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CASH-FLOW TESTING MODELS AND THE APPOINTED ACTUARY

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A discussion and examination of cash-flow testing models, including those developed by the British Working Party, Finnish Working Party, and others.

MR. CHRISTOPHER DAVID DAYKIN: I have some remarks that I want to make to get our discussion going.

I will start by discussing the appointed actuary system, with apologies to those of you who attended the previous session on appointed actuaries around the world, and then go on to talk about the use of cash-flow modeling for an appointed actuary in a property/casualty company. Quite a lot of what I have to say on the question of cash-flow modeling is addressed in *Practical Risk Theory for Actuaries* [Pentikäinen, Teivo, Pesonen, Martii, and Daykin, Christopher David, London: Chapman & Hall, 1994], which was published a few months ago.

The appointed actuary system began in the U.K. in 1974 as a life insurance role. For nearly 100 years before that we had a valuation actuary role, which was very expansive and, in fact, gave the actuary considerable control over the total financial resources of the company. But the formal requirement for each company to have an appointed actuary was introduced in 1974.

There are four major elements to the concept of the appointed actuary, as we understand it in the U.K. First, the appointment is a continuous one. It is not an appointment just to carry out a valuation at the end of year; it is a continuous appointment. If an actuary resigns, another one must be appointed immediately, because the company must, at all times, have an individual who is designated as the appointed actuary. Second, the appointed actuary has a responsibility not just for the liabilities, but for the assets side of the balance sheet, and has to take the two sides of the balance sheet into consideration in forming an opinion.

The third aspect is that the appointed actuary has a role of continually monitoring the financial condition of the company, and not just a role of carrying out the valuation from time to time. That is a very important element of the concept, because it is, in effect, a delegation of the duty of financial control from the regulator to somebody who is in the company or in close touch with the company, and can exercise this function continuously. That buttresses the need of the regulator, who looks at the position from time to time. Clearly, the regulator can't be there all the time, but the appointed actuary can, and therefore fulfills a very important monitoring function.

The fourth aspect of the appointed actuary system is that the appointed actuary must have a hotline to the regulator. The concept, as it was introduced in the U.K., was that the appointed actuary had the responsibility, if he or she could not convince the management of the company to take what he or she regarded as appropriate actions, to report that to the regulator directly, having first notified the company management that he or she was taking that action.

The U.K. appointed actuary system was introduced for life business, but that includes, in our context, long-term disability and pensions as well. It is a legislative requirement, which states that the actuary must be a Fellow of the Institute of Actuaries, or a Fellow of the Faculty of Actuaries. We do have provision for the regulator to allow some other person to take the appointed actuary role, but that actuary would be required to satisfy the regulator that he or she would comply with the standards of practice of the U.K. profession. In practice, that means the actuary would have to become an affiliate member of the Institute of Actuaries.

The profession has laid down practice requirements in relation to the appointed actuary role, which we call guidance notes. They are mandatory, they are essentially standards of practice, and they determine the detailed aspects of the way in which the actuary should fulfill this role, including the requirement to talk to the regulators if the actuary has an impasse with the company management. Because every appointed actuary must conform to the standard of practice and must sign a certificate for the regulator every year to the effect that the standards of practice have been complied with, the standard of practice has the force of legislation.

The actuarial profession has also recently introduced a requirement for each appointed actuary to hold an appointed actuary certificate, granted by the professional organizations. In order to get such a certificate, the appointed actuary must demonstrate to the Institute or the Faculty that he or she has adequate experience for such a position.

These actuaries have to seek renewal of the certificate annually and be able to demonstrate that they have satisfied the continuing professional development requirements of the profession in order to get the certificate renewed. Of course, the certificate would not be granted or renewed if the individual had been found guilty of any disciplinary offense by the profession.

The appointed actuary has to carry out an annual valuation of the assets and the liabilities, and to report that to the directors. This is a published report and certificate but, in addition, there is the continuous financial monitoring role. The guidance note GN-1 lays out what is required in order to fulfill this role. The appointed actuary has to monitor all aspects of the business of the company that might impinge on its financial condition, including: the design of products and the way in which they are marketed; the premium rates that have been established; any options and how they have been priced; the current investments of the company and the continuing strategy being adopted by the management in relation to investments; the current and developing level of expenses within the company; the mortality experience and experience relating to lapses, surrenders, and morbidity; and the reinsurance arrangements.

So there is a very wide area of responsibility, not to make the executive decisions in each of these areas, although the actuary may have some responsibilities in that regard in a particular company, but to monitor and to know what is going on, and to be able to inform the board of directors of the company how any of these aspects may impinge on the future financial condition of the company. The appointed actuary must have direct access to the board of directors, and has a duty to report regularly to the board on these matters.

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You can see from this responsibility to monitor the condition of the company that the actuary has to have some conceptual way of modeling what is going on. He or she cannot carry out a full valuation of the assets and the liabilities every day of the year. That full valuation will normally take place only once a year, or it may take place, in some companies, on a quarterly basis. But the appointed actuary must nevertheless be able to say what's going on, and must know enough about the type of business being written, the strains that might be imposed in putting that business on the books, the impact of the expenses and so on, in order to be able to comment to the management and to have a very good feel for where the company is and where it is going in the future in relation to its overall financial condition.

In Canada they have, for many years, had something approaching an appointed actuary system, following the general U.K. tradition. However, the recent 1992 legislation introduced a full, appointed actuary system for both life and property/casualty companies, and brought into the legislation some quite clear statutory obligations of the appointed actuary. These are buttressed, as in the U.K., by professional requirements. But the balance is a little different. There is rather more in the law, and rather less dependence on the professional standard of practice. So, for example, the requirement to have access to the board is in the law, and the requirement to talk to the regulator in certain circumstances is also a statutory requirement, rather than a professional one.

