CORPORATE DECISIONS IN GENERAL INSURANCE : BEYOND THE FRONTIER

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ABSTRACT

This paper shows how the powerful and flexible tool of stochastic modelling can be applied to a range of business decisions extending far beyond the asset allocation solutions that are common to many ALM studies. The example used to demonstrate these techniques is a general insurance case study, but similar principles can be extended to many different business situations. At each stage of the analysis we consider the implications of modern financial theory on the management decision process together with a practical perspective on observed behaviour in the real world. Opportunities are taken to suggest directions in which further research may be of benefit to the actuarial profession.

KEYWORDS

Arbitrage Pricing Theory; Asset Liability Modelling; Capital Asset Pricing Model; Dividend Discount Model; Dynamic Financial Analysis; Efficient Frontier; Financial Economics; General Insurance; Modern Portfolio Theory; Risk; Investment Strategy; Systematic Risk

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1. INTRODUCTION

1.1. How should an insurer price for risk? This question has been asked many times; many solutions have been proposed. Four methods in widespread practical use are:

1.1.1 *Premium principles*: The required loading for a given risk is assessed according to the distribution of cash flows from that risk. The required loadings are subject to various axioms, for example the premium should always lie above the expected loss and below the maximum loss. Depending upon the axioms chosen, various families of possible rules emerge.

1.1.2 *Risk adjusted capital/capital allocation*: The required profit for the company is expressed as a return on capital. The capital for the business is then allocated between lines of business, usually according to the perceived relative threat to solvency. Profit targets for each business are then calculated as the return on capital target multiplied by the capital allocated.

1.1.3 *Efficient frontiers*: This approaches risk from a different angle, taking the available returns as inputs. The procedure is then to consider alternative mixes by volume, and assess whether these mixes are efficient in the sense of minimising risk for a given level of return. Turning this around, the actual mix by volume is optimal if the available returns on each line of business are proportional to the marginal risk incurred.

1.1.4 *Shareholder value*: The approach considers how shareholders value a company, and sets return targets with an aim to enhance shareholder value. This can be thought of as an efficient frontier approach, but the efficiency relates to the shareholder's own portfolio, of which the insurance company is a small part. This approach makes a key distinction between risk that shareholders can diversify (that is, specific risk) and the remainder (systematic risk) which is not diversifiable.

1.2 These four paradigms may seem to conflict. Practical implementations of these four approaches will often produce different answers. However, this is often due to inconsistent assumptions or methodologies. In this paper, we implement these techniques for a simplified insurance company. We make use of a stochastic simulation model — a technique now known as *dynamic financial analysis*, or DFA. In doing this we are able to reconcile these different approaches.

1.3 DFA (dynamic financial analysis), also known as ALM (asset-liability modelling), is a powerful and flexible tool for evaluating different strategies on a consistent basis. A very powerful technique for interpreting the DFA output is the so-called efficient frontier. The classic efficient frontier from modern portfolio theory helps investors choose between different portfolios of assets, typically by comparing the trade-off between expected returns and risk as measured by the standard deviation of return. DFA extends this concept by calculating an asset-liability efficient frontier that captures a wider range of the different risks and rewards facing a general insurance company. In particular, the risk measure (likelihood of adverse outcomes) can vary with what management thinks is most important in any given set of circumstances. Typical risk measures might be ruin probability, probability of solvency impairment, or failure to meet a profit objective.

1.4 But there is a pitfall for the unwary. A typical efficient frontier uses risk measures that mix together systematic and non-systematic risk. The distinction between these types of risks is essential if the shareholder perspective is to be taken into account. The user needs to treat them separately, or to know which is dominant.

1.5 In particular, extreme care needs to be taken with efficient frontiers for insurance companies if they are used to address strategic questions which include choices between different investment portfolios. They can produce results showing apparent benefits of diversification, which are shown to be false once the concept of systematic risk has been factored into the equation. For example, the model can produce a result where the managers benefit (e.g. meet an objective) from taking more systematic risk. A knowledgeable shareholder would then require a higher return target, but only if he knows this is going on.

1.6 The capital markets, where most of the practitioners of financial economics work, are characterised by high liquidity and high levels of public information. Systematic risk dominates, and the efficient frontier is not very useful.

1.7 However, in the insurance industry, there are occasions when systematic risk is the dominant feature, and occasions when non-systematic risk dominates and the efficient frontier does come into play. Systematic risk dominates in investment decisions and in lines of business which are cyclical and related to the business cycle, e.g. creditor and mortgage indemnity guarantee business (MIG). Non-systematic risk and efficient frontiers are useful when taking decisions related to the purchase of reinsurance or targeting lines of business which are not strongly correlated to the business cycle.

1.8 This paper describes the problem of mixing systematic and non-systematic risk and their treatment, by means of worked examples. It will not deal at length with risk measures associated with insolvency, but will focus more on the example of a well-capitalised company, which wishes to manage its risk-reward profile so as to be competitive. We will illustrate the use of a DFA model and provide an actual quantification of the risk-reward choices facing our example company.

1.9 In this paper we tackle two questions facing the same company, one asset-related, and the other liability-related (mix of business/reinsurance). Note that it is not the DFA model that provides the trap, rather it is the interpretation the user puts on the output by using an efficient frontier that combines different types of risk. The key is to understand which tool to use in which circumstance.

