

Solvency Margins Technical RisksThe Adequacy of Premium ReservesM.G. Clarke1. Definitions

By premium reserves, it is understood that we are considering the provisions held specifically to cover the risks represented by policies effected in the previous year(s) and not yet expired; excluding claims already incurred. These are divided into two parts:-

- a) **Unearned Premiums** : the amounts set aside at the end of a financial year out of premiums in respect of risks to be borne by the company after the end of the financial year under contracts of insurance entered into before the end of that year.
- b) **Unexpired Risks** : the amounts set aside at the end of a financial year in addition to unearned premiums which is considered necessary to meet the cost of claims and expenses of settlement arising from risks to be borne after the end of the financial year under contracts of insurance entered into before the end of that year.

2. In terms of the factors which affect a company's trading result for a particular period, say one year, these premium reserves and their calculation appear in three different areas:-

- a) In deciding on premium rates to cover the business written in any period, the cost of claims arising in previous periods may be compared with the premiums earned in that period - for both the whole of a class of business and individual sections of that class.

Inadequate premium rates obviously weaken a company's solvency and it is therefore important to be able to allocate accurately the premiums written to the risks and periods of risk covered by the premiums. Knowledge of any margins (positive or negative) in the earned premium denominator may enable a clearer picture of the risk premium to be produced.

- b) In a rather more direct way, the size of the premium reserves at the end of the year has an effect on the trading result, to the extent that the company needs sufficient reserves to pay claims arising on contracts already taken on, or to refund premiums at the end of the year in the event of the company ceasing to trade.
- c) During the course of the year, the contracts of insurance covered by the premium reserves set up at the beginning of the year will expire (assuming that they are for periods of no more than 12 months) and any excess or short-fall in these amounts (subject to outstanding claim amounts having to be estimated) will affect the profit which emerges during the year and consequently the company's solvency.

Of the above, (a) is an observation that care must be exercised in measuring the experience preparatory to setting premium rates, (c) is perhaps the most important since the proper financial management of the business requires that we should know what margin there has been in the provisions, what risks affect the eventual outcome and what order of magnitude the margins and risks represent.

The trading result is not complete without the provisions made at the end of the year, i.e. item (b) and if the company is continuing in business, similar considerations to those concerning (c) apply. If, however, the company is to cease business, whether through impending insolvency or otherwise, the premium reserves take on a different meaning depending on what course of action is to be adopted.

One possibility is to pay another insurer to take on the business. The portfolio premium payable falls to be assessed by the other insurer, no doubt depending on, inter alia the adequacy of premium rates and quality of the business. As it is likely that inadequate premiums and/or poor quality business may be responsible for a wind-up being necessary it would be imprudent to assume that an amount as low as 30 - 40% of written premiums would be sufficient to cover the prospective outgo.

If, on the other hand, the company is to be wound up, there will be a liability to refund to the policyholders the proportionate amount of their gross premiums relating to the unexpired period of risk. In these circumstances, it is doubtful whether the commission paid to intermediaries would be recoverable and it may be considered advisable to display the ability to refund all the unearned portion of premiums to policyholders.

Returning to the technical risk that during the course of normal trading (rather than in a wind-up) the premium reserves prove inadequate, it will be seen that certain factors affecting the eventual outcome of the reserves are those that affect the eventual outcome of new business being written e.g. the random variation in the result and trend in claims experience. It is not proposed to discuss these factors in this note.

3. The problems peculiar to the adequacy of premium reserves, as distinct from the adequacy of the original rates, are:-

a) It is not usually possible to amend, retrospectively, the premiums payable for a period of risk, so that whilst inadequate premiums can be raised for future business, the company will have to retain the liability on account of in-force business for which inadequate premiums were accepted.

b) Since the premium reserves are being set up usually anything up to 12 months from the date of issue of the policies concerned, during which time more information on ratemaking may have become available, it is necessary, at least in theory, to assess the effect of any changes in the factors affecting the risk and to what extent premium reserves should be adjusted.

c) The claims on outstanding risks are likely to occur, on average, sooner than those on new policies.

