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Risk Management

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Summary: The financial industry has become increasingly interested in understanding and managing financial risks as well as business risk. While often perceived in terms of risk reduction or mitigation in the past, today's focus has expanded to improve performance and add to the value of 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. This session focuses on quantification of various financial risks insurers take on.

Ms. Shirley Hwei-Chung Shao: I work for Prudential Insurance of America in the corporate risk management unit. We also have two experts in the area. One is Cindy Forbes, and she's the CFO of investment operations for Manufacturers Life Insurance Company. We also have Tom Ho who is the executive vice-president of BARRA, Inc, which has recently merged with Global Advanced Technology which was founded by Tom in 1987. Tom has a Ph.D. from the University of Pennsylvania, and he is a professor of finance at New York University. He is actively involved with asset/liability management (ALM), risk management, and profitability measurements. He also is very famous for his wholly arbitrage-free framework. He also enhanced the duration concept and has worked with linear path space theory.

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Note: The chart referred to in the text can be found at the end of the transcript.

We're going to focus on two topics. First, we are going to give you a little bit of an introduction to value at risk (VAR). This is something that has been getting a lot of attention in the financial service industry in general and particularly at the trading desks and the banking industry. We're going to give an introduction which Cindy will do, and then we will focus on how it applies to insurance liabilities. Finally, both Cindy and Tom will talk about how we can link VAR with the management decisions.

Ms. Cindy L. Forbes: One of the reasons VAR comes up when you talk about risk management is because it gives you a comprehensive framework for identifying and quantifying your risks and putting them all together in a way that you can tell management how much of your risk exposure is from one particular risk versus another risk, (say mortality versus interest rate). It is a tool. It's not a be-all and end-all, but it certainly is a tool that allows you to present to management the risk to the corporation in an integrated framework. That's one thing that the banking industry has been able to do that insurance companies have not been able to do. When you think about our businesses as being just a combination of a number of probability distribution functions, it makes a lot of sense for us to think of our business as one probability distribution that has been put together from all of the risks that we manage.

You can think of your earnings each year as one observation from that probability distribution function. That makes for a very powerful conceptual framework to manage or to think about risk in. It has its drawbacks. I'm certainly not going to say there aren't any issues with VAR, but its power is in its conceptual framework.

I'm going to talk about VAR and give an example of how you might calculate VAR to try to make it tangible to you. Then I'll give some examples of how you can use it in the investment management process. VAR actually started in the banking industry.

What is VAR? I'm going to explain VAR in an earnings context. I could explain it in a portfolio management context, but I chose to use earnings because the message I'm trying to get across is that you can use it as a tool to manage or express the risk inherent in your annual earnings. As I said, earnings can be thought of as the result of random, correlated draws from a series of probability distributions. Each probability distribution is for a particular risk factor on your balance sheet—mortality, morbidity, lapse, interest rates, spreads, credit risk, prepayments, and equity returns. You can think of your total earnings each year as being, in essence, nothing more than a probability distribution or one observation from that probability distribution function.

Chart 1 shows a company that has an expected earnings each year of $100 million and a standard deviation of $10 million (I'm assuming the company knew what their probability distribution of earnings was). Assuming that it was normally distributed, the curve in Chart 1 shows what the earnings distribution would look like. The part that I've shaded at the bottom end is the tail of the distribution, and that's what VAR focuses on. For a 95% VAR, the volatility or variation in earnings that I might experience one time out of 20 is the question. If I was looking at an annual earnings period, what would be the worst variation in earnings for one year out of 20? For this particular company it's about $20 million.

So, my expected earnings are $100 million, and one year out of 20, I might expect to earn less than $80 million. This use of VAR is a powerful way of thinking about your earnings.

You can calculate VAR at the 99th percentile, which would be one year out of 100. Sometimes, when you talk to bankers, you might hear them talk about whether or not they're using a one-tail or a two-tail test. A one-tail test just means that you would expect to have, if you're doing a 99th percentile, one year out of 100 with a worse result than your 99th percentile. If it's a two-tail test, it's just looking at both ends of the distribution, and you would expect to have a result worse than one year out of 200 instead of one year out of 100 because you're looking at 1% in a combined tail together. It would be the low tail or the downside risk, as well as the upside risk in the upper part of the distribution.

How might you calculate VAR? It's conceptually not all that difficult. The parametric approach has been made famous by J.P. Morgan, and it's a fairly simple approach. For each asset in your portfolio, get an estimate of the volatility of the returns on that asset, and decide what percentile your test is going to be at. If it's at the 95th percentile, you simply pick up the value from the normal distribution for the 95th percentile which happens to be 1.65, and you multiply the volatility times 1.65 to get your VAR. If you have more than one asset in your portfolio, you have to pick up the correlations as well and go back to second-year statistics to work out how to combine variances of multiple, normally distributed variants. From a conceptual standpoint, there's nothing very complex when you calculate VAR using the J.P. Morgan approach. If you want to know more, you can go to J.P. Morgan's Web site. They have many, many technical documents you can download.

If you wanted to go that route, there's lots of information out there to help you. There are also lots of programs that you can purchase for about $5,000 (U.S.) that will calculate VAR on a particular portfolio. The difficulty comes when you're trying to do this across your whole balance sheet and trying to get all your correlations. You might have to calculate or track some of your own correlations

and some of your own volatilities. You may not be able to get them from other sources. If you were trying to do that daily on all your holdings, the effort is in coming up with a VAR calculation on one particular position at one point in time.

Another approach used by banks is historical, and that's not much different than the parametric approach. They basically take a period of history and look at the correlations of returns amongst their portfolios or assets over, say, a period of time that they've chosen that has enough volatility in returns. They use that as the basis for calculating their volatilities and their correlations. Monte Carlo techniques are also used by banks to calculate VAR and should be sort of near and dear to the hearts of actuaries. You would use that more often in your ALM models. That would entail using your ALM models to run a bunch of scenarios because you have the correlations. There are many assumptions as to how your assets and liabilities behave in those models. You can take that approach, use those models to come up with enough scenarios so that you have a probability distribution function, in essence, for that portfolio. You might need to change your approach a little bit because you'll get a lot of observations in the middle of the distribution using a standard Monte Carlo approach. What you really want to concentrate on for computational efficiency are the tails for VAR. You have many of the tools there already if you have an ALM model that's using Monte Carlo to look at your ALM process.