2. Premium Principles and Capital Allocation

2.1 Premium principles represent the earliest attempt to load prices for risk. They are calculated on the basis that the premium for a risk should depend only on the probability distribution of that risk, and not on how it may relate to other risks. A number of formulae have been proposed; the 1983 book by Goovaerts, De Vylder and Haezendonck (Insurance Premiums, North Holland, Amsterdam) describes eleven such rules.

2.2 Recently, more apparently scientific rationales have been developed for such formulae, based on capital allocation (see Hooker et al Institute paper). The idea is that capital has a cost, and risk in insurance business requires capital. The shareholders require a profit for each line of business, which can be expressed as a percentage of capital. If we can allocate capital according to risk, we then have an algorithm for allocating profit targets.

2.3 The algorithms are often hard to rationalise, because the theoretical cost of capital depends not only on the business riskiness but also on the capital base relative to which the return is measured. In theory, profit targets are virtually independent of the capital allocated. Without a robust theoretical framework, it is hard to achieve a consensus on how capital should be allocated in practice. The results of such exercises often end up resorting to premium principles in various guises, and so tend to be rather arbitrary. There are also numerous practical obstacles to allocating capital, including complications arising from the different stages of the product cycle (marketing, new business, unearned premiums, loss reserves) and interactions arising from overlapping generations. These issues are discussed in more detail in Ibeson et al (1999).

3. CLASSIC/TRADITIONAL ALM - A SUMMARY

3.1 Over the course of the past decade, ALM has become a mainstream tool amongst the actuarial community. As greater computing power has been made available at the desk-top, the number of practitioners in this field has increased. Applications have been found across a wide range of actuarial activities, including Life, Pensions, General Insurance and Investment.

3.2 The underlying purpose of building a stochastic model is to aid understanding of the dynamics of a particular business problem. One of the cornerstones of the actuarial profession was, and is, an understanding of compound interest. This naturally led to the development of cashflow models and it was a natural (though complex) next step to add a probability distribution around those deterministic cashflows to create a stochastic model.

3.3 Many papers have been written on the building of such models. It is not our objective in this paper to be unduly concerned over the type of model used — we are primarily concerned about the way in which output from a model is interpreted and business decisions made. Whether simple or extremely complex, the building of the model is generally the easy part. Understanding the output is the difficult part. The large number of variables typically used in a model means that the output is necessarily multi-dimensional. To analyse this data effectively and present the findings to senior colleagues in simple, easy to understand terms, represents a huge challenge to the modeller. It is probably fair to say that few can do this well.

3.4 One of the most common techniques used to present results is the efficient frontier. This is a technique borrowed from finance theory where the problem was originally framed in terms of portfolio risk and return. It is common to define “return” as the arithmetic mean of the surplus and to define “risk” as the corresponding standard deviation. Whatever definition of risk and return we wish to adopt, we can define an “efficient” set of portfolios. In this context, “efficient” means that there is no portfolio that has a higher return for any given level of risk, or conversely no lower risk for a given level of return. The principle

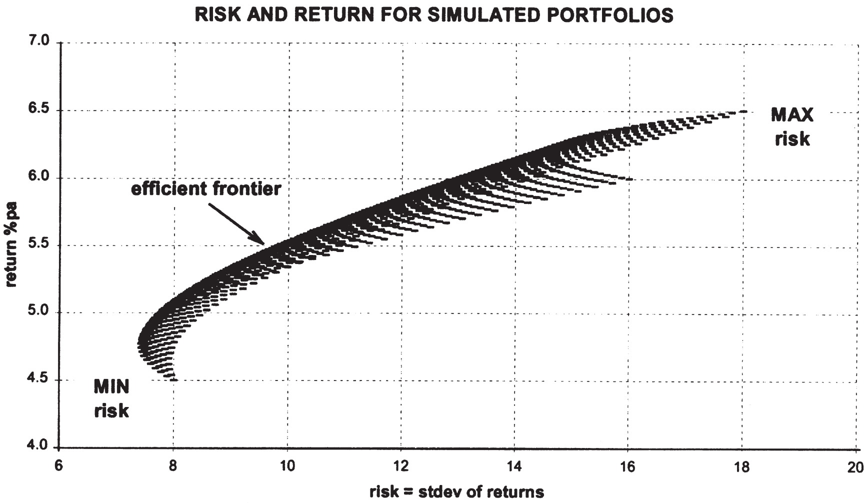

Figure 1. Efficient frontier measures of risk

is illustrated in Figure 1, which shows the results for simulated portfolios using a simple problem with three asset classes — UK equities, Overseas equities and UK bonds. The way in which portfolios cluster around the "frontier" is a well observed phenomenon. For more examples, and a more detailed exposition, see Sweeney et al (1998). In practice, this suggests we need not be too concerned with finding the most efficient portfolio. Given the uncertainties surrounding any inputs to the model, we would generally be satisfied with a solution that lies close to the efficient frontier.

3.5 In passing, it is interesting to observe upon one of the features with this form of analysis. If we change our definition of "return" or "risk" then the shape of the "frontier" may also change, and different strategies will look efficient. To illustrate this, we have revised the example above but defining risk to be the probability of negative real returns. Figure 2 shows how the shape of the feasible set and the frontier has changed.