Having noted these differences it is also relevant to mention that a strong similarity exists between the setting of premium reserves and the original rates, in that in both situations the claims have yet to occur, so that there is a stronger degree of uncertainty associated with these items than the outstanding claims reserves.

4. The usual basis for the unearned premium reserve is to apportion the premium, after a deduction for initial expenses and commission, between earned and unearned in proportion to the time exposed in the current and subsequent accounting year. As an approximation, the 24ths method assumes all policies renewed or incepted in a month pay premiums in the middle of that month (and that all months are of equal length).

The circumstances in which a company sets up an unexpired risk reserve and how such an amount is derived are not so clear cut.

In assessing the risks of these reserves proving to be inadequate, 3 factors separate themselves as distinct -

- a) The margins in the reserves which are present because of the manner in which they are calculated. It is necessary to be able to assess their importance in order to form an opinion on the company's overall solvency position.
- b) The adjustment to the reserves on account of discernible trends in those factors affecting the expected claims cost. Once again, even though it may not be felt important to adjust the reserves explicitly in the Accounts, it is useful for management to be aware of the magnitude and sign of any adjustments.
- c) The random variations which are an inherent part of insurance contracts. The risk to the adequacy of premium reserves represented by random events is the largest.

Since the UPR is a reserve calculated specifically according to a number of methods it is natural to think of margins (a) as being present in it and adjustments (b) being made as part of an URR. It is difficult to see how the random variations (c) can affect the outcome in respect of premium reserves any differently from that of the original premiums.

5. Margins in the Unearned Premium Reserves

If it is assumed that the UPR is derived on an 'accurate' 365ths basis, then the well documented possible 'error' caused by the distribution of renewal dates being other than even throughout each month will be removed. There are, nonetheless, reasons why the eventual outcome of the reserve may be different from that set up and these are discussed below, with, where possible, an assessment of their magnitude.

(1) Expenses

The deduction made from the gross premiums in calculating the UPR, in order to allow for the expenses incurred in writing the policy need not correspond to the expenses actually incurred. Investigations into the company's expenses might be considered in order to quantify the margin represented by this feature.

In terms of margins in the UPR, an assessment of whether the allowance for future expenses (implicit or explicit) in the premiums which carries forward into UPR is adequate needs to be made. There are two distinctly different situations in which the risks represented by UPR are run-off:-

- a) Normal trading; where the expenses incurred will be those of administering the policy during its term and handling claims in circumstances where fixed expenses are shared by new policies being written.
- b) No new business; where the expenses referred to in a) have to be met in

circumstances where the fixed expenses which cannot be offloaded immediately are not shared with new business.

Both of these might be costed. The likely conclusion is that a company has a wide margin to cover expenses though it is conceivable that the reverse position may hold and only an appropriate investigation and projection will determine and quantify this.

(ii) Inflation

For risks where the insurer is liable for any increases in the cost of claims over the period of insurance, (e.g. motor risks, index-linked household policies), the effect of this inflation is to weight the risk intensity more heavily towards the end of the policy year (other things being equal).

When the business was written, it seems sensible to assume that the net premium charged P contained an allowance for inflation, either implicitly or explicitly, of $100i\%$ p.a. If the unexpired term was $(1-t)$, the normal UPR would be $P(1-t)$.

Since the cost of the risk rises throughout the policy year at $100i\%$ p.a., the rate at which premium is being 'used up' at time s from the start of the policy year

$$= \frac{P(1+i)^s}{K} \text{ where } K = \int_0^1 (1+i)^s ds = 1/p$$

$$p = \log_e (1+i)$$

At the end of the accounting year, the 'unused premium' amounts to:-

$$\int_t^1 \frac{1}{K} P(1+i)^s ds = \frac{P}{pk} \left((1+i) - (1+i)^t \right)$$

and the difference between this and the UPR

$$= \frac{P}{i} \left((1+i) - (1+i)^t - i(1-t) \right)$$

$$= \frac{P}{i} \left((1+i) - 1 - it - i^2 t \frac{(t-1)}{2} - i(1-t) \right)$$

$$= \frac{1}{2} Pit(1-t)$$

- (a) Assuming, for example, that premiums are written uniformly throughout the accounting year, then the difference between this 'theoretical' premium reserve and the traditional UPR is

$$\int_0^1 \frac{1}{2} Pit(1-t) dt = \frac{iP}{12} \quad \text{where } P \text{ is now the total written premiums.}$$

Note that the traditional UPR would be $\frac{1}{2}P$ in this case.

