1998 VALUATION ACTUARY SYMPOSIUM PROCEEDINGS

SESSION 12TS

RISK MANAGEMENT FUNCTION

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RISK MANAGEMENT FUNCTION

MR. ALASTAIR G. LONGLEY-COOK: Our speakers, along with myself are Tom Ho, president of Barra, and a noted scholar in the area of value-at-risk in investment management risk tools, and Shirley Shao, vice president and associate actuary of The Prudential. Shirley has worked a great deal on Prudential's risk management program and has also been a speaker on this issue at various Society meetings.

I'd like to start off describing the risk management process we have developed at Aetna, and then Shirley is going to talk about the process at Prudential. Tom is going to get into value-at-risk and its processes. I'll conclude with a short discussion of procedures that don't work very well.

The process is the most difficult part. The mathematics are fairly straightforward, but it's the process that is hard. The process we follow is to begin by creating a risk profile for each of our business areas and that begins with risk identification. This is fairly straightforward, and I think you've probably seen this before, in terms of identifying various risks.

I tend to categorize them into two major categories: (1) financial risks, which are those you can model statistically in order to measure the contingent cash-flows; and (2) operational risks, where there are no stochastic models. In fact, there may be no models at all. Financial risks include interest rates, defaults, equities, mortality and morbidity. Operational risks are things such as your ability to stay current in the marketplace, legal risk, or certain strategic decisions. Operational risks, in fact, are what a lot of companies have the most trouble with.

When this process goes forward, it's like the story about the guy who loses his keys. He is looking for them under the streetlight, but he really dropped them down the block. The policeman asks, "Well, why are you looking here?," and he replies, "Because the light's here." That is what actuaries tend to do. They model this because they know how to model this. They don't know how to model legal risks, so they won't model and focus on it. The next thing you know, you have a major class-

action lawsuit on your hands. You haven't been looking to avoid that. Having said that, there are ways to deal with at least the identification of these risks, and there are many ways you can get rid of them.

The second step or the second column in the profile is the quantification aspect. As actuaries, this is near and dear to our hearts. Both Shirley and Tom will be discussing this, so I won't spend much time on it. Value-at-risk is becoming increasingly common in terms of a good way to do this, but it's only one of several possible quantifications. It has shown itself to be valuable in this regard. What I tell the business areas that are struggling to do this, is that if you can't quantify your risk, then you can't manage it. Therefore, you should either get rid of it, or struggle to quantify it in some way. This gives you some tools to do that.

The third column in the profile should be a list of the controls and the monitoring process.

I use a categorization of risk that comes out of the survey done by Wharton School. It's a very good overall view of risk management practices in the insurance industry as of 1996, when it was published. It's a little out of date, but still very useful.

They make a very good point. Basically risks should either be eliminated, transferred, or actively managed. You don't want to eliminate all risks. It is tempting for the business areas to look on the risk management process as a policeman effort. One way to counter this is to point out that you are not trying to get rid of all risks. You are trying to analyze them so that the business areas can manage them. Some of them, in fact, could increase. They may not be taking enough risk in some areas.

It is really a risk and return process or equation that you want to look at. You're not trying to eliminate all risks, particularly if you're an insurance company. That is how you make your margins. Some just need to be actively managed, but some are unacceptable or unquantifiable. Those are the ones you want to either eliminate or transfer. There are also various ways of managing the process: standards and reports, underwriting authority, and investment guidelines.

The last item is the most important of all. Unless there is some incentive and compensation tied into risk management, then the process will be one that just gets taken care of and stuck in a file drawer. What you really need to do to get management, either at the business level or at the senior level in the corporation, to focus on this is to tie it to their wallet. Value-at-risk is one way to do that.

The last column in the profile should be the action steps. This could be part of the plan process. What does the business area plan to do this year to either eliminate a risk or balance it better? Then at the end of the year, they need to evaluate how well they did.

That is the risk profile we use at Aetna. We require it once a year from every business area and then roll it up to an overall corporate view. There, we require quarterly updates regarding what has changed. A year is a long time. Look at what has happened to the foreign exchange risk this year. Clearly, you don't want to wait a year. Quarterly updates at least keep you abreast of the developments.

