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Stochastic Risk Modeling in Banks Versus Insurers

Track: Canadian Institute of Actuaries/Financial Reporting

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Summary: Modeling techniques are expanding in the financial industry to measure both reserve and capital requirements from both a company and regulatory perspective. This session includes an update on specific approaches adopted by Canadian insurers and regulators to deal with capital guarantees on segregated fund products, capital modeling in the Canadian banking industry, and emerging issues using these techniques in the U.S.

MR. MURRAY JOHN TAYLOR: When our topic, stochastic risk modeling, was published in the final program for our meeting, the summary explained that this session is designed for attendees who have no experience with the subject. Any of you who have dug into stochastic modeling and its associated issues might find that the world starts to get pretty complex pretty quick. Maybe this is a new area for actuaries to pursue, and, therefore, we'll approach this with an open mind. Or, perhaps this is a primer to get everybody going. In a way, it is because we're going to not just look at one unique area of our business or where these models might exist. We have people on our panel to represent some of the dynamics of the Canadian circumstance of both banks and insurers and from an American insurance perspective. We're going to pick up each of those perspectives.

One of the questions you might have is, why bother? I grew up going to a university in the 1970s. I'm now considered an old-timer because I studied Jordan. Models didn't exist, and computers were just on the verge of coming into the current realm. The world has changed in many ways. I think we need to stop and understand why. I think one of the things pertains to how emerging risks or products should be valued. The segregated fund risk in Canada is one of note where it certainly got so creative that stochastic modeling was really one of the only

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methods that one could use to properly assess the risk. Regulators want more credible assessment of risks. Much more attention is being brought to risk management than just what you call reserve or even capital management. We've seen that through the federal regulator in Canada and the Office of the Superintendent of Financial Institutions (OSFI), with the banks and certainly more and more with insurance companies.

I think companies desire a more precise value of their capital than what you'd get from unmodeled, conservative factors. If you take the first two points and say, "I don't want to go the stochastic modeling route; it's very complex, and takes lots of computers and too much math talent," then I think what you're left with is, between the regulators and the product marketers, capital that will probably be very conservative. That can be problematic. The cost of capital can inhibit a product being issued and so on. Finally, the first three were on the needs side, and the last is on the supply side in a sense. There is now capability to do this modeling that didn't exist 10, 20, 30 years ago. I think those are some of the key items of why stochastic modeling is becoming front and center. Now, I'd like to introduce our presenters.

Steve Prince is a Canadian actuary. He is a consultant with Dion, Durrell & Associates. He has done work in his consulting assignments with some of the bank challenges when it comes to capital. He's a member of the task force on segregated funds of the Canadian Institute of Actuaries (CIA), and in that role he is also leading a subgroup on developing a proposal for stochastic capital in Canada for the segregated fund risk. Donna Claire is president of Claire Thinking, Incorporated, where she does general insurance consulting with a focus on asset/liability risk management. She's the vice-chair of the American Academy of Actuaries' Life Practice Council, and she has also participated in a number of Academy activities, including the Life Liquidity Risk Work Group of the Academy, the task force for Variable Annuities with Guaranteed Living Benefits, and the Life Practice Notes Committee.

We have two individuals who have joined us who are associated with the TD Bank. Nico Meijer is the senior vice president of the TD Bank Financial Group in Toronto. He is a Ph.D. graduate of the University of Toronto with previous degrees from Waterloo and Toronto. He's in charge of many of the risk management activities of the bank. Chak Raghunathan is with the TD as well. He just moved there very recently. Before that he was working with Office of the Superintendent of Financial Institutions (OSFI), the federal regulator in Canada. He was also with Caisse de Depôt before that, and holds a master's degree in applied math. So, we have lots of math talent for you here. On that note, I'm going to turn things over to Steve.

MR. W. STEVEN PRINCE: As you've heard, and will continue to hear, products have gotten more complex and the consumers have gotten smarter. The traditional factor-based approaches to capital and anything else in the world just don't hold up, and they have distinct limitations. Companies are using increasingly complex software tools to develop and assess products. It's only logical to use those same tools to assess the capital and reserve levels that companies should

hold. One of the presentations this morning mentioned regulatory arbitrage. Companies understand these things well enough to shop risks out and move them offshore when it's advantageous to do so. We are simply applying that same logic in setting the capital levels.

I'm going to start with the reasons why you shouldn't use stochastic capital. I'm going to disagree with these people. For openers, it's just too complex. Companies are already using these models when they design and price their products. There are other sessions covering ways to use this. It's hard to say, "We're going to use this to set the prices and decide what we're going to sell." You can't then say, "We don't trust it enough to actually set our capital levels with it." If you don't trust these models in the first place, why are you using them at all?

Another argument against stochastic capital is that with complex, multidimensional models, you can manipulate assumptions far too easily. This is true of any complex formula. In Canada, we do not have prescribed valuation bases for reserves. The actuary has a professional obligation to use an appropriate basis, and if you want to use a mortality rate of 42% of table, you must come up with some sort of justification for the 42%. If you want to do some factoring in your stochastic model, you have to come up with a professional justification for it subject to peer review and review by auditors and regulators. If you can't tell us what's appropriate, the same situation applies. So why are you selling this in the first place?

Another argument against stochastic capital is that results are easily manipulated. Factor-based formulas can be manipulated, and this happens every day when companies add product features or guarantees or extra benefits that they know do not generate extra capital or reserves through their factors. So yes, you can manipulate a stochastic model, but you can also manipulate a simple formula simply by changing things that you know the formula doesn't reflect. The CIA task force worked on this process over the last two years. If you read the full report in its excruciating detail, you'd see that it's simply not possible to have a suitable adjustment for every factor that everybody might dream up in a product.

