

USE OF DYNAMIC FINANCIAL ANALYSIS AND FINANCIAL CONDITION REPORTING BY UNITED KINGDOM GENERAL INSURERS

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ABSTRACT

This paper presents the findings of a survey of the current Dynamic Financial Analysis (DFA)/ Financial Condition Report (FCR) practices in the United Kingdom general insurance industry. An independent samples t test for non-respondent bias was conducted, and the results suggest that the respondent sample is representative of the survey population. The survey results revealed: (1) that the use of DFA techniques in the industry was limited; (2) that scenario testing was the most frequently used technique; (3) that the most common DFA application was the evaluation of reinsurance programmes; (4) that less than ten scenarios were run regularly; (5) that inflation was the most frequently modelled economic variable; (6) that the capability of asset modelling of general insurers was restricted; (7) that the most common method of liability modelling was to use all in force policies in aggregate; (8) that the most common projection periods in DFA and business planning were three years; (9) that the main reason for not using DFA techniques and producing FCR was lack of need; and (10) that views on whether a Guidance Note on FCR specifically for general insurers should be introduced differed.

KEYWORDS

Dynamic Financial Analysis; Financial Condition Report; General Insurers; Postal Survey

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1. INTRODUCTION

Dynamic Financial Analysis (DFA) is a tool which actuaries employ to evaluate the effects of various risks and management strategies on the financial condition of an insurer. Due to its importance, a number of actuarial professional bodies provide guidelines to help actuaries conduct analyses using DFA or its variants. For instance, since 1994 the Casualty Actuarial Society (CAS) has been promoting and developing DFA as a tool for actuarial use to model the complicated and interrelated underwriting and investment operations of non-life insurers. In 1995, the CAS first developed the *Dynamic Financial Analysis Handbook* for property and casualty insurance companies. In 2000, the DFA committee of the CAS published the

Dynamic Financial Analysis Research Handbook, by combining the original handbook with other newly produced papers on DFA. The purpose of this updated handbook is to provide actuaries with guidance and a list of considerations when conducting DFA. It is noted that the handbook does not prescribe reporting requirements as regards DFA. The format of the relevant report is at the discretion of the actuary conducting DFA (Szkoda *et al.*, 1995). The DFA committee changed its name to the Dynamic Risk Modelling (DRM) Committee in 2003, to explicitly recognise that the family of DRM is broader than that of DFA. As indicated by the CAS Working Party on Executive-Level Decision-Making Using DRM (2004), however, DFA and DRM could be used interchangeably in many cases. From 1 January 1999, all Appointed Actuaries of insurance companies operating in Canada have been required by the Superintendent of Financial Institutions to prepare financial condition reports, based on the Standard of Practice on Dynamic Capital Adequacy Testing issued by the Canadian Institute of Actuaries (1998). This Dynamic Capital Adequacy Testing (DCAT) standard covers, not only life offices and fraternal benefits societies, but also property-casualty insurers. Before the DCAT standard was issued, the Dynamic Solvency Testing (DST) standard only covered life companies and fraternal benefit societies (Canadian Institute of Actuaries, 1991, 1993).

In 1994, the Dynamic Solvency Testing Working Party of the Faculty and Institute of Actuaries distributed a questionnaire to Appointed Actuaries in 153 United Kingdom life insurers to draft guidance on Financial Condition Reporting (FCR) (Dynamic Solvency Testing Working Party, 1994). In 1996, the Life Board of the Faculty and Institute of Actuaries introduced Guidance Note 2 (GN2) on FCR as recommended practice for Appointed Actuaries responsible for long-term insurance business. In Section 3 of GN2, the use of DST to obtain the information required by the FCR is discussed. DST is conducted using scenario testing, and involves projecting a life office's solvency position into the future under different assumptions, to assess its financial strength and identify the main risk factors affecting the company. Nevertheless, to the authors' knowledge, a survey of the practices of DFA and FCR of the U.K. insurance companies carrying on general business has never been administered before. In order to review current practice and see whether or not a Guidance Note similar to GN2 is needed for actuaries in the U.K. general insurance industry, it is essential to carry out a survey, as the Dynamic Solvency Testing Working Party did in 1994 for drafting GN2.

It is worth noting that, in the Canadian non-life insurance industry, there was a survey covering only very few topics regarding DFA and FCR practices. Oakden *et al.* (2001) invited 36 Canadian property-casualty insurance and reinsurance companies to participate in a study of Appointed Actuaries' approach to DCAT analysis and reporting. Twenty-two companies

responded to the invitation and were interviewed. Oakden *et al.* (2001) reported that Appointed Actuaries were significantly involved in determining input for the base scenario. Scenarios considered significant, and included in more than one-half of the DCAT reports of the companies surveyed, include frequency and severity of loss, understatement of unpaid claim liability, single catastrophic loss, increase in inflation, increase in interest rates, and deterioration in asset values. On average, more than six scenarios were used. In addition, the length of the projection period of the DCAT was roughly in line with that of the business plan. The DCAT projection period of more than 90 per cent of the companies was less than two years, while the projection period of the business plan of more than 90 per cent of the companies was less than three years.

The principal contribution of this article is to reveal the current practices of DFA/FCR of the U.K. insurance companies carrying on general business through a postal survey. As noted above, a survey of this nature has never been administered in the non-life insurance industry. The present study is the first one of its kind. The findings of this survey should be of value to management and practicing actuaries, the Faculty and Institute of Actuaries, and the supervisory authority. Management and practicing actuaries can compare the use of DFA techniques within their organisation with that in the whole market to assess whether there is a need to improve it, and, if so, to what extent. Based on the results obtained, the Faculty and Institute of Actuaries can evaluate whether or not it is necessary to draft a Guidance Note on DFA/FCR specifically for general insurers, and, if so, what should its status be. Also, from the survey results the supervisory authority is able to know the capability of the industry, and accordingly set feasible requirements for non-life companies when adopting risk-based approaches to regulation.