Let's discuss how you might calculate VAR using J.P. Morgan's approach because it's simple and easy to get your hands around. J.P. Morgan says to take your portfolio of assets and transform them into holding a zero-coupon bond portfolios. Take all your cash flows and map them onto a portfolio of zero-coupon bonds. Then you simply look up the volatilities and the correlations for those bonds off J.P. Morgan's database, stick them into the formula, and calculate your VAR. It's quite straightforward.

As an example, I did this for a three-year, annual coupon Treasury bond to make life simple. I've taken each of the cash flows and put them into year one, year two, and year three (Table 1). We looked up price volatilities, not interest rate volatilities, along with the correlations and calculated the VAR which turns out to be $301 on the present value of a bond that is a bit more than $100,000. That's roughly equal to 0.3% of the value of the bond and not dissimilar from what you would get if you calculated the price sensitivity to the bond, assuming a ten-basis-point move in interest rates because the duration of the bond is just under three years. You can knock it back fairly easily to sort of a duration framework if you want to by just looking at what kind of interest rate movement would have produced that kind of VAR, given the duration of the portfolio.

TABLE 1
EXAMPLE: (PARAMETRIC) VAR FOR A BOND

Year	Cash Flow	Volatility	Correlation
1	6,000	0.084%	1.000
2	6,000	0.209	0.939
3	106,000	0.316	0.933
PV of CF	101,263		
VAR, 95th P, 1 day holding period			301
VAR as a % of PV CF			0.30%

3-year, Annual Coupon Treasury Bond
Coupon = 6%

To give you a sense of how your assumptions on holding periods and percentiles might change your results, one of the things that J.P. Morgan does say is you can take the current volatility that they're using for a one-day holding period, and use the square root of time to extrapolate what the volatility would be over longer holding periods. In this case you're still using the same correlation matrix. Of course, correlations can change over time, so there are some shortcomings with this approach, but it does give you some idea of what extending the holding period would do when you're calculating VAR. My $300 VAR was assuming a one-day holding period, and that was about equivalent to assuming a ten-basis-point move in interest rates in one day (Table 2). When I move out to one month, my VAR increases by a factor of more than four. When I move out to three months, it's a factor of almost 2 compared to 1 month, and then it is another factor of 2 moving from 3 to 12 months. The difference between a 1-day VAR and a 1-year VAR is roughly in the magnitude of a factor of 16, just to give you a sense for what kind of difference it makes. If you go down the other way, you might wonder what difference does it make if you choose a 95th percentile versus a 99th percentile. The difference is a factor of about one-third.

TABLE 2
EXAMPLE: (PARAMETRIC) VAR FOR A BOND

	1 Day	1 Month	3 Months	12 Months
95th P	301	1,349	2,336	4,672
As %PVCF	0.30%	1.33%	2.31%	4.61%
99th P	396	1,773	3,070	6,140
As %PVCF	0.39%	1.75%	3.03%	6.06%

Volatility for longer time periods can be estimated by multiplying (vol for one day) by the square root of time

There are some drawbacks to using the square root of time to calculate a volatility for a longer holding period. The longer the holding period that you use this approximation for, the worse it is. In addition, with regard to the 99th percentile values, if you monitored how you did in terms of how many times you had an actual result that was greater than the VAR you predicted, you would find that, because the asset returns tend to be fat-tailed and not normally distributed, that more times than 1 out of 100 you would end up with a result that was greater than your VAR.

How might you use VAR in investment management? You can use it to select benchmarks, to set limits for your portfolio managers, to monitor how they're doing against those limits, and to measure performance on a risk-adjusted basis.

For benchmark selection, let's assume that you had a liability profile that you wanted to match up against, and your bond manager had given you several candidate benchmarks that he wouldn't mind being measured against. Your job is to decide which one of those is the best fit. You could use duration or key rate durations to do that, but you could also calculate the VAR of the portfolio and the VAR of the benchmark. You could use, as your selection criterion, the one that had the closest fit from a VAR perspective relative to the liability profile. You can also decompose VAR in much the same way as Tom pioneered decomposing duration into key rate durations. You can decompose VAR into beta VAR which will tell you the contribution to VAR of each risk factor as well. It is a little bit more sophisticated than using key rate durations. The focus with VAR is always being at the lower tail of the distribution.

So, you can use VAR to pick the benchmark that fits best. If I were doing this, I would probably use a one-year holding period assuming that I reevaluated my benchmarks once a year. So I would be using this benchmark as a proxy for my liabilities over a 12-month period. The advantages of using VAR is that you've got one number that brings all of the sensitivity factors into it. You end up with a number that management can relate to a little bit more easily than key rate duration

gaps. Over time, as you develop some experience with VAR, you could also use it to set policy limits for how well a benchmark has to fit the liability profile.

Once you have your benchmarks, you must tell your portfolio manager how much he or she can deviate from that benchmark. You probably have some guidelines now. They might be in duration terms or they might be in key rate duration terms. You could take those limits that you have and translate those into VAR terms. The advantages to doing that would be that if you have duration gaps as your limits today, you're really capturing only parallel changes in interest rates. If you have partial, or key rate limits today, you have a lot of limits. You've controlled interest rate risk along the curve, but you have many numbers to monitor and talk about. On the other hand, with VAR you can have one number, and it captures all of the risk elements in it.

You could take the limits that you have in place today, and look at historical volatilities and correlations, and come up with comparable limits on a VAR basis. Without changing the level of interest rate risk, the manager can just translate the correlations into VAR limits, so you would have one number that you could talk to management about in terms of the amount of surplus the bond manager could put at risk by taking bets. That's a much easier conversation to have with management because it gets to the bottom line a lot faster, and it's something that management can relate to.

One of the disadvantages with using VAR for setting limits and for monitoring actual positions against those limits is, of course, that now you've got some additional elements that change the VAR associated with your current position. As volatilities and correlations change over time, that could take a position that was on-side with its VAR limit and put it off-side simply because the volatilities went up. It creates another factor that could cause you to go over your limit.

