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# Session 24OF
# Bringing Risk Into Capital Management

**Track:** Financial Reporting

**Moderator:** ALASTAIR G. LONGLEY-COOK
**Panelists:** CHIU-CHENG CHANG
GEOFFREY HENRY HANCOCK
FRANCIS P. SABATINI

*Summary: Actuaries and rating agencies increasingly believe that the NAIC's formulaic required capital standard does not adequately address a company's insurance, economic (market and credit), reporting and pricing risk structure. Economic capital, based upon a stochastic evaluation of a company's total risk exposures, presents a new approach for accurately gauging a company's exposure to risk. Attendees learn what economic capital is, how it is calculated, what it tells company management about risk exposures and how it can serve as a valuable risk-adjusted measurement tool.*

**MR. ALASTAIR LONGLEY-COOK:** Professor Chang is going to talk about the difference between regulatory and economic capital and give some of the prospective from the Far East. Frank Sabatini will talk to us about using risk-based capital requirements and economic capital in performance measures and other risk management strategies.

The NAIC is currently considering a proposal made by the Academy formally last December, that would impose new risk-based capital requirements for variable products with guarantees. Historically, risk-based capital requirements have generally been formulaic. Generally they've been set to industry or marketplace averages, say historic credit losses from bonds, for instance, as opposed to reflecting a company's actual asset and liability structure. The requirement has



**Note:** The chart(s) referred to in the text can be found at the end of the manuscript.

been set to a 95-percentile type of cutoff. In other words, enough capital to withstand the kind of result that occurs five times out of a 100.

At the end of 2000, the "C3 phase one" RBC requirement was introduced following the Academy recommendation on how to improve on that type of formulaic approach for interest rate risk, which you really cannot adequately assess on a factor basis. You need to have the company actually model its assets and liabilities. This applies to annuities, single-premium life and interest-sensitive products. For those companies that were not exempt, they needed to run 50 scenarios and base their RBC standard on the weighted average of the 92nd percentile to 98th percentile.

The interest rate generator was provided; it's on the Internet, and all the company had to do was input its assets and liabilities. Ironically it turned out that all but about 43 to 48 companies ended up being exempt; so while the NAIC got results on those companies, the vast majority of the companies did not have to do scenario testing.

The next step in the evolution of this process was to turn the attention to variable products with guarantees—guaranteed minimum income benefits (GMIBs), guaranteed minimum accumulation benefits (GMABs), guaranteed minimum death benefits (GMDBs), etc. And last December the Life Capital Adequacy Subcommittee formally recommended "C3 phase two," and that is being considered now by the NAIC. There are industry comments that are being responded to and the expectation is that this will be effective year-end 2004.

One of the reasons this subject was included in this session is that as opposed to the formulaic approach, what this standard requires is that a company run stochastic scenarios using its own assets and liabilities and therefore get at what is also generally known of as economic capital—the capital that a company truly needs to stand behind its business and to protect it from adverse loss exposures.

**Recommendations—The Standard**

Like C3 phase one, the approach is to model accumulated statutory surplus and take the present-value. Let's say you do 1,000 scenarios; for each of those scenarios, you would look at the lowest present value of statutory surplus over the projected time period. If that projected time period is 30 years, it's the lowest of those 30 present values.

If you run 1,000 scenarios you now have 1,000 numbers; each number drawn from one of the scenarios. You then rank those 1,000 numbers, and look at the worst 10 percent or in this case worst 100 scenarios, zeroing out any positive numbers and taking the average. That's what's known as modified conditional tail expectation (CTE). The reason for using 10 percent, as opposed to the 95 percentile cutoff that's been used before, is that the exposures that we're talking about here for some of these products sometimes don't emerge until you get up into the 97th

percentile or 98th percentile. So you could have zero required surplus at the 95th percentile and a large required surplus at the 97th. You don't want to miss that. The average of the worst 10 percent should be about the same as the 95th percentile cutoff for your average type of exposure, but it would capture exposures that the 95th percentile would not for those products that we're looking at here.

CTE 90 is meant to be consistent with the 95th percentile, but the committee recommends not using the 95th percentile for these products, because you might miss that exposure.

This is what it looks like is if you do a cumulative probability distribution (Chart 1). If you're doing the 90th percentile, you're looking at the 10 percent point shown. For the CTE 90, you're looking at the average over all of the points to the left of the 10 percent point.

**Scenario Requirements:** As I mentioned, in C3 phase one, the scenario generator was provided. For C3 phase two, you can use whatever equity rate or economic scenario generator you want; but you need to validate to a percentile distribution provided in the proposal, which focuses particularly on percentiles in the tails to make sure that the scenario generator that the actuary is using has fat enough tails.

It's clear that the equity markets, particularly in the short term, have distributions with fatter tails than, say, lognormal. So we want to make sure that that's being taken in account.

**C3II Risk Scenario Model**

Those percentile validation points were developed from S&P 500 historic experience using a regime-switching lognormal model. The way that works is, you have a normal distribution for the normal period of equity market behavior and then another normal distribution for adverse markets, where it's highly volatile. When you combine them you end up with this one distribution, which is not normal and has this fat left tail (Chart 2).

State-dependent models, otherwise known as mean reverting, are not prohibited, but you have to justify them. And most finance theory does not support strong mean reversion. If you do that, be careful. Saying that the market's going to come back in a year isn't going to fly.

These are the validation points that are in the proposal for both the left and the right tail. At those points you have to be less than them on the left and higher than them on the right (Chart 3).

### Other Features

**Hedge Credits.** You can get credit for hedges. If you have a hedge program, you can model that, and there's no limit on how much credit. You can go up to 100 percent, but you do need to allow for basis risk, GAAP risk and cost risk; so probably 100 percent isn't going to be justified. But to the extent that the hedge is a good one, then you'd be able to reflect that and get credit in RBC.

**Interest Rates.** Interest rates are needed for discounting, as well as modeling the margin on GMIBs. You can use integrated scenario generators like our own "Cap Link," for instance—there are other ones out there—that model both equities and interest rates at the same time. If you don't have an integrated scenario generator, then you use the implied forward rates and the current swap curve for discounting.

**Reserves.** Reserves were a problem initially, because if you literally use commissioner's annual reserve valuation method (CARVM), you'd be doing stochastic on stochastic modeling; so the proposal basically floors reserves at cash value or the GMIB present value, if it's optionable.

There is a parallel project underway now under a task force chaired by Tom Campbell that's developing a reserve standard using stochastic modeling that we hope will be implemented shortly after this one, and we'll have consistent treatment of reserves and RBC.

**Alternative Method.** There's an alternative method for GMDBs that is factor–based, so if you don't want to do all the modeling, you can just use the factors. They'll probably be a little more conservative than what you get using modeling, but it's certainly an easier way out. That also may provide for a phase-in of this approach.

**Policyholder Behavior.** On the liability side, you need to model policyholder behavior, so that would include all these issues here: lapses, withdrawals, etc. That clearly is going to involve some judgment on the actuary's part. (A lot of this will involve judgment.) So the actuary has got to be responsible for making sure that the assumptions are appropriate and properly documented and justified so they can be supported.

Some modeling was done last year to see what kind of numbers emerged, and this is what came out (Chart 4). As you can see, some of those numbers are pretty high. Since then more sophisticated modeling has been done, and the numbers have come down; but for some companies with a large amount of business written such that now that business is in the money, there could be significant impact on RBC.

**Implications.** The time to address this issue is now, rather than waiting until this regulation is promulgated. If we are talking about 2004, then you really need to start doing the modeling, let's say, at the beginning of 2004, not the end of 2004. And here we are almost halfway through 2003. You need the time to start building the models, buying the models, doing whatever you need to do to gear up—analyzing your own RBC requirements and seeing what hedging programs you might need to put into place now rather than at the last minute.

The advantage in doing this is that you can evaluate different hedging programs against the cost of those programs on a risk/return sort of analysis to find the optimal degree of hedging or reinsurance or other changes to your product or to your investment strategy or your guarantees.

Jeff Hancock is consultant with Mercer Oliver Wyman in Toronto and specializes in risk management and risk measurement management of variable annuities. His professional involvement includes working on the Academy's C3 Phase Two Work Group that Rob Brown chairs and the CIA Task Force on Segregated Fund Investment Guarantees. His work and that of some of the work group members on the modeling of C3 phase two has been extremely important in coming to grips on the impact of this proposal.

**MR. JEFF HANCOCK:** I'm going to be addressing capital measures for variable annuities. I'm not going to go into a lot of detail about the C3 phase two proposal. Alastair's given you an introduction to that, and of course, the proposal is available online. So I'm going to spend more time on looking at results.

I'm going to be presenting four different ways of looking at capital for variable annuities with guarantees, two of which should be quite familiar. One is the C3 phase two proposal. Another is the approach adopted in Canada for MCCSR, the minimum continuing capital and surplus requirement, and then two others. So I'm going to be really focusing on a case study here and looking at some numbers.