In the following section, we describe the survey population, the questionnaire and the survey procedure, and in the subsequent section we show that the survey respondents are broadly representative of the survey population. The results of the questionnaire are presented and discussed in Section 4. Finally, Section 5 concludes the paper.

2. SURVEY POPULATION, QUESTIONNAIRE AND SURVEY PROCEDURE

Since there had been no research on the practices of DFA/FCR in the U.K. non-life insurance industry and relatively little was known about these practices, it was decided that an exploratory study was required to serve the purpose of this research. Considering the exploratory nature of enquiry, and taking into account the cost and time required, it was further determined that the postal survey method was the most appropriate means by which to collect data and gather empirical evidence.

Due to the availability of the returns, it was decided to survey the companies in SynThesys Non-Life (Version 3.32), instead of all insurers currently authorised to carry on general business in the U.K. This data set comprises the statutory returns over the 1985 to 1999 period for 346 companies, being the number of general insurers which had ever existed during the period. Firms were surveyed as long as they existed at the time of the survey. With respect to subsidiary companies which belonged to the same parent group, only the parent company would be surveyed, because these subsidiary companies are supposed to have the same practices as their parent company. These selection rules produced a sample of 131 general insurers.

The questionnaire was intended to gather data from two distinct groups within the population — those who had access to some form of DFA/FCR and those who did not. Respondents were asked whether they used DFA, how it was employed, which risk factors were considered, and how assets and liabilities were modelled within the individual organisations. Moreover, the questionnaire would also seek to confirm whether FCR was being produced, whether FCR was available to third parties, and whether it is necessary to introduce a Guidance Note on FCR specifically for general insurers.

The first step in the survey procedure was piloting the questions, to ascertain that the jargon was used correctly and that the answers to the questions were as complete and appropriate as possible. The second step was conducting the pilot test. One random sample of ten companies was selected from the survey population of general insurers for pilot testing the questionnaire. With a view to increasing the response rate, we addressed the questionnaire to named individuals and used first-class postage stamps. In all there were four responses to the pilot test, so the response rate was 40 per cent. Respondents were requested to add any comments concerning the questionnaire, such as suggestions concerning wording, instructions, response categories or type of questions. However, no useful comments were made, so it was assumed that the questionnaire was well received by the respondents. In the main survey there were 121 organisations contacted. Of the 121 organisations, 44 responses were received, representing a response rate of 36 per cent. Nonetheless, ten of these responses were in the form of a letter or an email, explaining why the questionnaire was not completed. This produced an overall total of 34 usable responses from a population of 121, giving a usable response rate of 28 per cent. A number of the respondents commented on the questionnaires and provided useful information on the current practices of DFA/FCR in the industry.

3. THE NON-RESPONDENT BIAS

Three financial characteristics were selected for an independent-samples

Table 1. Levene's test for the financial characteristics

Financial characteristic	<i>F</i>	<i>p</i> -value	Decision ($\alpha = 0.05$)
Average net admissible assets	4.601	0.034	Reject H_0
Average profit before tax	0.283	0.596	H_0 cannot be rejected
Average net premiums written	0.000	1.000	H_0 cannot be rejected

t test to determine whether non-respondent bias exists, including average net admissible assets, average profit before tax and average net premiums written. The required data were obtained from SynThesys Non-Life for the years 1996 to 1999.

Before carrying out the independent-samples *t* test, we conducted a Levene's test for equality of variances in the respondent and non-respondent groups. Table 1 shows that the null hypothesis is rejected for the average net admissible assets, but cannot be rejected for the average profit before tax and average net premiums written. Thus, these two groups were assumed to have unequal variances for average net admissible assets, but equal variances for average profit before tax and average net premiums written.

Based on these assumptions concerning variances, independent-samples two-tailed *t* tests were conducted, and the results are shown in Table 2. The null hypotheses of means equality cannot be rejected for the three financial variables at the 0.05 level, suggesting that the survey respondents are broadly representative of the survey population in terms of these financial characteristics.

It should be noted that the insignificant results presented above may be due to the small sample size. We might be getting more small than large insurers responding. The questionnaire is easier to complete for insurers which are not actually using DFA. These companies will tend to be the smaller ones with few actuarial resources. Nevertheless, there is no way to test the hypothesis that companies who were not using DFA might be more inclined to respond.

It is worthwhile to point out that one of the assumptions behind an

Table 2. Independent-samples *t* test for the non-respondent bias

Financial characteristic	Survey respondent (£000)	Survey non-respondent (£000)	<i>t</i> (<i>p</i> -value)	Decision ($\alpha = 0.05$)
Average net admissible assets	52,032	115,140	-1.543 (0.126)	H_0 cannot be rejected
Average profit before tax	19,675	24,980	-0.250 (0.803)	H_0 cannot be rejected
Average net premiums written	104,070	110,173	-0.092 (0.927)	H_0 cannot be rejected

independent-samples *t* test is the homogeneity of variances of the respondent and non-respondent groups. As previously reported, the null hypothesis of Levene's test is rejected for average net admissible assets. That is, the respondent and non-respondent groups do not have equal variances in terms of this financial characteristic. It means that these two groups differ in this regard. Nevertheless, when there are unequal group variances, a number of methods of separate variance estimates can be employed to compensate for the lack of homogeneity. One of the methods is called the Welch method. This method is implemented by most computer packages for statistical analysis, including the SPSS, which is the software used to analyse the survey data. Although these two groups differ because of unequal variances, it does not mean that one cannot continue to conduct the independent-samples *t* test. In this case, as mentioned previously, some method should be used to compensate for the lack of homogeneity of variances. In this study the problem is dealt with using the SPSS, which employs the Welch method.