Another argument against stochastic capital is that results aren't consistent between companies. Inconsistency between the companies is simply showing a need for a better understanding of the risk. While the task force has argued about whether this or that factor is significant, the fact is we don't always know whether it's significant. If we don't know whether it's significant, that's a case for further study, not for saying, "Let's ignore it." If you don't know what the answer is in the first place, why are you more comfortable with a wrong factor approach than a potentially wrong stochastically modeled approach?

Another argument is that we have to get consistent answers. If you want to get consistent answers even when you have an inherently different risk, that, too, must be wrong because the risks are different. You should get different answers.

Another argument is that these models are very hard to audit. They are, but you've already bet the future of your company on that model when you started selling the product and using it to set your prices. If you don't understand the model, and it can't be audited, why are you using it for any purpose, never mind surplus and capital?

Going forward, what are the advantages of stochastic capital? We are looking for consistency among pricing, reserving, and capital. The model should reflect, as I keep saying, every relevant factor about the risk. That doesn't mean it has to reflect every irrelevant factor, but if something is significant, it should be in the model. If that's in the model, and it's significant, and you set your prices on it, one type of analysis with that model gives you your reserves. A similar type of analysis, possibly to a higher confidence level, gives you the total balance sheet requirement. The difference is, therefore, capital. Companies can base their capital on the best available information, and this is a recurring theme. We know that this is an issue, and it's to our advantage, and we haven't reflected it. In the area of stochastic capital, you might know how to reflect it and thus reduce your capital because of that information.

If you know something is an issue, and you know the factors don't reflect it, this says you'll have to reflect it. The idea is to have an appropriate capital reduction for all your risk mitigation strategies. If that's hedges, let's model the effect of your hedges. If your hedges are working, you can get a big credit in your capital because of stochastic modeling. If your hedges aren't working, the right stochastic capital models make that abundantly clear. The capital stays current with evolving practice. As the world gets smarter and more refined or less refined, capital standards are adjusted automatically because they're based on those stochastic models.

Key regulators have expressed an agreement in principle to stochastic capital. They agree that there are a number of operational issues about auditing models, about control of models, about what is good or bad stochastic modeling practice, but regulators have expressed a view that these are educational and research issues rather than fundamental flaws in the process. In many bank situations, which I'm sure we'll hear about later, stochastic models are already in use for capital levels.

The CIA task force has been working with regulators to develop some consistent standards, and, in a parallel development, another group of the CIA has been working towards stochastic reserves for some types of product lines. We're not trying to develop complex models and simulations where it's of no practical difference in the reserve you would hold. But, where it is relevant and where it would affect your reserve, there is a movement in the other task forces of the CIA towards having stochastic reserves.

Much emphasis goes into total company management of risk. Much of the work in the last couple of years has gone into developing these stochastic models, but that's only half the story. If you've assumed a certain level of hedges, a certain level of rebalancing, a certain level of policyholder behavior, the model is of no value unless you have the corresponding company operational expertise to carry out

whatever strategy it is you've assumed in the model. You have to have good audit controls over your models. Traditionally, some models have been in the hands of one or two actuaries who were probably the only people in the whole company that understood it. If they thought of a refinement and wanted to implement it, off they went. Where you're betting company results, where you're changing regulatory surplus levels and so on and so on, you need more formal audit controls, just as you'd have on your accounting system, and just as you should have on your reserve systems. These are development and research issues rather than fundamental flaws in stochastic capital.

The task force has been writing technical guidance on what is a good model and how to demonstrate that you have one. Some of this is fairly straightforward. It's simply a matter of saying "We've tried it both ways, and A works over B here, and C works over D there, but it's a documentation as you find on any subject about what's good practice or not." We have not mandated specific investment models, although we've looked at several. Instead, what we have mandated is calibration criteria. You have the world's most innovative investment model. The first test is, does it reasonably reproduce actual investment returns of whatever it is you're trying to model? We've established criteria for answering that question, and if you answer that question properly, then we don't actually care what model you use. Equally, if you can't answer that question, we're not much impressed with all the theoretical justification for why they should be good models, even though it has a little practical tracking.

You will probably see a need for greater coordination between pricing product and investment operations than has been the case in the past. A parallel to this would be where insurance companies moved into what most of the world would call guaranteed interest certificates or deferred annuities. The days when the actuaries would set the prices and the investment people would invest disappeared when investment margins became very thin. You had to have weekly meetings with your investment people. You had to have regular reviews of your asset/liability matching. The result was that you had a much better sense of whether you were making or losing money. I can see a similar evolution taking place on segregated funds. If you guys want to invest in that, and we're going to guarantee it, we have to do such and such. If you can invest in this instead, then we can do something different. That's an entirely appropriate evolution of matching what the company's doing with how it reports on those results.

There's probably going to be more work for auditors or internal auditors. When you get significant dollar numbers hanging on the results of these models, there are significantly more controls and reviews of those models entirely consistent with the way reserves and capital are set in other processes. This seems like a lot of work, and that has been a recurring theme over the last day or two as well. However, the company took on that work when it decided to start selling the products in the first place. It's in the company's self-interest to make sure it's setting appropriate capital levels. The other way of saying the same thing is, make sure they have appropriate risk mitigation in place for the amount of capital they've decided to hold. It's in everybody's self-interest to hold appropriate capital levels. I do

significant work with some clients in private consulting practice. Aside from regulatory capital, they want an accurate assessment of the correct amount (aside from the rules) of capital we should be holding. This simply codifies that practice and applies it across the industry.