- (b) Assuming, instead, that premiums are increased by $100k\%$ mid-way through the year, the difference becomes:

$$\begin{aligned}
& \int_0^{\frac{1}{2}} \frac{1}{2} P i t (1-t) dt + \int_{\frac{1}{2}}^1 \frac{1}{2} P (1+k) i t (1-t) dt \\
&= \frac{1}{2} i P \left(\frac{1}{2} \left(\frac{1}{2} \right)^2 - \frac{1}{3} \left(\frac{1}{2} \right)^3 + \left(\frac{1}{2} - \frac{1}{3} - \frac{1}{2} \left(\frac{1}{2} \right)^2 + \frac{1}{3} \left(\frac{1}{2} \right)^3 \right) (1+k) \right) \\
&= i P / 12 (1+k)
\end{aligned}$$

In this case the traditional UPR would be $\frac{1}{2} P (1+k)$

It will be seen that the understatement in a traditional UPR depends on the implicit rate of inflation, the portfolio growth and the size (and incidence) of premium rises. The table below shows the percentage understatement of the theoretical premium reserve by the traditional UPR under several assumptions as to the size of premium rises and also portfolio growth (both assumed to take place at the mid-point of the financial year) and the rate of inflation implicit in the premiums paid.

		<u>Premium Rise + Growth</u>		
		0%	10%	20%
<u>Inflation</u>	0%	0.0	0.0	0.0
	10%	1.7	1.7	1.7
	20%	3.3	3.4	3.5
	30%	5.0	5.1	5.2

The conclusion from the above is that premium inflation is a more significant item than premiums growth in making up the above margin in the UPR.

(iii) Discounting

Just as the inflation of claim costs implies that the UPR tends to understate the theoretically correct reserve, the investment income earned on the balance of premiums held over claims paid will result in an overstatement and the effects of inflation and interest should be considered together.

The investment risk is being considered by one of the other working parties, but it is instructive to consider the net effect on UPR of inflation and interest. Different types of general insurance contract produce claims which escalate at different rates - and some contracts may produce more than one type of claim which escalate at different rates. Furthermore, the length of time between the premium being paid and the claim being settled varies between the different types of insurance, and also the type or types of investment appropriate to each class of business.

In considering the net effect (inflation less interest) we are only concerned with differences between interest rates and inflation.

(iv) Seasonal Risks

Apart from the effect of inflation, the intensity of insurance risks is not even throughout the policy year and so the allocation of premium in the UPR may be insufficiently accurate where the risks have particularly uneven intensity.

- a) Certain types of insurance contracts have risk intensities which vary according to the duration of the contract.

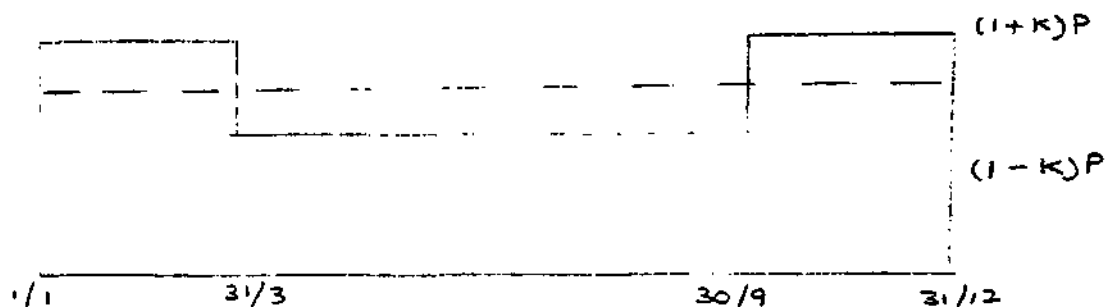
- e.g. 1) Mortgage guarantee where the sum at risk declines over the period of the policy.
 2) Travel policies which have 2 distinct periods of risk, namely the period prior to the holiday where the cover is for the cancellation risk and the duration of the holiday where the cover is for the other, in some respects more expensive risks.