4. SURVEY RESULTS

4.1 *Introduction*

This section presents a factual account of the survey findings of DFA/FCR practices in the general insurance sector. As stated previously, there is no similar U.K. research which can be fully compared with these findings. The only partly comparable survey is the survey administered by Oakden *et al.* (2001). The findings of their survey are compared with those of the present survey where appropriate. Nevertheless, it is worth emphasising that the comparison between the two studies should be treated with caution, mainly because the average size of the sampled companies in Oakden *et al.* is relatively large, whereas there is a considerable diversity of company size in the present study.

The respondents were asked about the kinds of insurance contracts which their companies sold. Seven classes of business were listed. Since most of insurers offered more than one type of insurance contract, respondents were allowed to tick more than one response to this question. The actual numbers, as well as the percentages, are shown in Table 3.

4.2 *Use of DFA Related Techniques*

Table 4 reports on the use of DFA related techniques within non-life firms, including sensitivity testing, scenario testing and stochastic simulation. The most striking result is that 59 per cent of the survey respondents did not use any of these techniques at the time of the survey. This confirms that financial modelling techniques were used by less than half of the non-life companies surveyed. Scenario testing was the most popular technique used in

Table 3. The class of business

Class of business	Number (percentage) of respondents
Accident & health	14 (41%)
Marine, aviation and transport	4 (12%)
Liability	10 (29%)
Motor	8 (24%)
Property	18 (53%)
Miscellaneous & pecuniary loss	14 (41%)
Other	10 (29%)

Table 4. The use of DFA related techniques

DFA technique	Sensitivity testing	Scenario testing	Stochastic simulation	None of the above
Number (percentage)	9 (26%)	12 (35%)	4 (12%)	20 (59%)

the industry. Of the respondents, 35 per cent reported using scenario testing, whereas 26 per cent said that they used sensitivity testing. Only four general insurers (12%) indicated that stochastic simulation was employed within their organisations. Overall, it seems that the use of financial techniques, stochastic simulation in particular, in the general insurance industry was limited.

Having considered the use of the financial techniques by type of techniques employed, it is also pertinent to examine that by number. Table 5 confirms that the use of these techniques was restricted in the industry. Only two respondents (six per cent) employed all three techniques. Twenty per cent used two of these techniques, while 15 per cent only used one. Of the respondents who reported only using one technique, it is interesting to note that 80 per cent employed scenario testing, whereas 20 per cent used stochastic simulation. None of them used sensitivity testing. Since the main difference between scenario testing and sensitivity testing is that the former changes a group of consistent variables at a time, the latter changes a variable at a time. Respondents who were able to use scenario testing were supposed also to be able to do sensitivity testing. It seems that the respondents preferred scenario testing to sensitivity testing, probably because

Table 5. The number of DFA related techniques used

Number of DFA techniques used	0	1	2	3
Number (percentage)	20 (59%)	5 (15%)	7 (20%)	2 (6%)

the results from the former were relatively reliable and comprehensive, and the respondents felt no need to do the latter.

It is also interesting to note that 86 per cent of the respondents who used two of these techniques employed sensitivity testing and scenario testing, while the rest employed sensitivity testing and stochastic simulation. This indicates that there probably existed a 'technical gap' between scenario testing and stochastic simulation. Lack of resources could be the main reason why this gap existed. Nevertheless, there could be other reasons. For instance, respondents might simply believe that scenario testing performed better than stochastic simulation, or they might think that scenario testing had already met their needs. Although the question of which techniques to use is largely a matter of judgement, cost also figures in the decision. Complex models using stochastic simulation have become more affordable, because of advances in methodology and declines in the cost of information technology. Accordingly, the trend in recent years has been towards more sophisticated modelling.

4.3 *Application of DFA Related Techniques*

The survey asked the respondents to indicate the applications of the DFA related techniques within their organisations. The results are reported in Table 6. More than half of the respondents reported that these DFA related techniques were used to evaluate reinsurance programmes (64%), help develop a business plan (63%), do solvency testing (57%), and price insurance contracts (51%). Only four non-life firms reported using the techniques for the purpose of capital allocation. However, these techniques were rarely used to optimise asset allocation or evaluate mergers and acquisitions. It is also interesting to note that no respondent reported using the techniques for distributing surplus by line of business and for communicating the results with rating agencies. One respondent who ticked the box for 'other' stated that these techniques were used to evaluate

Table 6. The application of DFA related techniques used

Application	Number (percentage)
Solvency testing	8 (57%)
Capital allocation	4 (29%)
Evaluate reinsurance programmes	9 (64%)
Help develop business plan	9 (64%)
Pricing	7 (51%)
Asset allocation	1 (7%)
Surplus allocation	0 (0%)
Evaluate merger and acquisition	1 (7%)
Communicate the results with rating agencies	0 (0%)
Other	1 (7%)

financial disaster, such as a stock market crash and the simultaneous failure of reinsurance companies.