MS. DONNA R. CLAIRE: There is much talk in the U.S. regarding stochastic risk modeling. The reality, however, is that the majority of companies in the U.S. do little or no stochastic risk modeling.

We are moving towards stochastic risk modeling becoming more important. However, it is a slower process than it has been in Canada. This is for a number of reasons. One is that there are a number of small companies in the U.S. such as pre-need funeral benefit companies, and for them, doing stochastic risk modeling may not make sense. Another major reason is that, in the U.S., there are statutory formulae which control reserve levels for most products and the risk-based capital formulae is mostly on a formulaic basis, so many do not see the need for stochastic risk modeling.

However, having said this, some progress is being made. There are a number (not a majority, but a decent number) of companies that have discovered that, because of the risks they are taking on, stochastic modeling makes sense. There are also a number of U.S. companies that are now part of international conglomerates. Some of these parent companies require stochastic modeling.

There are some companies that model much of their business stochastically. Others do it for a subset of their business, such as for a particular product line, like variable annuities. Others do it for a particular purpose, such as to see their exposure to liquidity risk.

The formulaic reserves in the U.S. are based on the Standard Valuation Law, which, although it has been updated periodically, has basically remained about the same through the 20th century. Many feel these reserves are generally more than adequate. There is no major push to change reserves simply to address adequacy concerns.

There are a number of people who would prefer if the U.S. went to a non-formulaic reserving approach, which would take into account stochastic modeling. However, there are a number of obstacles to this in the U.S.

A task force of The Academy spent several years developing what is known as the Unified Valuation System (UVS), which would bring in more stochastic risk modeling in reserves and capital requirements.

It was not uniformly embraced. Some of the opposed are those that would oppose any change, since change would require more work. Another concern in the U.S. is the tax structure: right now tax reserves, which are based on a formulaic valuation law are tax-deductible; it is not known what effect a change in reserve methodology would do to tax reserves.

The Academy's Life Practice Council still embraces a UVS concept, which would lean towards getting the right answer for reserves and capital, and would have a feed back loop on actual versus expected results. We are now calling it non-formulaic reserves, since the term "UVS" did not meet with approval.

C-3 modeling is done for risk-based capital. It introduces more stochastic risk modeling. The interest rate scenarios tested are expanded to 50 scenarios. It isn't pure stochastic modeling, since a specified set of scenarios is required.

This type of modeling is only required in certain circumstances, e.g., much of the reserves being in individual annuities. For year-end 2001, only 48 out of the over 1000 companies in the U.S. had to do such testing.

A second risk-based capital effort is now underway for products with an equity component, such as variable annuities with minimum death benefit guarantees. This project is in the early stages.

The actuarial guideline for equity-indexed annuities was the first to introduce risk management in reserving in the U.S. If the company meets a stated definition of "hedged as required" (which includes dynamic hedging strategies) they may hold reserves on a basis generally considered more liberal. The disconnect between the amounts on the asset and liability side should be minimal.

If the companies are not hedging, they are required to set up reserves such that, if a regulator walked in and required it, they could take the money in reserves and invest it in the current marketplace and be totally hedged.

Variable Annuities with Guaranteed Living Benefits are products that guarantee a certain return, e.g., the premium accumulated at a 5% interest rate, if a person stays in the contract for 10 years. They are equivalent to segregated funds in Canada.

Originally, there was an Academy working group that was looking into developing a very simple formulaic reserve method, consistent with the Commissioner's Annuity Reserve Valuation Method. It did leave open some possibility of stochastic modeling.

The CIA's work on segregated funds was read and appreciated by a number of people in the Academy group. Specifically, Mary Hardy and Geoff Hancock have been instrumental in furthering the intellectual basis of the Academy project.

Now more effort is being put into looking at the stochastic risk-modeling basis. This will also become important when developing the life risk-based capital level for these products. At this point, it is possible that a stochastic risk modeling basis will be incorporated in this guideline.

The liquidity risk inherent in the assets and liabilities on life insurance companies has gotten more attention in the past couple of years. One of the products that caused

concern was funding agreements, which are typically agreements with municipalities that allow the municipality to put the contract back to the insurance company at book value with as little as 7 days notice. The NAIC is looking into liquidity risk, and The Academy wrote a white paper on this subject.

The conclusion so far is that this is not a subject that can be answered with a formula. Instead there needs to be liquidity risk identification, modeling (generally stochastic modeling), and management of the risk.

One of the state departments that is generally up front when it comes to regulation is New York. They do have a capital management section within the department to look at capital risks. They have also sent out questionnaires on liquidity management for the last 2 years. They follow up with companies they feel need additional attention.

This year, recognizing the potential volatility of results on products such as variable annuities with guaranteed living benefits, they have sent out a questionnaire on the risk management of these products, and will be following up with certain companies.

Like New York, other states are talking to company management regarding risk management practices, and the models that are being used to measure the risks. There are certain states that will not allow certain product features to be sold in their state unless the company can show that the risks are properly managed. It is likely that risk management and measurement will become a more important part of the tri-, quad- or quinquennial exams the states conduct on their companies.

Due in part to a federal legislation known as Gramm-Leach-Bliley, which blurred the lines between financial serves companies, there is more interaction between insurance and bank regulators. The Academy is also having more dialogues with Federal Reserve Bank employees. On the banking side, they have some minimum capital guidelines, but there is much more reliance on the bank examiners' review of risk management. This thought is being repeated by the insurance regulators.

The Actuarial Standards Board in the U.S. has proposed updates to the standards on actuarial opinions and memoranda. It will eliminate prescribed standards, such as the New York 7 interest rate scenarios.

