BOOK REVIEWS

T. Pentikäinen (1982). *Solvency of Insurers and Equalization Reserves. Volume I, General Aspects.*
J. Rantala (1982). *Solvency of Insurers and Equalization Reserves Volume II, Risk Theoretical Model.*
Insurance Publishing Company Ltd., Bulevardi 28, 00120 Helsinki 12, Finland.

Finland is one of the only countries in which the solvency control of the non-life insurance companies is based on risk theory. The Finnish solvency legislation and the rules governing the equalization reserve are an example of how theory and practice may be combined in an outstanding way. The Finnish solvency system was introduced in 1953 where in general the solvency of the Finnish insurers was low. The introduction of the equalization reserve allowed the Finnish companies, free of tax, to equalize profit and loss in good and bad years by transference to and from the equalization reserve. Since the reserve was free of tax, it was necessary to introduce a specific transfer rule and to stipulate certain limits for the reserve. The equalization reserve was both regarded as a technical reserve and as part of the total solvency margin, which also includes the equity capital and underestimation of assets. The equalization reserve deals with the stochastic character of the insurance business and is used to equalize profit and loss in different years, whereas the total solvency margin has to be sufficient to safeguard the consumers' interest and must exceed a certain minimum solvency margin.

Since the introduction the system has functioned very satisfactory. The solvency of the insurers has improved, and the Finnish companies have been able to reduce reinsurance costs and to participate much more actively in the international insurance business to the benefit of the Finnish society and the Finnish consumers. The system has now functioned in almost thirty years, and since the previous revision was performed in 1965, it was decided in 1980 to review the entire system. For this purpose the Ministry of Social Affairs and Health (the Finnish supervising authority) appointed a project group to study the solvency problems in a broad sense and in particular to suggest new rules for the regulation of the equalization reserve. The chairman of the group was Teivo Pentikäinen, and the two volumes contain the extensive reporting from the project. Part I is designed to the general solvency aspects, whereas Part II contains the mathematical results.

The project group applied both empirical and theoretical methods in their work. Figures comprising loss ratios and the relative amount of the equalization reserve (relative to the earned premium) were collected for the Finnish non-life companies for the period 1962–1978. Similarly, loss ratios and the number of claims per insurance class were investigated. These figures all showed yearly variations, but an observation of great importance was the existence of cycles in the insurance result and the influence on the solvency. If the loss ratios are unfavorable in several consecutive years, the solvency margin may decrease

tremendously since the solvency is affected by the accumulated bad results. This is illustrated by a major drop of more than 50% in the relative amount of the equalization reserve for the largest general companies in 1968–1974. These results highlight the impact on solvency of the cycles, and they should, therefore, explicitly be taken into consideration when the solvency problems should be discussed in details.

To do this and to make a realistic solvency study, a comprehensive theoretical model of a standard insurer has been constructed. The model takes several background factors into account, and it is stochastic in the way that the yearly claim amounts X are assumed to vary stochastically. In order to illustrate the different kinds of stochasticity which were observed in the empirical data, 4 levels of variation were introduced. The number of claims were assumed to be Poisson distributed, the claim size distributions were empirical, delivered by the Statistical Center of the Finnish Insurance Companies, short term variations in the basic parameters were introduced by allowing the expected number of claims (i.e. the Poisson parameter) to fluctuate from year to year. Finally, business cycles were introduced in a deterministic way by allowing the expected number of claims to vary along a sine curve with a wave length equal to 12 years and an amplitude equal to 10–15%. The other components in the model were the size of the insurer, the portfolio mix, the claim and premium inflation i_x and i_p, the interest rate earned on the reserves i_{tot}, the real growth rate i_g, the safety loading λ and the net retention.

Many of the basic parameters were estimated from the empirical data. Since the final results depend heavily on these values, it is worth mentioning some of them. The interest rate i_{tot} were 8.5%, claim inflation $i_x = 9\%$, portfolio growth $i_g = 6.1\%$, safety loading $\lambda = 4.1\%$ and the amplitude of the cycles in the loss ratios were estimated to 10%. Also the standard deviation and skewness of the short term variation of the Poisson parameter were estimated, but since the exposure (number of policies and information about different risk groups) was not included, the estimates may not be very reliable. And as a peculiarity, it was decided in the final recommendation to the Ministry to use standard deviations estimated from loss ratios, although they should describe the fluctuating Poisson parameter. This is, of course, unsatisfactory; it illustrates, however, the problems which arise when practically manageable systems have to be developed from limited empirical experience.