Where a company writes a significant amount of business of such kinds, it would be advisable to make the necessary adjustments to premium reserves but otherwise the margin in an UPR calculated on traditional lines is minor.

- b) Certain risks show a correlation with the seasons.

- e.g. 1) pleasure boat policies where the vessels may be laid up during the winter months
 2) motor tractors and also motor cycles where the vehicles are used much more in the summer
 3) household and motor cars and lorries where the winter is a higher risk period.

If, for a given risk (premium = P) the seasonal variation causing the intensity is $(1+K)P$ for half the year and $(1-K)P$ for the other as shown in the diagram below



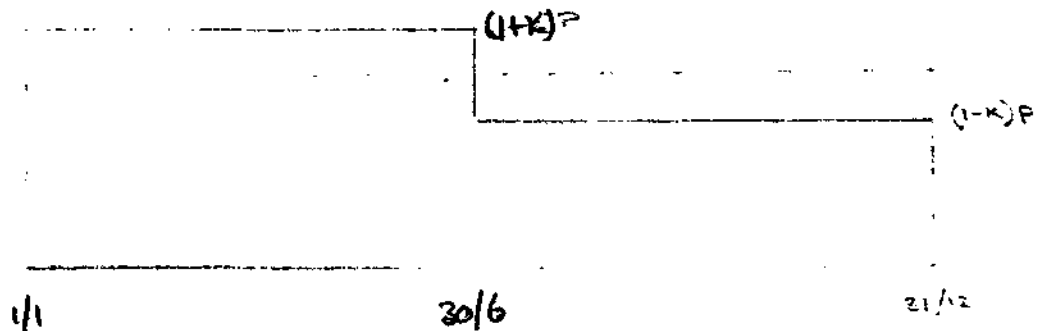
then the overall premium P is used up at the rate of $(1+K)P$ during the winter (Oct - Mar) and $(1-K)P$ during the summer months (Apr - Sept). If we assume that policies are taken out at the end of the month to avoid some complications and that a premium rise or premium growth takes place of 100% at the half-way mark then the traditional and theoretical UPR are shown on the following table for each month's premium.

Month	Trad UPR	Th UPR	Trad - Th
J	P/12	P/12 (1+K)	-KP/12
F	2P/12	P/12 (2+2K)	-2KP/12
M	3P/12	P/12 (3+3K)	-3KP/12
A	4P/12	P/12 (4+2K)	-2KP/12
M	5P/12	P/12 (5+K)	-KP/12
J	6P/12	P/12 (6)	-
J	7P/12 (1+j)	P/12 (7-K) (1+j)	KP/12 (1+j)
A	8P/12 (1+j)	P/12 (8-2K) (1+j)	2KP/12 (1+j)
S	9P/12 (1+j)	P/12 (9-3K) (1+j)	3KP/12 (1+j)
O	10P/12 (1+j)	P/12 (10-2K) (1+j)	2KP/12 (1+j)
N	11P/12 (1+j)	P/12 (11-K) (1+j)	KP/12 (1+j)
D	12P/12 (1+j)	P/12 (12) (1+j)	-
Total	P/12 (78+57j)		9KP/12 j

$$\% \text{ overstatement} = \frac{9Kj}{78+57j} \times 100$$

which is never likely to be significant where reasonable values of K, j are used.

The above example is one where the seasonal variation is balanced. A more significant margin may be obtained if the premium P were used up at the rate of $(1+K)P$ during Jan - Jun and $(1-K)P$ during Jul - Dec as shown in the diagram below.