The proposed standards will put more onus on the appointed actuary to test what is needed in order for the reserves to be at a proper level. This would, include stochastic testing, where appropriate. In summary, although we are not setting any speed records, the U.S. life insurance industry is making some strides towards stochastic risk modeling.

MR. NICO MEIJER: I'm responsible for market risk management within Toronto Dominion Bank. Based on what I've heard from the last two speakers, we actually have quite an interesting perspective to bring to this topic. We are in one of the few

areas where our regulators actually mandate stochastic modeling for capital purposes. I'd like to talk about organizational structure to see how that risk management model actually gets actualized in an organization. I'll also give some overview of the market risk models that we use for capital and risk management. Finally, I will give our approach to market risk management.

Our primary regulator, the OSFI, as well the Bank for International Settlements (BIS) International Group, has actually mandated the use of internal models for market risk within the trading books of banking organizations. We use stochastic models day in and day out. It's integral to the way we do business. Finally, just because the segregated funds have been a topical area, I thought I'd just show you how that applied to the equity options business that we have. We have equity exposure in our bank trading books.

We're organized so that I report to the chief risk officer of TD Bank, Tom Spencer, who reports to the CEO. A number of groups work with me. First, we have three risk monitoring groups—one in London, one in New York, and one in Toronto, where we have our primary operations. The one in Toronto also does all of the global risk reporting. In addition, we have two quantitative analysis teams, and these are teams that consist of primarily PhDs in math, physics, or engineering who do a lot of our model vetting and credit analysis. Our mandate is:

- to develop and maintain a set of policies that mandate what our trading groups can do so that we take positions consistent with the firm's risk capacity
- to provide an independent market risk oversight to ensure that those policies are being complied with, so we do the compliance function
- to report the key measures of market risk, specifically, how much risk we're taking for all of our businesses to our senior management
- to maintain our internal model for regulatory market risk capital, which involves calculating what we call value-at-risk and doing stress testing and maintaining the policies and processes that support that
- to provide some input and oversight for new businesses and for the proper conduct of new business initiatives with respect to the market risk and market risk capital
- to validate all of the trading and pricing models that are used in the dealer, making sure that they provide not only the correct pricing but the correct risk measurements and making sure that they're suitable for use within our risk systems.

I'd like to give you an overview of our primary tool for calculating market risk capital, which is a stochastic approach called value-at-risk (VAR). Basically, it gives you the expected maximum loss or worst loss that you'd experience given reasonably normal market conditions. It is normally a ten-day time horizon and a 99^{th} percentile confidence interval. That's basically what's mandated by our banking regulators. We calculate capital based on a multiple of that VAR stochastic measure. So we're trying to find a threshold beyond which our losses should not exceed more than one day in 100 days with this measure. It's a statistical measure.

There are several approaches that can be used to calculate VAR. One is historical simulation, which is like our mainstay, which is the main one we use. The second is Monte Carlo simulation. The third is variance/co-variance or sort of an analytic formula. Then there's a mix of hybrid models. The problem with the VAR measures is that they don't really tell you what could happen in the worst one day out of 100 where you exceed your VAR threshold or where you're expected, on a statistical basis, to exceed that. It doesn't really give you an extreme stress, but it does tell you by and large what your risk is. Second, there is a reliance on historical data, either directly through a historical modeling approach, historical simulation, or through the parameterization of your other models because you have to go back to your historical data to parameterize them. We can actually be at risk of misstating our risk due to recent market trends and volatile events in the market, for example, as they pass through your data set.

So one of the steps that we go through when we do our historical simulation is to define our market risk factors. For example, for equities, it might be the spot price, the volatility, or a dividend yield. We identify a set of market risk factors that affect the pricing or the valuation of the portfolio of products that we have. We'll collect the values of these market factors over a particular historical period. In particular, we use the previous year. So we'll construct a vector of values for those factors. Then we'll calculate the shocks, the daily changes period by period. Then we'll basically see what those shocks would do to our current day's portfolio in terms of how much that would move the value. So that creates a set of alternative values to the portfolio. We'll effectively sort those, and we'll take, in the case of a year's worth of data, the third worst day, which gives us, roughly, a one in 100 events. We will calculate the VAR based on that desired confidence interval. It's quite a simplistic approach, but it's very difficult to cheat this approach because it relies completely on a formula based on historical data. The critical thing is to make sure that historical data are clean, and that can be quite a challenge sometimes.

If you were to use Monte Carlo simulation, the approach is very similar. The only thing is that you would be constructing a mathematical process that you then run 1,000 times or 10,000 times or 100,000 times. That process would be a model of the market risk factor in which you're subject to risk. You would basically still rely on the historical data to identify the parameters that drove that process, but when it comes to actually implementing the VAR calculation, you do the same thing that you do with an historical simulation. You just run your current portfolio through the set of shocks that the Monte Carlo set of sample paths will give you and choose a scenario that is basically calibrated to the confidence interval that you desire.

The third common approach is a variance/co-variance technique where you actually look at the variance and the correlation among the market risk factors in a more or less closed form. You're really doing a first order or first and second order Taylor Series approximation to the risk in your portfolio. You make a normality assumption, but you can get the same kind of result for most portfolios. I guess this can break down when you have very short-dated options and a high degree of what we call gamma or convexity to them. By and large, this gives you a very quick and dirty, very fast way of calculating your stochastic factors.

Finally, it's possible to mix and match some of these factors. For example, it's possible to do a Monte Carlo representation of your portfolio, and then run it through a historical simulation. So we do those kinds of things sometimes, too.