3.6 Although selecting some tools from finance theory, the classical application of ALM tends to operate within a vacuum. For example, a pension fund is considered as an entity in itself rather than as part of an overall company balance sheet. In insurance work, the same misconception leads to definitions of risk (such as standard deviations) which fail to take account of the shareholders' ability to diversify. Whilst we recognise the difficulties of a more holistic approach, portfolio theory provides no way of optimising a "sub portfolio". Treating part of a business as an isolated entity will give misleading results. Such approaches implicitly assume that the shareholder faces infinite costs of diversification, and therefore attribute any diversification within a company,

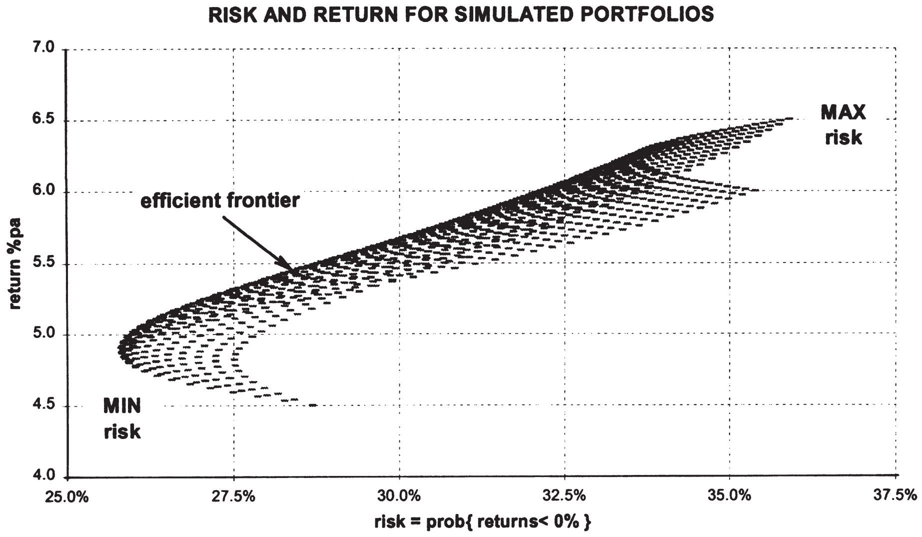

Figure 2. Efficient frontier using a downside measure of risk

whatever the cost, as a gain to shareholders. This plainly exaggerates the benefits of diversification.

3.7 To demonstrate the illusions that may be created by inappropriate use of ALM, consider the following example drawn from the field of general insurance. An insurer (MOTCO) is currently a specialist in motor insurance.

3.8 There is a proposal to diversify into employers' liability and mortgage indemnity business by acquiring ELCO and MIGCO respectively, creating a larger diversified general insurance company. A consulting actuary is hired to quantify the benefits of the business plan. Using the traditional ALM tools at his disposal, he uses the chart in Figure 3 below to illustrate the benefits.

3.9 The chart shows very clearly the benefits of the diversification. By combining the companies we are effectively shifting the efficient frontier upwards to the left. Although the mean return on capital is simply the average of the component parts, the variability of returns on capital is diversified across the different businesses and hence becomes lower than any of the underlying companies. The aggregate capital required to support the business is therefore less than the sum of the parts, hence surplus capital can be returned to the shareholders.

3.10 On the face of it, the analysis suggests that the diversification creates value for shareholders, while also improving credit risk for policyholders. However, there do not seem to be too many examples in history of a genuinely free lunch. Can these benefits be real — or are they just illusory? In reality, we

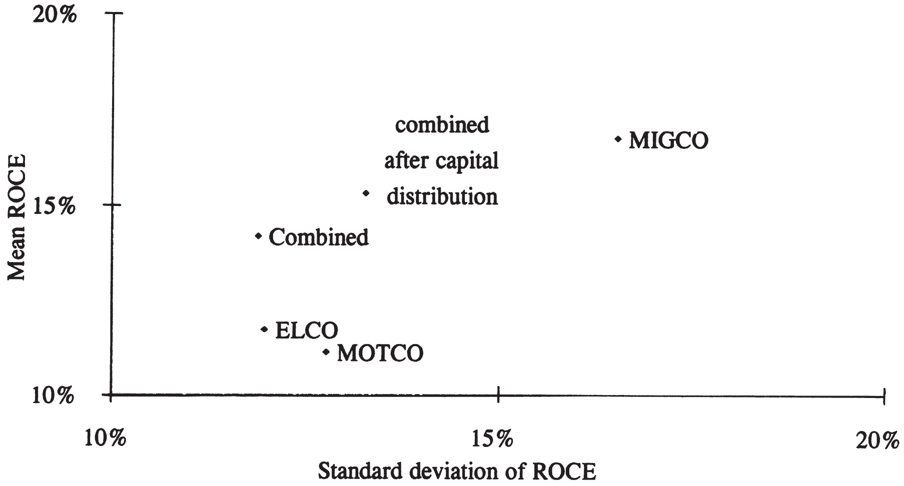

Figure 3. Benefits of the company merger measured in terms of return on capital employed (ROCE)

observe a large number of specialist companies. Are these all missing a trick, or is there another dimension to the problem we have missed? What would finance theory tell us about the benefits of the merger?

3.11 Advanced users of efficient frontiers can turn the problem around, designing optimal strategies. Under orthodox investment models, the efficient frontier contains the “market” portfolio of investments, and also various combinations of this investment with cash. For an explanation of why this happens, see Elton & Gruber (1981).

