<u>General Insurance Study Group - Dublin Conference   October 1981</u>

<u>Working Party on Solvency Margins - Technical Risks</u>

This Report consists of six papers produced by individual members of the Working Party as follows:-

1. M Trayhorn   -   A general survey of the problems and risks involved. Appendix I of this paper, referred to in Sec. 7.3, is not yet available.

2. D Sanders   -   A note on the Application of Risk Theory.

3. M Clarke   -   Adequacy of Premium Reserves.

4. J Ryan   -   Trends in Underlying Parameters.

5. G Healy   -   Inflation.

6. D Sanders   -   Underwriting Cycles.

A comprehensive review of the solvency legislation in Finland has been in progress for the past two years and the final report is expected at any moment. If this becomes available in the near future I will prepare a brief summary for distribution at Dublin.

M Trayhorn
14 September 1981

Solvency Margins - Technical Risks

1   The main risk that we are concerned with here is the possibility of a trading loss arising because one or more elements in the premium basis turn out to be inaccurate. Two cases may be distinguished:-

    (a)   Where the premium rates are adequate but losses arise from short-term fluctuations

    (b)   Where the premium rates are wrong.

An interesting question at this point is how a particular company can tell which of the two positions it is in when a loss actually arises but we shall return to this later. For the time being we shall deal with the easier of the two cases (a).

2.1   The most obvious source of short-term fluctuations is, of course, purely random factors affecting mainly the claims. It should be noted that an assumption that premium rates are adequate also implies that the amount of business to be written has been correctly predicted otherwise the expected number of claims (n) would not be known nor would the ratio of fixed expenses to premiums. Given these assumptions the random elements of fluctuation in the total claim amount can be dealt with by simple risk theory. The variance of the total claim amount is $n\alpha_2$ where α_2 is second moment about origin of the distribution of the individual claim amount. The extent of the random variation in total claim amount for a particular company will depend upon

    1   The size of the company as represented by nm where m is the mean claim amount

    2   The type of business written - reflected in the values $\dfrac{\alpha_2}{m}$ (ratio of second moment to mean) and $\dfrac{\alpha_2}{\sqrt{n\alpha_2^3}}$ (measure of skewness)

    Given sufficient data on claim size these values can be estimated for a class of business. For example the following values were derived from one company's data:-

Class	α_2/m	Skewness
Household	900	.02
Private Car	2,500	.06
Commercial Fire	20,000	2.8

3   Reinsurance which will alter the moments of the distribution. Again it is not difficult to estimate the effect if sufficient data is available.

2.2   These random fluctuations in a company's experience arise because it only has a sample of the whole market. The whole risk theory approach to random fluctuation assumes that the expected amount of claims is known and that the only problem is the result given by a particular sample of claims.

2.3   To assume that the expected amount of claims is known is, in practice, wider than assuming that the market claim frequency and claim distribution is known because the claims will run-off over time periods of up to 10 years depending upon the type of business. The run-off will be affected by inflation and so one is effectively assuming that one can predict future inflation rates. Not only this but the figures which are being used as the basis of future predictions such as last years claim amount is itself only an estimate based on those same future inflation rates.

2.4   The next point concerns the definition of 'adequate premium rates' in connection with catastrophe type claims. If a particular event is expected to occur on average every ten years then presumably premiums rates are 'adequate' if they allow for one-tenth of the expected cost of the particular event. However, there is no way that the premiums can be considered as adequate in the year in which the event actually happens unless one was able to correctly predict the year of occurrence and charge premiums accordingly. This is a rather different form of random variation from that considered above. That was concerned with the variation of one company from the market average whereas this is a random event affecting the whole market.

3.1   In order to demonstrate the effect and magnitude of the random factors mentioned above and the other factors we shall be dealing with later a computer model has been used and the basic features are described below.