This is just a brief overview. I'm going to talk in general about capital considerations and issues that should be taken into account when addressing capital measures and building the models to assess those measures. Then I'll jump right into the four parts I'm going to present to you today.

Of the two others, the third and fourth measures here—one has a purely economic focus. It's an earnings-at-risk measure. It's very useful and quite a bit different from the others. And then the last is just a modification of the C3 phase two approach. But instead of using cash value or a working reserve in the projections, it actually assumes that the reserves projected are cash flow tested reserves; so it actually does address the whole stochastic within stochastic issue.

After we look at some numbers we'll talk about capital volatility, which of course, is a natural consequence of all of these methods. Capital volatility is a very practical

reality that we're going to have to live with. That will dovetail nicely into a discussion of how to deal with capital volatility and the implications in pricing and risk management of this business.

**Capital Considerations:** The way we've decided to look at this is to take a total balance sheet approach, a very holistic approach. I've given a definition here: We're trying to come up with the total amount of assets that are required to fulfill the company's obligations—the commitments they've made to policyholders—taking into account policyholder behavior, company action, investment strategy and the variability in the future contingent events that we're modeling. So it really is a holistic, total balance sheet approach.

Capital, then, is that total number less the actual liabilities held. So that's the approach it's going to adopt; that's the approach I'm going to use in each of these cases here.

Some important considerations: Since it is a total balance sheet approach, a holistic approach, it does need to consider not just policyholder action and the traditional actuarial assumptions, but possibly company action, risk management strategies, shareholder commitments—everything.

Variability, of course, is a function of the frequency and severity of the model; so it is a key ingredient in all of this. You obviously need to take into account policy form and specifics with respect to the company; but also the exogenous influences that should be reflected in the modeling.

This approach is very general, so it can be defined in economic terms, stat terms, GAAP terms. And I'll touch on those. I'm not going to really touch on the GAAP issue, but we really have a statutory and an economic focus blended together here.

Lastly, it is important to reflect risk management in these projections; however, I'm going to be assuming for simplicity in these examples, that the company's just running the risk naked.

**Importance of Capital**

Why is capital important? Maybe that is a silly question, but I thought I'd put a few points down to put it in context.

The first and foremost is that regulatory measures just may not be appropriate. Factor-based approaches might suit the industry on average, but they don't suit any given company situation. So that's the first, and it's hard to disagree with that.

For variable annuities, it's also hard to disagree that the cost of the guarantees is mostly wrapped up in the balance sheet provisions, not the claims costs. So you actually do need to look at some modeling, the tail events, the skewness and equity

returns—all those things are going to be weighing into the capital provision. So you need to model. It's hard to accommodate that with a factor approach.

Of course, capital is important for pricing. For capital-intensive products, pricing for an adequate return on that capital is paramount.

Finally, proper measurement, I think, is needed to understand the risk profile of the company. You can't measure total profitability with snapshots or simple, single-scenario approaches. You really need a rigorous way of looking at capital and trying to understand the exposure.

**Why is Capital Measurement Difficult?**
Simple, point-in-time balance sheet ratios and factors just aren't adequate. Generally they're not adequate; so we need financial projection models. And for variable annuities particularly, deterministic testing is just too subjective. What-if scenarios are undeniably very helpful , but we need rigor. We have to bring some rigor to this process to come up with measures of exposure and to set capital standards, so that means stochastic modeling.

Of course, there are many things that go into that and are important in the modeling. What metrics do you use? What's the time horizon for your projections? Should we be using seriatim or grouped models? All these questions are practical considerations that need to be taken into account. It's a complicated business.

**The Four Measures**
Let's get into the four measures here, and then we'll see some numbers.

**C3 Phase Two.** The C3 phase two recommendation is present value of accumulated statutory surplus deficiencies, with the modeling done using best-estimate assumptions. And then it takes a modified CTE 90. That's the metric being used. You run out your scenarios, get a distribution and take a modified CTE 90.

**Canadian minimum continuing capital and surplus requirements (MCCSR).** The Canadian approach is very similar, except it's purely discounted cash flow. Again, all these methods are based on stochastic modeling, but the approach there is to project out the policy claims—all the policy features, policy cash flows—and discount them. So there's no concept of projecting surplus; it's just discounting policy cash flows. It's a net discount, net liability cash flow approach, and it's at a CTE 95 level, a higher confidence level.

**Economic Earnings At Risk (EEAR).** The third approach I'm calling economic earnings at risk. This is a one-year projection. It's a realistic projection, but it's done using best estimate assumptions, and the requirement is you need to prefund or need to fund at a certain confidence level—here at a very high confidence level, CTE 99. You have to be able to fund the fair-value liability at the end of that year.

So it's a short-term projection; but at a very high degree of confidence. You want to be able to meet your fair-value obligation at the end of the year; so we'll see how that weighs into this.

**C3 Phase Two Plus Cash Flow Reserves.** Finally, I'm going to look at the C3 approach using cash flow tested reserves instead of a working reserve or a cash value floor.

**Tail Measures of CTE and MCTE**

This is just to give you an understanding of the difference between CTE and modified CTE (Chart 5). Looking at the lines in the chart, one line is present value of net liability cash flow. This is just an example. We're saying here that the CTE at a confidence level of, say, X is the average of the one minus X percent worst results. We've described CTE.

Well, the modified CTE is just putting in a floor of zero before you take the CTE calculation, so it doesn't allow negatives, depending on which side you're looking at. It doesn't look at negatives or positives, and you can see that difference.

Here's the distribution of net liability cash flow, and then when you take a CTE, you get this second line; and when you take a modified CTE, you get this third line. So you can look at the grid here, and you can see the two converge; and they should converge, because once the net liability cash flow's entirely above zero, the two measures are equivalent.

So it has a big impact on results. The modified CTE is a more stringent measure than the CTE measure unless you're in the extreme, extreme tail. In this case we're talking about the extreme tail being sort of above the 95$^{th}$ percentile.

**C3 Approach Continued**

I'm going to quickly run through the four approaches and some of the important items related to them. The time horizon I'm using here is 30 years. Typically in the implementation, though, you'd probably look at about a 10- or 20-year horizon—maybe longer, but it's typically not necessary.

We're trying to come up with an amount in the C3 approach that's sufficient to avoid the need for external funding. That's really what the number represents. Consistent with phase one, it's approximately the 95$^{th}$ percentile; and again, the modified CTE doesn't allow you to use the excess from other scenarios to offset deficiencies. That's the whole point of the modified CTE.

**Canadian MCCSR Continued**

The Canadian approach is very similar and based on stochastic methods—discounted cash flow only, though. No need to project reserves or capital or accumulate anything; it's just discounted net liability cash flows, ignoring taxes and using best estimate assumptions with something that we call margins for adverse

deviation, which are just meant to reflect uncertainty in assumptions. So you can think of it as a best-estimate approach.

It is the amount sufficient to meet your obligations on a present-value basis on average. So certainly because it's a present value, it actually can fail to provide the appropriate amount on any given scenario. It's floored at zero; and in fact, in Canada, we take the same approach. It's actually a nice approach, because it's consistent with looking at a capital from the of perspective of reserves, except the reserves would be at a lower CTE level, not CTE 95.

**EEAR Continued**

Here's the economic approach in a one-year horizon. At the end of the year, you need to take account of all the income statement items in the first year. And at the end of the year, you need to be able to fund the fair value liability—the liability at which this obligation could be transferred or assumed by another company. This might be a very reasonable and intuitive approach for a regulator. They would feel comfortable that if you could provide for that amount at a very high degree of confidence at the end of the year, they could come in, or someone else could come in, and assume your obligations at the fair value. So CTE 99 is my high threshold here. It's a one-year horizon, so you need a very high confidence level. That's about a three standard deviation from the mean number, CTE 99.

**C3 Plus Cash Flow Continued**

Then lastly, I'll rerun the C3 phase two approach with cash flow testing reserves. So I'm dealing with the whole stochastic within stochastic projection issue, and I'm setting those cash flow tested reserves at a modified CTE 60 level. Net cash flow, discounted cash flow, and a modified CTE 60 level, which I think is one of the things that's being explored by Tom Campbell's group. This will give you a sense of moving to a stochastic basis for reserves and capital.

**Capital Measure Miscellany**

All these approaches give the amount that's required in excess of the current reserve. They share common elements. They're real-world projections,(i.e. they're "P measure" projections). They're aggregate measures. You run your models—perhaps seriatim, perhaps grouped—but you do the analysis on the total results. So you're reflecting diversification and aggregation in your modeling. You should also reflect your ALM strategy and reinsurance, things of that nature.