3.12 It follows that insurers may be able to reduce risk and increase expected return by moving their overall business towards the market portfolio. It is now common to see structured reinsurance deals that achieve this, for example by reducing the cedant's exposure to insurance risks and providing equity exposure in its place. Although this seems good from an efficient frontier perspective, in fact systematic risk has increased, so the cedant's shareholders are no better off. Furthermore, such strategies conflict with traditional rationales of why insurers exist. Once again, we are led to question whether reducing risk and improving return necessarily creates shareholder value, or whether the apparent free lunches are illusory.

4. Financial Economics and the Role of Systematic Risk

4.1 Finance theory provides a number of models by which economists can estimate the value of cash flow streams. The chief intellectual hurdle to clear is an understanding of how to adjust for risk. One popular approach allows for risk by an adjustment to the discount rate. The value of a business is then determined by discounting the expected future profit stream to the current date[1]. This requires two components: the expected future cashflows and the rate at which to discount these cashflows.

4.2 Note that this approach to valuation is the same as that used in a dividend discount model (DDM), a familiar tool that has historically been used by actuaries to value assets and liabilities. At any point in time, the theoretical value (and hence the potential sale value) is the value of discounted future profits. However, actuarial theory has often been imprecise on where the discount rate comes from.

4.3 In a proprietary company the interest rate that needs to be used to discount the cashflows is the rate of return that shareholders expect (or require) on average to earn, given the level of risk inherent in the cash flows. This required return is also known as the cost of equity.

4.4 However, shareholders can reduce their risk (i.e. diversify) by holding a basket of equities. In this way, the specific risk, which is unique to each equity, can effectively be eliminated. Therefore shareholders will not get any extra expected return for taking diversifiable (or specific) risk. Even though some shareholders choose not to diversify, this does not mean that a risk premium is required for diversifiable risk. This is because diversified shareholders will outbid non-diversified shareholders in the purchase of non-diversified shares. What remains after diversification is market risk, otherwise known as systematic risk or non-diversifiable risk. This is the risk that earns an extra expected return and so determines the cost of equity.

4.5 This insight is one of the fundamentals of the Capital Asset Pricing Model (CAPM). Although the theoretical development of CAPM relies on a number of unrealistic assumptions, the resulting framework has proved sufficiently reliable to form a practical tool for measuring the risk/return trade-offs for differing investments[2]. A number of generalisations of the CAPM are now available, and the systematic/non-systematic risk distinction is fundamental to all of them. Traditional efficient frontier analysis does not recognise this distinction.

4.6 The systematic risk of a company's equity is conventionally measured by the company "beta". This shows the average responsiveness of the company's

[1] In this context, "profits" include capital flows and investment returns on existing capital backing the business.

[2] However, it should be noted that CAPM is less robust where a more detailed analysis of bond-type investments is required, or where multiple currencies are involved — in these circumstances a multi-factor approach such as Arbitrage Pricing Theory is more useful.

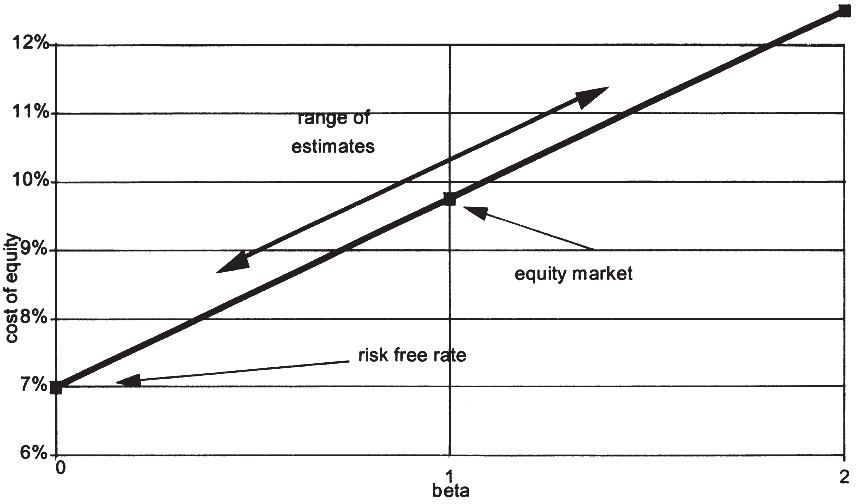

Figure 4. Capital market line

share price to changes in the overall market level. For example, a beta of 1.2 implies that on average when the market moves by 1%, the company's share price will move by 1.2%. The beta depends on the correlation between returns on the company's shares and returns on the market, and on the relative volatilities of these returns.

4.7 Figure 4 shows an example of the "capital market line" that results from CAPM. In order to construct such a line, assumptions need to be made for the risk-free rate and the market equity risk premium. The figure shows the cost of equity for each value of beta (i.e. for each level of systematic risk). By definition, the beta of the whole equity market is 1. The corresponding cost of equity is the risk-free rate plus the equity risk premium. Individual stocks offer different combinations of risk and return along the capital market line.

4.8 In order to estimate the cost of capital for a company, it is necessary to estimate the systematic risk, or beta, of the company's equity (see, for example, Copeland et al, 1995). City analysts tend to use estimates of beta which are based on the historical behaviour of the share price relative to the market. This is essentially a top-down exercise; analysts have insufficient data to construct a risk model of a company's own cash flows.

