leverage off all your existing models. You already have some really good stuff out there. I think that sometimes we don't use what we already have. Don't treat your cash-flow testing just as a box to be filled in for the insurance department. You've already built a tool that you can use to build from and make real decisions from, and I think we need to do more of that. A lot of companies are, but a lot of companies still aren't.

Mr. Oh: When Max said that the CFA exams were helping him communicate with the nonactuarial profession, I fully agree with him. Working in the environment where the Prudential investment is pretty much a mutual fund and annuity shop, I'm responsible for annuity actuarial services and risk management. Over the last three years, I've had two different managers: one came from a capital market background, and the other was a marketing officer. It was really a challenge for me when I tried to explain the difference between risk-neutral pricing and stochastic actuarial pricing. If you use their terminology instead of actuarial terminology, I think that will be very helpful. Also, if you provide a solid value proposition so that they can act upon that information, I think that you can get across your point very well.

Our next speaker is Jean-Francois Lemay. Max Rudolph's analysis has been focused on the interest risk, duration, and convexity. Jean-Francois, in contrast, will talk about the market risk associated with variable annuities (VAs), general account guarantees, and so forth. Jean-Francois is a pricing actuary with RGA Financial Products, Inc., a risk management consulting firm that specializes in advertising and managing risks that corporations and financial institutions are typically faced with. He's involved in the pricing and hedging of VAs and segregated fund guarantees in both Canada and the U.S. As a former pricing actuary of RGA International, he was primarily responsible for all reinsurance codes generated during the process of developing a pricing basis for newly emerging markets.

Mr. Jean-Francois Lemay: As was mentioned, the first thing that usually comes to my mind when you're talking about market risk and risk management is interest rate risk. That tends to bring up asset/liability modeling (ALM) and cash-flow testing. But with the popularity of products like VAs and segregated funds in Canada and a whole slew of products (equity-linked, index-linked, and surplus) that can be invested in equities, there is a significant risk towards equity. This brings more of a nontraditional role to risk management. You will need some expertise that I think actuaries are very qualified to provide. The actuary can expand into the management of these risks. Investment banks have been doing risk management for derivatives for awhile, but I think the actuary can pick up that role within the insurance companies and do the risk management of these guarantees embedded in such products. These guarantees have market risk, but they have the mortality, lapses, and all the traditional risks. I think the actuaries will be uniquely qualified to go into that role. I guess that fits into that topic of a big tent, where you want to expand the role of the actuary. That will be the focus of my presentation.

Back to market risk. Market risk is always present. You just need to look at the Dow Jones. From 1958 to 1980 the Dow Jones has been moving sideways, and in 5 occasions there has been a drop in excess of 20%. The market risk is present even if people tend to forget it because we're in an eight-year bull market and everything seems to be going fine. But if you're backing a surplus with equity, you can see that you might not get the performance you would like; you're going to want to have some risk management in place to mitigate that risk.

Dynamic hedging is an active form of risk management. You can look at it as something quite similar to an ALM process, where I would be duration-matching and convexity-matching. Here, I would do the same, but I'm dealing with equities, so I need to know what the duration of your equity is, what the convexity of your equity risk is, and so on. You basically run through the same process.

With the options that you have (and when I'm talking about options I mean all those things that are embedded in the VAs—your guaranteed minimum death benefit [GMDB] and guaranteed minimum accumulation benefit), you have basically embedded options into your VA. And with those you are, obviously, exposed to market risk. But if the market goes down, you'll have to perform on those guarantees and incur some costs.

You're also exposed to interest rate risk, which, obviously, affects how you discount the present value of all these payments and the cost of your hedging strategy. You're exposed to change in volatility and correlation. You have your risk, but, truly, the process of dynamic hedging can be viewed as very similar to an ALM process.

I'll go in more detail. You can break down the process that you will use to do dynamic hedging. You need, first of all, a model in order to calculate your sensitivities and the value of your liability. That's the first step. Then, obviously, you'll need to put in your inputs to evaluate your inputs. What is the volatility?

What is the interest rate? You need to work on all those inputs. Then you need to figure out which hedge instruments you're going to use to eliminate your risk.

You'll need to make model assumptions to generate future stock values. You need to generate future scenarios, which gives you the value of equities into the future. You need to make assumptions, such as what kind of distribution will the stock return take? Is it like a normal assumption? Is it inverted gamma distribution or any model that you want? Whatever the case may be, you're going to need to make that assumption first in order to generate scenarios.

Also, you're going to need to incorporate the policyholder behavior. When are policyholders going to lapse? If you have embedded some reset options or some option into your products such as VAs, you may have given the policyholder the option to switch between funds, withdraw the money, or put in more money. You need to model this as well to get the true value of your liability. Once you have a model, you're able to generate the things that you need for your dynamic hedging such as your sensitivities, the value of your liability, and so on.

The model itself is important, but if your inputs into the model are wrong the numbers that you're going to get out of it are going to be wrong as well. You need to put in your policyholder characteristic. You need to feed your in force into your model to get as precise a picture of your liability as possible. You'll need to put in capital markets information. What is the current interest rate curve? What are the volatilities of the equities? Also, actuarial assumptions are very important. What is the lapse rate, mortality, etc.? It really combines everything.