I've got four different methods here. How do we compare them? They are different. I'm going to actually compare them to what I call an objective distribution, and that is a discounted cash flow. We're running the same policy in all these examples, so it's discounted cash flow, less the net option value. So that's my objective fair value liability—the option value.

Which is the best measure here? Well, I'm not going to really answer that for you; it depends on your perspective. They are different. But as we'll see, the results are

actually strikingly similar.

The International Actuarial Association Working Group on Solvency Assessment is actually looking at a "higher of" approach. It's one of the things under consideration, and the two approaches that they're looking at are discounted cash flow, the so-called Canadian approach, and this one-year measure. So they are looking at a long-term perspective—out to the end of the liability and then a short-term perspective, the one-year economic value at risk, and taking the greater of the two. That's why I presented them to you.

**Variable Annuity Case Study**

Here's my case study. Here are the assumptions I'm using (Chart 6). They're fairly typical. They're not unreasonable, and they're fairly realistic and very close, if not identical—to the testing that's being done by the C3 Phase Two Work Group. I think there were a few minor differences. Again, we're not assuming any hedging here.

So here are the four results (Chart 7). My objective distribution there is the present value of net liability cash flow less the option value. So I can make reference to that distribution to see where these four numbers come in.

Here are the four approaches that I'm presenting to you today. I've expressed the capital requirement as a percentage of guaranteed value—as opposed to dollar terms, to put it all in perspective. You can see I'm only graphing the very tail of the distribution here for the objective distribution, because that's where all the fun happens, and you can get a better spread of numbers.

So there are the factors. Yes, they're different; and we'll talk in a minute about why they're different. But they are remarkably close to each other. The spread here is not one or five times or 10 times the other. They're very, very similar to each other, which is a good thing, I think. It actually adds credibility and consistency to the different approaches, given that they are trying to measure different things.

You can see a bit of a... I shouldn't say, coincidence. The C3 phase two proposal is the lowest number of them all, and the Canadian approach is the highest number. They're not identically comparable, because there are some differences in assumptions; but even despite that, we've only got a range of 0.6 percent here from high to low. So that's the good news.

This is the chart of some of the numbers (Chart 8). I showed you the capital factors there. Now I'm just giving you some more statistics from the distributions. We ran stochastic models, we can calculate various statistics; here they are.

One thing you can see that's very different between these two: Here's the dollar capital amount for a $100,000 deposit. This product is 20 percent in the money

now; so we're assuming that it was issued a few years ago, and it's already 20 percent in the money. That's a 5 percent roll-up GMDB.

The dollar measures are reasonably close, but the differences really start to come in when you look at the extreme, extreme tail. So if you take a look at the maximum result, the maximum capital required from each of these four methods, is very different. These methods do start to diverge the further you get out in the tail.

Then the last number on this page is, I think, a useful one. It's showing where the capital number lies in the objective distribution. You can see these are extreme tail measures, between the 97$^{th}$ and 98$^{th}$ percentile.

**Observations**

I made this observation before; these methods are comparable. In fact, given some of the uncertainties in the modeling, we can't even say the differences are statistically significant, so that's actually a good result that lends confidence to the process.

There is sampling error here. There is measurement error. We're only running 1,000 scenarios here. There's perimeter uncertainty, there's model risk. Of course, policyholder behavior is an unknown as well, especially in these tail scenarios that are giving rise to capital. Given all of those uncertainties, these four methods give very, very consistent results, so that's a good thing.

The differences could be larger for a real portfolio. This is just an example; it's one policy. For a real portfolio, these measures could diverge more. They are measuring different things.

The most important point I want to make here is the ease with which you can implement these varies significantly. These four methods, they are not equally easy to implement; and in fact, one is quite difficult, one is quite simple, relatively speaking. They all require you to build a stochastic model. The C3 phase two is actually somewhere in between. So they're not equally easy to implement. Arguably, the discounted cash flow approach is the easiest of them all. It only requires you to project the policy cash flows. You don't have to project reserves. There's no stochastic-within-stochastic issue, it's just project the policy cash flows and discount them back.

I've got three charts here (Charts 9, 10 and 11), demonstrating how volatile the capital can be.

My current AV to GV ratio is .83, and then I projected out a year. This is the spread of where that ratio could lie one year from now. Each of the dots is what the capital would be a year from now. You can see the box is where we are now. It's a pretty big range. This is what gives rise to capital volatility.

There's the C3 approach, there's the Canadian discounted cash flow approach. Here's the economic capital approach—this is actually the least volatile. But the other two, the C3 phase two and the Canadian, are quite volatile. Capital volatility is going to become a fact of life, and we're going to need to be able to manage it.

These models are very sensitive to initial conditions. They start with current market value—that's one of the things that leads to the capital volatility. We're assuming Markov models here, which are very sensitive to starting market values. So that's going to weigh into your measurement approaches and your risk management philosophy and your tolerance that you would set at your company. So get ready for capital volatility. Expect it. All of these methods are demonstrating that it's coming and it's real.

**Implications**

What are going to be the implications? These projections are pretty critical for pricing and for sound risk management. You need to be able to project capital, not just calculate it now. You're going to need to be able to project it. So this whole stochastic-within-stochastic problem, that challenge, will become real. So people at companies are going to have to confront it if they're pricing for adequate return on capital. It will be a challenge, a real challenge.

All of these depend on modeling extreme events, so things like model risk, perimeter uncertainty and choice of model have a great impact on results.

Finally, what's going to happen with capital volatility? Well, two things are going to happen. People might obviously withdraw from the market, increase prices to cover that increased risk in capital volatility; or they're going to actually engage more fully and take greater interest in active risk management and hedging. And of course, that lends itself perfectly to stochastic modeling. That's one of the best ways you can understand the efficacy of the hedging strategy is through stochastic modeling.

So all of it will fit together, but it is a lot of work. And if capital volatility is coming, the time is now to get an understanding of not just the magnitude of these numbers and what they might look like, but how you're going to manage that volatility and price your products for that volatility.

It's my pleasure now to introduce Professor Chang. Chiu-Cheng Chang is professor at the Graduate Institute of Management at Chang Gung University and has obviously flown a long way to be with us today. He's going to talk about the difference between economic and regulatory capital and some of the perspectives from his viewpoint.

**PROFESSOR CHIU-CHENG CHANG:** To start out, I will quickly review how we determine capital requirement traditionally.

A long time ago you used an absolute amount or fixed factor, 3 percent of reserves plus, for example, 0.2 percent of the sum at risk. A slight improvement is the absolute amount with a risk factor. And then you come down to dynamic solvency testing.

Now we are talking about realistic assessment. What I am going to present to you is more global, as you will see later on. I will show you what the European and the international insurance markets have been doing, as well as what the United States has been doing. So it is more global.

What do we mean by a realistic assessment? This is really what we mean by economic capital. The capital requirement takes into consideration the risk an insurance company has been taking. This approach will enable us to ensure allocation of capital, also called dynamic allocation of capital—or what we like to call strategic financing. I think they all mean the same thing.

Also, this approach will facilitate a clear comparison of profitability across product lines and geographical areas. For example, American life insurance or P&C companies now also are going to the international market, as I witnessed in Asia after having worked in North America for so many years. I can witness all these American companies also competing in China, East Asia and also in Japan. I think this may be an important tool for American companies.

Even though American companies are getting into the international market slowly in comparison with European companies, they have no choice but to expand overseas, because their currency value is so small compared with America. Also it allows return to be adjusted for the cost of economic capital, and this is very important for evaluating investment return. It allows an objective evaluation of strategic plans.

**Defining Risk**

How do you define risk? There are many ways to define risk. If you are a mathematician, statistician, you talk about standard deviation. But for this purpose I will just look at risk as the possible threats to achieving an insurance company's objectives. It's very simple, but over what time horizon; what base metric to use and what level of risk do we care about?

For a life insurance company, the major risk areas can be seen here (Chart 12). I believe that you are all familiar with all these, so I think I will just go on without mentioning them.

These are recent corporate failures, and I think you could add more that are due to other problems (Chart 13 shows four recent failed insurance companies).

### Cautionary Examples from Europe

**Internal Factors.** Here are examples of factors underlying the deterioration of financial strength of EU life insurers (Chart 14). I think you are very familiar with North America, so I picked the EU companies that have problems probably very similar to North American companies.

One problem involves a bonus structure, what we call a dividend structure, and the policyholder expectation of a smooth return. Because of the fall in the equity markets and these policyholder expectations, they cannot pass on this fall in equity market entirely to policyholders, and that is an important factor.

Another problem is that of high-level guaranteed investment returns, which result in a mismatching of assets—again due to equity market problems. Other guarantees contribute to the problem such as annuity options, surrender values and benefits on investment-linked contracts.

**External Factors.** Regulatory issues, increased compliance costs, sales compensation costs, government-imposed product pricing in UK, increases in solvency requirements and pressure from distributors all contribute to the problems.