Another potential use for VAR, and this is certainly a use that the banks have found, is to allocate capital on an economic basis. You have risks in your asset portfolios that risk-based capital (RBC) doesn't capture, and if you want to move forward in terms of making sure that you're allocating capital to your investment managers on an economic basis (meaning the amount that they can put the firm at risk for), VAR is an excellent tool. You can use it to decide how much capital to allocate clearly because it focuses on the downside risk, the risk in the tail of the distribution, and the amount of capital that is needed to cover catastrophic events. Those are events that are in the tail of the distribution. There is good alignment between the tool and what you need to look at when you're allocating capital.

There are issues you have to think about when you're using VAR to allocate capital, assuming that you've already gone through and are monitoring your positions based on VAR and you know the VAR associated with all your holdings. For example, let's say you have a bond manager who holds positions for a month, and you've calculated his VAR limit on a one-month holding time frame. He can take positions throughout the year, and by just using his one-month VAR limit you don't know the amount of capital he can chew up because he can put on a number of positions throughout the year and lose more than just his VAR limit during the year. You have to determine what multiple you need to go from; is it say, a one-month holding period for a portfolio manager to what his annual capital allocation should be? You could use stochastic modeling to figure that out. Banks have said they use a multiple of two because they've had to deal with that issue as well. But you have to decide how you're going to go from your trading limits to what they can actually put you at risk for during an entire calendar year.

Finally, you can move forward to measure your portfolio managers on a risk-adjusted basis, and this is, again, another thing that the banks have already done. What you can do, if you've got benchmarks that you're measuring your portfolio managers against, you can calculate the risk-adjusted return for the benchmark which is simply the return of the benchmark over the capital that would have been allocated to the benchmark. You can compare their performance on the same basis, and determine what the actual return was relative to the capital that they utilized. You can use performance measures and bonus them based on whether or not they do better than the benchmark on a risk-adjusted basis. So those are some ideas for how you can use VAR in the investment management process.

There is work that has been done by J.P. Morgan on using a similar framework for credit risk, which basically is a very actuarial approach to measuring credit risk. For each rating class, it takes a look at what historical defaults have been, so that you can come up with transition probabilities, i.e., what's the probability that a double A will become a single A and a single A will become a triple B? You can download this from the J.P. Morgan Web site. You can look at what the recoveries or losses are on bonds that go into default in each class and come up with a methodology for quantifying credit risk which if you picked it up and read it, you would immediately say sounds very similar to how actuaries think about credit risk. That can be incorporated into a VAR framework as well.

Ms. Shao: I'm not an expert on the VAR, but I find it very difficult to get a speaker to talk about VAR when it applies to the insurance liabilities. I am speaking by default because I'm the moderator for the session. If you look at many of the seminar topics, you'd notice that they are talking about VAR. Many pertain to derivatives, credit risks, and interest rate risks, and there doesn't seem to be a lot out

there on insurance liabilities. I think this is where our profession can really add value to the process, and I encourage every one of us to become involved in making this work for the insurance liabilities.

My company is going through this process because we were not necessarily happy with formula-driven framework. We like to know our risks a little bit better, and we also like to look at them from economic-based frameworks.

I'm going to talk about the kind of framework my company uses. We use the parametric approach that Cindy talked about to look at the normal risks. We try to tackle it in single summary, statistic measures, due to the normal market movement. We then try to combine the normal risks with stress tests (scenario analysis) to try to get to the tail-end risk. A laundry list of all the variables needed when doing VAR would include: risk units, risk drivers, volatility, sensitivity, correlation, confidence level, time horizon, look-back period, and estimation methods. You need to come to a decision about every one of these, and I will go through some of them in more detail a little later.

There are four steps to calculate VAR. The first things you need to determine are what I call risk management units and the risk drivers. The next thing you need to determine and calculate is the liability value. The third step is to try to look at the volatility, sensitivity, and correlation of each one of the risk drivers. Finally, decide on the time horizon and the confidence level.

I want to talk about time horizon. The topic is somewhat controversial for the insurance liabilities. If you look at the trading desks, you would find that many of the term horizons are very short. They can be daily or weekly, but what does it mean for insurance liabilities? We had a lot of debates within my company to try to figure out what that really means. Does that mean it's the period in which you want to report your risks or is it really the period in which you can change your risk profile? Some people will argue that can be 20 years down the road for an insurance company. Once you write business, you're stuck. You can't really change your risk profile short of reinsurance in a secondary market. That's something that's difficult to decide, but you have to come to a conclusion on that one.

Let's talk about the risk units. For risk management units, we look at the lowest level of detail that we want to analyze and use to report our risks. We try to group the risk profile so that we have homogeneous groupings, and then we look at the risks and make sure that in that particular group, these products all correspond, in the same fashion, to various risk drivers. If you think about the C–2 risk, you'd realize that these units should generally coincide with the product groups you have.

Next, we look at the risk drivers within each of the units. These are the drivers that will give rise to uncertainty and risks in the economic value of that particular unit; therefore, some of the usual suspects like mortality, surrender, and expenses are the risk drivers that have potential impact on the value. Our profession has done lot of the research and had a lot of discussions, but I think it's really important for us to come to some kind of consensus on how we want to fair value our liabilities because everything we work on, whether it's VAR or the valuation task force work or even GAAP, seems to be directed toward fair valuing of your liabilities. We had a tough time in our firm trying to figure out how that works. We look at a lot of research material and different approaches, but we decided to use the direct method called the market value analysis method just because of simplicity.

There are various issues under this approach. First, how do you handle the modeled cash flows? To the extent possible, we use our cash-flow testing model as a starting point. The next one we need to decide is the liability spread. This is the difficult part of using the market-value analysis. You have to develop a different liability spread for each risk management unit. In contrast, under option-adjusted value of distributable earnings, you can use the company cost of capital as a spread. You have to develop and see your own unique liability spread. That's somewhat challenging. The next issue is if you have interest-sensitive products, there are the normal challenges about deriving the option value to a piece. That's also challenging for us. The last issue is the challenge of using the market value analysis, and there is no real easy way to get to the cost of the capital if you use this particular approach.

