RISK-ADJUSTED PERFORMANCE MEASUREMENT AND CAPITAL ALLOCATION IN INSURANCE FIRMS

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ABSTRACT

This contribution discusses a number of ideas for using a shareholder value approach to the problems of risk-adjusted performance measurement and the issue of capital allocation. We demonstrate that, if shareholder value is to be consistently maximised, then not only the total amount of equity capital of a financial services firm (i.e. the capital structure of the firm), but also the question of how much capital is to be allocated to each of the business segments should be derived from an optimisation calculation.

JEL-CLASSIFICATION: G22, G 31, G32

1. INTRODUCTION

The issue of risk-adjusted performance measurement (RAPM) in (financial services) firms has been discussed for several years now in business administration theory and practice.[1] Prominent risk-adjusted performance measures are "Risk-Adjusted Return on Capital" (RAROC) or "Economic Value Added" (EVA). As fields of application for these concepts, the literature mentions, in particular:[2]

- decisions on restructuring business segments;
- decisions on future business policy, e.g. on setting reservation prices for products in the individual lines of business;
- risk management in the business segments;
- performance evaluation of the business segment management.

RAROC and all other RAPM concepts have in common that capital is assigned to the firm as a whole or to the business segments. The cost of the allocated capital is compared with an earnings figure for the firm or the business segment, and from that comparison conclusions are drawn with respect to the above issues.

In our article we analyse in how far the concepts of capital allocation and risk-adjusted performance measurement are compatible with the shareholder value approach. We will demonstrate that, if shareholder value is to be consistently maximised, then not only the total amount of equity capital of the financial services firm (i.e. effectively, the issue of what capital structure the firm is to have), but also the question of how much capital is to be allocated to each of the business segments should be derived from an optimisation calculation.

Our model differs from other approaches found in the literature in which the capital allocation problem in financial services firms is, at least in principle, linked to the shareholder value concept[3]. For whilst the articles by James (1996); Matten (1996); Zimmerman (1997); Albrecht (1998) or Saita (1999) all have in common that they determine the amount of equity capital for the whole firm on either a value at risk ba-

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1 cf. especially Harris/Raviv (1996); James (1996); Matten (1996); Zimmerman (1997); Froot/Stein (1998); Myers/Read (1999); Saita (1999); Cummins (2000).

2 cf. Merton/Perold (1993), p. 27; James (1996), p. 2-4 and p. 15; Albrecht (1998), p. 66; Saita (1999), p. 97; Cummins (2000), p. 9.

3 cf. especially James (1996); Cummins (2000).

sis or a default put option basis, they all do this without raising the question as to how far this corresponds with the shareholder value concept.[4]

The same problem applies to the issue of capital allocation to the individual businesses. A whole variety of allocation methods can be found in the literature. Thus, it is suggested that the whole capital for the firm, measured on a value at risk basis, should be allocated to the lines of business.[5] Merton/Perold (1993) suggest (as do, in principle, Myers/Read (1999)) allocating that amount of (marginal) risk capital to the business segments that would be freed if it were decided to withdraw from the respective business segment.[6] It is, however, unclear whether the shareholder value of the firm can really be maximised by such approaches of capital allocation, or by decisions based on such methods, since these models assume that the optimal safety level for the firm is known.

The structure of our study arises from the problem fields pointed out. After presenting in section 2 a formulation of the prominent performance measure RAROC that is compatible with the concept of shareholder value, we pursue, in section 3, the question of the optimal capital structure of a (property/liability) insurance firm. A theoretical approach based on contingent claims approach will form the foundation for this. In section 3.1 we will see the irrelevance of the capital structure, if both the owners of the insurance company and the policyholders price their stakes by the same NPV-Method. In section 3.2 we derive an optimal capital structure by introducing the empirically verifiable high sensitivity of policyholders' reservation prices to the threat of default on their claims. In section 4, we discuss problems of making decisions with regard to business lines. We will find similarities between our approach and the "marginal risk capital" concept used by *Merton/Perold (1993)*, as neither approach leads to a complete distribution of the capital to the individual lines of business.

Furthermore, we will see clearly that decisions made simply by looking at the performance of a division within the present firm context may be misleading. The reason for this is that the risk structure of the firm will be altered after a decision alternative

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4 cf. the overview in Cummins (2000).

5 cf. e.g. Albrecht (1998).

6 "Risk capital is the smallest amount that can be invested to insure the value of the firm´s net assets against a loss in value relative to the risk-free investment of those net assets" (Merton/Perold (1993), p. 17). Risk capital can therefore be described by the concept of the default put option of the liabilities, see Cummins (2000), p. 20-23.

has been opted for, and it is difficult to derive the new risk structure from the original situation.