Again, as everybody knows, EU life insurance, P&C insurance as well as lots of other financial institutions suffered tremendously from the falling investment market. Merger and acquisition activities also played a role.

### Worldwide Developments & Drivers of Change

You have different market conditions, of course. Also, now the worldwide regulations focus more on risk, as seen in Basel II, where so many documents are coming out. Mr. Longley-Cook mentioned RBC and evaluating risk, for example. There are many papers comparing RBC versus evaluated risk, particularly those evaluated risks based on stochastic simulation, have repeatedly been shown to be superior to RBC. But regulators are usually behind these theoretical events, so I predict that someday in the near future, these risk management methodologies may become one of the regulator's tools.

We have the UK's Integrated Prudential Sourcebook and also the EU solvency tool on phase two. Another important report that I highly recommend is the so-called Turnbull report. from the UK. In any case, these resources should be considered when looking at risk management.

The approach of the UK regulators, I think, might also be very interesting for American regulators to take note of. They are implementing proactive and risk-based regulation, and they are going to bring together banking and insurance, too. This is very important, because the dividing line between financial institutions—banking, insurance, trusts, stock brokerage houses, investment bankers and so

on—is blurring. Take Canada, for example: For many years, Canadian regulators have been consolidated under one roof, and the UK also did the same thing. They are under one roof and called a Financial Service Authority, supervising all financial institutions, not just insurance companies, but also banking, trusts, stock brokerage houses and so on. So this all comes into play.

I think they also recommend the so-called market-consistent valuation of options. By market-consistent, they mean that it has to be consistent with observable market prices. They also do requirements for stress and scenario testing.

Scenario testing using deterministic approaches, stochastic approaches, partial stochastic approaches or full stochastic approaches and deterministic stress testing are being done. And you are supposed to do your internal capital adequacy calculation. The whole idea is to move further toward fair value liabilities when the EU directly allows; and this is consistent with what Mr. Hancock said. The whole picture, not only the asset size or asset calculation, but projecting the assets must be done. What is adequate to do the projection?

You also have to look at the liability side and consider fair value liability along with fair-value assets, the whole picture. I think this is a good direction.

**UK Regulatory Risk Model**

This is the risk model (Chart 15), and I suppose you can download this from the Web sites. What's the definition of risk management? I think this is not as important as what I will touch upon later.

The risk management process is easy for you to remember—Iced Tea (ICE-TI). (laughter) Identify, classify, evaluate, tolerance, integrate. Mr. Hancock also asked: What is your degree of tolerance?

What I'd like to emphasize is integration. By integration I mean the whole process used for all specific decisions; not only pricing, but also the whole company's strategic decisions. And this whole idea has to be embedded in corporate culture and organizational behavior, as we in the EMB program have been teaching. I emphasize that this organization of culture, organization of behavior; and this whole concept of risk management process has to be embedded in the culture. If we get to the point, then I think we will be successful in introducing the concept of risk management.

**Risk Identification**

Risk identification, classification, how to do the mapping. By mapping, I mean you have hundreds of risks. How do you make them into a few groups and then assign the job to individual managers?

### Quantification

Risk quantification: There are numerous ways, historic simulation, evaluated risk I just mentioned. You can do it on a scenario basis; you can do it on a stochastic basis. How to measure risk is separate territory for so many different kinds of risk—market risk, credit risk, and so on. How are you going to put them together? That is what we call the corrected model or equity model.

For all of the risk, you use the square root of the sum of the square of the individual risks. I think the NAIC and also the banking industry use that approach and also stress analysis or stochastic modeling techniques.

The approaches used should incorporate the various historical published academic papers on the subject as this is a highly sophisticated area of actuarial work.

### Potential Threats

A concrete example is bonus structure and policyholder expectations, guaranteed investment returns, mismatching and other guarantees. How should you do the monitoring and controlling functions? Use more sophisticated modeling of assets and liabilities, cost of guarantees and options using ALM techniques.

We should do dynamic solvency testing or implement hedging strategies to mitigate the impact of unfavorable future investment conditions. I recall a study that was presented a few years back at the IAA's annual conference in Australia, where I presented a paper. They were coming from Wharton School, where they did a study of more than 2,000 companies in the United States. How many of them use hedging strategies? I was so impressed that four or five years back, more than 1,800 companies used securities for hedging purposes. At this point in time, I would think that that number probably exceeds 2,000, but I think you probably know better than I do.

So I think it's probably quite common now for people to hedge using derivative securities. To mitigate stress, many have moved away from traditional products into investment-linked products. This is what I have seen in Asian countries. Because of the low interest rate environment, the traditional product becomes so expensive, easily 30 percent or 40 percent higher. So the consumer now does not have a choice. The consumer does want to buy this kind of product, so even in today's low interest rate environment the investment-linked products have become very popular in Asian countries. I still see a move toward more structured investment-linked products, the so-called structured note with two features: one single premium and some kind of guarantee for net capital return. And that kind of product is doing very well in Asia. Of course they had to use a derivative for hedging purposes.

Review your dividend structure; move toward more terminal bonuses rather than regular dividends; allow more investment risk to be passed on to policyholders. Reduce or eliminate guarantees. Make greater use of market-value adjustments or

withdraw the problem products.

**Why Risk Management?**
First, there is a lot of international activity regarding risk management. If everybody's doing this, and you aren't, I think that would be detrimental to your company. In addition, the development of a global risk management network is currently underway.

Effective allocation of capital for the risk being taken by life insurers is important. Risk has a great impact on how a company performs, so it should be a primary concern. Finally, it makes sound business sense to manage risk effectively. There are many potential benefits.

**MR. LONGLEY-COOK:** Thank you Professor Chang. Last but not least is Frank Sabatini, who is partner with Ernst & Young's insurance and actuarial advisory services group, specializing in risk and capital management.

**MR. FRANK SABATINI:** I'm going to take this into the practical world and talk about using risk capital concepts and extending them into performance measurement. I'll also talk about how you can use them as a management tool and some of the issues and challenges you have surrounding implementation.

**Risk-Adjusted Performance Measurement**
Let's define the terminology. Risk-adjusted performance measurement (RAPM) has been called other things. In the banking world, it's called RAROC or RORAC, and I'll use this term, but at the end of the day, it's a pretty simple concept. You measure return on a purely economic basis, and you measure capital on a purely economic basis. The goal here is to get a true understanding of the performance of the particular organization or the product that you're looking at. We're going to reinforce these themes as we go along.

**Marketplace Drivers for RAPM**
What's driving what's going on out there? A lot of organizations are implementing more enhanced risk management programs and more sophisticated and more normalized performance measurement systems.

**Framework Inconsistencies.** One of the big issues everybody has is that a dollar of capital in one product line isn't a dollar of capital on an equivalent basis in other product lines.

I can guarantee you, having actually implemented these systems, that there are certain product lines in the United States that are just over-capitalized by the regulators and other product lines are terribly under-capitalized. So the regulatory framework is inconsistent. The factor-based approach leads to inconsistency—inconsistency across products, across assets, across the different risk elements. Is a dollar for credit risk, a dollar of C1, really the same as a dollar of C3 risk capital

or C2 risk capital? Even more important is the concept across industries and across countries, and particularly as we become more and more multinational—expanding on the comments of Professor Chang—do I invest more in Europe or in France or more in the U.S. in terms of allocation of capital? How do I make that decision? Without having a consistent framework, it's got to be next to impossible.

You need a capital system, you need a measurement system that reflects your circumstances and the circumstances of the company, and part of that has to do with the diversification of risk across the enterprise.

**Inconsistent Accounting.** What else is driving the need? We have all these accounting systems that really don't tell the truth; they hide the truth. The economics are the economics, and in some instances, they give us too much capital. In some instances, they give us too much recognition or too much volatility. And in other cases, it mutes it, but it doesn't help management make any better decisions. It just makes their life even more difficult, and they're becoming more and more frustrated with it, which is driving that need.

You'll see some of that if you look at the evolution in the banking industry. Some of that need has been driven by the regulators toward a more common framework. The analysts and the rating agencies need to have some sort of measurement system that's transparent so they can understand that a dollar of profit at one company is equivalent to a dollar of profit at another company, and that they're in a comparable risk framework.

In the instances where this has been introduced in the industry—at least one life insurance company has gone public with this kind of framework—it's gotten an extremely positive reaction from the rating agency and regulatory community. Now, I hope none of those people are here today, but I hang around with them from time to time. They don't understand it, but they think it's great, and eventually they'll get to understand. But they understand conceptually that if somebody's giving them risk-adjusted returns, that at least then in theory, they're getting a better sense that the return is being measured against the risk that's inherent in the business.

**Management.** Then, finally, what's driving the need? Management wants to be able to relate performance to the risk that they're taking. They want to understand risk before it jumps up and bites them where they'd rather not have it bite them.