After you're done with the exercise of the value of liabilities, the next task is to work on the risk drivers. Once you have identified the risk drivers, the next step is to evaluate the three things you need to get. One is sensitivity. The second is correlation, and the third risk driver is the volatility. The sensitivity is the easiest one, in my mind, because basically this is very much parallel to what we do, for example, for cash-flow testing. It's like a sensitivity run. You shock the risk driver. For example, mortality, and then you calculate the liability value before and after the change. That's your sensitivity. As long as you have a pretty good model, this is a fairly mechanical process.

The next one is correlation. This is supposed to help us to understand whether a particular risk driver correlates with another one within the risk management unit. For example, if you have annuity business as a risk management unit, you may want to look at whether there's any relationship between mortality and surrender. Also, if you have a life insurance risk management unit versus an annuity risk management unit, you may want to look at the mortality correlation across the two units.

The next one, volatility, is where we have spent the most time doing the research because we don't have the J.P. Morgan databank to give us this type of information. We have had to create it on our own. This is where I think the actuarial profession can add quite a bit of value. First of all, I think we all should support the Society's efforts to update the mortality studies or lapse studies because without that, we really can't get very far with volatility.

This volatility is supposed to measure the expected variability of a particular risk driver, for example mortality, in the future. My firm started looking at the past as a starting point. We looked at the historic volatility. Then, we apply log linear regressions to estimate various components of volatility. After looking at the historic volatility, we then have to apply judgment. This is very important because sometimes what you expect in the future may have changed from historic volatility. In particular, if you have changed the product design or your risk profile has shifted.

For example, for mortality volatility, you have to decide to look back 30 years to see how volatile the mortality experience has been. While the look-back period is important, what's really relevant is how it relates to your current risk profile. You may want to give more weight to the recent observations than the older observations. There are also judgments that must be made once you get past the statistics. You need to really try to figure out if it makes sense for your own business.

After you have done all four steps, then you simply do the calculation of VAR. First we calculate what we call an undiversified VAR. That's the fair value of liabilities times volatility times sensitivity and times your confidence level. We then sum it up to a diversified VAR so we can get to the enterprise or even the risk management unit level or the units themselves. This is where we apply the correlation matrix.

Perhaps an example can help clarify some of the concepts here. Let's assume that we have the asset portfolio supporting the GICs and terminal funding annuity contracts. Although I'm only talking about the product risk today, I will try to illustrate the interest rate risk to show that you can have different risk management units for different types of risk. For example, when you look at the product risk, you may have two units—one for GICs and one for terminal funding annuities because they represent very different risk profiles. When it comes to C–3 calculations, you may want to then lump them together if they are being managed in the same segment. In this case, you will have only one unit at the asset segment level for C–3 risk, while you have two for the C–2 risks.

When you look at the risk drivers for GICs, we look at expenses as the sole risk driver. We realize that there are cash-flow variabilities due to the contribution or

withdrawals of these GIC contracts. We thought that with all the underwriting restrictions, we are really not holding much risk these days. In this example, we chose to ignore the contribution and the withdrawal risks. For the annuity business, we look at mortality as one of the risk drivers. We also look at early retirement when there are subsidies involved with early retirement. We also look at expenses as another risk driver for the C–2 risk. For C–3 analysis, we actually look at seven points on the year curve; 3 months, 1 year, 3 years, 5 years, 10 years, 20 years, and 30 years. Then we try to estimate the correlation along the seven key rates to come up with the interest rate risk. We still get just one number, but that one number is derived based on sensitivity to these seven points on the curve. The next step, after we define the risk management units and risk drivers, is to calculate the value of liabilities.

As I said earlier, we look at the discounted cash flows plus a spread to derive value of liabilities. We use the current pricing spread, not the original pricing spread, because we try to value these liabilities to today. That's the correct way to do it; however, you have to make sure that yesterday's liabilities have not changed from today's liabilities. In other words, the risk profile should not have changed much from today's new products in order to use today's pricing spread. We use our cash-flow testing model for the calculation, and in these two particular risk management units, we don't really have much interest sensitivity. Therefore, there is no need to do a lot of option value calculations for these two blocks.

After we have the value of liabilities, we try to calculate the sensitivity, volatility, and correlation. To calculate the sensitivity, you shock the risk drivers by a certain percentage in order to get the value before and after the change. Regarding volatility, I'd like to give an example on mortality risk for the terminal funding annuities to illustrate. To derive the mortality volatility we look at three things. We look at whether the long-term best estimate has changed and that's the first one that we call the underlying change in mortality. That's where we really refer to the risk of variability around the best estimate, long-run mortality. For annuity business we need to see if there's any long-term drift in the underlying best estimate. In other words, we want to see if there's any change in the improvement scale. In the last component, we attempt to measure the residual variability due to the noise of risk drivers. This is the year to year random noise. We try to differentiate that from the long-term underlying change.

There's no correlation assumed. Expenses, mortality, and early retirement are the three risk drivers. We assume a one-year time horizon. We also try to look at historical volatility on a yearly basis. If the historical volatility is not evaluated at the same frequency as the time horizon, you need to apply the square root or something to get them on the same basis.

The last piece we need to decide is the confidence level, and since we look at value of risk to come up with normal volatility, we use the 95% confidence level. The *Z* score for the one-tail distribution will give you a factor of 1.65.

Now that we have all of this information, we can put it together in Table 3 where we show a GIC line and the terminal funding line. All the risk drivers can be found in the left column. The second column shows you the liability value. We have $5 billion of GICs and $3 billion of terminal funding. Out of the $3 billion terminal funding, only $1 billion has the early retirement subsidy. The volatility was derived based on what we just talked about, i.e., the variability around the best estimate. The sensitivity is derived based on shocking the model with different percentage changes indicated in (4). VAR is calculated by multiplying the first, the second, the third, and the fourth column.