Equally important are the roles and expectations in this process. The role of the corporate risk management unit is to show the leadership needed to establish this process, determine levels of risk tolerance, and ensure that the decision maker, be it the CEO, the CFO, or the head of the business area, understands the risk exposure. That is the hardest part. These decision makers tend to have their own feelings, based on their background, of how big a risk they're running. That may be fatally flawed, as history has shown. Therefore, this process needs to give a better, more disciplined picture of what the risk exposure is; that means either correcting misconceptions or, in some ways, validating those preconceptions.

Second, their role is to provide an independent, objective view. This is absolutely key. Business areas, even whole companies, tend to be incestuous in terms of their understanding of risk. For example, a business area might say, We've never lost any money on mortgage loans, so we're not going to lose any money now. That kind of thinking feeds on itself, and what you need is somebody from the outside to come along and say that maybe the first part of your sentence is correct, but let's examine the second part. Maybe the risk manager can provide that outside view, but maybe he or

she isn't competent to do that. The risk manager needs to bring in a consultant or somebody who is an expert in that field to provide that independent, objective view.

Third, their role is to ensure that the risk identification and measurement are consistent across businesses. This is very hard to do. If a company has very disparate lines, I would say it is almost impossible to create a consistent view of risk. Think about individual life and annuities versus managed care. What models work for one but not the other? You quickly see some of the complexities involved.

Finally, their role is to aggregate the risks across businesses to the extent that you can achieve consistency, and then look at the overall corporate picture. You may find that some businesses have a natural hedge against others. There are some risks that look pretty bad at the line level but don't look so bad from the corporate level. Maybe they shouldn't be stamped out quite that quickly.

The role of business management, on the other hand, is to own its own risks. As risk manager or risk analyst, you can come in and talk to the business areas about the risk process. The first thing you have to say is, "I don't understand your business or your risks the way you do. That's your business. What I'm here to do is help with the process." Therefore it's risk management's job to identify, measure and manage, and monitor the risks. Second, the risk manager needs to make risk management an integral part of the planning process.

MS. SHIRLEY HWEI-CHUNG SHAO: I work for Prudential Insurance Company of America in the corporate risk management department. This department was formed about four to five years ago, and it has risk managers as well as corporate actuarial functions. It was formed as a result of Hurricane Andrew, among other resources. Our company, like some of the other property/casualty companies, suffered quite a bit from that hurricane. We also have our fair share of the C-4 risks. It seems like we had a new surprise every year for a period of time.

Management thought there might be risks that we were not aware of. We have models to look at these risks, but not one model ever predicted a loss of this magnitude. Therefore, there was a lot of interest in looking at risks more closely in order to reduce volatilities.

We have always had an area in corporate that looked at risks. In fact, we still have the risk framework we established more than ten years ago. It's a risk-based capital (RBC) kind of framework. We have factor-based formulas, and we develop the factors based on a combination of statistics and negotiation skills. We tend not to update those factors for a very long period of time. Some of the factors weren't updated for over ten years. We do, however, update the balances. We look at them frequently.

We use that framework to do capital management. We didn't really use that framework to do the risk monitoring. It was largely used for capital management purposes.

Why did we choose value-at-risk? Since our CEO and CFO are bankers, and the banking industry is very big on using value risk, we feel this is a framework that allows us to look at our risks more dynamically. We can update our risks more frequently than quarterly. We get updated more quickly than with static formulas.

I think the other reason value-at-risk was attractive to us is because it is very economically-based. In today's world, it seems like the accounting bases are moving more closely to the economically based valuation, and this is certainly a move in that direction. Although Alastair said that it is almost impossible to come out with a consistent framework across a variety of business, that was our goal. We wanted to come out with the framework so that we could look at different areas of businesses. We also wanted to be able to sum it up, so that, at the corporate level, we could make business decisions based on the numbers we saw.

However, when we started working on this about three years ago, we didn't quite know what the objective was. We would ask how should we use these numbers? We knew that capital allocation was a very sensitive issue, so we would say, let's just concentrate on looking at these numbers from

a risk monitoring perspective so we can better understand our risks, and then we'll decide what to do with them. That is how we started up the framework.

There are several different approaches to calculating the value-at-risk. Value-at-risk is really just a single summary measure of losses due to normal market movements. It tries to measure the maximum loss with a specified probability (for example, 95% probability) over a period of time. If you're in a trading company, that is probably a daily calculation, but in the insurance industry, we like to look at things more on a yearly basis.