They want to be able to measure performance on a consistent basis across businesses and legal frameworks, and at the end of the day they're trying to increase shareholder value. The only way to do that is to invest in the businesses that you should be investing in on a risk-adjusted basis, because ultimately the investing community figures out whether or not you've made bad choices.

Some of the recent history of the capital markets has brought that home in terms

of some of the companies that have made certain bets and now have made bets in terms of capital and invested capital and product lines that are much riskier than they thought they were when they made the bets.

**Specific Issues**

Some specific issues: Am I getting compensated for taking some of the risks that I'm taking? There's nothing wrong with taking credit or mismatch risk. The thing that's wrong is not knowing whether or not you're getting adequately paid for it. I think management's finally getting around, having lived through the past few years, to the idea that if they're going to take the risk, they want to get compensated.

And not only that, there are situations where you're being forced by the regulators to capitalize at a certain level, but you have high-quality, well-matched assets, and you can't understand, "Why can't we make any money?" It's because the regulator assumed you were mismatched and you were taking a credit bath. That's why you can't make a return.

Then the analysts are beating you up because you're not making the returns on the capital you're deploying. So it all comes home to roost, particularly on new products.

We're getting more and more innovative. We're bringing more bells and whistles out and guarantees, and the regulators don't have a framework that allows us to say, "Here's how this fits into the regulatory framework; here's how much capital we have." So you develop a product, and you really don't know how much risk capital you have. If you have a good risk capital framework you will, and you make the right decision about whether or not to introduce a product.

**Measuring Your Risk**

Now, how do you go about measuring it? One of the unique things is that this risk capital concept is sort of spilling over from other industries. It started in banking, and there have been some major efforts in the P&C arena. It's finally spilling over into the life arena.

When property/casualty people start doing a lot of what they do in terms of measurement and quantification of risk, almost everything they do is independent. Hurricanes have nothing to do with car accidents have nothing to do with commercial lines. I don't even understand their products, but they tend to be independent. So you can go off and you can measure and capitalize each of the different businesses independently and then add them up. The correlations aren't that strong, so you can do back-of-the-envelope calculations around correlation and come up with a total risk position.

**The Integrated Approach**

In the life insurance industry, we understand that we need a fully integrated approach (Chart 16). You can't push one button without something coming out the

other end. So in life insurance, you really need to quickly realize that you measure the risk in aggregate, and then you decompose it into the pieces. This is just consistent with a lot of things that Jeff and Alastair talked about in terms of producing a distribution of results, identifying what point in the distribution you want to measure capital. This is in the 99$^{th}$ percentile, so it's a simple illustration.

What are the benefits of an integrated methodology? You build a model that has stochastic interest rates, and it has stochastic equity returns. Mortality is a risk element, so then mortality becomes a stochastic element, both in terms of both systematic and nonsystematic risk, as well as catastrophic events. Morbidity is involved, policyholder behavior is involved. All of these elements are stochastic.

The benefit is that you get risk equivalents. Credit is a stochastic event, and as actuaries we are used to projecting 20 basis points a year. Well, it could be. And in a stochastic context, it comes from a distribution, and it could be issue-specific or it could be asset-class-specific, but you end up with risk equivalents across the major risk elements, and you get accurate measurement of the diversification benefits.

There are tremendous diversification benefits on many of our balance sheets, and with some of the companies that we work for, the diversification benefits are substantial and are a competitive advantage. We're not leveraging them. For others of us who are more heavily focused on one or more product lines, we have less of that, and we need to understand that as well.

Finally, with an integrated and a risk capital methodology, the economic environment is going to drive the amount of capital. Measuring the risk capital around minimum guarantees today is going to produce a much bigger number than it did 10 years ago.

Chart 17 shows a simple illustration of the concept with fully integrated results. You build a big model and you produce the results. You get 97.

Then you go back and there are different techniques that you can use. You can go back and measure each of the pieces independently, but what you find is that the tail of the worst interest rate, or ALM event, isn't going to happen at the same time the worst mortality event happens or at the same time the worst credit event happens. There are people who will argue that the correlation is 10 to 1 in the tails, and there's some truth to that. You can factor that into the modeling, but at the end of the day, you end up with a total uncorrelated exposure of 145 and a fully correlated exposure, a diversified total, of 97.

That 48 is a real diversification benefit, and the only really effective way to get at that number is through an integrated approach. All we did on the right-hand side is go back and reallocate. You can use some pretty sophisticated techniques to figure out what the diversified risk capital is across each risk element.

Chart 18 is taking the same concept and is doing it not only across risk elements, but across products, because Joe showed a measurement of the correlation effects . The whole point here is to develop a fully integrated approach.

**The Framework**

OK, we're measuring this stuff—what's the framework? Well, the natural inclination—the purist in me—automatically leads to cash is king.

The trouble is, we grow up in this environment where we have all these accounting frameworks. It doesn't mean that you can't implement a risk measurement framework as long as you're consistently developing it. We need to be clear, though, that the minute we start employing accounting conventions, it is those accounting conventions that introduce distortions into the system.

Dollar reserve in product line X is not the same as the dollar reserve in another product line. So you start using accounting conventions in terms of determining risk capital, and you start reintroducing the distortions you were trying to get rid of.

I'm a firm believer that if you're measuring risk capital, let's get at the economics and understand what the economic risk is, understand the risk capital for term life insurance, and be able to compare that on a dollar-for-dollar basis to the risk capital for variable annuity.

**Developing Risk Capital**

Now when developing risk capital, typically I would be promoting the idea of calculating a solvency number, but there are some people who like to take an adequacy view. In the P&C world a lot of times, they'll be looking at the value-at-risk (VAR) approach, where you're really looking at the volatility—the change over a relatively short time period—in the balance sheet value, and that's not necessarily a bad approach.

The approach that's outlined here (Chart 19) is one that's economic and fully integrated. Once you're measuring it at every point, if you think of a stochastic projection over a time horizon at every point in time, you're stopping and marking your assets and liabilities and calculating the market value of surplus. Along each path, you're looking over time and saying, "What's the minimum value along that path?" and then discounting back, having a distribution in minimums, and then finding the point in the distribution to determine your risk capital.

**Stranded Capital**

Now you say, "OK Frank, the regulator says I need 100. You say I need 80. What do I do with the 20?" Well, it's a concept of stranded capital (Chart 20).

Reality is if the regulator says you need 100 and you have 80, you have a couple of choices. One is you can take more risk to get up to 100, and hopefully you'll get the corresponding return to compensate you for it. The other choice is to say, "OK,

the extra 20 is the cost of doing business." You have to carry that cost.

At the bottom I'm showing an example, but the whole point here is that you're funding the cost of that extra capital in the numerator, not in the denominator, and it has a difference in terms of the return implications. In this case, as a simple example, you're going to get almost a 1.5 percent higher return by funding the stranded capital as just the cost of doing business, a reduction to income, not something that you have to fund in terms of capital and the denominator. It's a subtle point, but a very important one.

I'll have you look at this at your leisure in the interest of time, but in terms of the numerator, you'll see particularly in the banking world that they'll take a GAAP numerator and then they'll calculate risk capital and use that.

There are advantages and disadvantages to using different numerators, as well as the different denominators. You need to think it through to understand the differences. A lot of it has to do with how quickly risk emerges through the return measurement.

At the end of the day, we're trying to enhance shareholder value. We're trying to make reasonable and fair comparisons that allow us to make good capital deployment decisions.

**FROM THE FLOOR:** Most of the talks that I attend on this subject tend to focus a lot on the asset/liability risk, the minimum guarantees, the stochastic nature.

Frank, you brought it up somewhat in your talk, and I'm wondering if you have any more comments about good, old-fashioned mortality risk and how you would go about evaluating that. You mentioned systematic and nonsystematic factors are involved. Can you elaborate on that?

**MR. SABATINI:** I'm in the middle of a project now where we're actually looking at a deferred variable universal life block of business. But quite honestly from an economic point of view on this particular product, mortality is bigger than the ALM risk capital. And it depends on your view. One of the problems you have around mortality is deciding how you want to capitalize mortality or what you think mortality is going to do in the future. The minute you start worrying about trends, you start coming up with a lot more capital than you thought and it ends up being a much bigger number. I think that hits your question.

**FROM THE FLOOR:** Yes, it is more than just the pure random fluctuation stochastic. It's the making a multiyear guarantee and then seeing the trend.

**MR. HANCOCK:** I support what Frank just said. When we've been looking at mortality risk stochastically in trying to decompose it into different components—level, trend, volatility and catastrophic—the volatility risk, the statistical fluctuation

really isn't that large. The diversification comes into effect, the large numbers. It's all real. It's really the trend and level risks that come into play, and they can be substantial.