Canada broke new ground in introducing the appointed actuary system in its full form for property/casualty companies as well as for life companies. There are other countries that have had a formal actuarial role for property/casualty actuaries. Finland has had a role of this type for 40 years or so. When the Canadian legislation was introduced, the valuation of the provisions was moved onto a GAAP basis, particularly for life insurance. As a result, the requirement for an appointed actuary was coupled with a standard of risk-based capital. Risk-based capital had already been introduced as part of the compensation fund arrangements organized by the industry. However, it has now been taken on board by the Office of the Superintendent of Financial Institutions as part of the overall structure of financial control.

The actuarial profession decided, as part of these discussions and agreements with the government, to impose a requirement on their appointed actuaries to carry out dynamic solvency testing (DST). The profession determined that this dynamic solvency testing should be done on the basis of a five-year forward look at the affairs of the company, translating the British concept of continuous financial monitoring into an even more, future-oriented approach. The appointed actuary was to look at a number of scenarios as to what might take place in the next five years, and then report to the board of directors on the consequences of those different scenarios. This proved to be controversial in the property/casualty area; the Insurance Bureau of Canada (IBC), representing the insurance companies, fought against the idea of the actuarial profession imposing this five-year forward look. A compromise was reached, whereby the appointed actuary only has to look one year ahead, for the time being, in order to fulfill the dynamic solvency testing requirement for property/casualty companies.

The scenarios envisaged in DST are deterministic scenarios, so this is not a stochastic modeling exercise, as it stands in Canada at the moment; but it is a requirement to

look at a variety of scenarios, some of which are specified in the standard of practice, and some of which are up to the appointed actuary to determine. This exercise then forms the basis of a report to the board of the company, which has to be made available to the Office of the Superintendent of Financial Institutions (OSFI), should the inspector wish to see it.

On the life side, where this is well established, OSFI is now expecting to see these reports as a matter of routine, rather than on request, for each company. For property/casualty companies, the process is just getting underway. At this stage, not every property/casualty company has to have a DST report prepared.

That's some of the background as to how the appointed actuary system can lead the actuary to carry out cash-flow modeling. DST is essentially a modeling of the cash flows of the company to see how alternative views of the future can impact on the future financial condition. The idea is that the actuary exposes the model of the company to shocks of various types to see how resilient the company will be to those different shocks, and what will happen to the company in terms of its ability to report a sound financial condition to the public and to the regulator.

What do we mean by cash-flow modeling? Cash-flow modeling has become the terminology that is used in the United States for the requirements under New York Regulation 126 on life insurance. In this case, the actuary has to carry out certain cash-flow modeling exercises to determine the asset/liability position and expose interest-rate risk.

The work that we did in the U.K. on this subject, in the Solvency Working Party of the General Insurance Study Group, referred to this as the emerging costs approach. Instead of looking at the balance sheet of the company as representing current values of assets and liabilities, we sought to unpack the financial condition of a company by looking at the future cash flows, which those valuation items represent. The valuation of the assets on the balance sheet of the company is an accounting concept used to translate a future flow of dividends, interest payments, and maturity payments into a single item which can be placed in the balance sheet. Likewise, the provisions on the liabilities side represent an actuarial assessment of the future payments that are going to be made over a long period expressed, in the case of life insurance, in terms of a discounted present value. For general insurance, it's usually in terms of the aggregation, rather than a discounted present value.

The business of a property/casualty company can be looked at in terms of the cash flows that will take place each year into the future. On the inflow side, we have the income from premiums; and we might want to differentiate between the income from the premiums, which have already been committed, and income from future business, which has yet to be sold. There is also income from the investments. The third item is not a cash item, but it is just as important in terms of the overall wealth of the company. It is the growth in the value of assets, such as real estate or stocks. Then there are the recoveries from reinsurance. On the outflow side, we have payments made in respect to claims, premiums payable to reinsurers, expense payments, and a number of items, including tax payments to the Internal Revenue Service, dividend payments to shareholders, and maybe other items.

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We can express this in terms of a year-on-year transition equation. The total assets of the company at the end of year T can be expressed in terms of the total assets one year earlier, with a growth factor for the growth in the value of the assets over that year, and various terms of income and outgo. I_t is the investment income term, B_t the premium income, and on the outgo side, we have X_t for claims, E_t for expenses, T_t for tax, and D_t for dividends. I've left the reinsurance transactions out of account here, so you can regard the premium and claim elements as being net of reinsurance.

In a cash-flow modeling exercise, we convert each of the terms in the transition equation into something that we can model, either by means of an equation, which will express the item in terms of other elements of the data, or in terms of a simulation process. The concept of the cash-flow model is that, rather than looking at the balance sheet and saying that a company is solvent or insolvent in accordance with the items that appear in the balance sheet, the real test of adequacy for a property/casualty company is the ability to pay out the cash flows that are demanded year by year as they arise. In order to make payments of claims and expenses, the company has income flows from premiums and from the proceeds of the assets that are held. The balancing act is to get the flows to match up, and to ensure that at no stage is there an inadequate level of income flow to meet the outgo. Income flow can be generated, of course, by selling assets, and that needs to be included in the modeling process.

I shall give an overview of some of the main elements of the cash-flow or DST modeling process. We should first distinguish between two situations that can be considered under a cash-flow model. One would be simply to look at the run-off of the existing liabilities and the assets that are currently held, and to leave out of account all future commitments in terms of future business written and the liabilities that will result from those commitments. The alternative is to view the company in terms of a going concern, include the future premium income, the claims and other outgo in respect of that.

The DST process in Canada is a "going concern" approach, and that is probably the concept which is of most interest in terms of reporting to company management. It is conceivable that, from a regulatory perspective, there may be more interest in the run-off situation, because the regulator tends to take the view that their main power is the ability to withdraw the authorization or the license of a company, which stops future business. They can only do that if they feel that the company is not going to be able to meet the liabilities that it has already taken on.

First, I will assume that we are looking at a going concern and, therefore, that premium income is a key element of the process. It is one of the most difficult aspects to model, because you have to look at the future premiums, not just in terms of the income they generate, but in terms of the liabilities that go with them, and the profitability of that future business.