2. Risk Adjusted Performance Measurement and Shareholder Value Maximization

In this section we demonstrate the link between the prominent RAPM concept of RAROC and shareholder value maximization. In order to keep things clear, we will refer to a two-points-in-time world.[7] As is well known,[8] the net present value (NPV) of a company to its shareholders is a rational decision criterion, under the assumptions that shareholders do not hold any other stakes in the firm; that capital markets are arbitrage free; that the cash flows of the company to its shareholders can be duplicated (spanned); and under the assumption of competitivity. The latter means that the cash flows of the company do not change the pricing method, thus eliminating a positive NPV.

The cash flow to the shareholders is composed of their initial investment outlay E (the amount of equity invested at time t = 0) and the gain or loss G made by the firm during the period. $E[\cdot]$ denotes an expected value, and r_f the riskless rate of return. R stands for a risk adjustment, derived from a particular pricing theory (e.g. the CAPM, the APT, or the Froot/Stein (1998) approach) the NPV of the shareholders is given by:

$$(1) \quad NPV = \frac{E + E[G] - R}{1 + r_f} - E \ .$$

The numerator in (1) is a certainty equivalent of the probability distribution of the cash flows. For the shareholders, it is optimal to choose those company decisions by which the (positive) NPV will be maximized.

If one takes a look at the literature on “risk-adjusted performance measurement”, one finds the “risk-adjusted return on capital” (RAROC) typically described by the procedure that the return of a firm or business segment is compared “against capital in-

7 The static context is therefore mainly applicable to property/liability insurance companies.

8 cf. Ross (1978); Wilhelm (1985); Wilhelm (1989).

vested by adopting some form of risk-adjustment", which "is usually based on a technique called value at risk."[9]

Let us try to find these descriptions in the NPV-equation (1). It can be reformulated in an expression that is basically compatible with the RAROC concept:

$$(2) \quad NPV = \frac{1}{1+r_f} \; E \cdot \left\{ \underbrace{\frac{E[G]-R}{E}}_{RAROC} - r_f \right\}$$

The differences between the RAROC concept according to (2) and the usual descriptions to be found in the literature[10] are:

– According to (2), it is the expected gain made by the shareholders minus a risk adjustment (i.e. the expected gain accruing from the risk-neutral distribution) that should be used as a return figure, and not just the gain or loss observed over one (e.g. the last) period.
– Maximizing the quotient in (2) maximizes the NPV, if the equity capital E is not a decision variable. This is a very strong assumption especially in financial services firms, where the customers are typically the main debt-holders of the firm and the equity capital has the function of safety capital. We will return to this point in the next section.
– The hurdle rate[11] that must be exceeded by RAROC to have a positive NPV is the riskless rate of return r_f. The hurdle rate is therefore not a decision variable for the firm. A deviation from r_f, however, leads to a sub-optimal firm policy as a result of either under- or over-investment.

Other concepts of risk adjusted performance measurement such as EVA ("economic value added"), ROC ("return on capital") or RORAC ("return on risk adjusted capital"), as described in the literature,[12] would also prove not to be compatible per se with the NPV concept.

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9 Matten (1996), p. 58-59.

10 cf. Matten (1996), p. 58; cf. Cummins (2000), p. 8.

11 cf. e.g. Cummins (2000), p. 10.

12 cf. e.g. Matten (1996), p. 58 ff.; Albrecht (1998).

3. OPTIMAL CAPITAL STRUCTURE IN INSURANCE FIRMS

3.1 THE STARTING POINT: IRRELEVANCE OF THE CAPITAL STRUCTURE

As we saw in the last section, risk-adjusted performance measurement according to equations (1) and (2), both at the overall firm level and at the level of the business segments, requires as an input that the amount of equity capital E. There are, in principle, several ways of determining this figure: one could use the regulated amount of equity, the balance sheet equity capital, an amount of equity determined by a specific risk assessment (such as the "value at risk") or a level of equity capital endogenously derived from a shareholder value calculus. At the centre of the traditional RAPM approaches is a level of equity capital determined on a "value at risk" basis.[13] In this paper, however, we focus on an endogenous determination, whereby the amount of regulated capital must, of course, be seen as a secondary condition that must be observed.

As a starting point, we investigate the question of how much equity capital the owners of the insurance firm are willing to invest. Assuming that the owners enjoy limited liability, we answer this question by using an option pricing approach. Formally, we rely on the assumptions of the NPV calculus from section 2. Both the owners of the insurance firm and the purchasers of insurance apply a NPV calculus to evaluate their stakes, and they have homogeneous expectations. Therefore, both the owners and the policyholders demand rates of return on their equity investments or on their insurance premiums, respectively, that are commensurate with the level of risk.