When we looked at the approaches, we picked the parametric approach. Other approaches are the Monte Carlo method and the historical method, but I'm not going to discuss those. We picked and assumed a normal distribution of risks for risks other than the catastrophic risks.

However, we do realize that it is fine to use this framework to measure and to monitor our risks from a day-to-day or other frequent basis; but if we use this framework for capital management, we also like to combine the normal, value-at-risk approach, with a stress analysis to try to get to the risks at the tail end.

To illustrate value-at-risk, I want to pick out the C-2 risk because if you go to seminars outside the SOA there are a lot on risk management or on value-at-risk. However, the focus is most likely to be on the trading side. You can see a lot of C-1 type of risk, either on the credit or derivative risk. There are very few sessions about value-at-risk and its implications on the insurance business. I deliberately use C-2 risk as an example.

The steps for the value-at-risk are actually pretty simple for the actuaries. It's difficult to come up with the assessment for the variables, but the process is simple. First, you decide on what kind of risk management units you want to look at. This is how I look at risk management: it's a homogenous grouping whose components respond in a similar fashion to various risk drivers. These units are typically the lowest level of detail you want to have in analyzing and reporting the risks.

The next thing you need to do is to come out with various risk drivers. These risk drivers are the variables that give rise to uncertainty or risk in economic value. In the insurance business, things like mortality or surrenders are very obvious risk drivers. You then need to look at the value of liabilities. You need to evaluate the risk drivers in terms of the sensitivity of the liabilities in terms of their volatility and correlations. You also need to determine the time horizon you want to look at. As I mentioned before, you can look at a day if you're a trading desk, or maybe a longer period if you're in the insurance industry. There is the confidence level, the probability of losses you do not want exceeded.

I would define *risk management units* as the lowest level of detail to analyze risks. *Risk drivers* would include mortality, surrender, and so on.

One important component of the value-at-risk is the market value of liabilities. Various decisions have to be made regarding discount rates, cash-flow components, liability spread, liability options, overall framework (i.e., market-value analysis versus option adjusted value of distributed earnings).

These decisions are difficult ones to resolve because, as you know, our profession is still struggling with how to market value liabilities. When we try to figure out the value-at-risk, this is one of the toughest things for us to deal with. In our company, we have had a heated debate about this because the risk managers are not just the actuaries, but also the investment folks.

Investment people like the market-value analysis, which looks at assets and liabilities separately. Actuaries are more comfortable with Option-Adjusted Value of Distributable Earnings (OAVDE), which look at asset liabilities as a whole. We had a lot of debates about that. In any event, we finally settled on looking at liabilities on their own, and trying to discount the cash-flows of these liabilities at the then-current Treasury rates, plus a spread. I'm going to talk more about spread later.

When we look at liabilities on their own, there are several things we need to address. One thing is the financial modeling: what kind of models should we have? The biggest risk now is the modeling risk.

The story there is that they are only as good as the assumptions (and the people, I guess). It is very important to have models that you feel comfortable with, that you do feel reflect the risks. Insurance is such a long-term business, that it is very hard to know down the road what is going to happen. What we need to figure out, to the best of our knowledge, is what will happen?

The next thing is the liability spread. Under this market-value analysis, you're forced to assume a spread for each risk management unit. The good thing about the other approach is you can use an overall spread. Under this particular approach, however, we were forced to make a determination of the right liability spread for each risk management unit. We went through a lot of thinking in that respect.

The other thing is, when we have interest-contingent liabilities, it is hard to come up with an option-adjusted value for these liabilities. More importantly, I think we know how to do it, but technically we need to make it efficient so we can report on this liability more frequently than annually. That was really the challenge. We went through several different approaches and tried to streamline that calculation. Also under this approach, unlike the OAVDE approach, we could not factor in the cost of the capital. Therefore, the cost structure of reserves is not really reflected in our model.

The next step is to look at the risk drivers. As I mentioned before, risk drivers are things like mortality for the C-2 risks. The first item you want to look at is the sensitivity. How sensitive is the liability value or the economic value to any kind of changes in your mortality in this example? This is something the insurance companies feel pretty comfortable with. We already do what-if scenarios, (*e.g.*, What if mortality changes 10%? What is the change in present value?) This is not a difficult exercise once you get a good model to work with.