The aim is to consider how each factor affects a particular company according to its size and the type of business written (reinsurance is being considered by another working party). Size of company is represented by the expected number of claims (in the initial period) and three sizes with 500, 5000 and 50,000 claims per period are used. The average claim amount is assumed to have a log-normal distribution

and several different standard deviations are used for the distribution. In addition two different run-off patterns are used, where it is considered that length of run-off might have an effect.

The company allows for inflation, interest and the expected claims costs (or at least what it expects) and set its premium rates in such a way as to try to maintain its solvency margin at the initial level.

3.2 Our main concern in this paper is to consider the implications for solvency of the uncertainty involved in setting the premium rates. We need to consider how the company determines its projections of future costs and the time lags involved. It will be assumed that the company uses its past experience (as it appears to be at that point of time) to decide on its future expected costs. Of particular importance will be the length of time it takes the company to realise that circumstances have changed and adjust its view of the future accordingly. There are two aspects to this. Firstly it will change its premium rates as soon as possible, which may not be immediately to what it now considers to be adequate. Secondly, it will need to re-evaluate all its outstanding liabilities (ie technical reserves) in the light of its new view of the future. Obviously, in types of business where large technical reserves are necessary the readjustment of these reserves could far outweigh any losses coming through from the trading in that period. One also needs to consider the effect of different accounting policies such as the discounting of outstanding claims.

3.3 Before moving on to the more complex model it is worth considering the effect of business cycles. Economists have long claimed to be able to distinguish cycles of various lengths in the level of economic activity. These cycles will also affect insurance because of the effects they have on an insurers customers. During a recession the market is likely to be declining in real terms and insurance rates have to become more competitive. In addition there is likely to be an adverse effect on claim numbers and, possibly, amount. There are two courses a company can follow during such a cycle, assuming it recognises it as such. Firstly, it could attempt to follow the cycle; increasing premiums during the downswing to allow for the worsening of the claims experience. Theoretically, this course should not pose any solvency problems as the premium rates are always adequate.

However, in practice this course is unlikely to be feasible because at the time that premiums should be increased the market will start to decline and competitive pressures increase making premium increases difficult. The alternative is to base premium rates on the average throughout the cycle but this means that the cycle in claims will produce a similar cycle in the companys results.

3.4 Table I summarises the effects of short-term fluctuations mentioned above on a variety of companies.

The figures below show the 95% confidence interval for the percentage of the change in the solvency margin in one quarter. So if the solvency margin at the start of the quarter is 30% and the appropriate figure from the table below is x then, allowing only for random fluctuations in the claims, one can be 95% confident that the solvency margin will be between 30(100 - x)% and 30(100 + x)% at the end of the quarter. M is the mean of the individual claim amount.

Table I

Standard Deviation of Individual Claim Amount	Expected Number of Claims		
	500	5000	50,000
0^1	2.5	0.85	0.28
M	4.0		
2M	6.2*	1.9	0.56
5M	18.2*	6.6	1.33
10M	22.0**	15.3	2.65
20M			7.98

1 This line has random fluctuations in the number of claims only.

* The model used a solvency margin starting around 30% and run for 75 quarters. However, with the expected number of claims equal to 500 it is necessary to use a higher starting margin or else insolvency is almost inevitable. Those marked with * used a margin of 65% and the one marked with ** required a margin of 100% to produce stable results.

4.1 Premium rates charged may be inadequate if one or more of the elements contained in the premium basis is wrongly predicted. When one considers the number of individual items involved it would seem to need a miracle to correctly predict all these factors rather than being a major sin to get one wrong. Of course it is always possible to make wrong assumptions about everything and finish up with the right answer and so we shall also be interested in the relationship between the various assumptions. Our main concern is with the way in which the management of the Company can attempt to control or assess the magnitude of the risk involved with each factor. Before getting involved in detailed examination of the major risks we shall briefly discuss the items that are involved in the premium basis.