Market assumptions. You need growth rate of assets, volatility of assets, and correlation of assets. These are quite important and sometimes very difficult to estimate. For example, volatility is not something you can directly observe in the market. You could look at implied volatility. You look at how much the options are traded in the market, what the value or the cost of a put option is, and work backward to get the implied volatility in the market. But if your products are based on an actively managed fund, you have offered a guarantee in your VA on various mutual funds. Well, you have no options trading on those mutual funds. You can't just go and extract what the market thinks of the volatility, so you need to do your own study and put in an estimate on volatility. The same goes for correlations between those various assets.

I think volatility estimation is important, but, I guess, not totally within the scope of that session. These are the kind of complexities that one comes into when you want to put in your input. You want to go through your dynamic hedging and feed the best inputs that you can, but you can get stuck there. First, how do I estimate volatility? I could go out and calculate just the straight average of the last five years of volatility on my mutual fund and use that as an input, but is that truly a good input? Your mutual fund that you're going to be hedging may not even have existed or had different fund managers five years ago. The managers may have been behaving differently back then, so is it a good estimate of future volatility behavior? These are the trade-offs that you need to work on.

How far back should I go when I try to estimate? I need a method that is stable. Each time I run my ALM, if my volatility changes drastically, then all my hedges have to change, which I don't want. But, also, I want to change often enough to capture any true change in volatility over time. I don't want to be lagging if volatility has changed—I want to capture that into my model.

If I just say I'll take the average volatility as a simple standard deviation, I'm going to be very sensitive to how far back I go. The volatility is slow to react to recent shock. If something happens recently and the volatility suddenly increases, your method of averaging will not truly capture that until there's a lot more volatility in your sample. Also, if you do a straight average, the most recent data has as much weight as the very last data in your sample size. Should you put more weight into the more recent data? Maybe the more recent data is more credible.

Advanced methods that you can use are expedient weighted moving average models and complex autoregressive conditional heteroskedasticity (ARCH) models, and generalized autoregressive conditional heteroskedasticity (GARCH) models. These, like the ARCH and GARCH, talk about stochastic volatility. You're now saying, "I'll take a straight average. I'll just say that volatility is itself volatile. I'll try to make a model that predicts how volatility behaves over time." While the principle of dynamic hedging is the same and can be viewed as quite similar to an ALM process, just evaluating the inputs and calculating your liability can be quite complex in the case of dynamic hedging.

How to proceed with dynamic hedging. First is the sensitivity analysis. You have your models and inputs, and now you're able to generate what you call the Greeks. What is the sensitivity of your liability to a change in the market? Well, it is the change in liability to change in interest rate, change in volatility, and all the inputs that you have. You need to know how sensitive it is.

Once you know how sensitive your liabilities are and by how much they move, you can find assets to match that sensitivity. If I have a liability that will increase by \$1 million if the market goes down 1%, I want assets that will make me \$1 million when the market goes down 1%; then I'll be balanced. I need to go and select those hedge instruments. Sometimes it's not very obvious.

If I'm doing a cash-flow matching, I need to find bonds or instruments that have cash flows to match my liability cash flows. When I look at instruments, for example, I have my underlying funds. They could be actively managed mutual funds. I can't go out and short this mutual fund to have a balance. I have to go and find other assets—for example: futures, stocks, options—or anything else that will have the desired behavior. It takes more science to come up with your hedge instruments. Once you have your hedge instruments, you'll need to implement them and put them on your books, and you'll have to do frequent rebalancing.

I guess the other difference between dynamic hedging on these equity options and traditional ALM would be the frequency of your balancing. You probably would need

to look at your hedge position at least twice a week. You may have to continuously monitor the market and be able to make the trade when you need to do it. Because your liability has a lot of convexity, you need to rebalance your position much more frequently.

You will also need to throw in some more scenario analysis in order to complement your model. Say you have a model and you're hedging and calculating your deltas. It's all very nice, but you need to throw in some extra scenarios and do some stress testing to complement your strategy.

Sensitivity analysis. The sensitivities of liability to change in asset values, volatility correlation, and interest rate give you what are called the Greeks. As was mentioned before, it was difficult to explain convexity to senior management. When you're talking about the Greeks (delta, gamma, vega, etc.), that becomes quite a challenge to convey.

If you're talking about option risk management, you're going to be talking about delta, which is basically the same as duration. Duration for a bond is the change in bond price when the interest rate changes. Truly, the delta of an option is the change in the option price when the value of the underlying changes. If I have an option that's on mutual funds, then the delta is the change in value of the options you've written on that mutual fund when the mutual fund moves. If the mutual fund moves \$1, by how much does my option move? Convexity is the same as gamma, so how much does my delta move when the underlying moves?

Vega is how much the option price moves when there's a change in volatility. Then you have rho, which is the option price versus the interest rate risk, and the list goes on. For example, a delta hedging strategy would be to just manage that your assets have the same delta as your liabilities so that each point in time you're immunized to a small shift in the market, which you would need to rebalance. A delta/gamma hedging strategy would have you match the delta and gamma, meaning that you match both duration and convexity.

One of the things that is frequently asked is, what are the transaction costs? When setting up such a hedging strategy and once the concept is understood, I'll be matching my liability with my assets. How much is that going to cost me? That's always an extremely difficult question to answer, because until you've actually decided on which assets you need to hedge and you've nailed down what volatility you're going to have on all your underlying (what type of guarantee you have, what is your tolerance to risk, and how frequently you're going to be rebalancing), you can't answer that question.