The next item is correlation: how do various risk drivers correlate with each other? You can end up with a huge correlation matrix, but for the C-2 risk, we did not address this issue. At this point, we have not done a lot of work trying to figure out how mortality is correlated with surrenders and variables like that.

The next item is volatility: What is the expected variability of a particular risk driver? For example, what is your expected mortality variation? We also looked at the historical data for our company in the industry data. We looked at the SOA data, and we applied many statistic techniques to come up with standard deviation. We then used the standard deviation to measure the variability.

When you do this historically, it is very important that the actuaries use their judgment. We have a lot of data, but the past doesn't necessarily portend the future. You really have to use a lot of human judgment at the end of the exercise. Also, it is very difficult to begin because you will find that you just don't have the data cut out or stored the way you would like to see it. There is a lot of data compiling and running.

After you are done with that, you calculate what I call the undiversified value-at-risk. It is the product of the value of liabilities times volatility, times sensitivity, times the confidence level factor. I didn't discuss confidence level too much because we arbitrarily chose 95% and the factor is 1.65.

What it means is that the number we come up with would measure the level of losses which we're 95% confident will not be exceeded. That's the formula. After you're done with one risk driver, you want to sum it up for the entire risk management unit. You then need to apply the correlation matrix among the various drivers to come out with the diversified value-at-risk.

I'll go through an example to shed some light on the theoretical discussions. I picked a simple portfolio. The type of portfolio a lot of companies have is an asset portfolio that supports GICs and terminal funding contracts. I think everybody is familiar with GICs. They are a short-term investment instrument. The terminal funding contracts are very long-term annuity contracts on terminated pension plans.

When we look at risk management units, we calculate a future risk. We would really like to look at these two product lines separately even though they have the same underlying assets. The product

risks themselves are very different between these two groups. For GICs, a lot of risks are taken off the insurance company these days. They are being managed by the brokers. When we're looking at risks, we only have one risk for the GIC, which is expenses.

When we're looking at terminal funding, we have very different risk drivers. We also have the expense risk, and we have a group of terminal funding contracts that allows subsidies for early retirement. That is a substantial risk to us. We have early retirement risks (people retire earlier than what we assume in the pricing), and we have another risk driver—mortality. As these are annuity contracts, we also worry about mortality improvements.

When looking at the C-3 risk, these two product lines are combined in one asset segment, and the risk management units become just one unit. We look at a C-3 risk for those products with the underlying assets together. We use a key-rate duration concept. Tom Ho has written a great deal on key-rate durations. There are many key-rate durations on the yield curve, but it is not difficult for us to do the calculations. Also, we have bought Tom's software, which makes it even easier.

We then calculate the value of liabilities. What we do is pick a spread. We come up with the theoretical spread. We like to be able to revalue these businesses even though they are largely in-force businesses and we are not getting a lot of new business in this segment. They're very mature businesses, but we still like to reflect the current pricing to bring them to market valuation or to current valuation. In theory, we like to use current pricing spread for these businesses.

The model we use on the liability side is what we use for cash-flow testing. When we look at the interest-sensitive products, we have had more difficulty in calculating the option value. In this particular case, we don't have too many options.

Next our task is the risk drivers. The sensitivity part, as I said before, is not difficult. For example, we can increase the expenses by 10% and try to derive a percentage difference between the present value of liability cash-flows before and after the increase. That will give us the sensitivity number. For the volatility piece, more work is involved.

We basically try to dissect the mortality risk into three components. The first one is what we call "underlying changes." That piece reflects risk of variability around the best-estimate, long-term mortality. We try to go back to the original pricing mortality and assume that that was our long-term, best-estimate at that point. Unless we have a different perspective, we try to stick with that. Since these are annuity contracts, we look further at the improvement piece and try to capture the long-term drift in the underlying best-estimate assumption.

Finally, we look at a statistical variation portion of the risk. What we attempt to measure is the residual variability or noise from the risk drivers. We want to isolate the year-to-year kind of variations.

The other factors we look at are correlation and the time horizon. We look at a one-year time horizon because we feel that is probably more reasonable for our insurance block of business. We also pick the competence level of 95%. After we have all that information, the table I've prepared shows an example of the calculations (Table 1).