4.2 <u>Expenses</u>

Commission and the acquisition costs will be directly linked to the amount of business written and, in theory at least, should be directly controllable by the management. If these initial costs are high it is obviously possible to create a new business strain by writing too much business but this can only be described as bad management. More of a problem is the case where the Company is geared up for a particular level of business but, due to competitive pressure perhaps, the actual level is much lower with the result that the expense ratio rises rapidly and increasing premiums to compensate will only make the position worse.

The overall level of expenses will, like most of these factors, be affected by inflation. As the major part of expenses will be staff costs it is tempting to say that these are also under management control but this is probably debatable. The ratio of continuing expenses to premium should be fairly constant provided the amount of business is correctly anticipated. The only area where random elements are likely to have any influence is if a large number of claims gave rise to extra administrative costs.

Expenses are subject to some outside interference such as changes in rate of VAT, National Insurance etc which are unpredictable.

4.3 <u>The number of claims</u>

We have already dealt with the random fluctuation of the number of claims from the expected number of claims and we are now concerned with changes in the expected number of claims itself. This can be influenced by events inside or outside the Company. The market claim frequency will be affected by economic conditions such as petrol prices etc whilst the Company's claim frequency may well be affected by its own policies. For example, increasing household insurance rates and indexation has undoubtedly led to an increasing number of claims solely as a result of the higher premiums being charged.

The problem with the 'expected' number of claims is that it cannot itself be measured only the actual number of claims occurring

In order to ascertain any trend cycle or other variation in the expected number of claims it is first necessary to eliminate the random effects in the actual numbers. The result of all this is that it takes time before any change in the expected number becomes apparent and during this time-lag the Company may be charging inadequate premiums.

4.4 The average amount of each claim

If ascertaining trends etc in the number of claims is difficult then picking up trends in the average amount is attempting the impossible.

(a) The random variation in the average amount is far greater normally than in the numbers.

(b) Whereas delay in <u>notification</u> of claims is usually measured in weeks the delay in <u>settlement</u> of claims may be many years.

(c) 'Inflation' will affect the amount of the claim and even past inflation is not easy to measure because it varies in form between different types of claim ie whilst RPI might be appropriate for small AD claims, the liability side will depend on the escalation in court awards.

(d) The amount outstanding at any one time may form such a large proportion of the incurred claim amount that any error in estimating this outstanding will be geared up in future premium rates.

Apart from the above problems the Company needs to be able to assess the effects of changes in the portfolio mixtures on the average claim amount.

The only option open to a Company is to monitor claim payments as they are made and use the best available estimate of future claims costs based on these. Inevitably there is going to be a long delay between a change in the claim amount and the change becoming apparent to the Company through its claim settlements. The whole subject of time-lags in the system will be deal with later with reference to the use of the model.

4.5 Investment Income

These days investment income must be considered as part of the premium basis and in the case of long-tail business a major part of the premium basis. Obviously, the overall effect of any error in estimating the investment return is going to depend on the type of business written and the size of the technical reserves generated but even writing short-tail business there is the return on the capital and premium reserves to consider.

If the Company follows a long-term investment policy then the investment income in the next two years (say) may be fairly

easy to estimate because it will not be greatly affected
by changes in interest rates. On the other hand this type of
policy may put the Company at a commercial disadvantage
when short-term interest rates increase and so affect the
amount of business written.

It is also interesting to consider the effects of investment
policy on the level of margin in outstanding claim reserves.
If the rate of inflation increases then the outstanding
claim reserves need to be increased but as interest rates
tend to increase in times of high inflation this increase
would be offset to some extent if the actual income could
be increased in the short-term. This effect would, of
course, only come through to the published accounts if
discounted outstanding claim reserves were used but for
management purposes the margin in the outstanding claim
reserves could be considered as an extra solvency reserve.

The amount of investment income generated each year to be
included in the trading profit will depend upon the type
of assets held. Capital gains only come through into profit
when realised and in times of high inflation and high interest
rates market values may be depressed.