Transaction cost is one of the risks. What if transaction costs increase over time? What if I can't find the instrument to do my hedging strategies? Because of all these uncertainties, you need to complement your hedging strategy with scenario testing.

Basically, throw in "what if" so that the model can look perfect and throw out perfect scenarios in the future. You could say that I'm hedged under all these

scenarios that are randomly generated from my model. But what if I put in hand-picked scenarios? What if not everything goes as planned?

Hedge instruments are also very difficult to come up with. I need to find the best combination of hedge instruments to create a proxy portfolio. By proxy portfolio I mean some combination of things to trade in that mimics the underlying instrument on which I'm actually writing the options. In the case of VAs, I'm writing on all kinds of mutual funds, but I don't want to short these mutual funds or to short all 600 stocks in each one of these mutual funds. I want to short something that's liquid and is not quite as costly to trade, but that is also very highly correlated with the underlying. That's the process of selecting your hedge instruments.

Once you have these hedge instruments, you need to rebalance. As the market moves, new business comes in, and your experience realized may be different from what you expected—you will find that you need to rebalance. You're no longer in a delta-neutral position. You need to go and buy or short more of your hedge instruments. You'll need to do that when there is a change in the fund composition or when your trading limits are reached. Either my underlying funds have changed, so a policyholder has changed his or her holdings, or the fund manager has changed his or her holdings, meaning I need to change my hedge instruments. When I've reached a limit where I'm no longer sufficiently balanced, then I also need to rebalance.

Suppose I've written options such as a GMDB on the VA. In most cases I don't have to pay. If the market keeps going up, I will never have to pay up on that guarantee. But if the market goes down and stays down for an extended period of time, and the policyholder dies, then I'll have to pay that difference between my guaranteed amount and the current account value. This has very large catastrophic tails and is the kind of risk that cannot be diversified. When the market goes down, it goes down for all your policyholders.

What if I'm doing dynamic hedging in the presence of basis risk? With basis risk I can't short my underlying mutual fund, so I have to short something close to it that's liquid enough. Obviously, I still have an error in my hedging strategy. What does hedging do? Well, that reduces the volatility of my result. I no longer have the possibility of a zero payoff, but I certainly don't have the possibility of a very large payoff, so I've basically limited my risk profile. I have much more certainty in results and much less volatility year over year because I'm balancing my assets and liabilities.

That represents the process of dynamic hedging. We start with a model. You need inputs, such as fund holdings, the in-force blocks, lapse, and mortality assumptions. You need to put in your volatility correlation estimates, the interest curve, and other market assumptions. And from your model you get your risk, delta/gamma, all the Greeks. But you also need to go to that fund replication to find which hedge assets you need to use. Since I can't use the mutual funds themselves, I need to go and figure out what I'm going to need to short. Once I have that, then I need to

rebalance between the risk that the model gives me and the hedge instrument that I actually have on the books. I need to go through that process and rebalance.

Risks. Even if you're doing your dynamic hedging, obviously, you still have lots of risk left on the books. For example, liquidity risk. What if I have this nice hedging strategy, but I can't trade because there's no liquidity in the market? Then I can't be balanced and I'll have risk left. The same goes for large event risks. What if there are market gaps? I can't trade during that large market movement—the market is just dropping. It can't short fast enough to get balanced. There's a substantial operational risk.

Model risk. What if the model is wrong? What if my inputs are wrong? What if I can't get my data in time to keep my hedging strategy in place? Obviously, the usual risk where you misestimated your mortality, lapses, and policyholder behavior shows up in your hedging.

That's the hedging strategy, and, like I said before, it's new and it's something that I think actuaries are very well-qualified to do. It's not just the investment bank that can do these kinds of dynamic hedging strategies—actuaries can do them too. Certainly, because of all the mortality and lapse risk in these products, I think only the actuaries should be doing this kind of thing.

Mr. Oh: I think it's especially true that the actuaries are in a better position to handle this type of risk in an integrated fashion because that's something that bankers, capital market people, or accountants may not be able to address in an integrated fashion.

The next speaker is Randall O'Connor, a principal in Tillinghast-Towers Perrin's Minneapolis office. He specializes in providing actuarial and management consulting services for life and health insurance enterprises. As a member of Tillinghast-Towers Perrin's financial services practice, he has gained experience in many areas, including product development, valuation, financial measurement, risk analysis, cash-flow testing, and mergers and acquisitions. His experience spans a wide variety of products, including liabilities, life, disability income, and long-term care.

Mr. Randall M. O'Connor: Today's topic is about the actuary's role in risk management. I will address what ERM is, detail why risk management is important by looking at the objectives of senior management, and describe a generalized framework that helps senior management achieve those objectives.

As part of this presentation I would like to show that traditional and the new "big tent" actuaries both have a role in this process.

What is risk management? Basically, risk management looks at all risk, both financial and nonfinancial. It says an entity is exposed to a myriad of risks which affect capital returns and volatility of results. Required capital, expected returns, and volatility of returns are the three areas we are going to look at within the framework. What we want to do is to use risk management to give us a better

understanding of these three areas and to improve the value of our firm for either our shareholders, stakeholders, or fraternal members.