If one then in the model equals the premium earned and the investment income with the claims, the expenses and the change in the relative solvency margin/equalisation reserve one may obtain the following fundamental transition equation

$$u_1 = ru_0 + (\bar{f} + \lambda - f), \tag{1}$$

where $u = U/B$ denotes the relative solvency margin/equalization reserve and where U and B are the actual margin/reserve and premium earned, respectively. The other quantities are the actual loss ratio $f = X/B$, its mean $\bar{f} = E(X)/B$,

and the safety loading λ. r is the inflation and growth adjusted interest factor $r = (1+i_{tot})/\{(1+i_g)(1+i_p)\}$, and it is typical less than 1. This basic relation (1) is valid both when u denotes the relative solvency margin and the relative amount of the equalization reserve. But in the latter case λ and i_{tot} should be substituted by a loading coefficient a, and a nominal interest rate i_n, which both should be approved by the Ministry. In that case (1) becomes the transfer rule which regulates the flow of the equalization reserve. The equation (1) describes how the solvency ratio or the relative amount of the equalization reserve changes from year to year. It illustrates how it is increased by the investment income and by the safety loading, but reduced by inflation and real growth. The fluctuations are caused by the stochastic deviation of the actual loss ratio f from its mean $\bar{f}$.

From this relation (1) numerous simulation studies have been performed in order to evaluate the range of the fluctuations in the future solvency margin. Also analytical methods have been applied. The purpose of the study has not been to develop accurate forecasting models, but to study the consequences of an adverse development in the loss ratios whenever such a situation occurs. In the simulation, the yearly claim amount X were generated by a random number generator taking the different background factors and the different levels of stochasticity into account. Since the transition equation (1) depends on the actual loss ratio $f = X/B$, it is important to note that the calculation of the premium only takes portfolio growth and inflation into account. This means that the cycles are not taken into consideration, not even with a time lag. It implies that the premiums are not adjusted during a bad cycle period where the claim amounts may increase with up to 10–15% during a 6 year period. This assumption gives rise to an enormous increase in the minimum solvency margin and the increase may be of more than 50%. To illustrate some of these results it was found for the standard insurer that a minimum solvency margin equal to 42% of the premium was sufficient to ensure survival with 99% for a 10 year time span if the ruin barrier was 10% of premiums and if cycles were disregarded. The introduction of the cycles increased this minimum solvency margin from 42% to 94%. If the time span was reduced to 1 year, the figures were 25% and 39%, respectively. These figures illustrate the importance of the cycles, but they do also show the very high solvency requirements which are necessary to ensure the long term survival of the company. However, one would expect management to change policy if the solvency drops dramatically and the company shows a deficit in several years. Therefore, also a lower solvency margin ought to be sufficient to ensure the long term survival, but the study illustrates how business cycles may affect solvency in a severe way.

The cycles represent only one important element of the model; the books also contain an extensive study of how the solvency and the fluctuations in the equalization reserve are affected by changing for instance the portfolio mix, the net retention, the inflation, the growth rate, the safety loading and the time span of the study. All these factors influence the solvency more or less, and they are all important elements when an overall solvency policy has to be determined.

The ultimate goal of the solvency study was to revise the rules for the calculation of the minimum solvency margin and to design new limits for the equalization reserve. The new rule for the calculation of the minimum solvency margin is based on the same idea as the previous one, i.e., the minimum margin has to be so large that the company is able to pay the next years claims with a probability of 99%. Some of the constants in the formula for the minimum solvency margin have been changed slightly in order to take the new empirical experience into account. It is important to note that, compared with the current EEC-rules, the Finnish minimum solvency rule is often larger and that it explicitly takes into account the portfolio structure, reinsurance, and the stochastic character of the insurance business, whereas the EEC-rule is just a fixed percentage of premium income.

Concerning the equalization reserve the project group introduced the concept of a target zone. The upper limit of the target zone is dimensioned at a level which permits the equalization reserve to fluctuate between zero and the upper limit. In other words, the upper limit has been derived so that it represents the height of a 99% confidence region of the future flow of the equalization reserve. In more practical terms that means that in good years the companies by applying (1) are allowed to increase the equalization reserve to such an amount, that they are able to meet the liabilities during a bad period, where a cycle may deteriorate the solvency in several consecutive years. However, a situation may occur where the transfer rule (1) gives rise to an equalization reserve, which exceeds the upper limit. In that case the company is forced to reduce the transference, for instance by premium reductions, in order to keep the equalization reserve inside the target zone. A lower limit of the target zone has also been introduced, but it was made optional since the short term survival of the company is safeguarded by the minimum solvency requirements.

The new rules for the minimum solvency margin and the equalization reserve were introduced in 1981. As a technical reserve, the equalization reserve was before the revision not shown explicitly in the yearly accounts since it was regarded as part of the claim reserve. This situation has now changed, and it is explicitly shown together with a solvency indicator, which is the reserve in percentage of the upper limit of the target zone. This solvency measure is of course only a very rough measure, but it makes comparisons between companies possible, and it has (of course) attracted great public interest.

The reader will understand from this review that the two books contain numerous elements of interest. The Finnish solvency legislation deserves special attention since it is one of the most advanced in the world, and the recent solvency investigation is a fine example of how an extensive theoretical model may be used to study practical problems, and how the results may be implemented in practice.

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