On the whole, it seems that non-life firms tended to apply DFA techniques to underwriting related operations, such as the evaluation of reinsurance programmes and the pricing of insurance contracts, possibly because they focused relatively on underwriting activities compared to life offices. Evaluating reinsurance contracts was a prime application of DFA models, because of the potential use of reinsurance to control some sources of operational and catastrophic risks. Also, these models were often applied to pricing, since most general insurers were, more or less, exposed to underwriting risk. As for solvency, it was the main concern of the management of all insurers.

4.4 Scenario Testing Related Issues

Eighty four per cent of the respondents using scenario testing ran fewer than ten scenarios on a regular basis. These results could be broadly in line with those reported by Oakden *et al.* (2001), who found that, on average, Canadian property and casualty insurance and reinsurance companies included more than six scenarios.

It appears that non-life firms generally used a small number of scenarios in scenario testing. There are two factors which can explain why few scenarios were used. The first is that many general insurers were relatively incapable of generating scenarios, and, accordingly, their capability of employing financial techniques was limited. A second explanation is that non-life respondents might simply consider it unnecessary to use a large number of scenarios in scenario testing. This can be confirmed by a number of additional comments volunteered by the respondents to the survey. For example, one finance director from a company offering accident & health insurance commented: "Generally speaking, we normally run about six scenarios half yearly. Due to the nature of our business, there is no need to run many scenarios."

A similar comment was made by an actuary with a non-life company, who reported running less than ten scenarios on a regular basis: "We only run a very small number of scenarios, which suffices our needs."

On the whole, the additional comments volunteered by the survey respondents suggest that there was no need to run a lot of scenarios, possibly due, in part, to the nature of business. This seems to imply that, in the past, the lack of simulations was acceptable to non-life companies. Nevertheless, at present non-life companies operate in a fundamentally changed business environment, and face challenges from both underwriting and investment operations, such as adverse claims developments and subdued financial markets. A wide range of scenarios which might be beyond the actuary's preconceived notions could happen. In life insurance, stochastic methods were rejected as overly complex and unnecessary by many offices in the

Table 7. The frequency of scenario tests conducted

Frequency	Daily	Weekly	Monthly	Quarterly	Half yearly	Annually	Other
Number (percentage)	0 (0%)	0 (0%)	4 (33%)	2 (17%)	4 (33%)	2 (17%)	0 (0%)

Dynamic Solvency Testing Working Party Report, and yet they are widespread now. Similarly, it is reasonable to expect that using stochastic simulations to generate a large number of scenarios will become increasingly important to non-life firms.

As to the frequency of scenario testing, the results are summarised in Table 7. Monthly (33%) and half yearly (33%) were the most common frequencies. None of the respondents reported conducting scenario tests daily or weekly. In contrast, banks usually conduct scenario tests relatively frequently. According to the survey of 43 major commercial and investment banks by Fender & Gibson (2001), most of the banks surveyed reported running stress testing (one kind of scenario testing) daily, weekly and monthly. It is generally agreed that the frequency of scenario testing is influenced by both the technical burden of conducting scenario tests and the frequency of shifts in portfolio positions. For general insurers, frequent scenario tests are a burden and shifts in portfolio positions are relatively infrequent. The difference in frequency of testing between banks and insurers is because banks have much greater liquidity issues than insurers.

Question 5 listed 19 risk categories, and asked the respondents using scenario testing whether any of these risk categories were included in their scenarios, i.e. whether they varied any of the assumptions regarding these risk categories. Table 8 shows the results. Eighty three per cent of the survey respondents, not surprisingly, reported including *levels of new business* in the scenarios. The following quotation, from the actuary of a non-life company, is indicative of the concern of many respondents who included this risk category as one of the scenarios: "High levels of new business could have a huge impact on the solvency of the company."

High levels of new business might indicate favourable business expansion. Nevertheless, an unusual increase in the levels of new business often seriously depletes the capacity of the company. It is especially hazardous for a small non-life insurer to underwrite a great deal of new business before reinsurance agreements can be arranged.

In addition, the risk categories, which were included in scenarios by more than half of the respondents, are *expenses* (75%), *frequency and severity* (75%), *premium volume* (75%), *risk of reinsurer default* (67%), *future investment conditions* (58%), *pricing* (58%), and *interest rate level* (58%). The possible reasons why the above-mentioned risk categories were included as scenarios are discussed below.

Table 8. The risk category included in scenarios

Risk category	Yes	No	N/A
Future investment conditions	7 (58%)	1 (9%)	4 (33%)
Levels of new business	10 (83%)	0 (0%)	2 (17%)
Expenses	9 (75%)	1 (8%)	2 (17%)
Taxation	3 (25%)	4 (33%)	5 (42%)
Effects of asset defaults	1 (8%)	6 (50%)	5 (42%)
Risk of reinsurer default	8 (67%)	1 (8%)	3 (25%)
Frequency and severity***	9 (75%)	1 (8%)	2 (17%)
Pricing	7 (58%)	0 (0%)	5 (42%)
Misestimation of policy liabilities***	3 (25%)	2 (17%)	7 (58%)
Deterioration of asset values***	4 (33%)	3 (25%)	5 (42%)
Government and political action	2 (17%)	6 (50%)	4 (33%)
Off balance sheet (e.g. derivatives)	0 (0%)	2 (17%)	10 (83%)
Unexpected inflation	2 (16%)	5 (42%)	5 (42%)
Interest rate level***	7 (58%)	2 (17%)	3 (25%)
Equity returns	4 (33%)	2 (17%)	6 (50%)
Premium volume	9 (75%)	0 (0%)	3 (25%)
Leverage	0 (0%)	3 (25%)	9 (75%)
Liquidity	2 (16%)	5 (42%)	5 (42%)
Asset mix	4 (33%)	3 (25%)	5 (42%)

