Capital Allocation for Insurance Companies—What Good Is It?

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Abstract

In their 2001 *Journal of Risk and Insurance* article, Stewart C. Myers and James A. Read Jr. propose to use a specific capital allocation method for pricing insurance contracts. We show that in their model framework no capital allocation to lines of business is needed for pricing insurance contracts. In the case of having to cover frictional costs, the suggested allocation method may even lead to inappropriate insurance prices. Beside the purpose of pricing insurance contracts, capital allocation methods proposed in the literature and used in insurance practice are typically intended to help derive capital budgeting decisions in insurance companies, such as expanding or contracting lines of business. We also show that net present value analyses provide better capital budgeting decisions than capital allocation in general.

Introduction

The usefulness of capital allocation methods, i.e., ways that allocate the equity capital of an (insurance) company to different lines of business, can be assessed only in the context of the company's economic goals. Although this statement sounds so obvious, failure to consider *context* is precisely the current state of affairs in capital allocation discussion. Articles about capital allocation typically begin by listing certain properties that an allocation method should possess,[1] the most prominent of which are: adding-up property, no undercut, symmetry, and consistency.[2] Capital allocation is supposed to be useful in accomplishing the goals of competitive pricing of insurance contracts and making optimal capital budgeting decisions,[3] but instead of analyzing

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[1] Denault (2001), Fischer (2003), and Valdez and Chernih (2003).

[2] Descriptions of the "no undercut," "symmetry," and "consistency" properties can be found in Denault (2001, p. 5) and Valdez and Chernih (2003, p. 520). The "adding-up" property is defined below.

[3] Valdez and Chernih (2003, p. 518).

whether various allocation methods are appropriate in certain situations, the literature focuses almost exclusively on whether the proposed allocation methods encompass the above-listed "essential" properties.

Stewart Myers and James Read[4] have proposed an important capital allocation method for insurance companies. They discovered "a unique and non arbitrary"[5] allocation method that leads to an "adding-up" property; i.e., the equity capital allocated to the single lines of business "adds up" to the overall equity capital of the insurance company. Using option-pricing techniques, the allocation depends on the marginal contribution of a contract in a single line of business to the default value of the whole firm.[6] Myers and Read propose using their capital allocation method in pricing insurance contracts. In particular, they propose using it to determine correct loadings on fair premiums in cases where there are frictional costs of holding equity capital.[7]

The Myers and Read article won the 2002 ARIA best paper prize and has since been widely discussed in the academic literature. For example, Kneuer (2003), Ruhm and Mango (2003), Vrieze and Brehm (2003), and Mildenhall (2004) analyze the technical requirements, especially concerning distributional assumptions, and the practical limitations of the Myers and Read approach. Meyers (2003) argues that for the question of expanding or contracting lines of business, capital allocation, including the Myers and Read approach, is not necessary, a finding in line with Phillips, Cummins, and Allen (1998), if no frictional costs are taken into account. Because of the huge number of possible risk measures and allocation methods, Venter (2003, 2004) does not believe the approach will give clear guidance about the profitability of different lines of business or help in making capital budgeting decisions,[8] but does think the method is appropriate for the purpose of pricing insurance contracts.[9] Cummins, Lin, and Phillips (2005) find, on an empirical basis, that the Myers and Read way of allocating the frictional cost of capital is reflected in the insurance premiums observed.

The first goal of this paper is to show that capital allocation to lines of business based on the Myers and Read approach is either not necessary for insurance rate making (in the case of no frictional costs) or even leads to incorrect loadings (when frictional costs are considered). Furthermore, capital allocation techniques are proposed for making capital budgeting decisions in lines of business. We will show that these techniques lead, in principle, to wrong decisions – and not only with respect to the Myers and Read approach. Setting out the reasons for that result is our second goal.

The paper is organized as follows. In the next section, "Pricing Insurance Contracts, Risk Management Costs, and Equity Capital," we set out our arguments in a situation without frictional costs, setting the stage for the next section, "Pricing Insurance Contracts and Frictional Costs," in which we do consider frictional costs. In the section,

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[4] Myers and Read (2001).
[5] Myers and Read (2001, p. 545).
[6] The default value is the value of the payments the insured will forego if the insurance company defaults.
[7] Myers and Read (2001, pp. 550 and 573).
[8] Venter (2003, p. 465).
[9] Venter (2004, pp. 102–103).

"Performance Measurement and Optimal Capital Budgeting Decisions for Lines of Business," we discuss the main problems that arise when capital allocation methods are used for profit ranking and capital budgeting decisions. The last section summarizes the key results and concludes.