Second, and perhaps not generally very closely studied in relation to property/casualty companies up to now, is the question of expenses, which forms a fundamental element of the DST modeling process. Then there is the claim process, the claims arising from the business that has already been written, that is corresponding to the

loss reserve and the unexpired risk provision, and the claims that will arise in respect of the new business that will be written in future.

There are issues to be sorted out as to how much you can disaggregate the business into lines. Clearly, the modeling process will have to take some short cuts. You cannot model every line of business separately because that would create too complex and difficult a model to handle. It is necessary to use model points, which represent the business of the company through a limited number of lines.

The next and fundamental item of the modeling process is the assets, which is one of the most interesting and difficult aspects of the problem. You will then need to convert all of these different elements into a projection of the cash flows, year by year, into the future.

There are some additional choices that can be made to increase or reduce the level of sophistication of the model. The first one is the question of market interactions. The premium income, which we generate for the future predicates, some view as to how much business is going to be written. If one lowers the price for a particular line of business, one might expect to write more business, but it will be less profitable. There are, therefore, some very important interactions between the level of pricing and the amount of business written, which must be incorporated into the model in some way if it is going to have any degree of realism.

Second, there is the question of whether we can handle this on a deterministic basis, as the Canadian DST seems to imply, or whether a stochastic modeling approach is necessary. The work that we did, which led to *Practical Risk Theory for Actuaries*, started from the assumption that, on the property/casualty side at least, and probably in other types of business as well, the actuary should be looking at a stochastic approach to modeling future financial conditions. After all, one of the things that we say we can do as a profession is to help manage the uncertainty of a situation. Unless one tries to evaluate those uncertainties, then it will be difficult to manage them. The investment models that have been developed in Europe, are essentially stochastic models, and they reflect our understanding of the variability of the asset flows. Similarly, on the liability side, particularly for property/casualty work, we can express our understanding of the variability of the claim process through a variety of different stochastic models, either relating to the total aggregate claim amount, or separately to claim numbers and amounts.

The third item is the question of superimposing an accounting model. A pure cash-flow modeling approach does not concern itself with the accounting representation of the impact of future cash flows, through the balance sheet and profit and loss account. It looks simply at the ins and outs on a cash-flow basis, year by year into the future. However, the reality of the situation is that the company will have to report to its shareholders, and to the regulator, year by year. A very important element of the modeling should be to ask, if this scenario takes place, how will it look at each year-end when we have to prepare our balance sheet? We may be satisfied that we have got the resources to meet all our future liabilities, but are we going to be able to convince the regulator that we are meeting solvency, risk-based capital, or other requirements year by year throughout the process? The message to the management of the company may be, yes, you will be able to meet your liabilities,

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but you will not be able to demonstrate adequate financial strength unless you take certain management actions.

The fourth issue has a lot of potential for future development, it is the whole question of feedback. Any good model should make use of the information that becomes available in the modeling process. We cannot simply set in motion a process which assumes that nothing is going to be done by the management of the company as the market goes up and down and the claims process yields adverse results. In practice, they will react to events such as those projected by the model. The challenge to the modeler is to find some way of representing what management might do in certain situations, *without being so idealistic that you assume that they will always take the right decision on the basis of the information that is presented.* Some element of feedback has to be incorporated into the modeling process.

The concept is a dynamic one. It is very different from the static balance sheet, where the assets in the balance sheet must exceed the liabilities by a fixed amount, which is the risk-based capital requirement or solvency margin. We are looking at the dynamic development of the company's business. From the perspective of the actuarial profession, there is something to be said for laying down certain scenarios, *which the actuary is required to test, at least in terms of the broad structure; but it should be left to the individual appointed actuary to determine which scenarios are the most critical in relation to the company itself, and to test for those things that probe potential weaknesses.*

Another issue is the time horizon. How far should we look forward? We cannot really expect to say anything about what is going to happen in 20 years. So many things might take place. The five-year horizon of the Canadian system is a modest attempt to look a few years ahead, but without going too far. The modeling work that we did in the U.K. and in Finland tended to look further ahead than that, perhaps for ten years, or in some cases even more, to see what the implications were of the strategy being adopted. This is particularly necessary if you are writing liabilities that may have a 20-year run-off, which is the case for some property/casualty business.

Then there is the question of what scenarios are acceptable. We do not want to create a situation where the scenarios produced by the actuary automatically produce panic in the boardroom, because the actuary has demonstrated that on certain assumptions, the company will be insolvent within the next two or three years. The purpose of the exercise is to identify weaknesses in the company's defenses, and to present to management what the outcome would be if particular scenarios took place and they did not change their strategy. The exercise should also be able to show what could be done to defend the company against these adverse scenarios. It is, therefore, a tool for putting in place strategic decision-making processes that will enable the company to safeguard itself against adverse scenarios.

The exercise is very company specific and, therefore, it is entirely appropriate that, where possible, all the data used should be company specific. For certain purposes, particularly on the assets side, you will need to use models that describe the market situation, rather than modeling in detail the actual investments held by the company. But insofar as is possible, everything should be tailored to the company's own

experience, and it should be based on a proper analysis of the data that you have available from the past. Of course you cannot read directly from the past into the future; there will always be a strong element of actuarial judgement required in making assumptions about the future.

The actuary needs to focus on those aspects of the risk exposure of the company that are critical in terms of its future financial condition. The model should test resilience to some key scenarios, and identify to which particular aspects the company is most vulnerable. Some have suggested that the complexities are such that one should have a rather straightforward initial test in order to determine whether or not it is necessary to go through the whole process of the dynamic solvency testing. That may be one approach; to start with a very simple model, to identify weaknesses, and then to explore them in more detail. The result should not just be a pile of numbers. You can imagine that this process could develop quite a considerable amount of computer output. The important thing is that it should be translated into a report to management and the board of directors on the financial condition of the company.