**MR. SABATINI:** Well, at the risk of getting into a debate... Depending on the measurement technique, just the pure variation around the mean can be meaningful, because your worst case, the tail of that distribution, is the one where it's worse 10 times at its level. On average, it's a net-zero position. You would expect the mean of the capital around pure variation to be zero, but if you're looking at the tail of the distribution, it can be a pretty large number.

**FROM THE FLOOR:** So you would agree that it's really not a statistical-type exercise when you're looking at the tail, especially when you're talking about the long-term trends?

**PROFESSOR CHANG:** Regarding your question, I do have a study covering almost 100 years of mortality experiences. Very interestingly, only in 1918 and in 1940 were there huge changes in mortality—up by 50 percent and down by 38 percent. It is quite stable.

**FROM THE FLOOR:** Until a year ago, I was the chair of the solvency subcommittee of the International Association of Insurance Supervisors (IAIS). I have two very short questions arising from that. One of them is that in a couple of the presentations identifying different types of risks, there was some elaboration of liquidity risk and recent difficulties that some companies have had as a result of liquidities, a cause of distress. But when we actually brought together the modeling framework for this kind of work, then invariably liquidity risk just slips off to one side. My question is whether, in the view of the panelists, liquidity risk can be capitalized, or is it something that needs to be managed separately, and therefore we'll always have scenario-based stress tests rather than probabilistic based ones?

As you can hear I'm Australian, so I'm new to the country and certainly not familiar with the local circumstances as well as compared to others, but the EU Solvency Two proposals and also the Basel Two proposals are introducing the concept of an approved internal model for capital purposes, and Stuart Wason's IAA committee is quite enthusiastic about the same sort of thing. I was wondering if the panel had any views as to whether this was something that might come to pass here from a regulatory perspective.

**MR. LONGLEY-COOK:** Let me start with a regulatory situation and the other panelists can comment on it as well. Liquidity in the United States RBC requirements has been an issue that continues to be of concern, but one that we haven't found a good solution for yet. It is on the list of issues to be dealt with in this country. New York has certain reporting requirements around the liquidity issue, but as a general RBC standard, there is not a specific requirement. So that is one that is being looked into, but not finalized and not solved in the regulatory

environment.

**MR. SABATINI:** I would argue that liquidity risk is really a manifestation of other risks. At the end of the day, even if the companies had the difficulties when liquid and were able to meet the demands, they still would have been in trouble when it was all over. The problem was, in many of the instances what got them in trouble in the first place was they had some mismatch issues, they had some over-concentration issues in particular product lines.

I would argue that even if they had the liquidity to fund the demands, they would have had an economic meltdown of some sort, anyway. What the liquidity crisis does is just accelerate the end. I would argue that to the extent that you're measuring the other risks, there might be some incremental capital that you would need to sort of plumb the liquidity risk, but I don't think it would be that great.

**MR. LONGLEY-COOK:** And I think that's been the problem from the regulatory standpoint—separating so you don't double up on your requirements. If you already have requirements for diversification, for the interest rate and equity risk and pricing risk, then you're not doubling up when you add liquidity. But clearly there are situations where a company has liquidity problems that are not taken into account by those other factors. Could you rephrase your second question?

**FROM THE FLOOR:** With both the Solvency Two proposals and with Basel Two and also with a number of other statutory solvency developments in other jurisdictions, the approach that they've taken is to say, "Well we've got a certain factor-based approach," which is what I would characterize the RBC as being, "and rather than try to refine this so that it takes account of all possibilities to make it more useful and perhaps a closer match to the economic capital, let's just say we've got this. We'll accept that it's broad brush to some extent and we'll allow the more sophisticated companies to build their own internal model and seek regulatory approval for use of that instead."

**MR. LONGLEY-COOK:** The developments that I described for C3 phase one and C3 phase two are movements in that direction. They do not encompass all risks the way that I think you're proposing.

The reasons for that are that I think we have to walk before we can run. Frankly, when C3 phase one was introduced, there was a lot of push-back from the industry saying, "We don't have the resources to do this modeling. It takes too long, it's too expensive…." And that's why we had all these exemptions, so only 43 companies ended up having to do it.

With C3 phase two, I think the feeling is well, "If you're writing these products, you'd better be modeling it, so model it." Where that comes out we'll see, but there are ways to do models without having to run all 10,000 scenarios and still get a good handle on the exposure. So there are ways to deal with that issue.

The idea of modeling everything is not on the table yet. To be a devil's advocate, having tried to model everything for the last 30 years, theoretically it's great. It can end up being a black hole of effort. Trying to model everything just becomes overwhelming.

One of the biggest problem areas that we touched on briefly this afternoon is operational risk or any risk in which you don't have a nice statistical model that you can plug in and run. If you don't model everything, then you're in the camp that Frank mentioned, where you've got separate distributions and you've got to correlate them. It's not as good, but frankly, that's kind of where we are.

Perhaps computing power, technology, the rest of it, will get us to a point where we can literally model everything. I have to say, having been in this area of work for a long time, it's very, very hard to do without having all the lights dim and modeling for three months to get an answer. And then you say, "Well, what does it mean?" I don't know, it's what came out of the black box.

Chart 1

Conditional Tail Expectation

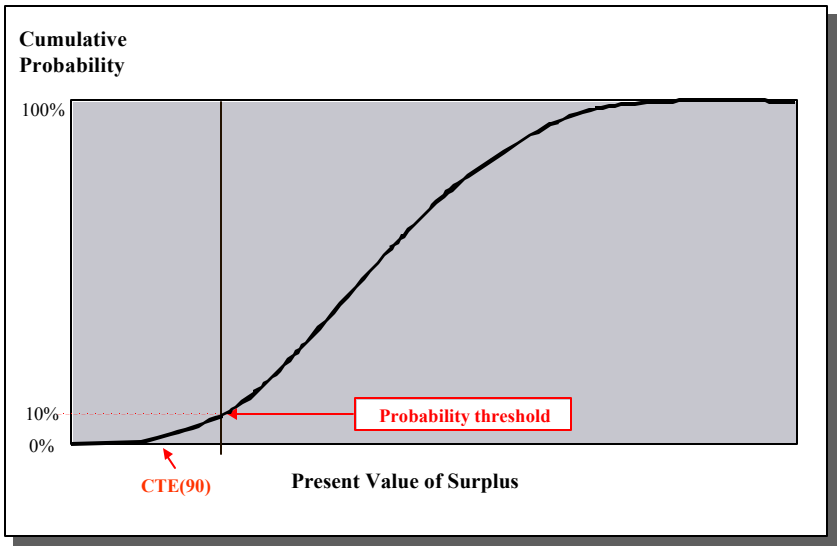


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Chart 2

C3II Risk Scenario Model

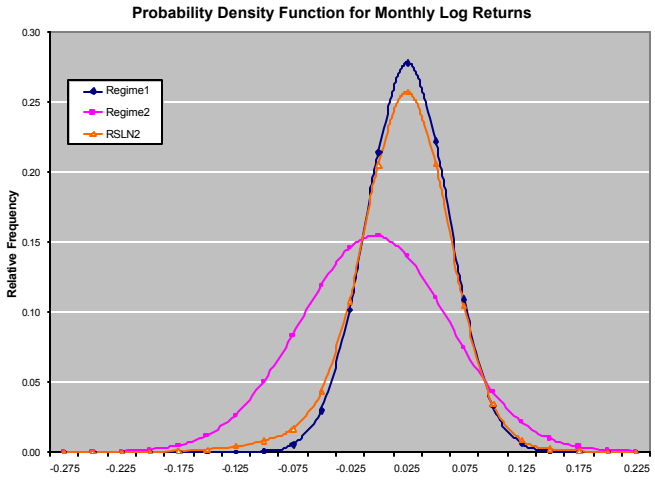


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Chart 3

## Calibration Points

**S&P 500 Total Return Accumulation Factors at the Calibration Points**

| Calibration Point | One Year | Five Year | Ten Year |
|---|---|---|---|
| 0.5% | 0.65 | 0.58 | 0.67 |
| 1.0% | 0.70 | 0.66 | 0.79 |
| 2.5% | 0.77 | 0.78 | 1.00 |
| 5.0% | 0.84 | 0.91 | 1.21 |
| 10.0% | 0.91 | 1.07 | 1.51 |
| 90.0% | 1.35 | 2.73 | 5.79 |
| 95.0% | 1.42 | 3.07 | 6.86 |
| 97.5% | 1.48 | 3.39 | 7.94 |
| 99.0% | 1.55 | 3.79 | 9.37 |
| 99.5% | 1.60 | 4.10 | 10.48 |

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Chart 4

## Preliminary Sample Capital Requirements

| Product | Return of Premium | 5% Roll-up | Ratchet | Greater of Roll-up & Ratchet |
|---|---|---|---|---|
| **GMDB** | | | | |
| At the money | 2% | 5% | 2% | 5% |
| 20% in the money | 5% | 10% | 5% | 10% |
| **GMIB** | | | | |
| At the money | 3% | 11% | 7% | 12% |

