A Financial Approach to Insurance Economics

by fil.lic. **Per-Johan Horgby,** Research Assistant, CEFOS*, University of Gothenburg

Per-Johan Horgby

This article aims to introduce basic financial applications in insurance economics. Financial modeling is one of the most growing fields of insurance research. Major progress in understanding important relationships between insurance pricing and insurance markets is achieved through integration of financial theories and statistical models of insurance. This is especially urgent in the light of a more deregulated European insurance market. The European insurance market will in the near future be more competitive (Eisen et al. 1993). The structure of insurance institutions will thereby be determined by their market performance, how they succeed in insurance pricing, portfolio investment and organizational efficiency. The financial models of insurance in this article will hopefully shed some light on how insurance policies are valued in a competitive market.

I. Insurance in a financial context

Insurance exists as a method for dealing with special types of financial risks. For this mission insurance institutions have been created to perform risk-sharing and risk management functions. If we assume that insurance institutions are acting in a competitive market, their structure is a function of how well they succeed in their performance. To ensure survival, insurance institutions have to find the most efficient set of prices, contracts and investment portfolios. Insurance pricing is thereby not only a question of pooling risks. By a financial approach to insurance economics, the outcome is endogenous to insurance and financial markets. This view provides an explanation of important aspects of insurance institutions and insurance markets which statistical models fail to do.

In order to obtain insights into management of insurance pools, I introduce a financial model of the insurance firm that Cummins (1991, pp. 284) discusses in an excellent survey on the announced theme. The insu-

*) Centrum för Forskning om Offentlig Sektor.

rance firm is described by the following equation:

$$Y = r_A A + r_U P \qquad (1)$$

where

- Y = net income,
- A = assets,
- P = premiums,
- r_A = rate of return on assets,
- r_U = rate of underwriting return.

Equation (1) tells that the net income of the insurance firm comes from two sources, to wit, from investment management (the factor r_A A) and from insurance writing (the factor r_U P). By dividing equation (1) with equity *E* on both sides and making some rearrangements, we have a formula for return on equity, r_E, as follows:

$$r_E = r_A + s\,(r_A k + r_U), \qquad (2)$$

where

- *s* = P/E = premiums-to-surplus ratio
- *k* = L/P = liabilities-to-premiums ratio.

Equation (2) shows some interesting aspects of an insurance firm. The formula for return on equity says, that the insurer will earn r_A on investment of assets plus the net return ($r_A k + r_U$) on underwriting business multiplied by the underwriting leverage ratio *s*. In case of no underwriting business ($s = 0$), the insurance firm will be a single investment company, investing equity at rate r_A. Considering the case with insurance business ($s > 0$), the firm will be profitable until $r_A k > -r_U$. Hence, even writing insurance at a negative underwriting profit will be advantageous! The reason for this is of course the delayed nature of claim payments which enables insurers to invest premiums and get return on investments. In other words, from the time premiums are paid until payment occurs, time for capital investment opportunities pass. Therefore, even an insurance line with a negative return will be profitable, if the investment income multiplied with the funds generating factor, *k*, exceeds the underwriting loss.

II. Capital Asset Pricing Model

Up to now, the insurance firm was described in isolation from other competitive insurers. A policy that fulfills $r_A k > -r_U$ is not necessarily the equilibrium rate of return in a competitive market. To be able to determine the equilibrium return it is necessary to introduce an asset pricing model. In a competitive market the underwriting return must be compared with other investments in the same risk category. To describe the equilibrium condition between risk and return on a security in general, the Capital Asset Pricing Model (CAPM)[1] (Sharpe 1964, Mossin 1966) is used. See equation (3).

$$r_i = r_f + \beta_i\,(r_m - r_f), \qquad (3)$$

where

- r_i = the expected return on asset *i*,
- r_f = the risk free rate of interest,
- r_m = the expected return on the market portfolio,
- β_i = the beta of asset *i*.[2]

The CAPM-formula in equation (3) says that the return on an asset is a function of the market risk premium and the covariability of the asset return with the market return. Through diversification the capital market can eliminate all so-called unsystematic risk and the risk which is not offset is called systematic risk or market risk. Since the investors can eliminate the unsystematic risk through an efficient portfolio mixture, the important part is how an asset contributes to the market risk. The beta value, β_i, for the asset informs how sensitive an asset is for changes in the market and is measured by the covariability of the asset return with the market return. The CAPM says that in a competitive market the expected market risk pre-

[1] The CAPM constitutes "the centerpiece of modern finance theory" (Hirshleifer and Riley 1992, p. 79). For a review on the impact of the CAPM on capital markets, see Sharpe (1991).

[2] $\beta_i = \mathrm{Cov}\,(r_i, r_m) / \mathrm{Var}\,(r_m)$

mium ($r_m - r_f$) will vary directly in proportion to the asset beta. According to the model the portfolio manager has to choose a suitable risk level. If the manager chooses a portfolio with $\beta > 1$, he can expect a higher average return than the market portfolio, but it also costs a higher degree of risk. We see that the CAPM implies that investors will only be rewarded for bearing market risk and not for bearing unsystematic risk. The reason is that the unsystematic risk can be diversified away, but not the systematic market risk.