TABLE 3
VAR RESULTS

	Liability Value (Million) (1)	**Volatility (2)**	**Sensitivity (3)**	**Change for Sensitivity Calc (4)**	**VAR at 95% (Million) (5)=(1)* (2)*(3)*(4)**
GIC					
Expense	$5,000	15.0%	0.01%	10.0%	$1
Terminal Funding					
Expense	3,000	15.0	0.01	10.0	1
Mortality					
Underlying	3,000	1.5	0.20	1.0	15
Improvement Factor	3,000	0.1	0.20	0.1	10
Random	3,000	5.0	0.01	1.0	2
Early Retirement	1,000	1.1 years	1.50	1 year	27

If we look at the last column where the results are, you can see that we charge very little for the expenses because our focus is on variations related to administrative expenses. We did not account for anything that's more business risk-related type of expenses, like the litigation my company's going through or expenses for demutualization. Those types of expenses are not covered here. These are more the normal administrative expenses and the variations around the plan. For expenses, we look at planned versus actual. For mortality, if you sum up the three pieces, there's underlying mortality, the improvement factor, and the random variations. You can see that there's about $27 million of VAR. We're 95% confident that the loss from our plan or our expected value is no more than $27 million.

Although you can see that the liability value is pretty small, it's only $1 billion, but the charge is pretty hefty because when we look at the past volatility and how we price these terminal funding annuities, we find out that the volatility is about 1.1 years for the early retirement benefits. In other words people may retire 1.1 years earlier than what we priced. The charge for that volatility is about $27 million.

The early retirement piece shows you why the market-value framework works pretty well for the VAR concept because it automatically incorporates the sensitivity number. It automatically incorporates the market value change because the subsidy in the early retirement really depends on the interest rate environment you're in. So, the sensitivity automatically incorporates the interest rate environment you're in by running the discounted cash flow based on the current Treasury curve.

In addition to the normal risks, we also look at what we call the tail-end risks. There are several ways you can approach this. You can apply a higher confidence level. For example, for the normal VAR, if you usually assume 95%, you might want to move to 97% or 99%, but that assumes that the risks are normally distributed which may or may not be the case. Many people will argue that's not the case at all. You can try to replicate some historical event or horrible experiences and see how much risk, measured by VAR, there might be if the events are repeated. Of course, you can dream up some of the worst case scenarios to see how VAR will move.

These stress test results may be used, for example, to allocate capital, while using the normal VAR number to figure out your risk-adjusted performance. There can be different uses depending on how management decides to look at these numbers.

We feel that we have learned a lot in the process, and we think there's a lot of work remaining to be done here. I think the VAR concept in and of itself is really not difficult. However, applying that to insurance liabilities is still really challenging. Part of the difficulty is because we don't have the data yet—a J.P. Morgan credit risk type of databank doesn't exist. We need that for a lot of other work we're doing as well, for example, GAAP numbers, for our cash-flow testing, and for our pricing. We really should have much better data than we do now. We have some of the tools available in the models like, for example, our cash-flow testing model or some other projection model. My company doesn't feel that we have been using these tools to communicate effectively to management. We use that as a pass and fail tool for the regulators, but we do not really use it for management purposes.

I think that the other stumbling block for us is the fair value theory. Our industry and our profession have not come to a consensus, and I think it is extremely

important for us to come to a landing on that. I don't think many of the challenges are unique to VAR, but they are the challenges to our profession.

Finally, we really need to sell the framework to management and show management how it can be used to manage our business. Tom is going to show us how to do that.

Mr. Thomas S. Y. Ho: The purpose of my talk is to discuss how we analyze our balance sheet and roll it up all the way to the shareholders' value or the stakeholders' value. I think that's an important link for our work. There's so much we have worked on, such as ALM, value of liabilities, how to do risk-based capital, and so on. In the end, we still need to maximize the firm's value. Much of the research that has been done showed that the best thing for the employees and stakeholders is to maximize shareholders' value as well. It's important to go beyond our immediate task and to think of a consistent framework that helps bring all the parts together to meet the common goal of the firm.

Shirley has talked about the importance of VAR. I want to emphasize that beyond the life insurance business in the U.S., VAR is a very important tool globally in all the financial services. Many major banks have already implemented VAR for their trading portfolios and beyond just the trading floor. They go to the assets and liabilities on the balance sheet and look at how the VAR numbers can be used. Regulators have used the VAR numbers to decide on the capital allocation and the capital adequacy, as Cindy pointed out. Throughout the world, we have talked about how to use VAR as a risk measure so that we can compare one firm to another firm and compare industries, such as property and casualty business to life business to banks and so on. In this period of integration, we shouldn't think how VAR should be used for us. We should think how, in a broader context, we in the life insurance business will be integrated with all the financial services worldwide. For this reason, it is a very important aspect to think through and learn from all the other industries what they have done in this business. Part of it is what I'm going to talk about.

Why do we need to go all the way to shareholders' value from what we're doing now? I think the trend is really in terms of performance. In the end, after satisfying all the rating agencies' and regulators' constraints, we still need to perform. What is the benchmark performance? Some often think in terms of the shareholders' value you have created. There's so much market consolidation now that we can no longer do in a business vacuum; we need to look at life business across companies and across other common industries. VAR enables us to look at a firm-wide level, and how to manage at an enterprise level.

VAR can be used as an internal management reporting system. We can talk about how each business unit can work together, how to attribute risk through the whole firm, and which product line would put our firm at risk. I mentioned the globalization aspect. Now we do business globally, and global firms do business in the U.S. market. We need some kind of standardization across the world, and VAR seems to be a very good candidate to help achieve standardization.

You could ask, after doing all the VAR, what do we do with it? How could we add value to a firm? One way is optimizing ALM. What do we do with it? Is it just immunization? Is it all the techniques we talk about? We first have to talk about how these techniques can lead to increasing shareholders' wealth and increasing the goal. Asset allocation is another way to add value. How do we do asset allocation, linking from that technical decision to the global aspect? Adding value to the firm, adjusting for the risk. Then we link up to the liability side. What kind of product will you sell? How will we decide on products. The final way we can add value is to measure performance on a risk-adjusted basis.