TABLE 1
VaR Results

	Liability Value (Million)	Volatility	Sensitivity	Change for Sensitivity Calculation	VaR at 95% (Million)
GIC					
Expense	$5,000	15%	0.01%	10%	$ 1
Terminal Funding					
Expense	$3,000	15	0.01	10	$ 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	1.5	1 Year	$27

In the first column we have GIC business where there is only one risk driver—expenses. The next column is terminal funding. We show three types of risk drivers: expenses, mortality, and early retirement.

In the second column there are different liability values. Those represent the different values associated with different blocks of businesses. You can see the volatility which we derive largely from the historical variations of those risk drivers, plus some judgment. The sensitivity found in the third column was derived from the cash-flow testing models. To get the sensitivity back to the same unit, we have a unit column next to it that is called the "change for sensitivity calculation."

The last column is really the product of the first three, divided by the fourth column, times the confidence level factor which is 1.65. If you want to sum up the total product risk for this particular segment, all you do is sum up squares of the value-at-risk and then take the square root of that sum. In particular, if you look at some of the numbers, you can see that in this example we are not charging a lot for the expenses.

We don't charge much for expenses because we look at them more as noise. We only charge for one year of variation. The assumption is that expense is something we can manage, unlike some of the mortality and other risks which are more difficult for us to manage. Expense is something we have more control over. If you look at the other risks, the biggest one is the early retirement risk for the terminal funding contract. That gives us a sense of where the risks are concentrated.

We also like to perform some stress analysis, and there are several ways you can do that. You can take a simple approach. Instead of picking up a 95% confidence level, I would like to pick up a 99% confidence level and, where would the number be? Of course, the problem is that you're assuming the risk is normally distributed, which may or may not be the case for that particular risk driver.

What some people have done in their risk models is replicate some historical event. A prior crash, for example, in the trade index, could be used to calculate how much loss that type of event would mean to the portfolio. For instance, what if Hurricane Andrew happened again? How much capital

would we need to come up with to pay the bill? The risk managers have to try to come up with various scenarios.

What I have learned through this exercise is that there is a lot of work when going through the theory. Much of that is because the theories are all there, but they are difficult to apply to businesses. I think we still have a long way to go. Our area has spent a lot of time trying to first understand the theory and then trying to understand how that may apply or not apply to our businesses. To implement whatever comes up is a completely different ballgame. That is really a process issue. It goes beyond the quantification. There are many other factors that have to be in place before you can make that happen.

We already have some tools in place such as the cash-flow testing models. We only use cash-flow testing for regulatory analysis. I'm interested in extending that and showing that it is a useful tool for other purposes. However, we're still missing a lot of the other tools. We have something, but we don't have everything at this point.

The next point is that we really need to ask the actuarial profession to come up with ways to calculate liability valuation efficiently. If we are going to be in the business of providing market value or economic value, or some real value to the business, we need to come up with modeling techniques that are more efficient than what we have today.

Lastly, I can't emphasize enough that all of this is meaningless unless you can hook it up with part of your business process. I think it is very important to first understand how this is going to be used, and then try to link back to that purpose.

FROM THE FLOOR: Is this process being used by business management in their decisions?

MS. SHAO: We started this process in my company about three or four years ago. It is on the back burner right now because we're so busy with demutualization and getting GAAP ready for the public. This is not really being actively used by management at this point. We do have a capital

management initiative right now, and the goal is to use this framework. Right now, however, it's not affecting business.

FROM THE FLOOR: I was contemplating how one could calculate the spread that should be used for computing the market value of the liabilities. One of the methods that could be used is to look at the undiversified value-at-risk divided by the total value of liability. That gives you the value-at-risk per unit liabilities. One could use that to determine the level of the spread needed.

It is probably the best method of obtaining the risk that is still not that diversified. That risk should be used for valuing the liability, too.

MS. SHAO: I can tell you about the way we did it for the GIC business. The GICs are still an open portfolio. We're still selling GICs. We're not selling too much these days, but we are selling. Therefore, we do have a spread we use for pricing currently, and that is the spread we use for this calculation.

We do look at the previously sold contracts and try to determine if their risk profile is similar to the new business we're selling. Our conclusion is that the risk profile is very similar. Therefore, using the current spreads makes sense. For terminal funding, which we're not really selling too much of these days, we don't have a good pricing spread to use. We have gone back to the original spread and have also looked at the relationship between the assets. We also look at the asset side of the balance sheet and try to figure out the spread there. We have to look at a couple of things to try to come up with a spread on the liabilities. Different approaches are used with different risk management units and different blocks of business.