The literature of which I am aware may be regarded as somewhat biased from a European perspective. Brian Hey and I wrote a paper on cash-flow modeling in 1990, called "Managing Uncertainty in a General Insurance Company," [Daykin, Christopher David and Hey G. Brian, "Managing Uncertainty in a General Insurance Company," *Journal of the Institute of Actuaries* (1990) 117: 173-259] which was the culmination of eight years of work in the Solvency Working Party on this subject. Meanwhile, parallel with that, a Finnish solvency working party had been doing very similar work under Teivo Pentikäinen. They published their book, *Insurance Solvency and Financial Strength* [Pentikäinen, Teivo, Bonsdorff, Heikki, Pesonen, Martii, Rantala, Jukka and Ruhonen, Matti, Helsinki: Insurance Publishing Co., 1989]. As a result of the collaboration between the U.K. and the Finnish actuaries working in this area, we published *Practical Risk Theory for Actuaries* at the end of last year. That brought together the longstanding tradition of this work in Finland and the work that we had done in the U.K.

This topic is becoming of vital importance in North America, with the DST requirement in Canada for property/casualty companies. The Casualty Actuarial Society (CAS) is currently addressing the educational and professional consequences of possible moves towards an appointed actuary system in the United States. Whether or not the legislative requirements go as far as the appointed actuary system, the profession should position itself to be able to give advice in this area. There is a task force of the CAS looking at these models and working towards the possibility of developing a DST handbook, which will be helpful to property/casualty actuaries. The subject also seems to be a topic at most of the meetings of the CAS. It is hoped that there will be some new reading on the Part 10-D syllabus from next year to cover some of these topics.

I will skip briefly through some of the elements of modeling each of the different items, without attempting to go into any detail.

On the premium side, there needs to be some way of determining the level of profit that is going to emerge from future business. Therefore one has to build into the

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process some modeling of the target level of profit and how that might be affected by the variability, which will undoubtedly occur as a result of the stochastic uncertainty in the claim outcome. Inflation must be incorporated, because any future development of premium income and the claims underlying that new business will inevitably depend on inflation. There is the question of whether investment income should be taken into account in setting premiums. You need to have some model in mind as to how rating is carried out.

For certain types of business, one needs to have regard for the possibility that there may be a cyclical process of profitability of premiums, and that the premiums set by your company will, in some way, depend on what's going on in other companies. There will be a market impact. The model that we developed in the U.K. models the company and the market side by side. The market was deemed to be sufficiently large so that the decisions of the individual company would not change the market; but whatever you decided in your company, relative to what the market was doing, would affect the volume of business you wrote, with some sort of gearing effect. There could be some dynamics built into this, whereby as the solvency margin changes, for example, or as the financial strength of the company develops, there may be a direct effect on the ability to write profitable business.

On the claims side, there is the question of the variability of the claim experience year by year, but there is also the variability of the claim-settlement experience associated with the loss reserves in respect of past business. You may want to break claim amounts into claim numbers and size. There will be some issues relating to trends and cycles on the claims side. You will need to have a model of claim settlement, and how that is taking place over time, and issues relating to catastrophes and reinsurance.

The amount of business is clearly critical, and this will have to be linked into the company's business plan, so as to take account of the likely future business prospects in terms of volume of activity, profitability, which lines of business are likely to be growing and which are declining. There is the possible need to consider the closure of certain lines of business, or maybe the opening up of other lines of business.

Expenses are important. In my experience, from a regulatory point of view, many of the problems that arise in companies arise on the expense side rather than the claims side. The modeling must look realistically at the development of future expenses, and not through rose-tinted glasses. There are different ways of modeling the expenses. You can link them to the business volume, or you can say that they are independent of it and just go up in line with inflation. You can introduce certain expense elements that may leap up once you get above a certain level of business, or there may be one-off items, like major investments in computer systems. The question of tax payments and shareholder dividends will also have to be brought into the modeling process.

On the assets side, there is a need to develop models that will represent the main categories of investments held, and to find a way of representing those satisfactorily, from the perspective of both income and capital value. For some types of assets, there will be issues of default to be considered and how to model that process.

There is the question of how the asset income interacts with inflation. The models that have been developed in Europe for income streams take, as their starting point, a stochastic model of the inflation process.

The stochastic approach depends on the availability of suitable models, particularly on the assets side, and hence, it is particularly appropriate to discuss this in the context of an AFIR Colloquium, where some of the models are being further developed and exposed in papers that are being presented. It is an area that is still very much in its infancy. We are not talking about models that will forecast future investments, but models that will forecast the uncertainty in future investment. They produce a distribution of outcomes that will not enable you to take individual investment decisions and beat the market, but enable you to quantify uncertainty and to try to immunize yourself against the consequences.

I have referred once or twice to feedbacks, and there are a number of different areas where feedback responses might be considered. For example, the dividend to the shareholders might be deferred in the event of a weak, balance-sheet situation. One could envisage rating changes being driven by the responses of management to the scenario that is developing. Investment strategy might be changed as a result of investment outcomes. Marketing strategy, in terms of lines of business and volumes of business, might also be responsive to the profitability and development of the business. Indeed, there may be a need to include some supervisory feedback, because the supervisor may take some action when certain trigger points are reached.

We can think of the financial strength of the company as being built up from a number of elements, reflecting the underwriting, the expenses, the investment, the capital and surplus of the company, the management, and the reinsurance program. Each of these needs to be introduced into the modeling process in some appropriate way.