When we started a VAR operation, some of the questions we hear about are as follows. How do we talk to senior management? That's a point that Shirley talked about. When should we get senior management to use VAR? Because we're so focused on measuring risk we do not tell the senior managers how to use that number to add value to the firm. That's why it's very hard to get their attention. What are the benefits of market value versus book value? There is a lot of discussion moving towards the fair value of liabilities. I think part of the reason is that VAR is based on a fair value approach. Few people talk about the book value approach when it comes to VAR.

Next is the financial modeling. There are many issues of how to do financial modeling of liabilities. One very crucial point is missing here. There's a lot of discussion about the discount rate for the liabilities, but if we use a very low discount rate, like a risk-free rate, for liabilities, it jacks up the liability value and lowers the equity value. What it really does is take the future profit release from the product away. So, that's a trade-off between future income and market value of liability. If I focus on looking at fair value of liability, then we're missing the point. There's a trade-off between future income you want to release versus the to-date price. So, future income, shareholders' value, and today's income are highly interrelated, and we need to address all of them at the same time.

There's another issue we talk about which is an investment horizon. That has to do with how you take action and what kind of action you take with the information to relate to what kind of time horizon we want to use for calculating VAR. Corporate issues might be, how do you assign risk? How do you assign probability on a risk-

adjusted basis? When we go into this project you see a lot of these specific questions, but we need to have a consistent framework so that it takes the corporate issues into account, and then we can deal with these questions specifically. For example, we just had a session on the fair value of liabilities. My concern is that we focus on what is the right way of valuing the liability without breaking the whole firm value within the context? Then there will be inconsistency down the road.

This brings me to the purpose of my presentation which is to provide a solution. We need a corporate model before we can deal with all these problems in specifics. What does a corporate model mean? The corporate model relates a whole balance sheet's economic value to shareholders' wealth. People often talk about assets minus liabilities equaling equity. It's only a surplus number. Equity takes all the future income of the firm into account, and that is important. That is the ultimate goal. If you keep maximizing the asset minus liability value, then we are missing the point somewhere. How we define liabilities affects that number, but it should not affect the shareholders' wealth. We need consistency. Then we need to relate a VAR number to the shareholders' VAR. You will be looking at a balance sheet risk at the end, assuming that you liquidate a firm, sell off the assets, pay off the liabilities, and look at that risk. That shouldn't be the risk you're looking at. You should relate that risk to the risk the shareholders are facing.

Finally, there clearly has to be a trade-off between capital and the return. We need to emphasize that because a lot of firms we talk to hold a lot of cash, and that's a tremendous drag to the shareholders' value. They say that they need the cash around for the firm to be very safe and solvent. You are not maximizing shareholders' wealth. The crux of the problem is that we don't have a consistent framework assigning this capital appropriately for each business unit to grow. So in financial businesses, the real investment is of capital, and that's why the allocation of capital within the firm is crucial. At the moment, we are very far off in setting up one consistent framework to deal with these issues. I think we should welcome this opportunity, look at risk carefully, and have a rational way of assigning capital to business units. I think that's the most important part of building shareholders' wealth.

The idea is not so much focusing on the specifics or one part of the problem, but looking at the whole. Both Cindy and Shirley talked about how we use the parametric approach. Let me give a very quick overview of some of the parameters we're talking about. Once we have the financial modeling of the balance sheet (assets and liabilities), then we can actually calculate all the deltas. Deltas are the sensitivity to small changes of the whole fair value to each of the risk sources or what Shirley called the risk drivers. You can look at interest rate risk, simulating over a time horizon, your volatility risk, and so on. The idea is to shock each risk

to find the marginal change in value. Then, through the co-variance matrixes, you can get the VAR number.

Let's go straight to the balance sheet issue. We often talk about surplus as being the assets minus the liabilities. But once again, remember that we are talking about the market value of assets. We often hear insurance companies say that for banks it's easy because they are all market and trading based. That's not true anymore. VAR applies to a lot of banks internationally on their balance sheet. Banks own real estate, direct investments, and equities that do not trade. These items are not traded, but standardization can be set up so that people can agree on the value of these assets.

We have talked about how to do the fair value of liabilities. The surplus number is on a fair value basis. Then VAR of the surplus can be calculated using the deltas and the correlation matrix. The VAR is really on the surplus dollar level.

Next, I want to talk about how the VAR relates to the shareholders' value. When we calculate the VAR number, the question I often hear is where does the tax come in? If you look at assets minus liabilities and a variance, it says nothing about how we pay taxes. What about the growth? We are selling more and more annuities. The growth rate has changed. Yesterday I heard someone ask, "We do the VAR over a one-month horizon. What if something happens two years from now? How do you take the future into account today?" This is all a growth issue. How do you build the growth of the business into the shareholders' value?

Finally, there are two other items related to the cost of required surplus. That means the cost of capital. How does it relate to the shareholder's discount rate of the value? For mutual firms, it will be the policyholders. What is the cost of capital to policyholders? Finally, we must have some kind of performance number to indicate how well we are performing on the risk-adjusted basis. This is what a corporate model is about.

For the model assumptions, I really want to know what, in specifics, is meant by a corporate model? This is what we want to build up to. Asset value is talked about in each line item. What is the market value of assets? What we talked about has to be future cash flow projected. There can not be anything amortized and no costs can be carried forward. We look at future cash flow going forward, and under the arbitrage-free calculation we look to see if the value has been consistent with all the other liabilities. I would also advocate that for VAR calculations, or for all the purposes we're going to talk about the liability value has to be consistent with other corporate liabilities the firm might have. For example, we issue bonds, and the bonds have a certain value. This procedure of valuing liabilities has to be consistent

with it because of the way we look at our balance sheet; we don't make distinctions between what is the liability for insurance products versus other corporate issues. There's a procedure that shows how to set all this up so they will be consistent in the true sense of this market valuation approach.

Surplus will be the difference between assets and liabilities. Then we'll try to build a model. I'm linking *S*, the surplus number, to the stock value. Therefore, we go beyond the balance sheet and look at future income. It is useful to set up a market pricing curve. It gives some kind of reference curve for assets and liabilities. We make an "extra return." The *r* in the formula below can be our market pricing rate.

$$r_a = r + t_a$$
$$r_l = r - t_l$$

You can have the Treasury rate or the Treasury rate plus the credit rating of the firm plus additional return that investment managers can make. On the liability side, subtract off the profit release of the product.