What constitutes risk? We've seen a lot of information regarding what I would call risk of the portfolio or financial risk, which is very important and is what a lot of us concentrate on. There is another layer outside of that operational risk or risk to the portfolio which I will also be addressing because both types of risk affect our companies' experience.

Is ERM important? A lot of companies are starting to create what's called a chief risk officer or a risk management officer, who is responsible for evaluating risk and process controls that companies are putting in place to manage on a unified risk basis. We find it's becoming very important.

Why is ERM important? Because it gives you a competitive advantage. ERM is not a "need-to-do" process, but rather a process which allows you to become successful. Today, we are seeing a lot of people take on risk without getting an appropriate reward. With risk-based capital (RBC) and rating agencies worried about capital levels, we're finding that the use of capital and how capital is used becomes very important. Obviously, if you look at any ROE, capital becomes very important. An important part of our framework is understanding the dichotomy between what a shareholder wants and what a policyholder wants in terms of capital levels and returns of a company.

Also, people are starting to realize that operational risk has become more and more important, affecting their company's results overall. A classic example of operational risk, of course, is the market conduct lawsuits that are going on right now. We feel that by looking at ERM it can help, if you're a stock company, increase the value of your stock or the value of your firm.

Let's look at senior management objectives. Most stockholders and board members would say that senior management objectives create the largest volume. How do you do that? By getting the highest stock price possible. Let's begin with number one. How do you increase the value of a company? Tillinghast performed an analysis of a financial service institution's stock valuation with respect to the following:

1. a high return on capital
2. a high earnings growth
3. or a low earnings volatility

As you can see in Chart 1, and I was actually surprised by these results, companies with low earnings volatility have a higher value than companies with a high return on capital. The market appears to reward stability in earnings more than it does level of earnings, which is not an outcome I expected. And, you will notice the market seems to approve if you also have earnings growth.

We looked further into this to see if low earnings volatility was a true driver of stock value, so we broke it down further into these four factors: low return, high return,

low growth, and high growth. Inevitably, you will see that the companies that minimize their earnings volatility had a better value in the marketplace. Obviously, earnings volatility becomes a huge driver of success in terms of stock price.

Now we come to what I consider to be the interesting dichotomy I referred to earlier. Senior management must balance the need of increasing the company's value with the policyholder's security needs. If I'm a shareholder, I would like my company to operate with \$1 of surplus because every return I get is a huge return on my investment, right? As a shareholder, in the extreme, I want the least amount of capital a company can hold. A policyholder, on the other hand, is almost always concerned about insolvency and wants a company to hold the most capital they possibly can and doesn't really care what the shareholders get in terms of return. We end up with a dichotomy where owners want return and policyholders want security.

We now come to a very interesting situation. What is the appropriate level of capital? Once you know what the appropriate level of capital is then you have to ask, what's the appropriate return on that capital? Once you know that you now have to ask, how can I minimize my volatility? To do that we think you really need to look at an ERM framework.

There are a lot of pieces to this framework, but we will be looking at the actuarial nuts and bolts of this, which is a very small subsection.

We'll start with an overview of the concept, which says (on the left-hand side of Chart 2) that policyholders are interested in capital. They want to buy from people who aren't going to go out of business. On the right-hand side of the chart, owners are interested in expected returns and the minimization of volatility of returns. We want to put a process together that assesses risk, determines necessary capital levels and required returns, looks at the volatility, and figures out how to minimize volatility. To do this we want to go from the policyholder's interest to the far right-hand corner where we smooth out that return curve so it has nice returns and low volatility.

What we want to do when we assess risk in a very simplistic way is to identify risk factors. It may sound kind of silly but you really want to ask yourself, what are the risks my entity is facing? Then you want to prioritize them.

I was speaking with one chief risk officer of a company and he was telling me how he had just spent two weeks worrying about the company's auto insurance on employees who are traveling. He said, "I really don't think that was a good use of my time," and it probably wasn't. What you want to do is prioritize your risk factors to determine what is a material risk and what is an immaterial risk. Once you determine which ones are material to your outcomes, you will need to determine how to model and quantify those risks. Then you will need to decide how best to develop the risk strategies necessary to minimize the impact of these risks and then how to implement these strategies.

First, we look for low-hanging fruit. What are the simple things we can do to take on the reward and minimize risk? How then do we quantify risk, including operational risk? There's a whole myriad of ways of quantifying risk. Chart 3 gives you an overview of the various methods. Each method has advantages and disadvantages. Personally, as a financial services actuary, I tend to like stochastic simulation modeling because it's what I am most comfortable with because of cash-flow testing. But we may need to remember as actuaries that we have a whole toolbox at our fingertips to use beyond just our traditional models to properly evaluate these types of risks.

Once you have modeled risk, the outcome of what we're looking for is a distribution of earnings. If you look at the bottom part of Chart 4 where it says no assigned capital, it would be your cumulative earnings under various probability scenarios. In other words, we've run X number of scenarios and we've come up with a distribution of returns. What we basically look at here is where that capital line intersects the zero line. This is the insolvency point. Obviously, once the cumulative capital or earnings fall below zero, you're insolvent. What we are then basically saying is OK, as an organization I have a solvency risk-tolerance level, so I need to hold capital in such a way that I'm happy at my solvency risk tolerance level (or what we call economic cost of ruin (ECOR), which I will discuss further in just a moment).