4.6 Target rate of return

All the above factors need to be estimated in order to
calculate the required premium but the Company also has to
decide what its objective is in terms of overall profit.
This would generally be an overall rate of return on capital
taking account of the dividend policy it hopes to follow
and the effect of the expected rate of inflation on its
level of free reserves.

5.1 Let us now consider how a Company might go about putting
some numbers on these risks. There is a distinction to be
drawn between the risk of technical reserves being inadequate
and the risk of future premiums being inadequate. In the
former case events are already virtually outside the control
of the Company once the reserves have been set up. The
future premiums are theoretically under the Company's control
but, as I hope to show later, this may be largely an illusion
(or delusion!)

5.2 Unearned Premium Reserve

There is a separate paper by Martin Clark dealing with UPRs
so I shall restrict myself here to a few comments on the
main features.

The UPR is a reserve to cover future events for which the
premium has already been collected. The income is predetermined
but the outgo is subject to all the possibilities mentioned
in Section 4.

The usual method of calculating the UPR by the 24ths method
takes no account of inflation over the period nor of seasonal

claim patterns. On the other hand the reserve is not
discounted for interest. It is also usual (traditional?)
to deduct 20% for acquisition costs regardless of the
actual level of acquisition costs.

5.3 Outstanding Claim Reserves

There are two main sources of problem here.

(i)   The rate of inflation assumed in the calculation
      of the outstanding claim reserve may be too low

(ii) The actual estimates (excl. inflation) may be
      wrong.

The effect of the first obviously depends on the length
of the run-off and the difference between the actual and
expected rates of inflation. The use of any form of
distribution for the difference between these rates must
be subjective and even more so as the period increases.
Given a run-off pattern the effect of a 5% (say) increase
in the rate of claim escalation may be calculated and one
cannot do much more than choose a 'maximum reasonable'
rate of inflation and calculate its effect. Using the
run-off pattern of a direct insurer the following
illustrate the magnitude of the losses that would arise on
UK business if inflation were to be 15% instead of the
assumed 10%.

Class	Loss as % of premiums
Motor	5
Household	1
Commercial Fire	4
Liability	22

If a statistical method of estimating outstanding claims is
used it may be possible to calculate the standard deviation
of the estimate after taking out the effects of inflation.
Otherwise best guide is likely to be an examination of past
accuracy in estimating, excluding inflation, but projecting
this forward involves making assumptions about the consistency
of the experience of the claims staff and the instructions
given to them.

5.4 IBNR Reserve

Generally the company will keep extensive records of numbers
of claims notified by date of occurrence so forecasting the
number of claims and putting a confidence interval around
it should present no great problem. As the claims have
already occurred the company will know of any particular
event which might give rise to an exceptional number of
claims so it is in a rather better position than when it is

setting future premiums. However, the problems are likely to arise in estimating an average claim amount for the IBNR claims. Because of the relatively small size of this reserve it can be unduly influenced by individual large claims. Past experience would seem to be the best guide to deviation from the estimate but liability accounts may be subject to large IBNR arising from presently unknown diseases or hazards.

5.5 The adequacy or otherwise of the above reserves determines the solvency of a company at a particular point of time but says nothing about the financial security of the company to write business in the future. Because of the inevitable delay between the end of the financial year and a detailed examination of the figures by the supervisory authority a company could put on a lot of business at inadequate premium rates during that time. The management of the company will be interested in longer term solvency rather than just being sure the technical reserves are adequate.

6.1 At this juncture it is worth considering the effect of taxation on solvency. In order to maintain its solvency margin in times of inflation a company needs to increase its free assets at the rate of inflation out of taxed profit. However, because losses only gain tax relief against future profits, additions to the free assets are taxed immediately whilst losses reduce the free assets by the gross amount initially. The effect is to make the downward fluctuations in the solvency margin from its expected value roughly double the upward fluctuations.