Owners and policyholders are assumed to be distinct groups. The uncertain wealth of the owners at time t = 1 without investment in the insurance company $V_1^{E,\text{no ínsurance}}$ originates from their initial capital V_0^E invested in the capital market at the risky rate of return r_E:

$$(3) \qquad V_1^{E,\text{no insurance}} = V_0^E\left(1+r_E\right).$$

Let E again be the capital invested in the insurance company by the owners, P the premiums paid by the policyholders, r_{ins} the risky rate of return on the capital invest-

13 cf. e.g. Matten (1996), p. 95 ff. and p. 125 ff.; James (1996), p. 18; Saita (1999), p. 107.

ment of the insurer and S the distribution of insurance claims, then the final position of the shareholders at time t = 1, V_1^E, is given by [14]:

(4) $$V_1^E = \left(V_0^E - E\right)\left(1 + r_E\right) + \max\left\{\left(E + P\right)\left(1 + r_{ins}\right) - S,\, 0\right\}.$$

Under the assumptions made in section 2, there is a linear pricing function φ which prices future payments V_1^E at time t = 0.[15] The investment in the insurance company is not unfavourable for the owners so long as:

(5) $$\varphi\left(V_1^E\right) \geq \varphi\left(V_1^{E,\text{ no insurance}}\right).$$

Assuming an arbitrage-free financial market, we find:

(6) $$\varphi\left(1 + r_E\right) = 1$$

With (4) and (6) in (5), the amount of equity E that the owners are willing to invest at a given premium income P is therefore implicitly given by:

(7) $$E \leq \varphi\left(\max\left\{\left(E + P\right)\left(1 + r_{ins}\right) - S,\, 0\right\}\right).$$

The analogous calculus for the policyholders produces their implicit reservation premium P:[16]

(8) $$E \geq \varphi\left(\max\left\{\left(E + P\right)\left(1 + r_{ins}\right) - S,\, 0\right\}\right).$$

Therefore, in arbitrage-free markets there is an infinite number of E-P-combinations that do not result in any transfer of wealth between owners and policyholders. These combinations are given by:

(9) $$E = \varphi\left(\max\left\{\left(E + P\right)\left(1 + r_{ins}\right) - S,\, 0\right\}\right)$$

For arbitrage reasons, policyholders would not pay a premium if no equity were invested (and vice versa). A huge amount of equity capital E rules out any default situations and therefore the premiums P reach their default free value, e.g. the traditional

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[14] The investment structure (and together with that, r_E) is assumed to remain unchanged with respect to (3). For reasons of simplicity, the effects of reinsurance are not considered.

[15] cf. Ross (1978), p. 456 ff.; Wilhelm (1985), p. 101 ff.

[16] cf. Doherty/Garven (1986), p. 1034.

insurance-CAPM premium. Furthermore, implicit differentiation yields $\frac{\partial P}{\partial E} > 0$ and $\frac{\partial^2 P}{\partial E^2} < 0$. In a P-E-diagram P is therefore a concave function.[17] Line (a) in the figure of the following section 3.2 illustrates that.

In this arbitrage-free setting, we can establish the irrelevance of the amount of equity invested. However, given a certain premium P, the capital structure of the firm is determined by (9), and in that sense is not irrelevant.

In the initial situation described here, insurance is, typically for neo-classical models, irrelevant. It offers neither advantages nor disadvantages. Insurance becomes relevant, and we thus obtain an optimal capital structure, if we deviate in the following section from the assumption that purchasers of insurance will display the same behaviour in choosing their insurance as the capital market participants described here.

3.2 OPTIMAL CAPITAL STRUCTURE IN INSURANCE FIRMS

The equity capital in insurance companies typically plays only a minor role in financing the company's physical assets: instead it fulfils, above all, the function of safeguarding policyholders´ claims. This is of central significance, as the customers at the same time are also the (often exclusive) debt-holders of an insurance company.[18] Because their ability to make use of private diversification strategies is limited[19], policyholders may in the event of the insurance company becoming insolvent be exposed to a "personal bankruptcy". For this reason, Cummins/Sommer (1996), in their paper on optimal risk management measures of the insurance firm, assume that the policyholders' reservation price is highly sensitive to the company's risk situation (measured by the value of the default put option). According to Cummins/Sommer (1996), an insurance firm that is maximizing expected gains can then determine the optimal risk management mix. The line of reasoning pursued by Cummins/Sommer (1996) effectively corresponds to the notion proposed by Doherty/Tinic (1981), who, in an otherwise neo-classical model environment, derive the relevance of reinsurance from the risk sensitivity of the insured.