So TD Bank Financial Group's approach uses a combination of models for market risk quantification. We rely primarily on historical simulation. We're looking now at specific risk for interest rate, or, in other words, risk to migration and default of some of our obligors that we have exposure to. Therefore, the migration and default piece will look for a different methodology, more of a closed-form methodology. We also have some very complex businesses, which are difficult to model, and we've taken some approximating approaches there like the variance/co-variance approach.

One thing to note on this is that all of the model inputs, all the models we use for pricing, are subject to rigorous vetting. All of the historical data that we use, or the estimate of the parameters that go into our models, is subject to vetting as well. We have two quantitative groups. One we call market quantitative analysis, and one we call credit quantitative analysis. The market group basically tests all the models for pricing validity. They're basically a group of seven or eight primarily PhDs in math and engineering. Even our audit group hires PhDs in mathematics to audit the vetting team. We have some multiple layers of control on that. Then we have a credit team that audits the way we measure our credit exposure, for example, for off-balance-sheet products like swaps and options, and they have a similar academic profile.

How do we implement this? We have a hierarchical structure of VAR limits. For example, the local desk trading head might have some authority to go to a certain level. The business manager who he reports to would have a higher level, as would the global business head and the head of TD securities. I end up having a higher level, and my boss has the highest level of authority. We actually implement this through an automated process. All overages or all excesses to limits get entered into a database and are escalated automatically through that channel.

We report our VAR numbers daily, and we typically get those reports done by early the next day. We do the final one possibly by noon of the next day. We have a centralized database. The nice thing about having this all tracked in a database format is that we have an audit trail of all our exceptions. We can track whether excesses were pre-approved. Our auditors will look at that ratio, the pre-approval versus post-approval, and we can report statistics on which desks have been the worst violators. This is very much embedded in our risk culture.

VAR does have some limitations. As I mentioned before, it isn't really used at the trading desk level. Very few traders manage their business on a VAR basis. It's really more used for a very high level view of the risk at 30,000 feet and the calculation of market risk capital. To address this shortfall, we actually have a comprehensive set of other limits. They are what we call Greek limits, notional limits, spread limits, or maturity limits. These control the risks in our positions.

To augment the shortfall of VAR, which doesn't really tell you what happens in the worst case scenario; we also do some scenario and stress testing. We'll try to set up some scenarios either based on our historical observed experience or based on what we think might happen in the market. For example, we might model a six to ten standard deviation event depending on the market. We will choose scenarios based on the distributional assumptions we can make about a particular factor. We do a weekly stress report for the bank, and it's interesting that this is the tool we use to define our overall firm-wide capacity for risk. We sat down with the CEO of TD Bank. We discussed how much trading loss we would be prepared to take in a bad quarter. It was basically looked at in light of what that would do to the stock price and what that would do to market perceptions of our organization. We agreed on a number, and we agreed on some methodologies in terms of whether we have some reserves, would we count those reserves? If we had some run-rate franchise revenue, how much of that could we count on? We developed a methodology where we actually come up with a global limit to how much risk we can take.

On the new product process, we look very carefully at what we get involved in. If we can't price it, we certainly won't do it. We also are required to vet the models independently of the trading desk that we use. We take into account costs of hedging. We take into account infrastructure. For example, if we can't support it from an operational perspective, we won't do it. If we can't measure the risk in it, we won't do it. We have a quality team of risk managers. Basically, the key for them is to have credibility with the business, to be seen as adding value to the business. My team is probably about 35 professionals. About 12-15 of them, depending on where we are at any point in time, are in these quantitative analysis vetting teams, and the rest of them are actively involved in compliance policy and monitoring the business.

That's what we do for risk, and I just thought I'd use the last little bit of this presentation to show you how this works out in practice with equity exposures. In particular, with the interest in segregated fund exposures, I think it's quite illuminating to see the different approaches that are taken within banks' investment dealers versus within insurance company exposures to equity-based investment products. In our equity derivatives business, we make two-way markets and equity options, typically up to five to seven years. The exchange-traded markets are typically liquid up to six months to a year. Perhaps in the U.S. you have some leaps and contracts of that nature that go out to two or three years. Basically, there's not that much in the way of maturities for active exchange-traded products. Beyond that, we can trade in the over-the-counter market through swaps documented on a bilateral basis through International Swaps and Derivatives Association (ISDA) legal agreements. The market there will go out to five years. We've seen 7–10-year products, but it's normally a five-year market for equities.

After we do a trade, we price and value those portfolios daily. Volatilities reflect the term and the strike of the options, and the positions would be marked using a surface. It's a fairly sophisticated thing. The volatility really depends not only on the maturity of the option, but on whether the option is "in-the-money" or "out-of -

the-money." So we actually use these surfaces not only in our pricing, but also in our VAR measurement for capital purposes. We would have a year of data and samples of these surfaces going back in time.

We would have VAR limits on our equity books. The VAR would be an equity VAR, and the interest rate risks in the equity books would be subject to a VAR limit. As I say, VAR is used in all dimensions of what we do. We feel the valuations in capital allocated to this business actually reflect the two risks in the transactions. What's more important is the cost of hedging because when we use something like implied volatility to mark these portfolios, what we're really saying is that we could go out into the market and source an offsetting hedge. We can lock in at least a fixed amount of loss, if not a profit. We could control our risk with that.

I think it's interesting to look at the differences. Bear with me if I haven't captured the insurance industry's correct approach to equity-related investment products absolutely correctly. From my viewpoint, which is somewhat uninformed, this seems to be what's going on. We can go through a point-by-point comparison.