6.2 In the model being used it was noticeable that over a long period that the solvency margin tended to drift down. The company sets its rates so as to maintain its solvency margin but after a loss is made there is a loss of interest because the tax relief is not immediate.

7   Time Lags and Lack of Knowledge

7.1 Any attempt to assess the possible effects of these factors is difficult because there are so many possible variations and, by definition, no way of attaching probabilities to these events. These can be divided into two types. Those where there is a sudden unpredictable change in the economic environment and those changes which can to some extent be monitored and possibly predicted by the company.

7.2 The case of an unpredictable change is straightforward because there is nothing the company can do in advance and the extent of its problems will be influenced by the speed at which it can react to the change. Suppose there is a sudden once-and-for-all jump of 10% in price levels caused by some exogeneous factor. The company's free assets are immediately reduced by 10% of its outstanding claim reserve and roughly 10% of its UPR. These effects may not be fully reflected in published results depending on the reserving bases used and whether some of the impact

can be reduced by weakening the bases, but the true effect is there. The premium rates will now be too low and a 10% loss will be made on any business written at these rates. Therefore, every month of delay is going to cost the company about 0.8% of premiums or around 1.5% of free assets. The length of delay will obviously depend upon the type of sales organisation but computerised renewals are often prepared well in advance and issued in monthly batches making rapid alteration difficult.

7.3 It is not easy to generalise about the effect of the company getting trends etc wrong when setting its premium rates because of the wide variety of different situations and the number of possible reactions to it. However, if we make the assumption that the company uses its past experience in some rational manner to project the future then we can see the effects of delays. Suppose a company at time T is in the following position (time measured in quarters):

It can change its premiums at the start of quarter T+2. The number of claims occurring is known up to period T-2. The amount of claims is known up to period T-4.

The company will measure trends by considering the change in the last four periods known to it over the previous four and project this forward. Appendix I gives details of the experience of this company in a number of different environments.

8 Summary

(a) What a company really needs to know is how much it can lose in one year (or other period).

(b) The risks can be divided between those on policies already on the books and those that will be taken on during the next year.

(c) The risk of loss arising from outstanding claims consists of the risk of its current cost estimating being wrong and the risk of its inflation estimate being wrong. One can use past experience as a guide to the former but one would expect the accuracy to improve as the number of outstanding claims increased. Losses due to using the wrong rate of inflation will be directly proportional to the size of the outstanding claim reserve.

(d) The IBNR reserve poses the additional problem that the number of IBNR claims needs to be estimated and also the risk that the IBNR claims may differ in character from the rest of the outstanding.

(e) The risks involved with UPR are much the same as
     mentioned for future premiums below except that one does
     have the benefit of knowing how much business was written
     and something about the type of business written.

(f) Future premiums

    (1)   Unless all expenses are variable one must make
          assumptions about the amount of business written
          to decide whether the premiums are adequate.

    (2)   For companies of any size, assuming that it keeps
          the standard deviation down to reasonable levels,
          pure random fluctuations in claim numbers and
          amounts are the least of its problems. This risk
          will be proportional to the square-root of the
          expected claim amount.

    (3)   Fluctuations in the underlying expected number of
          claims and the possibility of catastrophe type events
          will have more influence. The risk of the former is
          likely to be directly proportional to the claim
          amount whilst the latter may also depend upon geographical
          concentration etc.

    (4)   Inflation is probably the single most important
          factor. Any distribution of deviations from the
          expected rate of inflation can only be subjective
          and the risk involved will be more than proportional
          to the claim amount because of the gearing introduced
          by the length of the run-off. This run-off will
          further complicate the issue in that even past
          experience will not be certain for a considerable
          length of time.

    (5)   The whole structure and reporting systems of the
          company need to be taken into account as its speed
          of realization that a change has taken place and its
          speed of reaction to that change are crucial in
          restricting losses.

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