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[17] cf. Doherty/Garven (1986), p. 1044.

[18] cf. Merton/Perold (1993); p. 16.

[19] Because of the limited transfer of individual risks to several insurance companies.

The ideas of Doherty/Tinic (1981) and Cummins/Sommer (1996) are strongly supported by the empirical findings of Wakker/Thaler/Tversky (1997). They find in experiments that the pricing method used by policyholders differs massively from that given by equation (8). Policyholders react to an increase in the insolvency risk of the insurance company with a strong decrease in their reservation price.[20]

In our approach, again for reasons of simplicity, we only look at equity capital as a risk management measure for the primary insurer. We take up the ideas of Doherty/Tinic (1981), Cummins/Sommer (1996) and Wakker/Thaler/Tversky (1997) with regard to the sensitivity of the insured to the insurer's risk situation. Furthermore, we assume that the policyholders can observe the safety level of the insurer directly.

To set an optimal level for the equity capital, we assume a reservation price function of the policyholders that is contingent on the risk situation of the insurance company. This reservation price function is in line with the findings of Wakker/Thaler/Tversky (1997). Where the insurer faces no default risk, they find $P > E(S)$. As soon as the policyholders realize a significant default risk of their claims (e.g. when the ruin probability of the firm reaches a certain level), the reservation price drops drastically. A curve that might be taken by the policyholders' reservation price, contingent on the firm's risk, is given by line (b) in the figure below.

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20 Wakker/Thaler/Tversky (1997) find in an experiment that the reservation prices of the policyholders fall by a quarter if the probability of a shortfall in the insurance services rises from 0% to 1%. The extremely risk-adverse behavior shown by the test subjects is not, moreover, reproducible through common von Neumann-Morgenstern utility functions, cf. Wakker/Thaler/Tversky (1997), p. 10 ff. Similar behavior on the part of policyholders is documented in Cummins/Sommer (1996) and Cummins/Danzon (1997).

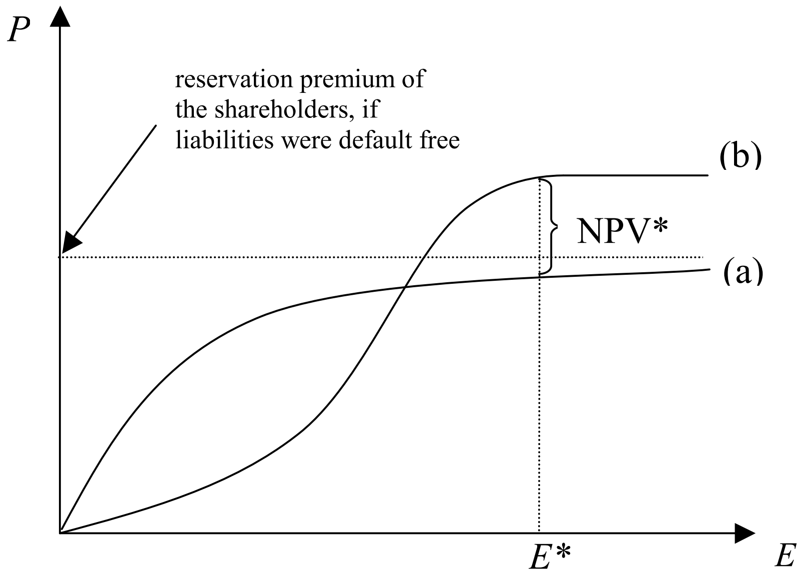

Figure: Determining the optimal equity capital

The optimal amount of equity capital E* (and consequently the optimal safety level) is reached, where the positive difference between the policyholders' reservation price, calculated on the basis of the behavioural assumptions made (line (b)), and the shareholders' reservation price, calculated from equation (9) (line (a)), reaches its maximum. This difference represents the maximal net present value NPV* for the insurer, if the insurance market allows the premium income, represented by the reservation price of the policyholders, to be earned.