DR. THOMAS S. Y. HO: My presentation is about applying value-at-risk to the management of an insurance company.

I was motivated to research value-at-risk because it is very much driven by the trading floor in capital markets. Value-at-risk is used to evaluate trading risks. If you look at the procedure and the

information we get, we have to wonder how that can be used by insurance companies as a whole. That made me think about how to extend this whole concept to management at an enterprise level. The most important issue I like to point out is that we are maximizing the value. With that thought in mind, what we're missing is the link between the balance sheet and the value-at-risk of the surplus number. At the end, this must relate to shareholders value.

Without bridging this gap, it is really hard to answer some of the questions raised. We say, "Give me a number of value-at-risk of $10 million. What do I do with it? What do I do next with this information. Why is this information important to us?" I would like to turn the problem upside down and say, if we want to maximize our shareholder value, what do we need? This is the purpose of this presentation.

Along with the presentation, I will give a numerical example step by step, showing how to add these numbers all the way to shareholders value.

Why is it that recently there has been such a focus on shareholders value? I think there are a number of reasons. First, there is a lot of focus on performance measures now. Are we really performing? Are we increasing shareholders value in what we're doing? Secondly, there is a lot of market consolidation.

For those that have done value-at-risk for a firm, you often get the following questions. They will say you haven't got all the value-at-risk numbers. How do you explain these numbers? Do we have to go through a covariance and variance analysis at each level to explain this? How does it relate to GAAP? There is always the book value versus market value question. Which number would be more useful? We buy bonds and hold them to maturity. Why should we be looking at market value and looking at the horizon of only one year? What kind of models should we use? Can we use this number for risk capital? How do we assign the risk analysis to each line of business to total up performance?

You find this sequence of questions lead to many technical solutions. These solutions seek to answer global questions. We need a very integrated theory, a framework to tie all these solutions together.

For example, you can have optimal asset/liability management on a global basis. You can be optimizing the asset allocation together with what you should be doing on the liability side, the product design, the growth, and so on. What is the good product mix? That is something that Alastair talked about earlier. Look for the natural hedging within your business and your assets. This is a risk management way to find good hedges and encourage them within your own business.

Looking at the end of the balance sheet, we are pricing our liabilities in such way that we are releasing profit. The valuation of a liability is directly related to how much profit it will be releasing in the future. You can't isolate liability value from the firm value because profit release comes from the liability. We need the in-force business to talk about how the relationship of profit release and the present value of free cash flows to the firm.

This is an important point when talking about the release of profit. Suppose we have a sales force that generates a lot of income. Even if surplus is relatively small, we're facing a lot of risk. However, as a firm, we may still be very safe because our income stream is strong and stable. You can't just look at a balance sheet in this whole revenue concept of a firm value and analyze it. I have prepared a model to show how you do this:

Assumptions of the Model

A.1. Asset value can be determined. The portfolio value is A.

A.2. Liability value is determined by a cash-flow model.

A.3. Surplus is defined as $S = A - L$. For simplicity, we assume an all equity firm with no capital structure problem.

A.4. Market assumptions: flat yield curve of rate r.

$$r_a = r + t_a$$

$$r_l = r + t_l$$

Assumptions of the Model (continued)

A.5. Income assumption. Let l be the annual before tax income, and the value is: $l = Sr_a + Lsp$, where sp is the spread income between asset and liability; i.e., sp: $= t_a + t_l$.

A.6. Growth assumption. The growth of the liability will be g annually through new production.

A.7. Cost of capital assumption. The cost of capital of the business for this risk class is assumed constant, and is c.

- The valuation model. The value of business is E, where:

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

- The cost of required surplus depends on the growth rate.
- The cost of not releasing the excess surplus.

E stands for the firm value. The first term is surplus times the return on the assets on an after-tax basis. The second term is the liability value times the spread between asset and liabilities. There is a spread generating income times a block of business we have. That is L times the after-tax basis. G stands for the growth rate, assuming the firm grows.

There is a required surplus term because there is a capital requirement. That becomes a cost to the firm. The mathematics will have to be "minus the growth of the surplus" because growth is costing the firm. This is then divided by required capital minus the growth rate. There is a constant growth model as shown on the following page.

Assumptions of the Model (continued)

A.8. Multi-businesses assumption.