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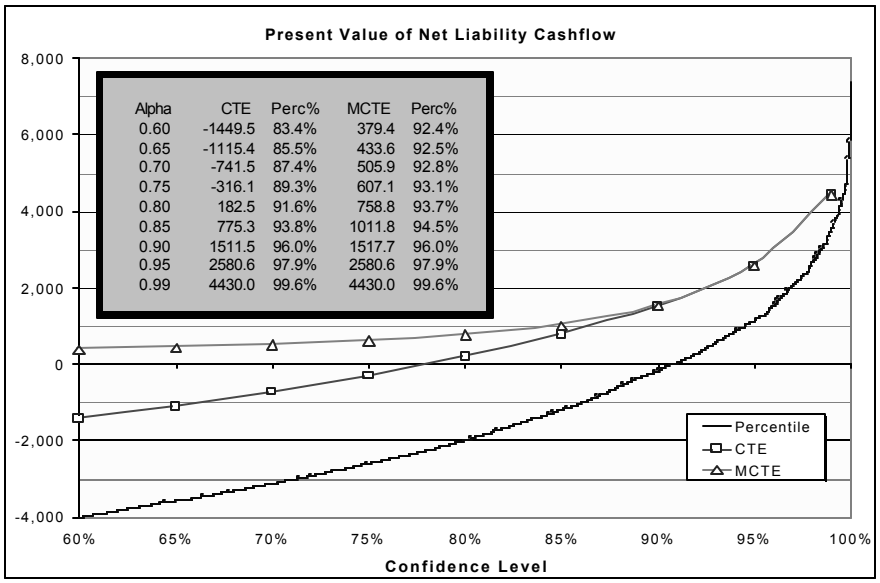
Chart 5

## Tail Measures: Percentile, CTE & MCTE




| Alpha | CTE | Perc% | MCTE | Perc% |
|---|---|---|---|---|
| 0.60 | -1449.5 | 83.4% | 379.4 | 92.4% |
| 0.65 | -1115.4 | 85.5% | 433.6 | 92.5% |
| 0.70 | -741.5 | 87.4% | 505.9 | 92.8% |
| 0.75 | -316.1 | 89.3% | 607.1 | 93.1% |
| 0.80 | 182.5 | 91.6% | 758.8 | 93.7% |
| 0.85 | 775.3 | 93.8% | 1011.8 | 94.5% |
| 0.90 | 1511.5 | 96.0% | 1517.7 | 96.0% |
| 0.95 | 2580.6 | 97.9% | 2580.6 | 97.9% |
| 0.99 | 4430.0 | 99.6% | 4430.0 | 99.6% |




Chart 6

## Variable Annuity Case Study: Assumptions

- 5% Roll-up GMDB to age 80, capped at 2× deposit
- Male age 65, duration 3.5, mortality = 65% MGDB 94 ALB
- $100 deposit, 20% in-the-money: AV=$98.85, GV=$118.62
- Monthly regime-switching lognormal scenarios, calibrated to AAA C3-II criteria (negative skewness, “fat tails”)
- Deterministic lapses (15% ultimate rate beyond duration 7)
- Pro-rata guarantee adjustment upon withdrawal; 10% FPW
- 270 bps MER, 75 bps net profit margin after amortization of CARVM allowance or DAC (Canada)
- Assume liabilities are not hedged

Chart 7

## Capital Results at T = 0: Policy Duration 3.5

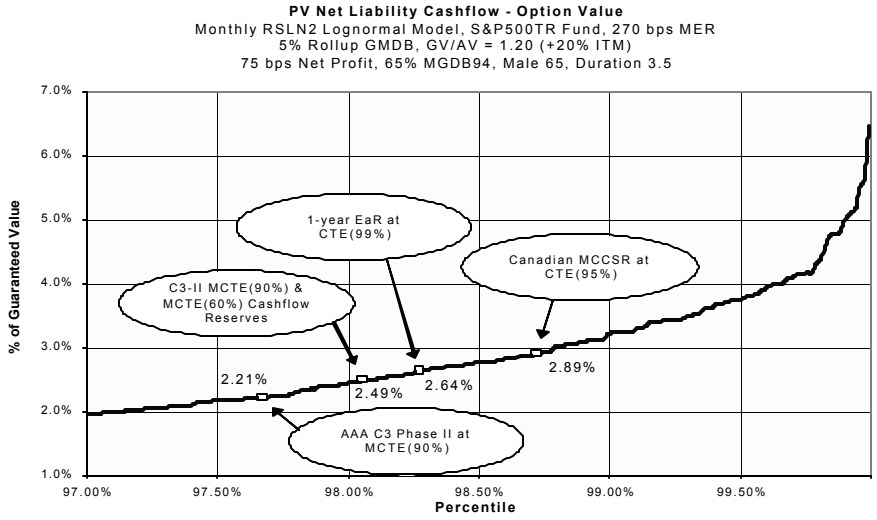






Chart 8

## Results at T = 0: Policy Duration 3.5

CAPITAL MEASURES
Monthly RSLN2 Lognormal Model, S&P500TR Fund, 270 bps MER
$100,000 Deposit, 5% Rollup GMDB, GV=$118,621 & AV=$98,851 (20% ITM)
75 bps Net Profit, 65% MGDB94, Male 65, Duration 3.5

| Distribution | C3 Phase II Drop/Recovery<br>PV Greatest Surplus Deficiency | MCCSR (PVLCF)<br>PV Net Liability Cashflows w/ Margins | 1 Year Economic Earnings-at-Risk<br>PV Net Economic Income | C3 Phase II Cashflow Reserves<br>PV Greatest Surplus Deficiency |
|---|---|---|---|---|
| Mean | $ 383.54 | $ (5,675.56) | $ (475.06) | $ 630.36 |
| Stdev | $ 841.03 | $ 3,877.84 | $ 1,256.04 | $ 964.91 |
| Skew | 2.77 | 0.45 | 0.47 | 2.07 |
| Measure | MCTE90 | CTE95 | CTE99 | MCTE90 |
| Capital ($) | $ 2,615.94 | $ 3,424.37 | $ 3,127.41 | $ 2,939.11 |
| Maximum ($) | $ 5,880.62 | $ 8,217.34 | $ 3,205.06 | $ 6,619.46 |
| Capital %GV | 2.21% | 2.89% | 2.64% | 2.48% |
| Capital %AV | 2.65% | 3.46% | 3.16% | 2.97% |
| % in Obj Distn | 97.6% | 98.7% | 98.3% | 98.1% |