We are in the spread business, so we need to talk about what any profits are released to? The in-force business is releasing the profit margin. Our profit come from assets and from the liability spread, and the shareholders' value will be all the future income on an after-tax basis plus the surplus number, or the investment income they make. It is a two-income stream coming back in.

Let's assume the income comes from the spread we're making on assets plus liabilities. Let's assume that we have this balance sheet. We have this spread that we're making in our firm, and for the purpose of demonstrating the whole concept, we assume some constant growth of the whole balance sheet. Let's suppose that the balance sheet is going to grow at 7% every year. What will happen? Assume a constant growth rate. There's a cost-of-capital issue. We need to look at our share value, or the cost of capital on shareholders' sides. So we need to bring that number into our calculation. That's the cost-of-capital issue.

If you take all these together, you get this valuation model:

$$E = (Sr_a (1 - t) + L(sp) (1 - t) - gS)/ (c - g)$$

L is the liability value. That is the value of our block of business. We're making a spread on that. That's multiplied by the spread on an after-tax basis. The interesting part is now you have to minus the growth rate of surplus. We are a financial business. We need to hold surplus to support the risks we're taking. But as we grow, the surplus becomes a drag to us because now, instead of paying off the shareholders and giving them their cost of capital, which is higher, we have to put it on as an investment. That becomes a drag. Therefore, you need to minus off that surplus.

This is a very important point. We often have regulations that say we need to hold more and more surplus to make sure that we will continue to have solvency. However, this point shows that it affects our firm's value, and if we have to compete internationally, regulations can have an impact on the success and viability of the industry.

If we assume this whole balance sheet grows constantly, then the present value will be the cost of capital. The whole numerator will be divided by the cost of capital minus the growth rate. The cost of capital will be determined by the stock market. The cost of surplus, therefore, depends on the growth rate and the cost of not releasing the surplus. So, there is the issue that if we keep holding this surplus and not releasing it, we are, in fact, not maximizing shareholders' wealth.

This leads to the multibusinesses assumption. Suppose we have several businesses going. How do we do that? Both Cindy and Shirley talked about this. Once we have a VAR number, you actually calculate what we call the dollar beta. You can attribute the risk to each business unit. If you calculate the VAR of each business unit, the sum of all the VAR numbers would not be equal to the firms VAR simply because of diversification and natural hedging within the company. However, if we look at a risk contribution from each business unit, then the sum of the risk contributions would be equal to VAR.

Given *g, $beta, VAR*, we define the required surplus as:
$S_i = S \ \$beta_i / VAR$
where $\sum \$beta = VAR$

Now we can assign how much surplus each business unit will have. That's a capital allocation. It is pro rata to the risk contribution you are giving to the firm. Suppose your business unit is adding 30% of the risk to the whole firm risk; then you get 30% of what the firm's required surplus is as the capital requirement. Suppose your business units provide a good hedge at no risk to the firm. Then you have a very low capital assignment making you very high on a capital return basis.

Now we have a way of assigning capital to the firm. We can take the risk of a down rating and manage it, and look at the liquidity default and risks through the capital that we assign to them. That will automatically encourage each business unit to control its risk, which adds value to the firm.

Ultimately we get a corporate model by taking all the business into consideration and taking the cost of capital for each business unit into consideration. I think that's very important. Many insurance companies still use one cost of capital number for the whole firm and apply that to all business units, but some business units have

more risk than the others. That has to be adjusted by that number. We then calculate the value of each business unit, and determine the kind of capital we assign to each business unit. So these are interrelated relationships. That's why they call it a corporate model. The corporate model took all the interrelationships into account, and we can solve for all these numbers at once.

The implication now is that we can bring the cost of capital and link up from the stock market level, all the way down to the business unit level to get some performance relationship. We have now come up with a risk premium concept. Cindy and Shirley talked about the risk-based-capital calculation. This calculation is missing something. It doesn't take the shareholder risk premium into account. We need to have some way of assigning capital to each business unit because of solvency. However, there's a risk premium from the capital market purpose, and that premium has to be taken into account to determine the performance of each business unit.

In performance measurements, you have the required surplus number, and you have to multiply it by the cost of capital of that business unit, divide by the risk-free rate, and that is what we call the risk capital. Once we know the income of each business unit, divide that by risk capital. Now we have a consistent way of comparing all the business units in one consistent framework to see which one is really bringing high return on a risk-adjusted basis. I mean risk in terms of both solvency risk as well as market pricing risk. We are taking this all into account to determine what is the right performance measure. It's return on risk-adjusted capital. Instead of adjusting your income side, you are adjusting your capital, and capital is not just how much money is assigned to you as capital allocation. I also adjust it for the systematic risk that you're contributing to the enterprise level.

Now we can see the whole picture together. It's all interrelated. Much of our discussion on VAR has pertained to the assets, liabilities, and surplus. But what I tried to get across in my presentation is that we have to see the whole framework; we're only talking about one part of this big framework. We'll need to link up to income statements on a market-value basis and then bring it all the way out to profit released. We must then determine who is adding more value to the firm. What will be the growth of business into the future? This leads to the firm value. We feed back into it through the cost of capital. Some of us have publically traded stocks, so we need to confirm the firm value with a stock value. From the stock market we infer how our shareholders discount our risk. How do we take the market risk into account? The cost of capital leads to risk capital. We adjust back so we have a $10 million surplus, but how much risk is at stake? You calibrate from the stock market to come up with the risk capital, and from risk capital to go back to return on risk-adjusted capital (RORAC) and then go through the whole process.

We now have a consistent framework of relating our balance sheet risk and value to the shareholders' risk and value. We also have a performance measure relating each business unit to this whole context.