The theoretical and traditional UPR now become:

Month	Trad UPR	Th UPR	Trad - Th
J	P/12	P/12 (1+K)	-KP/12
F	2P/12	P/12 (2+2K)	-2KP/12
M	3P/12	P/12 (3+3K)	-3KP/12
A	4P/12	P/12 (4+4K)	-4KP/12
M	5P/12	P/12 (5+5K)	-5KP/12
J	6P/12	P/12 (6+6K)	-6KP/12
J	7P/12 (1+j)	P/12 (7+5K) (1+j)	-5KP/12 (1+j)
A	8P/12 (1+j)	P/12 (8+4K) (1+j)	-4KP/12 (1+j)
S	9P/12 (1+j)	P/12 (9+3K) (1+j)	-3KP/12 (1+j)
O	10P/12 (1+j)	P/12 (10+2K) (1+j)	-2KP/12 (1+j)
N	11P/12 (1+j)	P/12 (11+K) (1+j)	-KP/12 (1+j)
D	12P/12 (1+j)	12P/12 (1+j)	-
Total	P/12 (78+57j)		- KP/12 (36+15j)

$$\% \text{ understatement} = \frac{(36+15j)K}{78+57j} \times 100$$

which is clearly more significant, though again affected only slightly by the value of j , the rate of premium growth.

(v) Profit

The loading contained in the premiums for profit will carry forward as a further margin in the UPR if calculated on traditional lines. The loading may be positive or negative - the latter case arising where favourable investment conditions allow an underwriting loss.

These two sources of profit - profit loading and investment return affect the UPR in different ways. On the one hand, the profit loading (positive or negative) carries forward into the UPR at the same rate, but because the duration of the incomplete policy at the end of the accounting year is shorter than the original, the investment profit from holding premiums in advance of claims will be a smaller percentage, since a disproportionate amount of investment profit is taken during the earlier duration of a policy.

In the following example a premium P per policy (after deducting expenses) pays, for claims $C = (1-K)P$ which are paid evenly throughout the duration of the policy.

$$\begin{aligned} \text{The original profit} &= (P-C) (1+i) + \frac{1}{2} i C & \text{where } i &= \text{interest rate} \\ &= P[(1+i)K + \frac{1}{2} i (1-K)] \\ &= P[K + \frac{1}{2} i (1+K)] \end{aligned}$$

The prospective profit on an unexpired risk with t yrs to run ($t < 1$) assuming a reserve of tP

$$\begin{aligned} &= t (P-C) (1+it) + \frac{1}{2} it^2 C \\ &= tP[(1+it)K + \frac{1}{2} it (1-K)] \\ &= tP[K + \frac{1}{2} it (1+K)] \end{aligned}$$

Assuming an even distⁿ of premiums over the financial year the total profit on the UPR

$$= \int_0^1 tP[K + \frac{1}{2} it (1+K)] dt = P\left[\frac{1}{2}K + \frac{1}{6}i (1+K)\right]$$

$$\therefore \text{profit margin \%} = \begin{array}{ll} \text{(a)} & 100 \left[K + \frac{1}{4} (1+K) \right] \quad \text{originally} \\ \text{(b)} & 100 \left[K + \frac{1}{3} (1+K) \right] \quad \text{on UPR} \end{array}$$

i.e. a drop of $\frac{1}{6} (1+K)$

Admittedly the mean term of the unexpired liabilities is somewhat shorter than the original liabilities, so a smaller % margin may be considered appropriate, but this does not wholly explain what will be a quite large reduction in the strength of the premium reserves in times of high investment profits (and lower or negative profit margins).

It may be thought that the above noted feature duplicates what has already been said about the effect of inflation. However, the earlier discussion covered the distribution of risk intensity over the policy year, not the margin over the risk premium represented by profit.

6. Margins in the Unexpired Risk Reserve (URR)

In considering the above we make the assumption that no URR is set up by the company and consider the factors which may lead to the setting up of a URR as though they were margins in this (zero) reserve. As mentioned earlier, time has elapsed since the business to which the reserve relates was written and we might be in a position to re-evaluate the risks which are still unexpired.