4.9 However, in practice, partly because the nature of the risks faced by a company can change significantly over time (perhaps due to acquisitions or divestments), or because different strategies under consideration may involve different levels of risk to shareholders, a forward-looking or prospective measure is preferable. This can best be carried out from inside a company, where sufficient data and expertise may be available to adopt a bottom-up approach to cash flow modelling.

4.10 A prospective estimate of beta relies on an understanding of the core drivers of the business and how they relate to the equity market. Some form of modelling is therefore required. This can be done by projecting a range of economic scenarios, and evaluating the returns to the market and to the business within each scenario. The correlation between the market returns and the business returns and the volatility of each can then be used to estimate the beta of the business according to the formula:

$$beta = correl(market, business) \times \frac{stdev(business)}{stdev(market)}$$

4.11 It is worth dwelling on some of the implications of this relationship. If an asset has a zero correlation with the market, then it has a beta of zero whatever the volatility of returns. Thus, in theory one would only require to earn the risk free rate to make the asset attractive. Hence the excitement over so-called zero beta assets such as catastrophe bonds, futures trading funds, commodities etc. Any risk premium offered is theoretically very attractive. Such investments, whilst popular in the US, have yet to make significant inroads into UK institutional portfolios.

4.12 These examples are interesting because an insurer writing such catastrophe risks may appear to move away from the efficient frontier. By traditional measures, this might be seen as a bad thing, but a deeper analysis allowing for the cost of capital could show that shareholder value has actually been created, because the insurance contract lies above the capital market line.

4.13 To understand the rationale, we have to look in more detail at why insurers are in business. In a pure CAPM world, there would be no need for financial institutions such as insurers or banks. Everyone would simply trade their risks in a huge market of equally informed participants. A major reason this does not happen in practice is the importance of private information. Insurers have become expert in collecting, managing and using private information in underwriting decisions. Banks occupy a similar role in lending decisions.

4.14 As private information is, by definition, not generally available, it is to be expected that insurers could gain an economic rent from their specialist expertise in this area, particularly where there are additional barriers to new entrants. Competitive equilibrium arguments would not apply here, so projects utilising private information may lie above the capital market line, hence creating value for shareholders. This contrasts to the situation of market investments, where insurers are competing with billions of other investors and there is little reason to believe insurers enjoy any special information or other advantage.

4.15 Having digested some basic financial theory, we can now return to our merger problem set out in Section 3. The concept of systematic and non-systematic risk is the missing link we were looking for! For each of the companies considered in the example, the risk profile is shown in Figure 5.

4.16 We can see that in this context, while much of the risk of MOTCO and MIGCO is systematic, ELCO contains a large dose of non-systematic risk. While

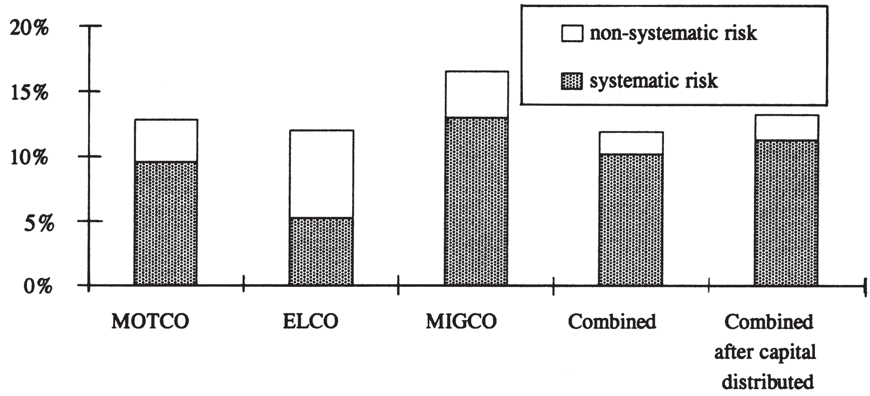

Figure 5. Systematic and non-systematic risk

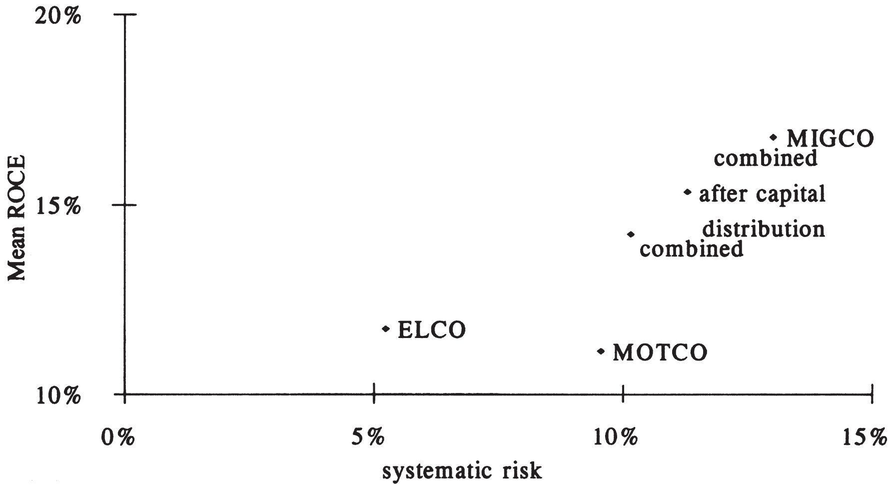

Figure 6. Systematic risk and return

the merger results in diversification of non-systematic risk, the systematic risk is conserved. A more meaningful risk-return plot would show return against systematic risk, as in Figure 6.