PRICING INSURANCE CONTRACTS, RISK MANAGEMENT COSTS, AND EQUITY CAPITAL

The theoretical basis of the Myers and Read capital allocation method is the contingent claims approach for insurance pricing.[10] In this framework, the fair insurance price is determined by the claims payoff distribution, the arbitrage-free valuation function, and the contract's safety level (measured by the value of the default put option). Clearly, this method of calculating competitive insurance prices does not depend on the insurance company's preexisting portfolio, which in turn means that it makes no difference to the insurance price whether the company is a single- or multi-line insurer, everything else being held equal. Thus, no allocation of equity capital to lines of business or to single insurance contracts is necessary in making the pricing decision.[11] To achieve a desired safety level, the insurance company must establish certain risk management measures. Equity capital is only one of these, and can be (partially) substituted by reinsurance, alternative risk transfer, and other measures. The necessary risk management costs are covered by the insurance premiums. Let us now formalize this line of reasoning.

The one-period option-pricing framework for pricing insurance contracts used by Myers and Read was first proposed by Doherty and Garven.[12] Let P^{old} indicate the competitive premium (paid at time $t = 0$) of the preexisting underwriting portfolio of an insurance company that consists of several lines of business. The insurance portfolio yields stochastic claims costs L_1^{old} at time $t = 1$. The present value of these claims costs is denoted by $PV(L_1^{\text{old}})$. $PV(\cdot)$ denotes an arbitrage-free valuation function. D^{old} stands for the present value of the default put option. If E_0^{old} indicates the initial equity capital of the company at time $t = 0$, and r the stochastic rate of return on its investment portfolio, then the default value D^{old} is given by:

$$D^{\text{old}} = PV\big(\max \big\{ L_1^{\text{old}} - \big(E_0^{\text{old}} + P^{\text{old}} \big)(1 + r), 0 \big\} \big). \tag{1}$$

The competitive premium of the initial insurance portfolio P^{old} is:

$$P^{\text{old}} = PV\big(L_1^{\text{old}} \big) - D^{\text{old}}. \tag{2}$$

Note that the premium P^{old} should also be the basis for a regulated premium if the regulatory authority wants shareholders and policyholders to earn a risk adequate return on their capital.

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[10] Doherty and Garven (1986).
[11] For this result, see Phillips, Cummins, and Allen (1998, pp. 605–606).
[12] Doherty and Garven (1986).

As in the Myers and Read article, the company's safety level can be defined by the default-value-to-liability ratio:[13]

$$d^{\text{old}} = \frac{D^{\text{old}}}{PV(L_1^{\text{old}})}. \tag{3}$$

The objective now is to price a new contract in line i with stochastic claims costs $L_1^{\text{new},i}$. The default put option value of the new contract is denoted as $D^{\text{new},i}$. If the default-value-to-liability ratio of the preexisting portfolio is to be maintained, then for the default-value-to-liability ratio of the new contract in line i, $d_1^{\text{new},i} = D^{\text{new},i}/PV(L_1^{\text{new},i})$, the following must hold:[14]

$$d := d^{\text{new},i} = d^{\text{old}}. \tag{4}$$

Given the assumption of needing to maintain the insurer's default-value-to-liability ratio, the competitive price of the new contract, $P^{\text{new},i}$, immediately follows from Equations (2) to (4)—without any allocation of equity capital to the lines of business:[15]

$$P^{\text{new},i} = PV(L_1^{\text{new},i}) \cdot \frac{P^{\text{old}}}{PV(L_1^{\text{old}})} = PV(L_1^{\text{new},i})(1 - d). \tag{5}$$

Given the default-free value of the claims, $PV(L_1^{\text{new},i})$, the price of the new contract, $P^{\text{new},i}$, is determined based only on the safety level d; the risk interdependencies between the existing portfolio and the new contract are implicitly caught by the $PV(\cdot)$ operator.

$P^{\text{new},i}$ is a fair premium only if the insurer does in fact maintain the promised safety level via adequate risk management measures. For arbitrage reasons, risk management measures (e.g., equity capital, reinsurance, financial hedging) that have the same effect on default value are all of an equal competitive price and that price depends—in contrast to the insurance contract prices—on the risk interdependencies within the insurance company. The way to figure the competitive price of a risk management measure is as follows. If the insurance company received $P^{\text{new},i}$ and undertook no further risk management, writing the new contract would lead to a certain (net) present value $PV_{\text{new},i}$ for the insurance company. But, in a competitive market, $PV_{\text{new},i}$ is exactly the price of an (additional) risk management measure, say $PV_{\text{RM},i}$, necessary to

[13] Myers and Read (2001, p. 557) and Butsic (1994, pp. 662–667). In contrast to the default value D, the default-value-to-liability ratio d allows a comparison between the safety levels of differently sized insurance companies.