This is very similar to the concept that a rating agency uses when it rates a bond. It basically finds what the probability is of defaulting on the bond. Many would think that is how it gets its rating, but it doesn't because there is also salvage value. The ECOR represents not only the probability of a company going bankrupt, but what the cost is when the company goes bankrupt.

For example, let's say I have company A and company B. Company A has a 1% probability of ruin, but when it goes under the policyholders only receive 50 cents on the dollar of what they expected to receive. Company B has a 1% probability for ruin, but when it goes under the policyholders receive 95 cents on the dollar of what they expected to receive. Which company is a better credit risk as a policyholder? Obviously, company B. ECOR looks at both the probability of ruin, which we are very familiar with in our actuarial research, as well as the expected cost when a ruin event occurs.

What an organization would do on a theoretical basis is to determine if it wants to play or sell as an AAA-, an A-, or a BBB-type bond. That way they can choose a spot in the spectrum of the market and determine if they want to be that type of solvency carrier. A company will determine what ECOR they want and use these models to determine their economic capital. From there the organization would decide that they are going to hold the economic capital in such a way that they had this probability of ruin and are equivalent to the targeted bond instrument in the marketplace. As you can see, we add the capital to move ourselves to the ECOR level that we want.

The ECOR, for those of you who do any health work, is both probability and severity (i.e., its frequency times severity of the event). The ECOR represents the premium required to lay off the entire risk embedded in the organization's strategy to the policy owners or the guarantee funds. We developed something called an ECOR ratio, which basically calculates my ECOR divided by my present value of expected customer payments. What we are looking at is a ratio we've produced which determines how much amount is at risk.

Why is this important? Because one of the important things in looking at strategies of an organization is to determine what capital should be allocated by line of business. How many people here allocate their capital based on RBC formulas, whether it is really necessary to give a line of business that much capital or not? Most of us probably do that; at least that's the feedback we are getting from the market. What we're saying is you really should be allocating capital based on risk and not on typical formulas. Most of the formulas done by the rating agencies and by the NAIC are based on a typical company in a typical environment doing typical things. No company is typical because we all differentiate ourselves somehow or in some way. To really understand the fundamentals of your business, you will want to go through this type of an exercise.

We recommend that if you do have ECOR ratios you then take your segments of business and allocate your capital such that every line of business has the same ECOR ratio, i.e., every policyholder has the same amount of exposure to solvency because, let's face it, if my individual life line goes under and my individual annuity line doesn't, my company's not insolvent yet. When insolvency hits, everyone is hurt at the same time. It's not as if one line has an insolvency and one doesn't.

Typically, we recommend using dynamic financial analysis, plus some of the operational risk-type tools to produce these earnings distributions. When a stand-alone analysis of each line of business is performed the sum of the capital required for the lines is greater than the capital you need as an organization. Why? Because there are diversification benefits, which is the form we use when talking to chief financial officers. If we are talking math heads, we, of course, call it covariance. But the important thing to remember is that when lines of business work together the amount of risk you are exposed to becomes diminished because they can offset each other with the results being this extra pot of capital at the end. You add up the individual lines. It's much higher than you need for an organization. Then an organization needs to determine how it's going to reduce the capital required by each line of business segment such that it comes back to the total necessary for the entire organization. That becomes what we call diversification benefit philosophy.

Once you have your capital allocated, you have to look at return. What is the return I want to use? Typically, in a lot of ERM analysis people worry about volatility. Based on the facts we covered earlier, this is a good cause for concern. The problem with volatility is that volatility in and of itself isn't bad. If I have an asset that has an expected return of 10% and volatility between 8% and 100% return, that's not bad compared to an asset that has low volatility and an expected

return of 7%. Obviously, I want asset A before I'd buy asset B. B has no volatility. A has a lot of volatility, but it's not harmful volatility. We need to start looking at risk not in terms of its absolute volatility, but what I call harmful volatility. What do I mean by that? I mean volatility that causes returns that are not acceptable to the marketplace or below market returns.

Now, what is below target return? What we are discussing here in terms of volatility is, how much volatility do I have below my target return? Target return could be a lot of things including your cost of capital or your hurdle rate return, or it could be what the market expects you to return. Typically, when talking with senior management, target return to them means stock or analyst expectations. If I know the stock or analyst expectation is 6%, then I want a zero probability that I am going to fall below 6%. I want to minimize the chance of falling below market expectations. We are looking at a series of returns that say, will I fall below the target returns if my return on a segment of business is appropriate? This approach will also address the issue of evaluating returns of individual lines of business.

Now we return to basic economics and say, "Let's go back and create a modified capital market line." This isn't your standard capital market line based on absolute volatility. It's a capital market line based on the probability of not meeting my target return. I can take the standard traded assets in the marketplace and map them based on the probability I'm not going to make my target return; then I can map my business segments. Any business segment that's above the modified capital market line is creating value for me. Any business segment that's below the modified capital market line is, obviously, destroying value.