4.17 Thus, without further management actions shareholders will see little gain from the merger. The systematic risk of the merged company is just an average of the constituents, with no gain for diversification. All the apparent risk reduction is merely a reduction in non-systematic risk, which the shareholder would have diversified anyway. The systematic risk is not eliminated by the merger — in fact, it increases if capital is distributed because the profits are more highly geared. The improvement in mean ROCE achieved by the merger is merely a fair compensation for the fact that the earnings have poorer quality. It is the same compensation as the shareholder would have got from gearing up his own portfolio. There is then, in theory, no overall gain to shareholders from the merger. This is one consequence of Modigliani-Miller's Nobel Prize winning irrelevance proposition (Modigliani & Miller, 1958) Bride & Lomax (1994) and Mehta (1992) both raise this issue in an insurance context.

4.18 Financial theory suggests that the merger does not create value of itself while the same assets are still being held to meet the same liabilities. The merger can only create value if something economic changes as a result. For example, if the new company is better positioned to take advantage of profitable business opportunities, or is more efficient in using customer information than the individual entities, then value could be created. Perhaps the new entity has the resources to eliminate competitors. There may also be expense savings. Possibly management resources can be better employed.

4.19 In order for us to judge whether, in fact, value has been created, we need to model the expense savings, oligopoly profits, business opportunities and effectiveness of management resources. It is still unusual to see asset-liability studies which address these issues.

4.20 If we are to accept the above economic views, then there are profound implications for ALM studies. The key question here is how the theory is borne out in practice. It would seem unlikely that the shareholders have adequate information about a company upon which to make their portfolio choices. In practice this is precisely the information that the managers of the business are searching for! It therefore cannot be well disseminated in the market. The separation of risk into the systematic and non-systematic components relies on estimated correlations between assets and liabilities; such correlations are notoriously difficult to estimate with any confidence. The extent to which individuals make rational portfolio choices is also open to debate. However, in practice there are a number of additional costs, including taxes, information costs and agency costs which fall outside the scope of Modigliani-Miller's results. When these costs are taken into account in a DFA model, we no longer find that all capital strategies are equally attractive. Instead we can use DFA to identify the optimal strategies that minimise the aggregate of these frictional costs.

5. Risk and Cost of Risk

5.1 Risk is not in itself a cost. As a result, reducing risk does not necessarily create shareholder value. As many of the risks borne by general insurers are non-systematic, we should see return targets only marginally in excess of the risk-free rate. This theory conflicts with the much higher rates conventionally used to profit test new products. Mehta (1998) demonstrates that the ex post returns achieved by general insurers are much closer to those predicted by CAPM than to the hurdle rates ostensibly used in pricing. In this section, we consider how risks may manifest themselves as costs to an insurer. This provides a motivation for managing risks in terms of managing costs. It also puts risk on the same axis as returns. This is important, because it enables us to identify the appropriate amount to spend on risk management, that is, where the marginal £1 spent on risk management generates £1 in cost saving.

5.2 Insurers who write higher risk business may find that their share prices are more volatile. As a result, shareholders may demand a higher return—sometimes misleadingly called the cost of capital. This extra required return has to come from higher premiums, and can be thought of as a kind of risk cost. Indeed, in most corporate finance text books, this kind of risk cost is the first to be considered.

5.3 Financial theory suggests that not all sources of variability will result in higher required returns. A higher return will only be required to the extent that risk is systematic, that is, correlated to an investor's other wealth. Other risks can be eliminated by diversification within the shareholder's portfolio, and so do not require a risk premium. This realisation produces a number of insights into corporate policy, for example:

(a) The risk premium is not reduced by diversification. The portion of risk correlated to shareholders' other wealth is additive across lines of business.

(b) There is no free lunch for insurers switching from one asset class to another. This is because each asset class simply earns its required return to shareholders, so any gain in expected return is cancelled out by a higher shareholder required return.

(c) The required dollar return is not affected by the amount of capital allocated. This is because if less capital is allocated, then the returns on a line of business are more geared, and so the percentage required return on capital goes up proportionately.

5.4 We will see that most of these statements are overly simplistic, because they take account only of systematic risk costs, and not other kinds of risk costs. Nevertheless, if the other risk costs are taken into account as cash flows, the systematic risk approach does provide a robust market-consistent way of valuing those cash flows. It is important to ensure that any economic model used for DFA is rich enough to support the systematic/non-systematic risk distinction.

5.5 It is reasonable to suppose that riskier lines of business require a disproportionate amount of management time, because they are more significant for the insurer. This suggests that overhead expenses should be allocated in some way related to the risk. Furthermore, if an insurer is risky at the aggregate level, it becomes a less secure place to work, so that a risk premium must be loaded into salaries in order to attract and retain skilled staff. All of these observations contrast with common practice, which may allocate overhead expenses in proportion, for example, to premium income. A more accurate expense loading automatically provides a larger charge for more risky lines of business.