We do daily mark-to-market or mark-to-model using implied prices from the market. Insurance companies seem to use an actuarial approach to pricing, using a long-term analysis of the historical behavior of the equity markets. Maybe that's a fair thing to do given the fact that the maturities in the products that you sell tend to be much longer.

We use market observable prices for hedging, implied versus historical data. I think you use historical data for valuation, if there's a mark-to-market at all. I don't know if there's a regular mark to market.

Our market focuses on short maturities, out to five years. I think that what we see in the segregated funds is maturities that extend 10 to possibly 30 years. It's problematic to even find a hedge that extends to that kind of maturity. I guess it's possible to do some kind of stack-and-roll where you sort of buy five years at a time and roll it as it matures. You're certainly left with a lot of maturity mismatch risk.

In terms of how we control our risk, we have comprehensive limits on VAR, sensitivity to spot prices, volatilities, dividends, interest rates, borrowing costs, and so on. We try to look at all the material risks that might affect our book. I think I see the insurance industry basically putting a limit on the program size or the amount of risk that you're willing to have in a particular program.

We manage our risk actively. So we go out and hedge the exposures that we have by buying offsetting products. That is not to say that we don't take market risk, but the market risk we take is a deliberate view that we have on the market at any point in time because we see certain flows, and we have certain information about the market. So we will trade it, but we'll trade around the core position. That core position tends to be hedged. In the insurance industry, it seems to be managed

more via diversification in a portfolio of risk, which could include mortality, property and casualty risk, weather risk, catastrophe risk, and earthquake risk or whatever. What's interesting is this goes to the core of the differences between the industries that we're in because we are basically in an intermediation industry where we try to take out a fee. We warehouse a limited amount of risk to facilitate that, but our primary business is not risk warehousing. (The exception is credit risk, and even there, we're being disintermediated by the capital markets). I think insurance companies are basically in the business of warehousing certain types of risks. On a portfolio basis, they are making sure that there is enough diversification that guarantees it is economic over the long cycle, so we make our earnings by locking in profit spreads between the product and the hedge. You'll make your earnings by fees and excess returns from predicted returns versus the committed payouts that you have.

It's interesting to ask which approach is correct. I guess my main observation here is that if you're going to warehouse a risk, you might as well get as well paid for that risk as you possibly can. I think there's a certain amount of due diligence that you need to have before you start selling equity risk to make sure that selling it through principal guaranteed investments is the most efficient way for you to bring that risk into your portfolio. You might get better paid for it by selling it to the capital markets. It would be interesting to get people's views on that.

MR. CHAK RAGHUNATHAN: I have just a couple of comments to add. First there is a regulatory requirement that all models used for capital calculations be back tested. That's something we do on a daily basis. There is also a requirement that models be used for more than just capital calculators. They have to be integrated fully with our day-to-day risk management. I think these are the two key things that we need to remember.

MR. MEIJER: There is one thing I wanted to mention with respect to Steve's comments on the advantages of a stochastic approach. One of the things that's not emphasized enough is that if you align your capital charges with the actual risks in your portfolio, then you're actually providing the right incentives for your business manager when it comes to product design and marketing programs. The kind of business you get involved in will be priced so your return on capital reflects the correct sort of risk-adjusted return on risk-adjusted capital and is reflective of the true risks in that product. So, I think getting the incentives lined up with the economics in the business is important.

MR. TAYLOR: I think we've heard a lot of diverse perspectives on a very common theme. The four-letter word has been mentioned many times, and that is "risk" and the management of it. So, the floor is open. Feel free to direct your comments to the panel at large or to any individual.

MS. NICOLE A. FENDE: I'm from a bank, but I'm an actuary. I'm a U.S. actuary, but I can give the Canadian perspective. On the U.S. side, insurers tend to hold two to three times the minimum RBC requirement for the rating agencies. They want to get good ratings so they can sell insurance to people who have faith in their

company. This is very interesting, and I actually have a math degree, so I love all the techy stuff. However, the bottom line is, what does a company need to hold to be competitive in the market? What value do you see in stochastic versus RBC if a company ends up holding two to three times RBC anyway versus the number that you're coming up with. Donna, you had mentioned that when it was done in New York, there was very little change from the existing methodology.

MS. CLAIRE: Again, the two to three times is actually based on, for example, Standard & Poor's (S&P) and Moody's formulas, which happen to be more formulaic. Companies that are actually doing really good risk management also explain that to Moody's and S&P, and they do get brownie points for that. These days, a lot of the larger companies will have their own internal formulas. They will pay some attention. They definitely have to do S&P, and so on, but they will have internal formulas that govern beyond or above the S&P, Moody's, and other agencies.

MR. PRINCE: As a supplement to that, and certainly in Canada, the objective is that by having statutory requirements based on these stochastic models you don't get into this two or three times RBC just because the rating agency wants it. If you're doing something risky, you should hold more capital. If you're not, you shouldn't. So that's one point. A second point is, I have clients who actually want to know whether the RBC formula is enough and that they aren't doing something that will get them into trouble; you can't hold less than RBC, but it's nice to know you don't need to hold more.

MS. FENDE: Do either of you actually know of or have clients that are able to convince a rating agency to hold very close to the minimum requirement and still maintain a very high rating?

MR. PRINCE: I have one client who has paid me a small fortune to tell them that the regulatory capital was, in fact, more or less right in their circumstance. However, it was right for different reasons than they expected going in, so they have a greater comfort that it is probably the right number. As we heard a moment ago, there were the right incentives. They hear what would make it worse, and what would make it better; although, in that case, it happened to work out to about the same number.