I'll go through a numeric example. Table 4 brings this together. The first block shows the financial analysis. We talk about all the asset values and all the liability values. Along the rows are your life products broken down into each business unit. The second block has a property and casualty business broken down with a product list, and then you roll them up. The third line shows a corporate headquarters, all its overhead, and the corporate issues. That will be a line by itself. We can look at assets, liabilities and surplus, the income we're making and what kind of growth there has been on each product line. Then we look at the risk side and calculate the VAR of each business unit. We calculate the total VAR of the whole firm. We can attribute back that total risk to each of the product lines through this VAR beta. It gives a very good picture of which business line is adding risk or hedging risk or giving a natural hedge across the liabilities. They add up to the total firm value.

TABLE 4
CORPORATE MODEL (PART ONE)

	FINANCIAL ANALYSIS					VAR RISK ANALYSIS				
	Asset	Liability	Surplus	Income	Growth	Mkt. VAR	Ins. VAR	Total VAR	Mkt. $Beta	Total $Beta
Annuities	1,587	957	630	13	0.059	65	7	65	(14)	(14)
Term Insurance	2,058	754	1,304	214	0.078	500	5	500	233	233
Life Total	3,645	1,711	1,934	227	0.078	396	9	396	219	220
Workers' Comp	985	658	327	32	0.068	123	38	129	97	100
Auto	1,421	1,091	330	25	0.081	112	64	129	25	30
P&C Total	2,406	1,749	657	57	0.078	188	74	202	122	129
Insurance Total	6,051	3,460	2,591	284	0.078	341	75	349	341	349
Firm-wide	6,051	3,460	2,591	284	0.078					

So now we can allocate the cost (see Table 5).

TABLE 5
CORPORATE MODEL (PART TWO)

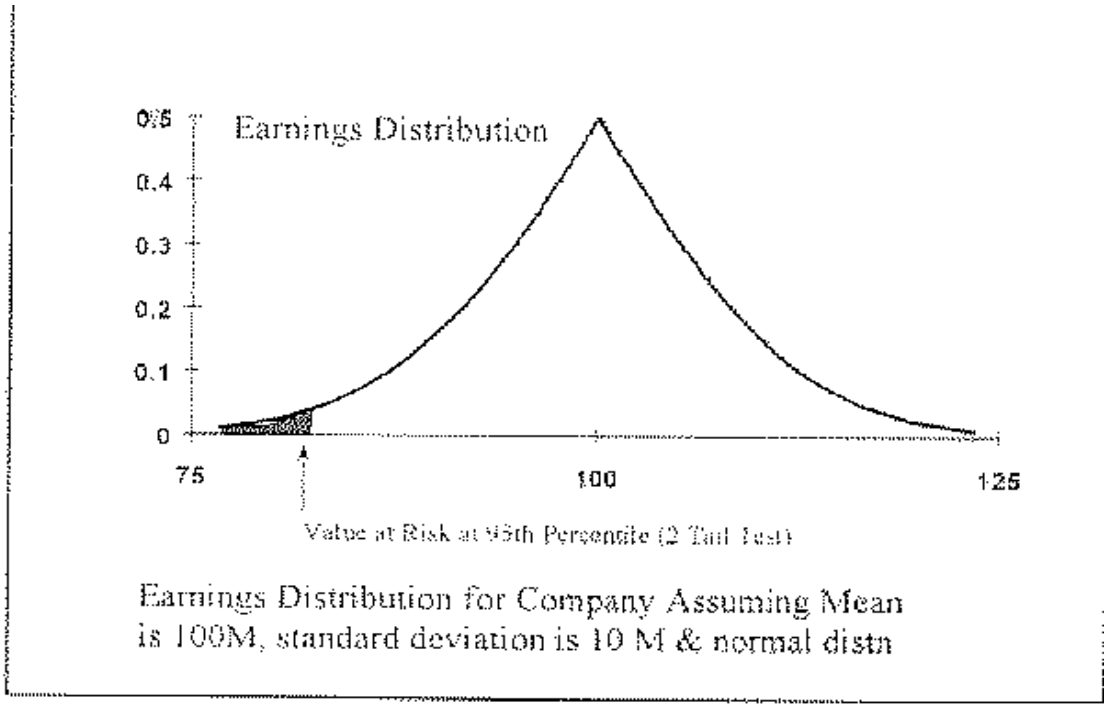
	RISK ALLOCATION				CORPORATE MODEL			
	Allocated $Beta	Allocated Surplus	Risk Capital	Beta	Cost of Capital	Equity	RORAC	ROS
Annuities	(0.039)	(100)	(184)	0.940	1.018	265	(0.071)	0.021
Term Insurance	0.669	1,732	2,848	0.900	0.097	11,263	0.075	0.164
Life Total	0.630	1,632	2,690	0.901	0.097	11,528	0.084	0.117
Workers' Comp	0.286	740	1,443	0.850	0.115	681	0.022	0.098
Auto	0.085	219	349	0.940	0.094	1,923	0.072	0.076
P&C Total	0.370	959	1,618	0.916	0.099	2,604	0.035	0.087
Insurance Total	1.000	2,591	4,289	0.904	0.098	14,132	0.066	0.110
Firm-wide		2,591	4,289	0.904	0.098	14,132	0.066	0.110

Now I know exactly how each of the units is adding cost to the whole firm. We know the firm is holding so much cash or has a certain surplus number. Now we can assign this capital to each of the business units, and we adjust this capital by the risk, according to the systematic risk from the stock market level, shareholder's level, or how each business unit should have risk capital. Finally we calculate the income of each part of the firm, and then divide income by the risk capital, which is the RORAC number. You can actually see the RORAC number which is a very good picture to quickly show you which business lines are adding value. This will

help to know where to encourage or not encourage growth. Oftentimes, people are simply dividing the return by the surplus number, and that would miss the point. My last column shows that the number is really way off when just simply divided by the capital and not adjusted for the risk numbers.

It's very important for us to focus on the balance sheet and risk, but I think it's important to look at, in a broad context, how the whole firm works together and how each part is put together. When we deal with all the regulator issues that come with standardization of the life business, we need to integrate that in a consistent framework globally to all other financial services. In this broad context, we can manage the enterprise as a whole. As Shirley says, there's a challenge for us as actuaries, and we should welcome it.

CHART 1
WHAT IS VAR?



Earnings Distribution for Company Assuming Mean is 100M, standard deviation is 10 M & normal distn