III. Insurance Capital Asset Pricing Model

Using the equilibrium risk-return relation implied by the CAPM, we can get important knowledge about the operation of insurance markets. Several authors have applied the original CAPM for insurance purposes (e.g. Fairley 1979, Hill & Modigliani 1987). In contrast to statistical insurance models, the insurance CAPM pays attention to the financial nature of an insurance contract and it identifies the specific types of risk that determines the price relationships that will hold in equilibrium. By combining equation (2) which expressed the rate of return on insurer's equity, with the CAPM model of return on the insurer's assets (3), we can solve for the underwriting return and get an equilibrium condition for underwriting profits. See equation (4).

$$r_U = -k\, r_f + \beta_U (r_m - r_f) \qquad (4)$$

where

- r_U = the expected rate of underwriting return,
- k = as in equation (2)
- r_f = the risk free return,
- r_m = the expected return on the market portfolio,
- β_U = the underwriting beta of the insurance[3].

[3] $\beta_U = \mathrm{Cov}(r_U, r_m) / \mathrm{Var}(r_m)$

Equation (4) is the so-called insurance CAPM. Premiums are paid in advance and the funds generating coefficient *k* indicate the average time between policy issue and claims payment. The first part of equation (4), $-k\, r_f$, represents the interest credit to the policyholders for the premium lending. As the insurer can invest the policyholder funds, the premium price must be corrected. The factor $-k\, r_f$ reduces required premium profits and the policyholders receive an implicit interest payment in parity of the risk free return over *k* periods. The second component of the underwriting return is the insurer compensation for bearing risk. The risk compensation consists of underwriting beta (β_U) multiplied with the market risk premium ($r_m - r_f$). In the same manner as the investors in the original CAPM only get compensation for the systematic risk, also the insurers only will be rewarded for bearing systematic risk[4].

Let us consider this feature of the insurance CAPM little further. If underwriting profits are positively correlated with the market return, $\beta_U > 0$, then the insurance firm will earn positive risk loading. On the contrary, if $\beta_U < 0$, i.e. if underwriting returns are negatively correlated with the market, the model states that the insurer should pay a risk premium to the policyholder! Underwriting profits can take negative values, since the insurer can invest the premium funds at an interest rate at least as good as the risk free return. And the policyholder is implicitly refunded in parity with the risk free interest rate for lending to the insurer. It is most likely, that profit margins will decrease in a competitive insurance market!

We can now state a fundamental proposition about insurance contracts issued in a competitive market:

[4] Here a tax-free world is considered. By adding taxes to the model, the equilibrium premiums will increase, see further Fairley (1979).

The insurance CAPM doctrine:
In a competitive insurance market the insurers will only be rewarded for bearing systematic risk but not for taking unsystematic risk. In equilibrium, the insurance underwriting profit margins are a linear function of the riskless rate of interest and the systematic risk of underwriting.

IV. Concluding remarks

Let me finally give some warnings and recommendations about the usefulness of the insurance CAPM. The insurance CAPM is not a perfect model, simply stated not a perfect mapping of the insurance business. It makes many simplifications by describing insurance markets as competitive with many insurers, no transaction costs and perfect foresight. In spite of that, I think that the market approach to insurance pricing in the insurance CAPM make us aware of some really important aspects of insurance economics. First, the insurance CAPM forces us to consider the essentially financial nature of insurance contracts. Moreover, the model claims that insurers will not be rewarded for bearing *any* kind of risk. Only systematic market risk will receive market rewards. This kind of relationships have not been visible in statistical models of the insurance firm. For actuaries the market does not exist, just the loss-distributions, and this shortcoming is to some extent over bridged by the insurance CAPM. Finally, the attention to undiversifiable risks provides a possible explanation of why some risks may be uninsurable in addition to other causes for market failures (Dionne and Harrington 1992, p. 28).[5]

[5] In the literature it exists several reasons why insurance markets may be incomplete, e.g. due to adverse selection, moral hazard, high transactions costs etc.See further Schlesinger and Doherty (1985).

References

Cummins, D.J. (1991), “Statistical and Financial Models of Insurance Pricing and the Insurance Firm“, *The Journal of Risk and Insurance* 58:2, 260-302.

Dionne, G. and Harrington, S.E. (1992), *Foundations of Insurance Economics - Readings in Economics and Finance*, Boston, Kluwer Academic Publishers.

Eisen, R., W. Müller & P. Zweifel (1993), “Entrepreneurial Insurance. A New Paradigm for Deregulated Markets“, *The Geneva Papers on Risk and Insurance* 18, 3-56.

Fairley, W. (1979), “Investment Income and Profit Margins in Property-Liability Insurance, Theory and Empirical Tests“, *Bell Journal of Economics* 10, 192-210.

Hill, R.D. and F. Modigliani (1987), “The Massachusetts model of profit regulation in non-life insurance, An appraisal and extensions“, in: Cummins, J.D. and Harrington, S.E., *Fair Rate of Return in Property-Liability Insurance*, Kluwer-Nijhoff Publishing.

Hirshleifer, J. and Riley, J. (1992), *The Analytics of Uncertainty and Information*, Cambridge, Cambridge University Press.

Mossin, J. (1966), “Equilibrium in a Capital Asset Market“, *Econometrica* 35, 768-783.

Sharpe, W.S. (1964),“Capital Asset Prices: A Theory of Market Equilibrium under Conditions of Risk“, *Journal of Finance* 19, 425-442.

Sharpe, W.S. (1991), “Capital Asset Prices With and Without Negative Holdings“, *Journal of Finance* 46, 489-509.

Schlesinger, H. and Doherty, N.A. (1985), “Incomplete Markets for Insurance: An Overview“, *Journal of Risk and Insurance* 52, 402-423.