MS. CLAIRE: In the U.S., there are actually companies that are closer to the risk-based capital level. They are typically health companies, though. For life companies, I think the rating agencies view the risk-based capital more as a minimum. Again, certain people are higher than others, but I know a couple that are close to the risk-based capital level with a decent rating. In general, it's a little bit harder on the life insurance side.

MR. TAYLOR: My experience in Canada has been with a large insurer. There is not a material difference between what the rating agencies are looking at and what the regulators are looking at. The regulator defines a minimum capital that is not really the minimum capital. There's a lot of discussion in Canada around the multiple of

that minimum that is really required, so you're caught up in the debate of whether it is 150%, 175%, or 200%. There's a tight range between 175 and 200 that companies tend to travel within. Stock analysts, because of the demutualization issues in Canada, are probably more of an issue than rating analysts and regulators.

MS. CLAIRE: Just one last comment on this. Actually the one company I'm thinking of that is a large U.S. company sells mostly variable insurance. So their risk-based capital is relatively low, and the rating agencies don't have a problem with it.

MR. MARK TENNEY: Does the VAR that you calculate include things like certificates of deposit or commercial loans, or is that only the trading portfolio?

MR. MEIJER: The internal model for capital is supposed to be used for what we call our trading book exposures. The bank has market risk within the banking book, and the corporate loans tend to be in a banking book and are accounted for on an accrual basis. The VAR does not apply to our loan portfolios. It applies primarily to our trading portfolios, fixed-income derivatives, foreign exchange, and equity and so on. With that being said, I think the impetus from the regulators is to move towards a models-based approach and a stochastic approach for all exposures that a bank has. In fact, the latest BIS proposal is supposed to be implemented in 2004. For our year ended late 2003, this proposal mandates that the banks start to supply some of the information that goes into our risk ratings for credit capital for the banking book based on our own internal estimates. For example, our loss given actual default and probability of future default. So, the whole banking industry is moving to a stochastic approach. There's also a lot of initiative within banks to take more of a portfolio management approach internally. Even though banks are still measuring their loans on an accrual basis for financial reporting purposes, for management information purposes, there's a strong interest in seeing those loans marked to market. The true volatility of those portfolios is made more transparent.

MR. RAGHUNATHAN: To the extent that we have loans in our trading books and all those instruments, if they continue to be in the trading books, they'll certainly be using the VAR model.

MR. MEIJER: It's actually interesting that one of the more challenging areas that we have to deal with is the area of credit derivatives. We're actually actively now trading credit exposures among different companies. Because we do that through bonds and credit default swaps, we can arguably also trade letters of credit, guarantees, loans, and so on, within those portfolios. The regulators are still struggling to come to terms with how they deal with us on those kinds of products.

MR. MAX RUDOLPH: Let me follow up on that a little bit. If you have a loan in a trading portfolio, do you use the same time horizon or are there some products that would use a 10-day and some that would use a five-year horizon? Are you essentially saying that if you have a loan in your portfolio, you'd have to ask, what

are the odds that this loan is going to default in the next 10 days? Is that really useful?

MR. RAGHUNATHAN: The 10-day holding period is a regulatory requirement for allocating capital. So it's a standard BIS requirement.

MR. MEIJER: We actually have had some extensive discussions on how we allocate capital, and we've adopted a one-year standard for the banking book products. I think it's a one-year and 99.5 percentile confidence interval. I guess the rationale for it is that one year represents a time horizon within which you can reasonably expect to raise additional capital in a distress situation. It seems to be emerging as a bit of an industry standard. I don't know that there's a huge amount of scientific justification for doing so, but that's where that part of the bank is headed.

MR. RAGHUNATHAN: The regulators have decided to keep it as one size fits all, with 10 days, across all trading positions for market risk.

MR. ARI LINDNER: I have a question, but also a few things to add to your rather lengthy list of the differences between the way that insurers and banks seem to look at this. We are basically leaning towards the fundamental difference between writing these puts into the capital markets and writing them within a segregated fund or a variable annuity portfolio. From my perspective, having priced these things for a number of years from a reinsurance standpoint, one of the things we lean on quite heavily is the inefficient exercise of the options that you're writing. With death benefits, if you have to die to exercise the option, that's a rather heavy exercise cost. The two things are interrelated. The second is the policyholder behavior and lapsation. If you write a certain amount of options into the equity markets, you're going to have that exposure until it's taken down. However, if you write it into a variable annuity or a segregated fund product, and you don't know how much it's going to be, is it going to disappear every year through lapsation? The amount might change depending on how the market has performed. So I guess those are more fundamental differences between the risks.

The question is, a few years back, I worked with some of your folks at TD designing a segregated fund. I looked at the possibility of reinsuring it. I've been out of touch with the Canadian market for a little while. Do you have a segregated fund that you write now?

MR. MEIJER: I'm actually not that familiar with that part of it, although we did get called in to consult on it. I know they were looking to expand it a little bit, and then I think they decided against it. But I think there was some activity in that area. I think your original comments are quite valid. There are sort of mitigants to the actual core capital markets risk due to retail or consumer behavior and investor behavior. It's perfectly legitimate to take those into account, and I guess I would point to the analogous situation in the bank where we actually have a central asset/liability management group that strips out all of the optionality risk in our retail products. They use historical estimates of prepayment risk on mortgages, for

example, as a way of sizing the amount of embedded option and the risk that they have in those products. They certainly wouldn't take the full gross amount of the mortgage commitment as the amount that is required to be hedged. They would adjust for those actuarial assumptions.

MR. LINDNER: But you were consulted at one point by the insurance side of the TD house that was looking into segregated funds?