Chart 9

# Volatility of Capital: AAA C3 Phase II

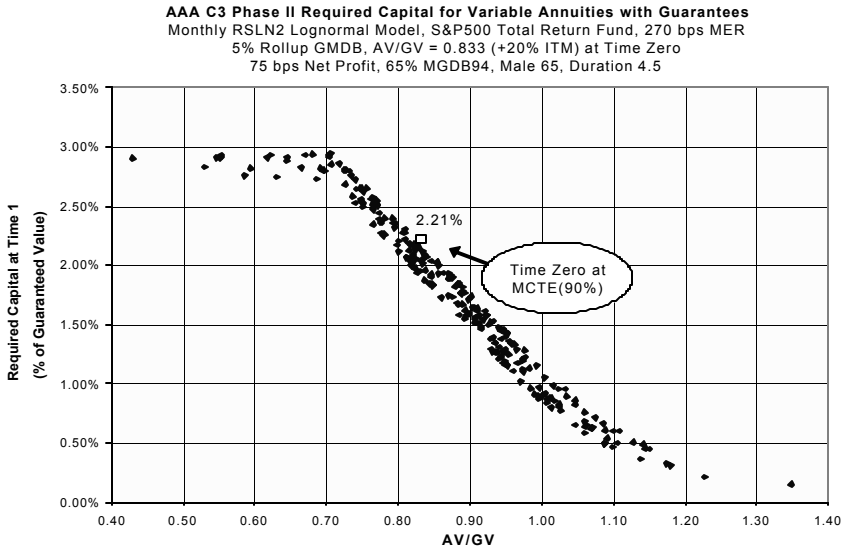






Chart 10

# Volatility of Capital: Discounted Net LCF

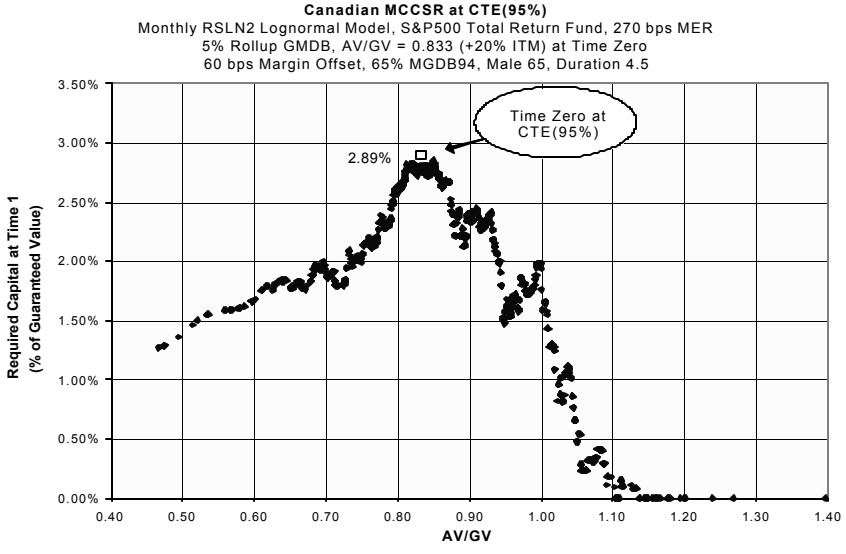


Chart 11

## Volatility of Capital: 1-Year Economic EaR

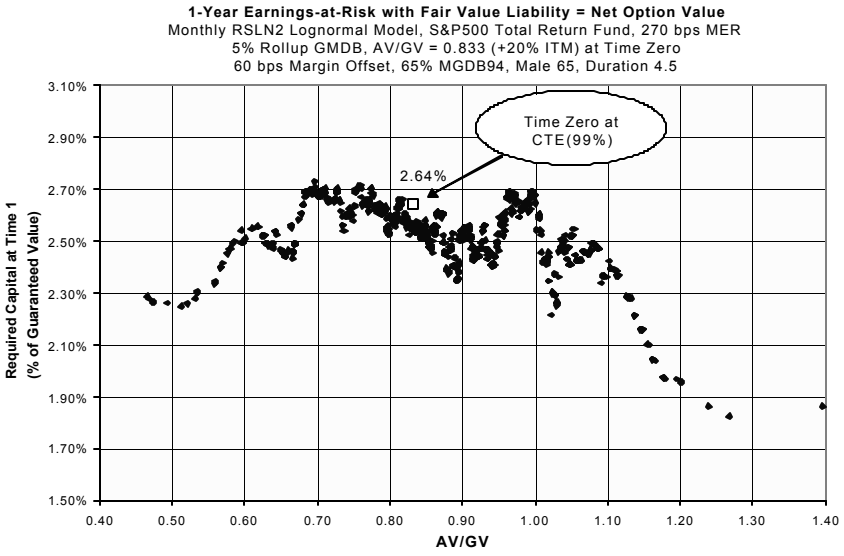







Chart 12

## Major risk areas of a life insurance company

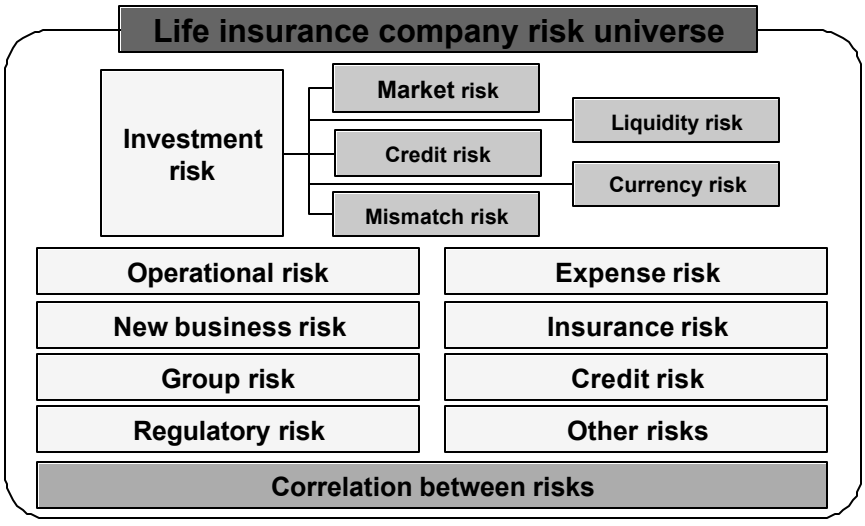


Chart 13

## Recent corporate failures

- Equitable Life (market/operational)
- General American (liquidity)
- HIH Insurance (insurance/operational)
- Nissan Mutual Life (credit/market)

Chart 14

## Examples of fa[illegible]ors underlying the deteriorati[illegible]financial strength of EU [illegible]ers

Bonus structure and policyholders' expectation of a smoothed return has meant that the fall in investment markets cannot be fully passed on

Other guarantees
- Annuity options
- Surr[illegible]values
- Ben[illegible]

Regulatory issues
- Increase compliance costs
- Compensation costs from mis-selling (USD20 billion)
- Government imposed product pricing

[illegible]requirements (Phase

Distributor pressure
- Rising costs

[illegible]from cheaper channels

Falling investment markets

Merger and acquisition activity
(Declining value in acquisitions)

Chart 15

## Approach of the UK regulator

- Implementing proactive and risk based regulation
- Bringing together banking and insurance rules
  - introduction in 2004
  - market consistent valuation of options
  - requirements for stress and scenario testing
  - internal capital adequacy calculations
  - move towards 'fair value liabilities' when EU directives allow

Chart 16

## Risk Capital Framework

Using a fully integrated approach

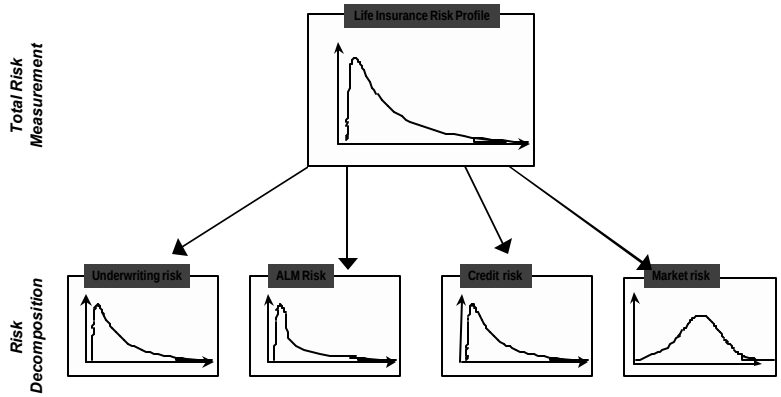



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Chart 17

## Risk Capital Framework

| Risk Element | Risk Capital | Diversified Risk Capital |
|---|---|---|
| ALM | 100 | 67 |
| Credit | 20 | 13 |
| Mortality | 15 | 10 |
| Operations | 10 | 7 |
| Total | 145 | 97 |
| Diversification Effect | 48 | - |
| Diversified Total | 97 | 97 |

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Chart 18

## Risk Capital Framework

| Risk Element | Universal Life | Variable Annuity | Uncorrelated Total | Correlation Effect | Correlated Total |
|---|---|---|---|---|---|
| Interest Rate | $8.5 | $2.1 | $10.6 | ($0.4) | $10.2 |
| Equity | | $21.3 | $21.3 | | $21.3 |
| Credit | $1.7 | | $1.7 | | $1.7 |
| Lapse | $0.4 | $1.0 | $1.4 | ($0.2) | $1.2 |
| Mortality | $6.2 | $0.3 | $6.5 | | $6.5 |
| Uncorrelated Total | $16.8 | $24.7 | $41.5 | ($0.6) | $42.3 |
| Correlation Effect | ($7.1) | ($4.2) | ($11.3) | | ($24.4) |
| Correlated Total | $9.7 | $20.5 | $31.4 | | $17.9 |

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Chart 19

## Risk Capital Framework

- Methodology Approach
  - For each period along each scenario, the value of "surplus" is determined
  - Economic Surplus (MVS) = MVA less MVL
  - Statutory Surplus (BVS) = BVA less BVL
  - MVL and BVL include liability cash flows and expenses
  - For each scenario a surplus value is determined at the end of each period; 30 years = 30 surplus values
  - For each scenario the smallest present value is determined
  - A distribution of minimum values results, and risk capital is determined by selecting the value at the designated risk tolerance level

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Chart 20

## Risk Capital Framework

- Stranded Capital
  - Natural consequence of risk capital framework
  - Excess of regulatory capital over risk capital
  - Businesses with stranded capital need to fund the cost of that capital

$$\text{Return on Risk Capital} = \frac{\text{Return Measure} - \text{Stranded Capital Cost}}{\text{Risk Capital}}$$

Simple example: Risk capital = 70; Regulatory capital = 100;
Return = 13 + 100 * .05 = 18
Traditional return = 18/100 = 18%
Return on Risk Capital = (13 + 70 * .05 – 30 * (.15 - .05))/70 = 19.3%

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