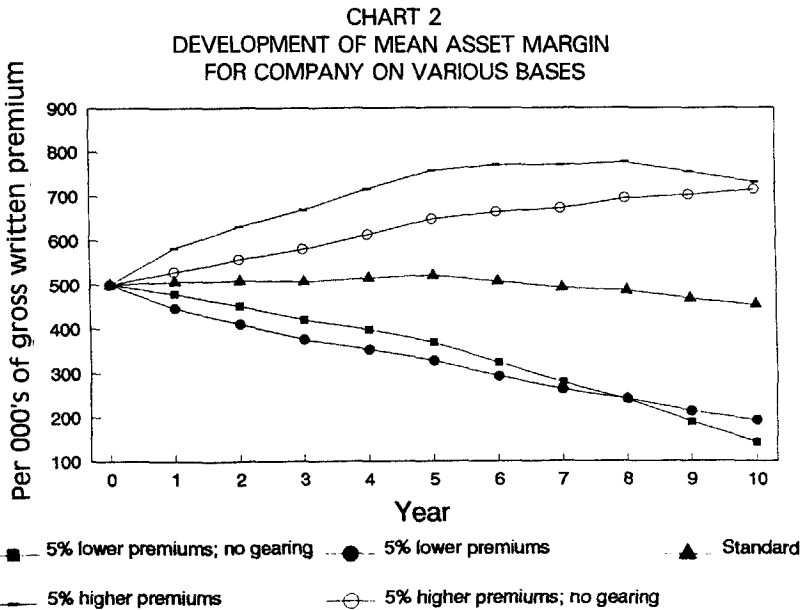
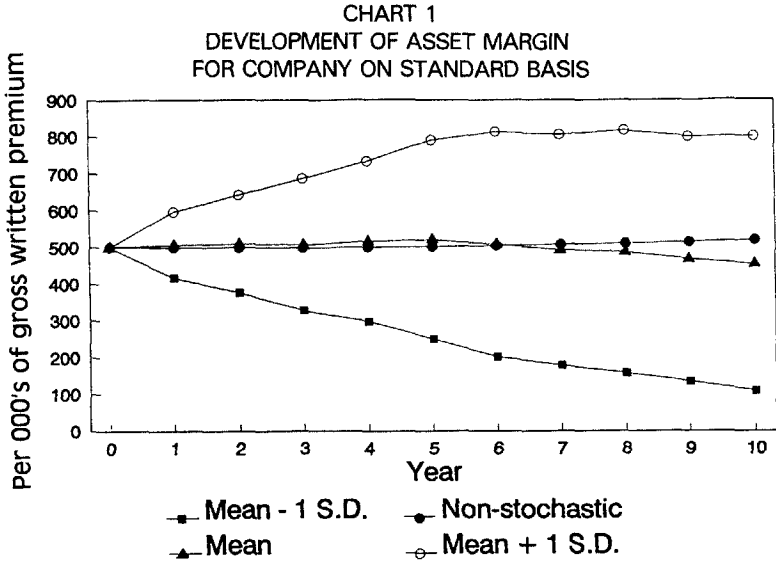
The report, which goes to the board on the financial strength and the future financial condition of the company, needs to cover the different elements that we have discussed; and it should present the board with information to enable it to make appropriate decisions, not to confuse them with a mass of figures, but to focus their attention on the vulnerabilities of the business and the decisions that are required in order to defend against those weaknesses.

This is a wide-open area for future research and development, and for practical application in a wide variety of circumstances. Particularly, I see a need for further work on the stochastic modeling process, asset allocation issues, the relationship between assets and liabilities, and the process of taking account of the dynamics of the business through feedback models. Some efforts have been made to look at whether control theory might have something to teach us, in terms of the stability of systems and the ability to create stable rather than unstable responses. We need to develop practical models that handle the whole business of a property/casualty company. Lastly, one of the biggest challenges of all is the concept of competition and the marketplace, and how one brings that into the modeling process.

I hope that I have given sufficient background and overview to stimulate you into making some contributions. The next three charts are a few pictures to indicate

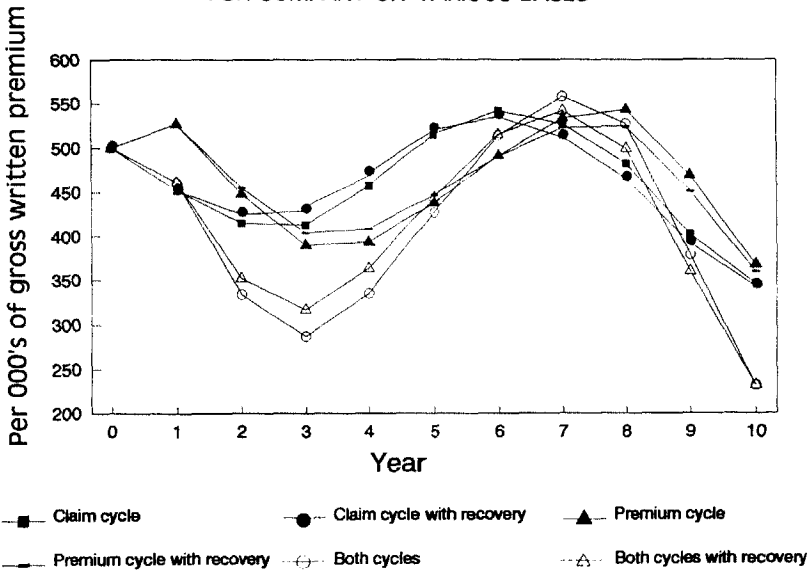
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some of the presentational aspects that may come out of the model. Chart 1 is looking at the development of the capital and surplus of a company over a period of ten years; exploring what happens if you look at the distribution in future years, in particular, the mean and the standard deviation. Then look at Chart 2 at how the mean changes with different assumptions about the premium income and the gearing effect.



You might then want to introduce some cycling of the premium process as in Chart 3. The presentation of results is another aspect that is very wide open and needs to be explored. The actuary needs to be able to convey to management, or to a board of directors, what is actually going on, so that they can understand and make good decisions. Can I open the meeting to discussion and invite anybody who would like to contribute?