Note:

1. ***Scenarios considered significant and included in more than one-half of the DCAT reports of the companies surveyed by Oakden *et al.* (2001)
2. N/A: not applicable

The scenarios considered significant, and included in more than one-half of the DCAT reports of the companies surveyed by Oakden *et al.* (2001), are *frequency and severity*, *understatement of unpaid claim liability*, *single catastrophic loss*, *increase in inflation*, *increase in interest rate*, and *deterioration in asset values*. Of these six scenarios, *single catastrophic loss* and *increase in inflation* were not listed in the present survey as responses to question 5. *Frequency and severity*, and *interest rate level (increase in interest rate)* are the scenarios which were found significant, both in the present survey and in the study by Oakden *et al.* However, the remaining two significant scenarios, *understatement of unpaid claim liability* and *deterioration in asset values* were not used by more than half of the survey respondents. How can the difference between the findings of the two surveys be reconciled? There could be two reasons behind this. The first is that the companies interviewed by Oakden *et al.* are the largest Canadian property and casualty insurance and reinsurance companies, whose natures of business might be different from those in the present survey population. The second reason is that the related techniques are more sophisticated and developed in Canada than in the U.K. Thus, the risk categories considered by the insurers in these two countries were accordingly slightly different.

4.5 Determinants of Company Performance

Question 6 listed 11 possible performance determinants, and requested the respondents to rate the importance of these determinants on a five-point scale, '1' being least important and '5' being most important. Table 9 presents the means of the importance ratings given by the respondents for these determinants in decreasing order of importance rating. These results reveal that the survey respondents perceived *stability of underwriting operation*, *solvency margin*, *reinsurance dependence*, *interest rate level*, and *stability of asset structure* to be relatively important to company performance (i.e. mean importance rating more than '3'). Not surprisingly, *stability of underwriting operation* was given the highest rating in terms of company performance. This is because the underwriting operation is the core business of a non-life insurer, and is, therefore, of particular importance. *Solvency margin* was also one of the main concerns of the non-life companies surveyed, possibly due, in part, to the fact that financially sound companies are better able to adhere to the specified underwriting guidelines. In general, adhering to these guidelines will do the companies good in the long run. In addition, *reinsurance dependence* was ranked third by the respondents. This is because non-life companies rely heavily on reinsurance. This is particularly the case for small companies, because their capacity is generally limited. *Interest rate level* was the investment related determinant given the highest importance rating. This is because non-life companies invest a high proportion of their funds in fixed-income securities, and, as a result, the *interest rate level* has a great impact on their investment performance. *Stability of asset structure* was the second investment related determinant considered relatively important. In general, a good asset structure is important to non-life companies, and a dramatic change in asset structure might indicate that the company is in financial trouble.

In contrast, the respondents indicated that *leverage*, *company size*,

Table 9. The mean importance rating of performance determinants

Performance determinant	Mean importance rating
Stability of underwriting operation	3.7
Solvency margin	3.4
Reinsurance dependence	3.3
Interest rate level	3.1
Stability of asset structure	3.1
Equity returns	2.8
Interest rate change	2.7
Unexpected inflation	2.6
Liquidity	2.6
Company size	2.5
Leverage	1.6

liquidity, unexpected inflation, interest rate change, and equity returns are relatively unimportant to company performance (i.e. mean importance rating less than '3'). It is worth noting that the mean importance rating of *equity returns* was only '2.8'. It seems that *equity returns* was not an important determinant. There could be two reasons behind this. The first is that non-life companies, in general, invest most of their funds in bonds instead of in equities. The non-life insurance industry, as a whole, invested 12.5 per cent and 24.4 per cent of its funds in equities and bonds, respectively, during the period 1986 to 1999. The second reason is that general insurers have focused their modelling on liabilities. They do not identify assets as an issue.

4.6 Modelling Related Issues

The general insurers surveyed were asked whether and how they modelled the term structure of interest rates, inflation, equity returns, currency rates, and credit spreads. Table 10 reports the results of the use of the five economic variables. Two main observations can be made from the results. First, on average more than 80 per cent of the survey respondents did not model these economic variables with the exception of inflation, which approximately half of the respondents did. The main reason why *inflation* was the most frequently modelled variable is that it is required for the liability modelling.

The second observation is that most of those who modelled inflation did it in a deterministic way. This finding suggests that deterministic models may be crude, but at least the results could be accepted as approximately correct. In addition, developing a stochastic model for inflation is not necessarily essential for a general insurer. The use of a deterministic or stochastic approach mainly depends on the applications of the model. For instance, it may be acceptable and adequate to model inflation deterministically when projecting the financial strength of an insurance company over the next few years. Nevertheless, modelling inflation in a stochastic way would be of particular value in assessing the ability of an insurer to withstand the wide range of possible changes in the external economic conditions.

Table 10. Modelling of economic variables

Economic variable	No	Modelling	
		Deterministic approach	Yes Stochastic approach
Term structure of interest rates	12 (80%)	2 (13%)	1 (7%)
Inflation	8 (53%)	6 (40%)	1 (7%)
Equity returns	12 (80%)	1 (7%)	2 (13%)
Currency rates	13 (86%)	1 (7%)	1 (7%)
Credit spreads	13 (86%)	1 (7%)	1 (7%)

The remaining factors were seldom modelled by the non-life companies surveyed. In general, only large insurers with complicated portfolios were relatively willing and able to model these economic variables.