Given g, $beta_i$, VaR, we define the required surplus as:

$$S_i = S \, \$beta_i / VaR$$
$$\text{where } \sum \$beta = VaR$$

The model is not affected by other allocation of capital. The allocation can be determined by the regulation.

The Corporate Model

The following equations solve for, c, c_i, E, E_i:

$$E = \sum E_i$$

$$Ec = \sum E_i \, c_i$$

$$c_i = S_i \, r_a \, (1 - t)/E_i + L_i \, sp_i \, (1 - t)/E_i - g_i \, S_i/E_i + g_i$$

$$(c_i - r) / \beta_i = (c - r) / \beta$$

Shirley raised the point that we have very good cash-flow testing procedures. How do you use them? Here is one way. If we look carefully at our assumptions of a cash-flow testing procedure, and we make sure our simulation scenarios are arbitrage-free, you could discount all those distributed earnings back around the arbitrage-free scenarios. That is the embedded value. You then build in the growth of the new sales and adjust for the cost of holding the surplus. That becomes firm value.

Once we have that, we have a way of relating our value-at-risk number to this firm valuation. We will be calculating the value-at-risk for the firm, and then we'll assign the risk contribution by business units. We now have a whole firm. What we want to do is pick up the firm and the different business units and repeat the whole procedure.

If we have several business units coming in, each has its own value-at-risk. However, the value-at-risk of the whole firm should be less than the sum of it because of diversification. This is a way of

calculating the net of all the hedging and diversification. What is the net contribution of risk by each business unit to this value-at-risk of the firm? Knowing the contribution of risk, we can now assign the capital back to each department.

After you calculate the value of the firm, you can then calibrate back to stock value, if you have a stock company. You now have a way of tying the balance sheet and adding up all the value. You will actually see a stock value. You can calibrate to make sure that everything is consistent. We have already linked up to a share value, and that is how we affect our shareholder's value.

Having done all this, we can then talk about performance on a risk-adjusted basis. I've prepared an example (Table 2).

TABLE 2
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' Compensation	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**					

In each of those sectors, calculate the risk exposure. Key the rate of 1 year, 2 years, 3 years, all the way to 30 years, of your exposure to the different mortgages and public sector bonds, and then calculate a value-at-risk. Calculate the contribution of risk to your portfolio, and then you can add up the numbers.

Now I'll discuss the business line level. Here you have the annuities and GICs. You can actually see on the business level line what the risks are and the contribution of risk to the total. You have your value-at-risk number for the annuity and the value-at-risk number for the GICs, combining the

two businesses. The total is 119, which is less than 116 plus 85. That is a diversification across the two products. We are now assigning the capital to each of the parts, and this is what we call the value-at-risk organization math.

You look at a whole business. You look at all the assets and all the liabilities knowing the calculated market value and the calculated value-at-risk for each of them. You note that if you add up all the value-at-risk numbers, you should get the total value-at-risk number. The value-at-risk, divided by the market value (that is the last column), shows you for each dollar, in each of these investments, what the risk of contribution is to the firm. That will be very useful in risk/return trade-off analysis.

Obviously, the item that gives highest return with lowest contribution of risk is what you want. It is useful to put everything in a consistent framework.

I will now go through the balance sheet level all the way to stockholders value (Table 3). First, we look at a book value, statutory or GAAP valuation and see how it compares with the market valuation. This is economic valuation. I will come back to that. We calculate the surplus for each of the lines that you have.

TABLE 3
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	0 108	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' Compensation	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**

Earlier I discussed calculating the value-at-risk, risk contribution from each department, assigning risk contributions, and therefore, assigning capital to each part. In other words, if your business has a high, systematic risk that the stockholder doesn't like, you have to scale that surplus higher. However, if that block of business is aggregated with other businesses at the stockholder's level, there is no risk at all. Surplus can therefore be minimized. That is the risk adjustment to this systematic risk, based on the total surplus you need.

The following is the calibration procedure. For each block of business, you calculate systematic risk and calculate their own cost of capital. From their own cost of capital, you can do this cost allocation adjustment so that you're consistent with the shareholder level.

We already calculated income, so income divided by the risk capital is the return on risk-adjusted capital (RORAC). Typically, we look at the return on equity on a book-of-business level. We know that return on equity is adjusted for risk, so you can see the difference in asset and the risk adjustment basis. This is the self-summary of the current model showing how it links up on balance sheet level to the shareholder level.