5.6 As pointed out by Jensen and Meckling (1986), shareholders incur agency costs when retaining managers to run companies for them. These agency costs are related to possible conflicts of interests between shareholders and managers. They are also reduced when shareholders can easily monitor managers.

5.7 The conflicts of interest are likely to be larger when more risk is involved. This is because managers inevitably bear some of the risk, but cannot diversify in the way shareholders can. This creates an incentive for managers to spend resources on reducing non-systematic risk (for example, via purchase of reinsurance) in a way which is detrimental to shareholders' interests. It is also more difficult for shareholders to monitor managers of more risky businesses, because the amount of random noise makes it difficult for shareholders to distinguish between luck and skill. This makes it easier for managers to conceal their failings and to destroy shareholder value by stealth. All of these issues mean that risky businesses create a particularly high incidence of agency costs.

5.8 Companies have different levels of skill in different lines of business. A skilled underwriter will seek out information until he has a good understanding of risk exposure, conditions of cover and possible claims that might result. However, in areas of expansion, for example emerging markets, it is not always cost effective to collect and analyse this information, or to spend resources recruiting and training specialist underwriters. This leaves the insurer open to adverse selection, and to more elementary blunders. This is another cost of risk, but in this context risk is measured not by variability or probability, but by the quality of information available to evaluate a risk.

5.9 We now move on to a less direct area of risk cost. Writing more risks usually increases the level of capital which an insurer optimally holds. But holding capital itself generates costs, which can be thought of indirectly as risk costs.

6. Capital and Cost of Capital

6.1 The amount of capital held by a company reflects several factors, including shareholder risk tolerance and regulatory and industrial constraints. These constraints might be thought of as dictating a minimum level of capital. In this section we discuss how an insurer can establish an optimal level of capital.

6.2 We have already discussed the way in which capital is a cost. In other words, the profit available from insurance must be sufficient to justify to shareholders the amount of capital held. Some mechanism must be found for allocating these profit targets down to policy level. This goal can be re-expressed as an allocation of the capital itself.

6.3 Great care is required when discussing the cost of capital. In common parlance, the *cost of capital* is taken to mean the shareholders' required return on the capital they have subscribed. If this cost of capital is used to evaluate a new project we implicitly assume that the additional capital will be invested in the same way as existing projects. In other words, a marginal injection of capital will result in an increase in new business. In this context, the cost of capital includes not just the cost of holding the capital, but also the cost of bearing all those extra risks assumed to be taken on once the new capital is in place.

6.4 It is sometimes more helpful to consider the *pure cost of capital*, that is the marginal cost of holding extra assets, with *no change* in the liabilities. This means we have to allow for the fact that the injection improves not only the expected profit (extra income from investment) but also the quality of earnings (ruin less likely because less gearing). On the other hand, the accounting return on capital has probably fallen as a result of the injection.

6.5 We can look at the required profit for a company before and after the injection of an additional £1 of capital. This can be expressed as the risk-free rate on £1 plus the pure cost of capital. In a perfect (Modigliani-Miller) world, the pure cost of capital would be zero. However, in real life some investment income is double taxed. As discussed in section 6.10 there may also be agency costs associated with managerial self-interest which become more onerous as more funds are injected. This and other effects contribute to the pure cost of capital.

6.6 The size of pure cost of capital may vary according to how the funds are invested. For example, in the case of UK General insurers the effect of double taxation is less severe for equities than for bonds, as the tax on capital gains can be deferred. On the other hand, equity investment may also increase agency costs, as the additional volatility creates a smokescreen, frustrating shareholder attempts to monitor managers.

6.7 We measure the cost of capital raising as a round-trip cost. This means we consider the raising of capital via a rights issue, followed immediately by a dividend payment which restores the insurer to the situation prior to the rights issue. But the shareholder has not been restored to his former position — he is worse off because various third parties have taken a cut. The whole process may well trigger banking fees, dividend taxes and other forms of frictional cost. It will also consume a significant amount of management time. The sum total of these is the cost of raising capital.

6.8 In practice, the cost of raising capital depends on a number of other factors, most notably the state of the market and the state of the company concerned. If an insurer finds itself suddenly in difficulties and in need of capital, that capital will come at a high price. This price can be explained in terms of the *under investment problem*. The problem arises because, when an impaired company seeks new equity, some of the benefits accrue to policyholders and other creditors. However, there is no cost-effective way of contracting with these other beneficiaries to contribute to the cost of the new capital, so the new equity holders demand compensation for that part of their injection which benefits other parties. In contrast, well-planned capital injections to healthy companies, for example to finance future growth, may be far less costly.

6.9 Let us suppose there were no cost to holding capital. Then it would be desirable to minimise future capital raising and distribution costs. The optimal strategy would be to raise a very large amount of capital in relation to the underlying business, so that the probability of future recourse to the markets is very slim indeed. In this context, DFA would be trivial, because the possibility of financial impairment would be more or less eliminated.

6.10 However, at such large levels of capitalisation, shareholders have little effective control over management. Managers can afford to ignore financial markets because they are unlikely to require subsequent favours from those markets. Such insurance enterprises are likely to be run for the benefit of management, not shareholders. This is an example of agency cost, that is, a capital holding cost. It explains why shareholders like companies to be lean and mean.