(i) Deterioration (or improvement) of Risk

The risks represented by contracts incepted in the previous year may have been written on premium rates which are no longer adequate for those risks and, were the contracts to be re-rated at the end of the financial year, the risk premium plus expenses may be considerably more than the reserve held to cover the risks.

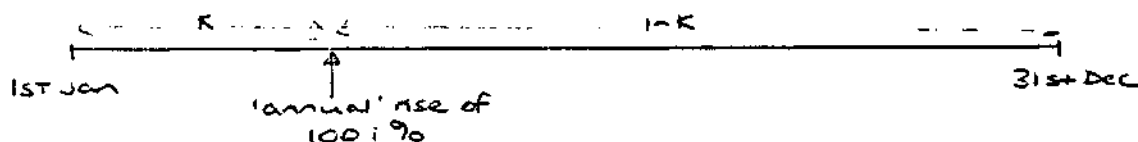
Changes in the rate of inflation (or net rate after allowance for investment return) applicable to the type of contract considered is an obvious example, and others could include, for example, the increase in frequency of domestic burglaries.

These are the sort of trends which should be monitored with a view to amending the premium rates, though there are bound to be delays as a result of:-

- (a) the need to accumulate sufficient data to isolate a trend (from random variations) and quantify its effects, linked to the availability of industrywide statistics, size of the portfolio concerned and the supply of supportive evidence e.g. inflation indices, change in court award practice
- (b) the processing delay of information used in (a)
- (c) the competitive pressure which may delay premium adjustments, or limit them from their full theoretical extent.
- (d) the administrative delays which may accompany premium rises caused possibly by the issue of renewal notices well in advance of renewal dates.
- (e) the internal politics such as pressure from representatives of intermediaries or agents.

A special case of risk deterioration is that of inflation of claim costs which causes periodic increases in premiums for certain risks (e.g. motor). In the description that follows, the inflation factor may be interpreted as claims cost escalation, or some other discernible trend in expected claim cost.

Suppose that premium rates are set annually and remain in force for 12 months, so that, on average the premiums are correct for risks incepted 6 months after the increase is applied, other things being equal.



If premiums are written at an even rate of P p.a. and $(1+i)P$ p.a. after time K , then the trad UPR

$$= \int_0^K P t \, dt + (1+i) \int_K^1 P t \, dt = \frac{1}{2} P \left[1+i (1-K^2) \right]$$

Consider two cases:

A; $K = \frac{1}{2}$ i.e. mid-yr prm rise.

$$\text{the trad UPR} = \frac{1}{2} P \left[1 + 3\frac{1}{4} i \right]$$

in this case a risk incepted at time $t = 0 \rightarrow \frac{1}{2}$ will be relatively under charged by a factor of $(1+i)^t \approx 1+it$, and a risk incepted at time $t = \frac{1}{2} \rightarrow 1$ will be relatively over charged by a factor of $(1+i)^{1-t}$

The theoretical UPR is $\therefore$

$$\begin{aligned} & \int_0^{\frac{1}{2}} P t (1+i)^t \, dt + \int_{\frac{1}{2}}^1 P t (1+i) \times \frac{1}{(1+i)^{1-t}} \, dt = \int_0^1 P t (1+i)^t \, dt \\ & = \int_0^1 P t (1+it) \, dt = \frac{1}{2} P (1 + 2\frac{1}{3} i) \\ & \Rightarrow \text{a positive margin of } iP/24 \end{aligned}$$

B; $K = 1$ i.e. an end year prm rise

$$\text{the trad UPR} = \frac{1}{2} P$$

In this case a risk incepted at time $t = 0 \rightarrow \frac{1}{2}$ will be relatively overcharged by a factor of $(1+i)^{\frac{1}{2}-t}$, and a risk incepted at time $t = \frac{1}{2} \rightarrow 1$ will be relatively undercharged by a factor of $(1+i)^{t-\frac{1}{2}}$