FROM THE FLOOR: Do you reflect in whole life, or whatever lines you have, the ability to change nonguaranteed elements? How do you reflect that in this model? There ought to be some risk relationship, and I don't see that relationship coming through this. I can understand Shirley is doing things with GICs, but the non-moving parts of our business are in the minority today. We've got moving parts. As long as you can keep adjusting the prices, we're not going to fall apart in a month or a year. What does it really mean for us?

MR. HO: I think that will depend on how much you are actually willing to change nonguaranteed elements. We can always change the credited rate. The reality is that we have competition. We can't really change it at will. If it turns out that you're willing to model the risk, then the model will reflect that.

MS. SHAO: I just want to add one point on the nonguarantee element question. The way we look at the credited interest rate strategy is that we look at our management process.

We look at the current dividend scale when we project forward, but we also come out with what we call a competitive dividend. This means we think we will be under pressure not to cut dividends even if in the future the experience deteriorates.

MR. LONGLEY-COOK: This is a list of issues to keep in mind as you apply value-at-risk for the insurance enterprise.

Difficulties Applying VaR

Assets
- Buy and hold strategy.
- Methodologies often employed may be overkill.
- Daily or even monthly recalculations may not be necessary.

Liabilities
- Liabilities have no readily determinable "market value."
- Issues of what discount rate to use.

Time Horizon
- Meaning of the time horizon as the time needed to unwind a position.
- Longer periods, a quarter, or even a year.
- A longer-term view may invalidate the linearity assumption.

Operational Risks
- Many of the most serious insurance risk exposures are not quantifiable by standard statistical measures.

Value-at-risk was developed basically within the banking environment. In particular, it was used for marketable derivatives or other volatile securities, where they were trying to get a handle on what their exposure was over short periods of time—the time until they could sell the holding.

We're dealing with a longer-term, buy and hold strategy. Some of the complexities of value-at-risk in the banking environment may not be needed. On the other hand, we have other complexities that we need to model instead. If the banks can do this, why can't we? They can do it every night. In fact, some do value-at-risk every night. One of the reasons is that our liabilities are very difficult to model. Also, the operational risks may not be measurable at all.

I'll discuss an example of a situation when value-at-risk, as Shirley and Tom have described it, runs into a wall of resistance from the lines in terms of their ability to relate to what you're talking about. Let's consider group health. Many of you have lines of business similar to this. If you don't have group health, you probably have one that has the same characteristics. Group health is annually renewable, and the traditional methods for modeling long-term liabilities don't really work.

If you walk into a group health operation and say, I'm here to help you manage risk, let's talk about measuring present value of future cash-flows and how they might change due to the different risk drivers, you'll get a blank stare. Obviously, they don't measure future cash-flows. Future for them is the next few quarters. To them, the sensitivities they might be worried about are persistency and rate versus trend. How do you react?

The health care costs may go up a certain amount and you can react to it by raising premiums. However, they may not go up. The question is, how do you model that? Is persistency a new piece of business, or just a retained piece of business? In the group health area, every piece of business only lasts one year. You have to deal with that issue.

One way to solve that might be to not calculate value-at-risk directly, but to go straight to what they focus on more, which is earnings at risk. I agree with what Tom is saying. You can bring this together in terms of surplus, and I agree with that for required surplus. Where I run into trouble, and I think Tom agrees, is if you're looking at value-at-risk as an entity in itself. Then there are going to be inconsistencies—or at least greater difficulties—in applying that principle to a line like this one.

We start with earnings at risk, and that is a measure they can relate to. You can use the same kind of principles. You're not just dealing with present values, obviously. We get to a sort of value-at-risk by multiplying by the price earnings (PE) ratio for, let's say, that industry. When you do that, you have to recognize that PE is also a variable. Look at what happened to the PE ratios for managed care companies over the past year. They had very high volatility. That is part of the risk associated with your analysis.

What you get is not the same as value-at-risk because, as Tom pointed out, you've got to build in growth. PE will take growth into account whereas a normal value-at-risk calculation may or may not. You're doing one for one line-of-business and this for the other. You've got to make them consistent.

That is one approach. It is certainly not the only approach, but one that points out some of the difficulties when doing this for different areas.