The next important issue on modelling is the degree of sophistication with which the assets were modelled by the respondents. Table 11 shows that 47 per cent of the respondents indicated that in each projection step the total investment return could be projected within their organisations. It is noted that a number of non-life companies did not have even the most basic capability of asset modelling. Some 47 per cent of the respondents indicated that they were unable to vary the assumptions from year to year. The scenarios which can be examined by these organisations were accordingly limited to a great extent. Twenty seven per cent indicated that they were able to vary income and gains independently, and the same percentage used separate model points for different asset classes for modelling purposes. None of the organisations reported that they were able to model individual assets separately. Generally speaking, the capability of asset modelling in the non-life insurance industry was very limited, possibly because this industry used to place great emphasis on underwriting instead of investment operations.

Having considered the capability of asset modelling, it is also important to investigate the liability modelling methods employed by the general insurance industry. Question 9 asked how the liabilities were modelled within the organisations surveyed, and the results are reported in Table 12. None of the general insurers surveyed reported modelling their liabilities using policies individually. In fact, more than half of the respondents (58%) modelled the liabilities using all or most in force policies in aggregate. In other words, most non-life companies surveyed modelled their liabilities using in force policies in aggregate instead of individually. This result is not surprising, because it is not convenient for general insurers to handle large risk collectives consisting of individual risk units, such as buildings in fire insurance and ships in marine insurance. Due to the nature of their products, it would be inappropriate for them to model liabilities using policies individually. This is the reason why a collective approach without any regard to the individual risk units is commonly regarded as more satisfactory, and is often employed in practice.

Table 11. The capability of asset modelling

Capability	Number (percentage)
Can project the total investment return	7 (47%)
Assumptions can be varied from year to year	8 (53%)
Can vary income and gains independently	4 (27%)
Separate model points for different asset classes	4 (27%)
Individual assets can be modelled	0 (0%)

Table 12. The method of liability modelling

Method	Number (percentage)
All in force policies individually	0 (0%)
Most in force policies individually	0 (0%)
A sample of in force policies individually	0 (0%)
Model points	1 (8%)
All in force policies in aggregate	6 (50%)
Most in force policies in aggregate	1 (8%)
A sample of in force policies in aggregate	0 (0%)
Other	4 (33%)

One respondent reported using model points, which are commonly seen in the life insurance industry. The rest of the respondents who ticked the box for 'other' used: 'all in force policies split into homogeneous sub-groups', 'incurred & paid claims & premiums', 'all past and present policies individually', or 'claims outstanding and incurred but not reported (IBNR) for short-tail business'. This suggests that the liability modelling methods in the general insurance industry were varied. Although modelling the liabilities using in force policies in aggregate seemed to be the standard practice in the industry, in some cases non-life insurers employed other approaches if need be.

4.7 Forecast Period

The length of forecast time horizon is vital in practical DFA applications. An analysis limited to a short time horizon may not completely reveal the long-term effects of adverse fluctuations and periodic variations of risk propensity. Nevertheless, the projection would become relatively unreliable as the projection period is lengthened.

In theory, the horizon of the business plan (BP), in general, should be consistent with that of DFA to provide confidence in the DFA results. In order to investigate whether such a relationship existed in the non-life industry, respondents were asked about the length of the forecast (or projection) periods in DFA and in the BP respectively. As evidenced in Table 13, the distributions of the length of the forecast periods in the DFA and in the business plan look similar. In order to give a formal indication of the correlation between the two, Kendall's tau-*b* and Spearman's rho correlation coefficients were calculated. Table 14 shows that both correlation coefficients are statistically significant at the 0.05 level, suggesting that the null hypothesis of no relation between the forecast period in the DFA and that in the BP can be rejected. These results confirm that in the general insurance industry the forecast period in the DFA was correlated with that in the BP.

Oakden *et al.* (2001) also report that the length of the DCAT projection

Table 13. The length of the forecast periods in DFA and the BP

Length	Dynamic financial analysis	Business plan
1 year	3 (20%)	3 (20%)
2 years	0 (0%)	1 (7%)
3 years	5 (34%)	5 (34%)
4 years	0 (0%)	0 (0%)
5 years	3 (20%)	2 (13%)
6 ~ 10 years	2 (13%)	2 (13%)
11 ~ 15 years	0 (0%)	0 (0%)
16 ~ 20 years	0 (0%)	0 (0%)
>20 years	2 (13%)	2 (13%)

Table 14. The correlation coefficient of the forecast periods

Measure	Correlation coefficient
Kendall's tau-b	0.568** [0.009]
Spearman's rho	0.666** [0.004]

Note:

1. *Significant at the 0.05 level; **significant at the 0.01 level
2. *p* values are in brackets

period of Canadian property and casualty insurance and reinsurance companies was in line with that of the business plan. The all companies' DCAT projection period and the BP projection period of 91 per cent of the companies were less than three years. Compared with U.K. general insurers, Canadian property and casualty insurance and reinsurance companies have a relatively short projection period. This is probably because the DCAT Standard of Practice suggests that the projection period for a typical property and casualty insurance company should be two fiscal years (Canadian Institute of Actuaries, 1998), whereas there is no similar rule or regulation for a non-life insurer in the U.K.

4.8 Considerations of DFA Results by Senior Management

The extent to which senior management incorporated DFA results into their decision making processes are summarised in Table 15.