The theoretical UPR is $\therefore$

$$\begin{aligned} & \int_0^{\frac{1}{2}} P t (1+i)^{-\frac{1}{2}+t} \, dt + \int_{\frac{1}{2}}^1 P t (1+i)^{t-\frac{1}{2}} \, dt = \int_0^1 P t (1+i)^{t-\frac{1}{2}} \, dt \\ & = \int_0^1 P t (1+it - \frac{1}{2}i) \, dt \\ & = \frac{1}{2} P (1 + \frac{1}{6} i) \end{aligned}$$

$\Rightarrow$ a negative margin of $1/12 \, iP$

These particular margins are exclusive of adjustments mentioned hitherto in the discussion of UPR and are quite sizeable, there being no offset in these amounts for investment earnings.

(ii) Change in Factors

As discussed in (i), inflation (or other discernible trend) was assumed to be a constant factor, though in reality the factors affecting insurance business are forever changing. Whilst it may be argued that adjustments on account of this, and indeed, other features noted are not necessary in premium reserves, as the margins emerge eventually as the experience develops, it must be said that one is concerned by the degree of solvency now as well as that in future years.

Examples of factors which might alter the eventual outcome of claims under this heading are

- (a) Changes in the rates of inflation (from that allowed for in setting premium rates).
- (b) Changes in the rates of deterioration (or improvement) other than inflation.
- (c) Legislative changes which may be either prospective or retrospective i.e. may affect business already written where the premium is fixed and paid - e.g. VAT changes.
- (d) Alterations to the cover during the course of a policy year brought about by a legal ruling for example.

Because of the need to make rate increases (changes) well in advance it is quite likely that a re-rating of in force business, for the time period represented by unexpired risks, could lead to an URR which may be either positive or negative; though accounting convention would preclude setting up a negative URR.

It is not really necessary to derive the numerical implications of each of the above mentioned factors on the premium reserves - each event must be considered on its own merits and methods of assessing the cost derived from the available information. Conceivably, the size of possible adjustments is large.

Examination of loss ratios has been suggested as a basis for assessing the URR necessary to cover the deterioration of claims experience ahead of the necessary premium increases. One would expect a company's management to have access to and use a variety of statistical and other information as part of the assessment of premium revisions.

These might include recent payments data (suitably split into year of origin and type of claim), recent claim frequency data, market statistics and comment, market premium rates, case estimates, indices (of housebuilding, garage repair costs for instance), comments of experienced claims personnel, court rulings, police statistics etc.

The assessment of the adequacy or otherwise of the premiums comprising the UPR is a similar exercise to the original setting of the rates and in order to assess the adequacy of the UPR, it is necessary at the year end to consider all the factors relevant to the setting of premium rates.

(iii) Mix of Business

The setting of original premium rates might be based on an expected mix of risks, the elements of which may vary in profitability - e.g. comprehensive/non-comprehensive motor risks, large/small SI on household policies etc. The causes of such a situation could be the unavailability of accurate data, market forces (the existence of loss leaders), the need to have a simple premium structure e.g. a point system or a uniform rate per £1000 SI.

Whilst no trend of worsening claim amount in the individual sections may be apparent, movements of business may cause the actual portfolio to be more/less profitable than the expected portfolio, and the overall effect is as in (ii) above.

Monitoring the makeup of the portfolio is therefore a necessary exercise in order to subjectively assess the adequacy or otherwise of the premium reserves.

7. Conclusion

Compared with the outstanding claims reserve, the potential for insolvency caused by factors affecting premium reserves is perhaps minor, though an awareness of their effects is no doubt valuable as far as obtaining an overall picture of a company's solvency is concerned. It is not impossible to envisage certain circumstances where the points described in this note become relevant though they may be unlikely or such that the adequacy of a company's premium reserves is the least of the company's worries at the time!

Of interest, would be the extent to which various companies investigate the factors discussed either formally or informally. To what extent do/should such consideration form a regular part of the financial management of insurance companies and therefore carry over into any independent investigation of solvency. Or is it sufficient to examine them only occasionally or not at all but to be aware merely of the general financial effect of the environment in which insurance companies operate?