MR. MEIJER: That was about two years ago. I think they haven't done anything since that time, but they might have been active in the market earlier. I'm not sure.

MS. CLAIRE: In effect, I think both sides can learn a lot from the short term versus the long term. There is what he calls the actuarial modeling. We have a tendency to look out forever. According to us, the banks have a tendency to look at tomorrow. Both are important. I was called in by the FDIC to look at a bank that was really on top of its VAR for today, but they happened to be doing some options, Synthetic GICs went out for several years, and, in effect, you need both numbers. I mean one isn't necessarily better than the other. It's just that, in effect, you need both types of information, depending on how you're managing your business.

MS. EVARONDA CHUNG: Nico, you mentioned the TD Bank calculates the VAR by desk. Presumably, if you have multiple bond desks and multiple equity desks, you will have a VAR calculation for each desk. Do you calculate the equity VAR at the enterprise level to present to senior management? If you do, how does the action, which is required as a result of the aggregated VAR, loop back to the individual desk?

MR. MEIJER: You're quite accurate in that every desk has its own VAR calculation. If you add all those values at risk at the individual desk level, the number that you'd come up with on a bank-wide basis is much bigger than what we actually report. That is because when we consolidate that to higher and higher levels of aggregation, we actually use all of the diversification that comes out of our historical analysis. For example, we might have two desks that trade. Each might have a VAR of $1 million. It might add up to $1.5 million when you put them together in our model because of the correlations or the lack of correlation between the data series that are driving the VAR at each level. Both of those could be identical, like equity exposures. They also tend to be a bit more additive, depending on the portfolio. It could be just coincidental diversification because interest rate risks move in a different direction from equity risks. So it all gets captured in the overall data set. As we consolidate to higher and higher levels of management, there's a diversification benefit at each step of the way that comes in.

MS. CHUNG: So, when you determine the aggregate VAR at the enterprise level, using the example of $1.5 million dollars is not acceptable at the company level, for whatever reason. Some actions would have to be taken. How do you loop back that required action to the different desks?

MR. MEIJER: We would have a set of limits at each level in the hierarchy. The head or the dealer would have a limit. His immediate managers would have a limit for each of their businesses. At whatever level it becomes unacceptable, in terms of it violating or creating a limit excess, the business manager of that level has to decide among his or her businesses where the reduction is going to take place. If you're just running a desk, it's fairly simple. You'd probably have a few core positions. You'll have to reduce some of them. If you're running four or five businesses, you'll have to look across those businesses to determine if you have a risk concentration with multiple desks taking the same view. In that case, you might have too much of that view embedded in your overall risk. You want to instruct some of your traders to reduce their positions. At the head of the dealer level it may be a decision among how much risk we take on our equity business versus how much risk we take in our convertible arbitrage versus how much risk we take in our credit derivatives. He has to make those tradeoffs.

MR. RAGHUNATHAN: We have other compensating controls. We have many other layers of operational limits, and it will help determine what has caused that VAR number to go up. It's not just VAR that we look at; we have other layers.

MR. MEIJER: Incidentally, the VAR results that we produce are actually reported in our financial statements every year or every quarter. You can take a TD Bank financial statement and look up what our VAR was and how it back-tests against historical profit and loss (P&L). We can see what our histogram of earnings has been over the last quarter. It's all pretty well disclosed.

MR. DARRYL DANIEL BENJAMIN: I've read some criticism of VAR because of its reliance on estimates of volatility correlations. They say that correlations are very hard to estimate, and when you can't estimate them, they're very volatile. I've heard a more general criticism of financial engineering applying precise scientific methods for what is basically a social science. It is the estimation of asset prices, which has some economic aspects to it. My question is more to the insurance people. To what extent is there debate about the validity of stochastic modeling and the limitations of it and reliance on it?

MR. PRINCE: I thought I was going to get off with easy questions. There is some debate about the reliability of it, and some of the debate simply is kind of the counterpositive. If you can't at least pass the test on this kind of admittedly simplistic stochastic modeling, then there's something seriously amiss. That's about the best defense I've come up with. If it loses money 10 times out of 100 on the simple scenarios, why are you doing it? If it makes money 99 times out of 100, maybe the models are imperfect. However, I still feel better than I would in the first case. The social science aspect has been debated at some length. In fact, I'm speaking on that very subject tomorrow in another session. It was explained to me by an investment professional some years ago. What we're modeling in the markets is the randomness of news. The market has analyzed the world to death. When the market reacts to something, it's news. IBM was supposed to earn $1 million. It earned $500,000. It's reacting to news. The news is, by definition,

random. It's the stuff nobody expected; therefore, it's a good candidate for a stochastic process. That's the best explanation I've heard so far.

MS. CLAIRE: Again, even if it's not perfect, at least it's something. One of the things that we're getting into, for example, with the segregated funds and the variable annuities with guaranteed living benefits, commonly known as VAGLBs, is what we consider a low-frequency, high-impact event. You might not have to set up reserves for them, but at least you have to know what your exposure is for the risks that you're taking. What is the maximum loss if things go really bad? For example, it wasn't terrible, but last year the stock market in the U.S. wasn't dramatically good. In fact, the NASDAQ went down 60%. That was a six or ten deviation event. If such things happen, what is your exposure? Can your company survive it?

MR. TAYLOR: I mentioned Steve is part of the Task Force on Segregated Funds of the CIA. I failed to mention at the outset that I've been involved in that group as well, and I'm chairing that task force. It comes to an end at the end of this year. It was a special purpose task force to look at stochastic modeling in this context. As it comes to an end, the report that's on the CIA Website as of August 1, 2000, will be updated later in 2001.