There is an argument people put forward that says, "I cannot be in business segment B if I am in business segment A." If this is true, you should probably model them as the same segment because if you can't operate in business without both business A and business B, you should model them together because that's a business strategy you've made. This is technical information beyond the scope of this presentation. But I think the basic concept here is that if you're not getting a return in excess of what you can get in the marketplace based on your probability requirements of not meeting your target return, you shouldn't be in the line of business or you need to reevaluate how you're managing that line of business.

In closing, what will an ERM process actually do? An ERM process will allow a company to determine the necessary capital level and required return, and improve earnings stability. You can say, "Here's my target return." I can implement my risk management strategies such that I can begin to minimize how often I fall below my target return, and make sure that my expected return doesn't drop to an unacceptable level. It gives us an analytical tool that looks at what we are really doing in an integrated risk management process.

The other thing I'm most concerned about in our industry right now is that we take on risk without being properly rewarded or reflecting the risk in how we evaluate return. This gives us a method for looking at returns not as point estimates, but looking at distributions and asking, "Is the risk we're taking on in a distribution-type

analysis appropriate for the return we're getting as compared to a point estimate?" Many times a return will look appropriate on a point estimate under a single scenario, but when you actually do a distribution analysis you'll say, "Wait a second, I'm not getting the kind of return I should for the amount of negative volatility or harmful volatility that's embedded in what I'm selling."

Also, in today's environment ROEs are very important. This gives you a unified framework for looking at both returns and how to use capital. For example, if you look at your economic capital and say, "There are a couple of segments here where I am way below what A.M. Best and the NAIC wants me to hold." I can do one of two things. I can increase the risk I assume, since I have to hold the capital anyway and get a better return, or I can go offshore and do arbitrage and bypass the capital requirements.

We talked about stabilizing earnings and increasing price/earnings ratios. I think we have documented that well enough. The final thing that I think is important about this is you can go to your reinsurers, your rating agencies, the capital markets, and your market analysts and show them what you're doing and say, "Listen, I don't need to hold as much capital as you say I need to hold or I'm getting an appropriate return." But it gives you an objective way to discuss these issues with those constituencies who determine your company's rating and how your company is evaluated. This type of objective discussion approach can help lead to, obviously, better ratings, lower capital requirements, or a better stock valuation, which ties me back to the whole ERM process and why we think it's important.

Mr. Oh: It is a fascinating concept, ECOR. I think I learned a lot of new concepts today—the GARCH model and the ARCH model. I should say I heard a lot of words and concepts, but I think this is the purpose of the session. We have tried to introduce risk management tools and some concepts.

Mr. Russell A. Osborn: I'm interested in this Tillinghast study regarding if investors are looking at the market-value-added dependent on company returns versus volatility in company earnings. Over what time period or length of time was the increase in stock price examined in this study?

Mr. O'Connor: From 1989 to 1998.

Mr. Osborn: You have ten years worth of data. I'm trying to find a way to ask what my question is. Maybe Max knows.

Mr. Rudolph: Russ, are you essentially asking an investment horizon question; that is, where are these one-year stock returns that have just compiled over ten years—

Mr. Osborn: Right.

Mr. Rudolph: —or is it the actual return over the ten-year period?

Mr. Osborn: Right, that's exactly my question.

Mr. O'Connor: I don't have the particulars of the study with me today; however, the results are available upon request.

Mr. Osborn: It is common wisdom that investors really are looking at volatility in current earnings. But I'm curious. I'm not aware that any companies have been bold enough to look at economic value and do what makes actuarial sense over the long term and ignore investor reactions in the short term. But I think it would be interesting if we had data to look at that question, because then we could focus on what really makes sense instead of focusing on short-term investor reaction.

Mr. Rudolph: I am aware of some companies, at least some fraternal, that are managing themselves off economic value-added and looking at things over a five-year plan. You know, their incentive compensation is based on the average of those five years; it's not just the current year.

Mr. Osborn: These are publicly traded companies?

Mr. Rudolph: No, these are fraternal. There are some people out there doing it, but I don't know if there are any stock companies out there doing it. It is the right question to ask though.

Mr. Oh: I have a question for Jean-Francois Lemay. We have some risk exposure in Prudential. We have the guaranteed annuity death benefit and the death benefit guarantee on our mutual fund. You mentioned dynamic hedging. How are you going to reconcile the difference between the actuarial pricing and the price tag based on dynamic hedging? In other words, I mean the difference between the realistic stochastic model and the actual cost of dynamic hedging, which is based on risk-neutral pricing and capital-market pricing and is very expensive.

Mr. Lemay: That's a good question. There are lots of ways to look at it, and it's often very difficult to explain. I guess the best way to explain it is that when you are hedging it's basically like a reinvestment strategy. If you are pricing or doing your actuarial pricing and you want to kick out a price, you'd also put out scenarios of, for example, interest rates and put in what is your investment strategy over time. Now, you can view hedging as a reinvestment strategy. I invest in certain assets in order to immunize my portfolio over time. What is my cost? The capital approach of pricing, which is using the risk-neutral valuation method. It's simply a shortcut to give me what is my expected cost knowing that I'm going to be hedging and shorting these positions over time, so, in essence, they're the same.