CHART 3
DEVELOPMENT OF MEAN ASSET MARGIN
FOR COMPANY ON VARIOUS BASES



MR. ALLAN BRENDER: I agree with everything you've said. I was thinking of adding a few more words about what is happening in Canada. One point that I think is interesting, in respect to the appointed actuary and cash-flow methods, is that we have introduced something on the life side that I think can apply anywhere. That is a new notion of cash-flow valuation. Right now we're doing this for annuities, but it could be done for any kind of insurance. The reserve is the value of the amount of physical assets that are held today that are needed, together with future investment income and premium income, to run off the block of business. So the assumption is that somehow you have allocated a certain amount of assets, and what you have to do is to determine exactly what those assets are, so that, with some sort of reasonable certainty, you can meet your obligations with those assets. "With reasonable certainty" raises the whole question of what scenario you are assuming about the future. Reasonable certainty implies, first of all, that you are going to do this with many scenarios, and that indeed is the case. Reasonable also says that you have some sort of probabilistic criterion, which means that somewhere in the background, there has to be some stochastic generator.

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One of the problems we have, I think, is that it's not clear that there are really good stochastic generators around. Particularly in this country, actuaries will grab any stochastic model that they find in the literature, without questioning how good it is. A lot of them are not good. There are a lot of generators, interest rate models, etc., which exist, which have been in the finance literature, which are aimed at pricing derivatives, and so on. They do not necessarily give you the appropriate yield curves and scenarios to do this kind of actuarial work. I think we have a lot of work to do in that regard. I think that the work that has been done in the U.K. and in Finland has shown the value of stochastics, and I recommend that people look at that. The ultimate goal should be to go that way. Incidentally, not only stochastics with respect to interest rates, which we tend to look at more on the life side, but certainly the claims process. The business cycle in property and casualty (P&C) is incredibly important.

That brings up the whole question of the time horizon. It's absolute nonsense to confine yourself to one year when you believe that there are things like P&C business cycles going on. On the life side, incidentally, we have adopted a five-year time horizon for our projections, for two reasons. One is that this is consistent with most companies' corporate planning horizon. There was a feeling that if the whole object of this is to report to management, it is not going to be very credible if we try to go way beyond what management is used to dealing with. They just won't believe it.

And the second reason is that, within the DST for life companies, there is a requirement that you will constantly be doing valuations. At the end of the fifth year, your reserves within the model have to be calculated using assumptions that are consistent with the experience that has developed in the scenario. In other words, the actuary should say if this were the scenario, what would my assumptions be at that time? In some sense you can argue, by doing that, you are taking care of a lot of future years as well, by embedding the provisions for that deteriorated experience in the reserves at the end of the fifth year.

The one-year time horizon should be understood as a very political move, because we moved from a situation where, on the P&C side, most companies had no actuary. All of a sudden this new legislation came in and said that you had to have an appointed actuary who has, essentially, not only a lot of responsibility, but independent access to the board. I can tell you that the average age of most P&C Fellows in Canada is well under 40. Management is just not used to the idea of accepting these people as persons who can go to the board and start blowing all kinds of whistles, so the IBC wanted to rein them in. There is an expectation, I think, on the basis of our experience on the life side, that once this whole process has proven its value, the limitation will disappear.

The standard of practice on DST for property and casualty insurance is making its way through the whole approvals process within the Canadian Institute. I think it will be approved this year, and that DST will be required in 1995 for P&C actuaries. The standard of practice certainly mentions deterministic scenarios, but these are not required; they are suggested to remind actuaries that there are certain, important factors, which you should at least look at. They are just suggestions. The standard of practice goes on to talk about using stochastic generators, although where they are to come from is not at all certain.

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There are many more topics that I could mention, but I have said enough. Chris, I think you gave a very good presentation. Certainly the problem of conveying these things to boards of directors is really, as Chris mentioned, a very difficult one. But one thing to say is that lay business people, which make up most boards of directors, are much more sympathetic to cash-flow arguments than they are to arguments involving discounting, present values, and so on. I think they can understand the concept of the models. My experience in talking to boards is that, in fact, this goes over very well.

One last comment; the original process was designed on the life side as a report to management, to the board of the company. There was always the option that the regulators would see the report, if they so desired. The original intention was that, when they did their triennial on-site examination, they would want the reports to be around, so that they could look at them. What has happened, particularly last year, is that there were several life companies experiencing real difficulty. Those are situations where the regulator has you on quarterly reports. In those circumstances, you can be sure that the regulators wanted every bit of information they could get. In particular, they were phoning the actuary weekly and saying, "Is your DST done?"

What has emerged in some of these cases is that the actuary's DST report said exactly the same sort of things that the regulators were worried about, so there was mutual reinforcement. The regulators felt reinforced by this inside view. On the other hand, the actuary felt reinforced because he had the regulator behind him. The situation, with respect to presentations to the board and getting the board to take remedial action, turns out to be quite favorable. As a result of this, OSFI has now said that when you file your annual statement, please send along a copy of your DST report. That's the way it has emerged in life, and I think we can expect it in P&C as well. We do have an attitude, with respect to our regulators that, generally speaking, they are not the enemy!

MR. RALPH S. BLANCHARD III: I have one comment and then one question. My comment relates to DST requirements in Canada for P&C companies. Sometimes you can have too much of a good thing. A requirement for a two-inch thick book on a company with \$20 million of liability is going a bit far. While it is a good thing, sometimes the standards have gone too far and have created enough work probably to bankrupt small companies for the cost of the requirements.

Now the question. As a lead in, I'm always skeptical of European imports that really don't appreciate the U.S. concept of liabilities and reserves. London has seen the U.S. definition of liabilities in Lloyd's of London, with all the bankruptcies and the problems they are having over there. Most of them have been blamed on the U.S. liability market. Given all of this quick brushing by the liability side to go at the assets, have you tried applying your kind of a model to the Lloyd's of London situation, to any of the syndicates, and to any of the entities that are having solvency problems, to try to test it against that kind of a U.S. liability situation?