6.11 Now let us suppose that there are zero capital raising costs. Then optimal levels of capitalisation will be determined by other conditions, such as customer credit sensitivity or capital holding costs. In this case, the insurer should declare frequent dividends or make frequent rights issues, so that the capital remains close to the optimal level. There is a hint of this in some recent announcements from insurers, who claim that they have more capital than necessary, and use this to justify a redistribution to shareholders. It is to be hoped that this calculation of capital allows for the possible costs of asking for it back next year.

6.12 So far, we have considered costs to shareholders. It is worth mentioning that company management may see these costs in a different light. One reason for this is that capital changes can play a role in signalling management competence to the market. Shareholders may question the competence of management if:

(a) dividends are suddenly cut
(b) the company becomes financially impaired
(c) the company admits that it has little use for its capital and hands some back.

6.13 In each of these cases, a possible shareholder reaction is to displace the existing management team. We should note that this eventuality is not necessarily costly to shareholders. Shareholders do not place a low value on variable dividends, but they do use it as information when considering alternative corporate structures. This contrasts to existing management, who view variability in dividends as personally costly, because they are averse to losing their jobs. This provides an incentive to existing management to smooth dividends and to manufacture rhetoric claiming that existing capital resources are well managed.

To the extent that DFA projects are commissioned by management (and not by shareholders), it is reasonable for DFA objectives to reflect management's preferences.

6.14 We have identified two different types of capital cost, and established that the optimal strategy is trivial if either of these costs is zero. We deduce that, if the problem is non-trivial, both of these costs must be significant. We would expect the magnitude of these costs to enter into the equation somewhere. Simplistic approaches which do not take capital costs into account, cannot be expected to produce defensible capital solutions.

6.15 If these costs are an issue for DFA, we would also expect them to be relevant in profit tests. In practice, capital costs are seldom incorporated into profit tests explicitly, but instead are reflected implicitly in a higher hurdle rate of return. This phenomenon, which is not unique to insurance, explains the apparent confusion when economists seek to reconcile hurdle returns to models such as the CAPM. As noted by Lewin et al. (1994), the explanation for the high hurdle rates lies not in any theory of risk and return, but in the observation that profit forecasts are often optimistic and neglect important costs. Other methods of risk loading, such as the use of premium principles or capital allocation, can similarly be rationalised as representing proxies for various costs which would not otherwise be taken into account.

6.16 In this section, we have focused in some detail on the costs of capital. It is worth noting that holding capital also has some benefits. The most obvious reason for holding capital is that policyholders and regulators require it. Demonstrating capital resources is an important way of signalling intent to pay valid claims. This is valuable to customers because other ways of reducing credit exposure (eg diversifying across insurers) are costly or otherwise impractical. The customer is therefore prepared to pay insurers to manage their own risks to reduce this cost.

6.17 Traditional ALM sets capital requirements by balancing return on capital employed against probability of ruin. We have shown that both of these measures contain significant shortcomings. We have now developed a new approach in which optimal capital is determined by trading off frictional capital costs against the need to signal commitment to customers.

7. Conclusion

7.1 DFA is a powerful and flexible tool for modelling the effects of different strategies on the financial position of an insurance company. The efficient frontier is an intuitively appealing method for interpreting the output from a DFA model, showing the risk-reward trade-offs between different strategies in a systematic manner. However, the traditional risk measures used, both those based on simple measures such as standard deviation of return or probability that solvency drops below a given level, and those based on more advanced ideas such as expected policyholder deficit and dynamic programming, mix together systematic and non-systematic risk, and can lead to misleading conclusions.

7.2 If the systematic risk component is small, then the efficient frontier is a valuable tool for evaluating medium-term tactical choices between mixes of lines of business, or reinsurance purchase strategies. But when management evaluates changes in asset mix, or considers moving capital into or out of the industry, systematic risk becomes significant and it is necessary to move beyond the understandings provided by the efficient frontier.

7.3 An understanding of the implications of financial economics is essential for the application of DFA in general insurance, otherwise false conclusions may be drawn regarding issues where investment strategies are involved. The actuarial profession has to embrace the techniques, and get more used to applying them in practice — it gives us opportunities, not just threats, and it gives us a framework within which to apply our professional judgement.

7.4 Actuaries need to ensure they do not get left behind in their understanding and application of financial economics — MBAs, merchant bankers and stockbroker analysts have moved ahead. But when it comes to general insurance, we do have a strong position arising from some natural advantages. Firstly our training in statistics and the measurement of uncertainty, and secondly our understanding of the nature of liabilities. In particular, the financial markets are used to dealing in hedged risk, but an underwriting operation is happy to set a price for accepting unhedged risk. Also, financial engineers may regard a liability as just a negative asset, but for an insurance company a liability is a service opportunity with an external customer, and so must be managed very differently from the assets.

7.5 Suppose the finance director asks the question: “this DFA is all very well, but what does it have to do with me?” We would reply that, if he wants to examine questions such as how much capital he needs to run the business, how much reinsurance he should buy, what dividends he should pay, and how the answers change if he changes the mix of business, then he needs a framework such as provided by DFA.

7.6 We are now living in a world increasingly populated by MBA consultants selling shareholder value concepts to senior management. Finance theory is now the language of the boardroom. The tide will not turn back. Actuaries need to learn this language and embrace the finance culture. If this is achieved, the actuarial profession will become significantly stronger. Only then can we realise the full potential of DFA to provide a framework to bring together finance and actuarial theory in one unified whole.

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