The long way would be to take my actuarial model, which projects, for example, realistic growth rates in equities, my volatilities, and so on. I take this approach and I recalculate over time at each point in time what I would have hedged and what instrument I would have used to hedge. When everything is said and done I say, "OK, here's what I paid for claims. Here are my gains and losses on my assets, and that should give me the same price as the capital market." The problem that

you raise is that if you've sold in the market just purely using my actuarial pricing, ignoring my hedging strategy, and then you decide to start hedging strategy, then the two might have different prices, in which case you may have some very unfortunate discoveries in that you find that you're actually underpriced and can't afford a full hedging strategy.

Mr. Sidney A. LeBlanc: Actuarial approaches to specific risk wouldn't have helped Bearings Bank on a derivative issue. It wouldn't have helped General American on their liquidity problem of funding, and it wouldn't have helped the class-action suit. Are you aware of any process that might try to ferret out any other reasons that a company might go broke? There are a number of reasons a company might go broke. How do you find all of them, think about them, and manage them?

Mr. Rudolph: I would just make one comment. I think that looking at a distribution of the potential results very well may have pulled out the possibility of insolvency for those instances. I think, as with Randy's comments, that looking at a distribution instead of a point estimate is probably where we can add the most value right now.

Mr. Alan S. Turkiewicz: I think I like the idea of sending management a distribution of results, but did you see a problem in the expectation in saying, "The range is between 1 and 3 with 99%, but is your actual result outside that range?" Are you setting too high an expectation for them and do they truly understand any one of ten assumptions could be off and the distribution would be totally different?

Mr. O'Connor: Well, with all analysis that we do, if our assumptions are completely wrong we're in a lot of trouble, right? To the extent your assumptions are fairly accurate within the framework of your stochastic risk modeling, you shouldn't have that kind of an outcome. And if you do, you've obviously made a major mistake in the model. I think it becomes more of a modeling error than a result error, and it needs to be explained as such.

Mr. Lemay: I guess when it relates to dynamic hedging often you're in a position where you already have these risks on the books. The question is, if I show a distribution of results without a hedging strategy, which is much wider, and then a distribution with a hedging strategy, even with caveats that I have assumptions, and volatility can change on me and I could be outside certain boundaries, just the sheer size of reduction in the tail-end risk is a good thing to see. It's very useful to give management at least an idea of what your hedging strategy is going to do for them, even if it might not be the perfect distribution.

Mr. Rudolph: I guess I want to challenge my senior management. If they're not able to understand the stuff, they shouldn't be managing the business. You know, I don't want to dumb down something that I'm doing just because my senior management doesn't understand it. I want to help them to understand why this makes sense. It's, again, an iterative step where we'll probably go somewhere else five years from now, but this will be a step along the way.