MR. DAYKIN: I don't think anybody has done this for Lloyd's as a whole, although it is underlying the considerations that are being given to the establishment of Lloyd's new company, which is due to be authorized in the next couple of years. Something must be done in order to demonstrate the appropriate level of capitalization for that

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new body, so we're looking at some of these issues in that context. One can see, obviously, the limitations of any model in relation to some of the unpredictable elements on the liabilities side. But one can build into the modeling process the uncertainty of, for example, the future inflation of claims that you've got on your books. You can build in a wide level of variation in claim outcomes in order to expose the results to that, and to see how it would react. One of the most difficult elements is modeling the reinsurance process and, for example, the security of reinsurance. And if you had a catastrophe situation, would your expected recoveries from reinsurers actually not materialize because the reinsurers would be bankrupt.

MR. BLANCHARD: People have tried to model the variability in the reserve payouts, and that's been exceedingly difficult. I've yet to see a final, complete, practical model out there yet.

MR. DAYKIN: Right. Well I accept that entirely, but I think one has to beware of implying that this modeling process is actually forecasting the future. It is simply exposing the vulnerabilities of companies. So one cannot actually model the future variation in the assets, but can only try to expose the range of variation; similarly, on the liabilities side, one cannot say what the liabilities are actually going to be, but one can expose some of the variability and say, this is clearly a vulnerability for the company, if this type of business proves to be very adverse in its development.

MR. RICHARD GAUTHIER: I had some say about the standard of practice for DST in Canada. I would like to pass a few words on the issue of time horizon. It has been hotly debated; how far can I go in the future and how far can I report to the board, before they throw me out? I think what we have here is a double time horizon. We have a time horizon for reporting to a board or to ask management to take an alternative course of action. Then we have a time horizon that is pertinent to an actuarial study. I'm growing comfortable with the fact that, in Canada, we are probably going to ask a property and casualty insurance company to have a time horizon of a year, two years, or something that is relatively short, because most business of Canadian insurers is short-term business. Therefore action can be taken in that time frame to correct. From an actuarial standpoint, I certainly have working papers on DST that go well beyond two years. But the informal interval of confidence, if I can say that around my third, fourth, fifth year results, will be so wide that I am not comfortable to sit in front of anybody to tell them that they have to change their strategy because this is going to occur with some probability. So I think, when we discuss time horizon, we basically have one horizon for reporting, for forcing companies to make changes, or certainly for management to start to explain what they are doing, and another time horizon, from an actuarial standpoint, that we can have a forward-thinking kind of process.

Second, I understood you to say that the DST in Canada is a deterministic kind of approach. I disagree with that. Yes, a deterministic approach can be taken, but a stochastic approach is not discouraged by any stretch of imagination. We just ask that some of the parameters in the stochastic model should take into consideration specific factors that we mention in our standards of practice.

MR. THOMAS V. WARTHEN: I had somewhat the same question about the time horizon. I can understand the conceptual desirability of a long time horizon, but did

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you definitively reject the alternative of a short, time horizon, of perhaps one year? Because the consideration of putting in feedback mechanisms and predicting what is going to happen for a significant, future time horizon, it seems to me, might potentially introduce more error than you would get by the process of using a short, time horizon, with more stringent criteria for the identification of companies whose solvency was weak.

MR. DAYKIN: I think there are arguments both ways on this. One of the reasons for using a longer time horizon was because of these issues of the cyclical nature of the business. You only expose the vulnerabilities if you look over a longer period. I accept what you say, that the more you look into the future, clearly there is a wide element of uncertainty. If you introduce models of the feedback, you may get it wrong.

MR. WARTHEN: What I'm asking is whether your working party specifically considered the trade-offs between a very short, time horizon and the tradeoffs in the long term. The deficiencies in the long-term approach seem quite clear to me. But I'm not sure that, by looking at a wider range of scenarios in the short run, you might not be able to, equally efficiently, at least identify those companies whose solvency was weak.

MR. DAYKIN: We took the view that the minimum you could look at was something like two years, because of the time lags in reporting. One will only be able to see the results of the next year some months after that, and the regulator can react some months after that. So, unless you look a couple of years ahead, you are not going to expose the likely happenings over a period that is of interest. Beyond that, we tend to take the view that, from an actuarial perspective, it is sensible to model further into the future, while accepting that the funnel of doubt is expanding. But there are certainly clear limitations in what you can do looking a long time ahead.

MR. WARTHEN: I have one other question. I believe you mentioned in your presentation a limitation on the complexity of the model, in the terms of the number of lines or segments of business being modeled. Yet it seems that once you define that process for an individual line, it's merely a matter of replicating that process with different assumptions and then aggregating the result. What actually is the limiting factor?

MR. DAYKIN: I think the limiting factor is the ability of the data to sustain separate assumptions for each line of business. There are limitations of computer capacity as well, but I don't think they are serious. As you say, you can replicate the same approach for a number of different lines of business. But you need to have some confidence that you can determine assumptions for each line of business.

FROM THE FLOOR: This is a bit off the point, but one of the items you mentioned was that the Institute and the Faculty seem to be renewing the certificate of appointed actuaries annually, which seems somewhat contradictory to the idea of a continuing appointment.

MR. DAYKIN: The expectation is that it will be renewed every year. The only reason for it not being renewed would be if the person had been subject to some sanction

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because of disciplinary action, or because they had failed to carry out their continuing professional development requirements. Appointed actuaries know what they have to do, and unless they're fools, they're likely to make sure that they do it, otherwise they will have their license refused. I think the likelihood is that appointed actuaries, once they've got their certificate, will simply have it renewed each year. It just enables the profession to have a handle on the process, so that you can stop somebody from being an appointed actuary more easily than having to go through the full rigors of the disciplinary process in order to get them out.

FROM THE FLOOR: For a company that has a great deal of short-term business, the most difficult part, in my mind, in modeling for a DST is whether or not management will recognize the need to change very quickly. Has much thought been given to the length of time to put in before recognizing trends for your repricing, whether it should be a year or two years, when you are going through the test?