This table shows a wide diversity in the extent to which the DFA results are incorporated in the decision making process by senior management. Half of the respondents indicated that the DFA result considerations are *always* or *usually* involved in the decisions made by senior management, whereas the other half are *often* or *occasionally*. None of the respondents using DFA related techniques indicated that such considerations were *never* made. This

Table 15. The incorporation of DFA results in decision making process

Extent	Always	Usually	Often	Occasionally	Never
Number (percentage)	2 (14%)	5 (36%)	3 (21%)	4 (29%)	0 (0%)

confirmed that all respondents took into account the DFA results obtained from their DFA exercises to a certain extent. One respondent further commented that: “in order to make sound judgement DFA results need to be looked at in their proper perspective”. This suggests that DFA is of help, in this sense, because it provides decision makers with some information which might be useful on the financial condition of the company.

4.9 Difficulties Experienced in Communicating the DFA Results to the Board

After investigating a number of issues on how DFA was used, the survey then sought to identify whether any difficulties have been experienced in communicating the DFA results to the Board of Directors. In Table 16 responses are presented, ranked from the most common to the least common responses.

Communicating complex issues to non-specialists was the most common difficulty in reporting DFA results to the Board. More than half of the respondents (54 per cent) confirmed this fact. As previously mentioned, the results of DFA exercises using stochastic simulation in particular, often show very technical terms which are sometimes difficult to understand for management. If management could not appreciate the DFA results and their importance, the DFA exercises would not be considered valuable. Therefore, how to communicate these results efficiently and effectively to non-specialists on the Board is the current focus of many actuaries charged with the DFA task.

One fifth of the respondents indicated that the Board expressed concern about the degree of conservatism in selecting adverse scenarios. As mentioned previously, the adverse scenarios considered in a DFA application

Table 16. Difficulties in communicating the DFA results to the Board

Difficulty	Number (percentage)
Difficulties in communicating complex issues to non-specialists	8 (54%)
Concern regarding the degree of conservatism in selecting adverse scenarios	3 (20%)
Other	3 (20%)
Lack of interest	2 (14%)
How to present extremely adverse scenarios without causing undue concern	2 (14%)
Too much focus on assumptions rather than on results	2 (14%)

should be plausible and possible. In particular, they should reflect the external environment in which the company will operate. Determining the degree of conservatism in selecting adverse scenarios is, in general, based on the professional judgement of the actuary. Generally speaking, this decision should be left largely with the actuary. After all, the actuary is employed to judge what is appropriate for the company in the particular circumstances in which it finds itself.

Lack of interest shown by members of the Board was recorded. This is partly because the DFA results were not considered important by management, and may also be due to the fact that management has difficulty in understanding the results. Moreover, if non-life insurance companies were required by the regulator to employ DFA techniques to produce an FCR, *lack of interest* would not be the difficulty in communicating the results to the Board.

Fourteen per cent of the respondents confirmed that it was difficult to present extremely adverse scenarios without causing undue concern while communicating the DFA results to the Board. The decision whether an extremely adverse scenario is to be presented to the Board should be left with the actuary. If the actuary considers an extremely adverse scenario to be plausible, it should be presented to the Board with detailed explanations, in order not to cause undue concern. On the other hand, if an extremely adverse scenario is not likely to occur, perhaps it should not be presented to the Board in the first place.

Fourteen per cent of the respondents confirmed that members of the Board focused too much on assumptions rather than on results. A respondent further commented that: "Sometimes board members paid too much attention to the probability distributions assumed for a stochastic simulation analysis." In general, the actuary determines which probability distributions and associated parameters should be used. This decision is based on the actuary's experience and understanding of the risks faced by the company. Sometimes the decision is somewhat subjective. Views on assumptions could be varied. Board members should concentrate on examining the reasonableness of the results, instead of going into too much detail on the assumptions.

A number of the respondents who ticked the box for 'other' provided the following answers to this question. For example: "Directors may have different views on assumptions" and "Directors do not understand the DFA results." One respondent stated that no particular difficulties had been experienced.

4.10 *Main Reasons for not using the DFA Related Techniques*

The final question in the first part of the questionnaire was directed at those organisations which did not use any of the DFA related techniques. The organisations were asked about the main reasons for not using these

Table 17. Main reasons for not using DFA related techniques

Reason	Number (percentage)
Lack of need	16 (76%)
Lack of relevant knowledge	5 (24%)
Lack of experience	4 (19%)
Too expensive	0 (0%)
Lack of appropriate asset or liability models	5 (24%)
Other	6 (29%)

techniques. The results are summarised in Table 17. The most striking result is that 76 per cent of the respondents indicated that *lack of need* was the main reason for not using these techniques. However, the FSA has proposed changes to insurance regulation indicating that risk-based approaches will be extensively adopted. Although the proposals do not prescribe a particular approach, DFA would obviously be useful. Thus, organisations not using DFA now will probably be doing something along the lines of DFA in the future.

Lack of relevant knowledge and *lack of appropriate asset or liability models* were the second most common reasons. A number of respondents further commented that they wished to apply DFA techniques to their underwriting and/or investment operations, but they did not know how to do it. This finding suggests that there was a need to provide guidance on the use of DFA techniques for those who wished to conduct the relevant analyses. Several asserted that there were no appropriate asset or liability models which could meet their needs. They alluded to the fact that they were not able to modify the publicly available models, and they could not develop their own models either. In this case, it seems that they had to resort to help from actuarial consultants.

Nineteen per cent of the respondents confirmed a lack of experience relative to the use of DFA techniques. An actuary alluded to the fact that the role of actuaries within his organisation was rather traditional. This confirms the popular belief that the areas in which actuaries are currently advising non-life companies mainly include determining the level of technical provisions needed for solvency and accounting purposes, and pricing non-life insurance products. This finding suggests that there was a need to encourage actuaries to be more involved with DFA exercises, so that actuaries would learn by experience.