CHART 1
DRIVERS OF STOCK VALUATION

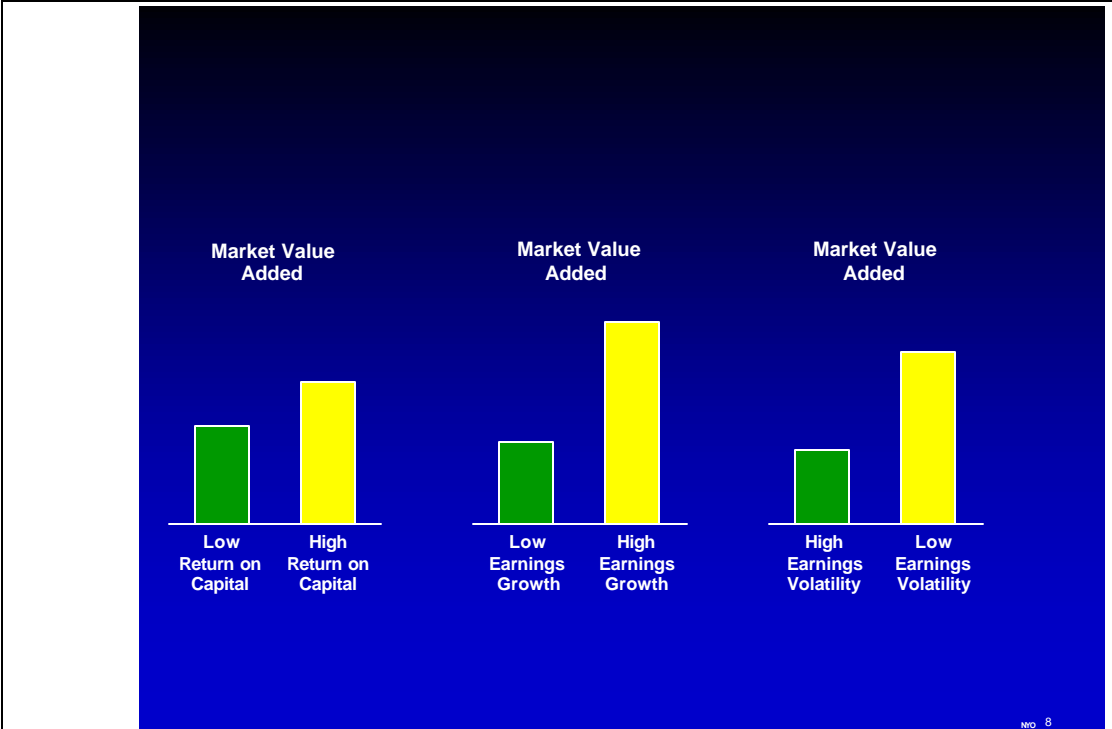


CHART 2
OVERVIEW OF ERM FRAMEWORK

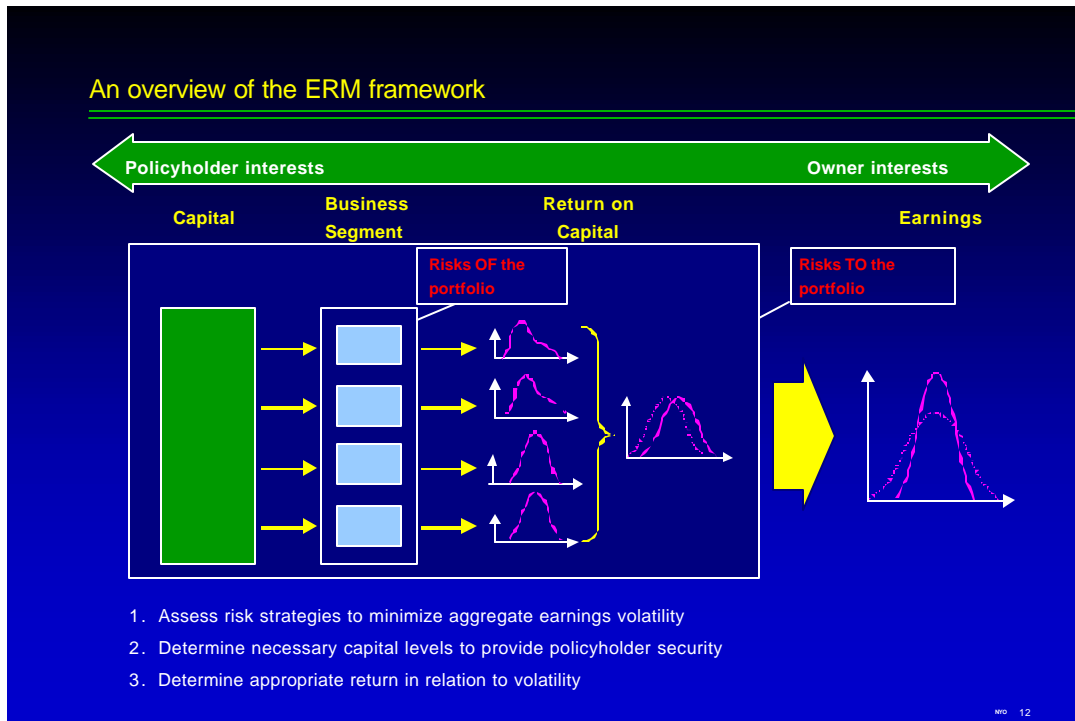


CHART 3
QUANTIFYING OPERATIONAL RISK

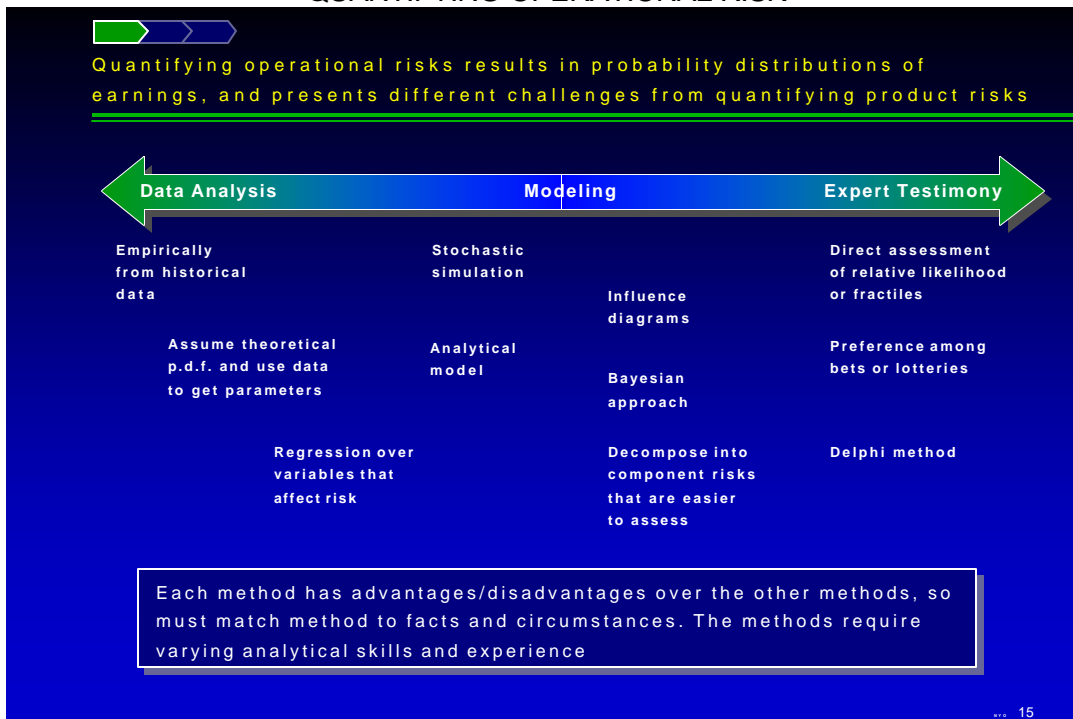


CHART 4
MANAGING ECONOMIC COST OF RUIN