MR. DAYKIN: That has come up quite often on the life side, where a company has the ability to change loadings, change deductions or something, to respond. The company management may well say, "Yes, we will respond immediately when something happens." The actuary has to take a slightly jaundiced view of that and say, "Actually, in practice, there are going to be competitive pressures and it's not going to be so easy to change. Therefore I will have to assume some lag." It is a matter of judgement as to how much lag you put in. Maybe when it comes to presenting this to the board, it is a question of saying, the practicalities are that you will probably have a lag here, and if that is so, this is what will happen. You might need to go on from there to say, you need to have a process in place that will enable you to react more quickly. That might be the management response to what you're saying.

MR. CLAUDE DESILETS: I would just like to comment on two topics that have already been commented on. One of them is about time horizon. I agree with the comment that I heard from Richard, where I do not see the point of trying to stretch it very long. We could talk about policies that are either six months or one year, and there are very few contracts beyond that. It is the short-tail lines that most P&C insurers are involved with. More important is the fact that the requirement is for annual reports. As you mentioned, if we have something that goes a little beyond one year, then we are all covered. If we say we are solvent now and we will be solvent a year from now, and then next year we say that we are solvent now and we will be solvent a year from now, we can just keep on rolling that way.

The other comment was about the one-foot thick report for a few million dollars of loss reserves. I think we have to be very careful when we drop our standards and the rules that we have to live with. For example, if the surplus of the company is larger than the annual writing, what kind of scenario have you got to think about or dream about to convince people that your company won't be solvent a year from now? I realize it's an extreme example, but I don't think that you have to go into a stochastic model in cases like that or even, perhaps, any model. You just say, even if there is an earthquake, I will still survive it. The issues are with us right now, and P&C actuaries in Canada are trying to deal with the time period, and also the complexity of the model. How detailed are we going to be in our requirement to say that you must go into that kind of modeling?

MR. DAYKIN: I think what you are saying is that there are different situations, and they demand different responses. A company with a very small amount of stable business may require something quite different from another company, which has got exposures in the liability lines. Many of our U.K. companies are exposed to business that has a ten- or twenty-year duration, for example, in the mortgage indemnity field. Where the actual exposure is for ten years, there is not much use looking for one year because you are not going to expose anything. The real risk is with the financial cycle, which may be a five- or eight- or ten-year cycle. So to really expose the weaknesses in that field, you would have to look further ahead.

MR. BRENDER: First of all, it seems to me that, particularly on the P&C side, it comes back to something you were saying about the ability of a company to adjust. If you are subject to cycles and all of a sudden things take a downturn, or claims go up, I think it is wishful thinking to assume that you are going to instantly adjust your premiums. That would assume that you will instantly be aware of what is happening. I certainly know, on the life side, that different companies are very different in how they track their experience and how they react. I think, in general, that you have got to ensure that your surplus is adequate to take you through some adverse experience, and recognize how it is, in fact, that you do react. So I cannot see this argument about short-term business getting you out of the situation that you have to do a projection for several periods.

On the time horizon, DST is now required in Singapore for life insurance companies. If you look at their new document (I'm not sure if it's a professional standard or regulation), it suggests that the actuary should do testing for 25 years, or 50 years on some of their products, but report for five. The actuary should test for long enough, and be aware of what can possibly happen. That might influence the vehemence with which he speaks to the board. The board might be able to absorb only a relatively short period; that's all that might be credible. But what you say to them about that short period might be quite different if you know what could happen down the road. That brings up one last point that I'll make now. This is all about what might happen. It's about sensitivity; it's about warning them about what risks they're exposed to over time. It's not about forecasting. This brings up again the whole question of stochastics. Stochastics are really great in terms of showing sensitivity. The barrier over which you should not cross, because this process is one of reporting to the board, is that you should not believe in your stochastics so much that you go to the board and say, I'm 99% sure, I guarantee you, that this company is safe. We do not have anywhere near the confidence with any kind of stochastic model to do that kind of thing. It seems to me that if you introduce stochastics into a process that is really directed at the board, someday somebody is going to try to make those comments to the board. I think we must be very careful about that. I'm concerned about how people use these models. I do not think we are paying enough attention to that.

MR. DAYKIN: The stochastic model can be seen as simply generating a large number of scenarios. If you decide on your scenarios in a deterministic way, you might introduce a bias, because you only think of certain things; whereas the stochastic approach throws up a whole number of possibilities, and effectively demonstrates which ones are problems. You might then want to go back through the process and find the stochastic simulations that are throwing up a problem. Do I

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actually believe that this could arise? Is that a feasible situation? You might then discard it, and say that it is a product of the stochastic model, which isn't really likely to happen at all.

MR BARKER: I thought I might briefly outline the moves in Australia on the life insurance side. You will be aware that there are now quite well-developed proposals to move to cash-flow projection on the liability side, which will include sensitivity testing on a deterministic basis. I guess that the difficulty has been to develop a methodology in a system that will handle both financial earnings reporting and solvency in one format. The feeling is that we are on the right track. The amending legislation is expected to be tabled in Parliament in the middle of this year. The Institute of Actuaries of Australia is working hard on drafting professional standards. The area that is giving us the most trouble at the moment is earnings reporting in relation to traditional with-profits business, whole life and endowment.

Another area that has not been settled yet is in the concept of a capital adequacy reserve. This is not to be a publicly reported reserve, but a figure that the actuary will have to have in his financial condition report. If the company is below that, then the regulator can start to take more interest in the company. If the company is above the solvency reserve, the regulator will not stop him from writing more business. If he's below the solvency reserve, then it will be an automatic judicial management situation.

On the future financial condition reporting, the current proposal is that the projection will have to include new business on the current-office, corporate business plan. There is a certain amount of debate about how long that period should be, and that has not yet been resolved. Once this is in place and has been run for awhile, I think that there will be more of a move to stochastic-type processes, or at least for deterministic figures to be derived after looking at some sample stochastics.