Two notes seem necessary concerning this approach:

1. The optimal risk level of the firm can, of course, also be achieved by different risk management methods other than by supplying safety capital. In arbitrage-free markets, all methods leading to the same risk level imply the same risk management costs.[21]

2. Introducing market imperfections into an otherwise consistently neo-classical model in general creates a serious problem: The consistency of the model may be lost. One cannot be sure whether equilibrium prices for capital assets can exist at all in the presence of market imperfections like the risk-dependent reaction function of the insured described in the figure above. Furthermore, the NPV calculus applied may not be rational any more. On the other hand, in a

[21] cf. Merton/Perold (1993), p. 26.

neo-classical model setting one typically gets irrelevance results, such as the irrelevance of financial intermediaries or the irrelevance of the capital structure. This is certainly an interesting starting point for determining corporate policy, but it hardly leads to an optimal corporate policy that takes into account the real-life behaviour of the stakeholders of the firm, deviating from the assumptions of neo-classical equilibrium models. So our approach faces this dilemma described. In accordance with the contributions of Doherty/Tinic (1981), Doherty (1991), Cummins/Sommer (1996) and Froot/Stein (1998), we decided to depict the real-life behaviour of market participants and insert it into an NPV calculus, which enables us to reach conclusions on an optimal corporate policy.

4. Optimal capital allocation to the lines of business

The NPV calculation introduced in 3.2 as a method for determining the optimal corporate policy (including the determination of equity capital levels) can be transferred directly to the problem of managing the lines of business. Because of the risk interdependencies between the lines of business decisions affecting an individual business segment can only be correctly evaluated in the context of the whole firm. This means that it is essential for the decision, that it maximizes the NPV of the whole firm.[22] This calculus, of course, involves the optimal amount of equity capital being determined.

Let us take a closer look at the decision to restructure an individual line of business of an insurance firm, e.g. by expanding or contracting the underwriting volume. For such a decision, all relevant payment changes, stemming e.g. from cross-selling effects or from the change in optimal equity capital, need to be considered in the decision process. A hereby implied change in the optimal equity capital is therefore the equity capital to be allocated to that decision. As a consequence, it may be that the optimal overall risk level of the firm, e.g. the ruin probability, changes in response to a change in the structure of the business lines. If the decision were, for example, to close down a line of business, the reduction in the optimal amount of equity capital needed would be the capital allocated to that line of business (for that decision). Determining in that way the reduction in the amount of capital needed for all the divisions of the firm and aggregating this figure will not, in general, lead to the optimal amount of equity capital for the whole firm in its present state. This "non-aggregation of the allocated capi-

22 cf. Merton/Perold (1993), p. 27.

tal to the capital of the firm" is analogous to Merton/Perold (1993) and their concept of marginal risk capital.

If one compares this approach to managing the firm and the business segments in terms of the NPV calculation with the methods proposed in the literature, based on risk-adjusted performance measurement, then the problems associated with the latter methods become evident:

– RAPM-methods generally demand that the whole of the equity capital be allocated across the business segments so that the latters' performance can be measured.[23] On the basis of an NPV calculation, this can be shown to be fundamentally inappropriate.

– The performance figures determined for individual business segments on the basis of these "traditional" RAPM methods are in a whole number of areas unsuitable for managing the business segments. This has less to do with the fact that the methods of capital allocation are largely arbitrary. The problem is more that it is virtually impossible to take the strong (poor) performance of any particular business segment in the context of the existing firm as a basis on which to draw conclusions as to the benefits likely to accrue from any expansion (contraction) of that business segment, or from other entrepreneurial decisions. The likely benefits can, as a matter of principle, only be determined if the NPVs for the various scenarios are calculated.

– In the presence of asymmetric information (e.g. with regard to the risk situation) between top management and business line managers, and the agency problems resulting from that[24], a number of areas can be identified in which it makes sense for different sorts of capital allocation methods to be implemented.[25]

Thus, a value at risk based capital allocation to the lines of business may be suitable for risk management purposes.[26] A certain amount of capital is allocated to the individual line of business on the proviso that the total losses incurred for the division

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[23] cf. Albrecht (1998), p. 70.

[24] cf. e.g. Milgrom/Roberts (1992), p. 126-287; Harris/Raviv (1996).

[25] cf. approaches in Saita (1999), p. 106; on the efficiency of capital allocation under informational asymmetry cf. Gertner/Scharfstein/Stein (1994); Scharfstein/Stein (1997); Stein (1997).

[26] cf. Saita (1999), p. 96.

can exceed the assigned capital only with a certain probability. In that respect capital allocation, and the risk-adjusted performance measures built on it, can indeed render useful services as an incentive scheme that can be used to supervise and steer the management at divisional level, where there are informational asymmetries.

The extent to which it makes sense to use capital allocation methods and risk-adjusted performance measures depends, then, on a firm's respective goal and on the circumstances prevailing. The use of the risk-adjusted performance measures proposed in the literature can, as we have shown, result in faulty business decisions being taken in a whole range of situations.

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