None of the respondents indicated that cost was the main reason. Nevertheless, using DFA related techniques requires many resources, which are usually 'expensive', such as people and technology.

The remaining responses were varied. Several respondents confirmed that

they did not have an actuarial resource at their disposal. This confirms the general view that the actuarial resource was scarce in most non-life companies. According to *The Actuarial Directory 2002*, only eight per cent of U.K. fellows work in the general insurance industry. In fact, many small non-life companies even did not have any actuaries within their organisations.

4.11 *Use of Financial Condition Report*

Organisations participating in the survey were asked whether they produced an FCR or its equivalent. Nine respondents (27%) indicated that an FCR or its equivalent was produced within their organisations. Those who produced an FCR were then asked how often the FCR was produced. Seven respondents (78%) indicated that they produced their FCR annually, with the remainder producing their FCR on a monthly or quarterly basis. This finding seems to indicate that the frequency of producing an FCR was varied in the general insurance industry, although most of the non-life firms did it annually.

The survey also asked the respondents who reported producing an FCR within their organisations whether the FCR was available to their auditors and the Financial Standards Authority (FSA). All of these respondents indicated that they made the FCR available to their auditors, whereas only six respondents (67%) made it available to the FSA. The respondents to this question were then requested to express their opinions regarding whether the FSA should have automatic access to the FCR. Four respondents (43%) indicated that the FSA should. Views were mixed on this issue on automatic access. These respondents who were against the automatic access argued that the regulator may tend to react prematurely to the FCR, and that premature intervention might cause a financially weak insurance firm to become insolvent. This result is very likely to occur if the news of intervention is made public and damages the insurer's ability to take measures to improve its financial strength. Nonetheless, if the FSA delays taking action against weak firms, some insolvencies which could be preventable may occur in the end. It is difficult to balance the risk of premature action and excessive forbearance in practice. On the whole, the comments volunteered by the survey respondents suggest that U.K. Chief actuaries and finance directors remained concerned with the release of the FCR. Furthermore, in a number of cases the respondents appeared to be more concerned with the misinterpretation of financial statements by the general public than with premature action by the FSA.

As previously stated, GN2 is a Guidance Note produced by the Faculty and Institute of Actuaries to help actuaries in the life sector produce FCR. However, there is currently no similar Guidance Note on FCR specifically for general insurers. The survey respondents were asked whether it is necessary to introduce such a Guidance Note. Fifteen respondents (44%)

indicated that a Guidance Note on FCR for non-life insurers is necessary. Those who indicated that such a Guidance Note should be introduced were then asked what classification they would like the Guidance Note to have. Eleven respondents (75%) indicated that the Guidance Note should be initially standard practice, whereas the rest considered that it should be mandatory. These results show that views on whether the Guidance Note should be introduced differed. Some respondents expressed concern about the impact of the introduction of such a Guidance Note on their authority. The following quotation, from the Chief Actuary of a multi-line general insurer, is indicative of the concern of these respondents:

“If it [Guidance Note] is introduced actuaries would like to be left with complete discretion and should be able to do whatever is necessary for their companies based on their professional judgement.”

This quotation suggests that the large proportion of the respondents reporting concern over the introduction of such a Guidance Note may be due to a reluctance to give up their complete discretion. Actuaries preferred to be left with complete discretion to make professional judgement on what should be carried out in FCR. Therefore, if this concern can be properly addressed, the proposal for the new Guidance Note would receive a generally favourable reaction.

Respondents who did not produce FCR were asked the main reasons for not producing it or its equivalent. Twenty-one respondents (83%) indicated that *lack of need* is the main common reason why FCR was not produced. As evidenced previously, this is also the main reason why the DFA related techniques were not used. *Lack of relevant knowledge* and *lack of experience* were the second and third most common reasons. Again, none of the respondents indicated that cost is the main reason. Other reasons provided by some respondents include: ‘lack of actuarial resource’ and ‘don’t know what it is’, etc.

5. CONCLUSIONS

The main contribution of this study to the academic literature is that the survey is the first comprehensive survey of its kind to investigate the current DFA and FCR practices in the U.K. general insurance industry. The research should be of interest to actuaries, the Faculty and Institute of Actuaries, and the FSA. Actuaries can compare the use of DFA techniques within their organisation with that in the whole market, to assess whether there is scope for improvement and, if so, to what extent. The Faculty and Institute of Actuaries could consider introducing guidance on FCR specifically for general insurers, based on the survey results. By understanding the current DFA/FCR practices, the FSA will be able to offer practical guidance to insurers for solvency monitoring purposes.

The use of DFA techniques, stochastic simulation in particular, in the general insurance industry was limited, with this survey indicating that only 41 per cent of the sample firms used these techniques, most of them employing scenario testing. The most common application of DFA was to evaluate reinsurance programmes. Less than ten scenarios were run regularly. Inflation was the most frequently modelled economic variable. None of the respondents was able to model individual assets. The most common method of liability modelling was to use all in force policies in aggregate. The most common forecast periods in DFA and the BP were three years. There is statistical evidence within this sample that the forecast period in DFA was correlated with that in the BP. The main reason for not using DFA techniques was lack of need. Less than one-third of the respondents indicated that FCR or its equivalent was produced within their organisations. Views on whether a Guidance Note should be introduced mixed.

Presumably the DFA and FCR practices will be changing over time, and the proportion of companies employing relatively complicated techniques will be greater than before. The survey of this nature is indispensable if we would like to have an overall picture and understanding of the practices. Future studies of a similar nature can serve as an update, and their findings can be used to compare with those of this research.

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