[14] Myers and Read (2001, p. 559). It is assumed that the different lines of business are being held in one corporation in which the equity capital serves as the only risk management measure. The lines have equal priority in the case of bankruptcy. However, different lines of business could have different safety levels. This could be the case if certain risk management measures (especially reinsurance) only applied to certain lines or certain insurance contracts. Furthermore, different lines of business might be run in separate companies (with different safety levels), owned by a holding company. For this case, see Phillips, Cummins, and Allen (1998, p. 599). Clearly, the pricing framework could easily be generalized in the case of different safety levels.

[15] Phillips, Cummins, and Allen (1998, pp. 604–607), Gründl and Schmeiser (2002, pp. 455–457).

ensure the desired default-value-to-liability ratio d for the sum of all contracts held by the company. Thus we assume that it is possible to provide the desired default-value-to-liability ratio for both stakeholder groups, the existent policyholders and the new one. In our case, after selling a new contract in business line i, the price of the (additional) risk management measure is:

$$PV_{\text{RM},i} = PV\left(\max\left\{ \left(E_0^{\text{old}} + P^{\text{old}} + P^{\text{new},i}\right)(1+r) - \left(L_1^{\text{old}} + L_1^{\text{new},i}\right), 0\right\}\right) - E_0^{\text{old}}. \quad (6)$$

Myers and Read consider only one type of risk management measure—changing the amount of equity capital. From Equation (6) we already know the competitive *price* for this change in the equity capital.[16] The *scope* of the equity capital change $E_0^{\text{new},i}$ can be (implicitly) calculated by setting the overall equity capital of the insurance company equal to the present value of the future payments to its shareholders:

$$E_0^{\text{old}} + E_0^{\text{new},i} = PV\left(\max\left\{ E_0^{\text{old}} + E_0^{\text{new},i} + P^{\text{old}} + P^{\text{new},i}\right)(1+r) - \left(L_1^{\text{old}} + L_1^{\text{new},i}\right), 0\right\}).$$
$$(7)$$

Equation (7) shows that in calculating the additional equity capital requirements, the competitive premium, $P^{\text{new},i}$, is an input variable. Hence we disagree with Myers and Read, who claim that to "set the premiums for a policy, an insurance company must estimate the surplus required to support that policy."[17] Furthermore, it can be seen that there is no need to allocate capital back to the lines of business (or to single contracts) when making pricing decisions or determining the change in equity capital needed.

The above model demonstrates the relationship between pricing insurance contracts, necessary risk management measures and costs, and the resulting necessary amount of equity capital. This will serve as the basis for assessing the Myers and Read approach. Myers and Read give an explicit closed-form solution of Equation (7) for the additional equity capital needed.[18] This is done for marginal changes of the present value $PV(L_1^{\text{old},i})$ of the claims costs in line i and under the assumption that the variables on the right-hand side of Equation (7) are either joint-lognormally or joint-normally distributed. Technically, Myers and Read determine the marginal change of equity e_i:[19]

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[16] Shareholders could alternatively invest their capital in the capital market. If the capital is invested as equity capital in an insurance company, shareholders need to be compensated for the additional risk of underwriting claims. The price to compensate for this additional risk is given by Equation (6).

[17] Myers and Read (2001, p. 573).

[18] Myers and Read (2001, pp. 559, 578).

[19] In fact, Myers and Read do not use the equity formulation shown in Equation (7) directly, but instead determine surplus requirements and make surplus allocations to lines of business. Surplus (before writing a new contract) is given by:

$$S_0^{\text{old}} = E_0^{\text{old}} - D^{\text{old}},$$

i.e., the value of the company's equity net of the value of the default put option. Hence, the marginal change of surplus s_i is $s_i = e_i - d$, where d again denotes the fixed default-value-to-liability ratio.

$$e_i = \left. \frac{\partial E_0^{\text{old}}}{\partial PV\big(L_1^{\text{old},i}\big)} \right|_{d^i=d}, \tag{8}$$

where d^i is the default-value-to-liability ratio of line i after writing a marginal contract, which must stay at the same level d as before changing the portfolio.

With the help of e_i, the amount of additional equity capital, $E_0^{\text{new},i}$, given in Equation (7), can now be determined explicitly. For small contracts with a present value of the claims costs of $PV(L_1^{\text{new},i})$, the amount of new equity capital $E_0^{\text{new},i}$ needed to ensure the company's desired (initial) safety level can be (approximately) calculated by

$$E_0^{\text{new},i} = e_i \cdot PV\big(L_1^{\text{new},i}\big). \tag{9}$$

By way of some tedious calculus, Myers and Read show that, with M denoting the number of business lines, the marginal equity requirements e_i—independently of the actual distribution of the company's assets and liabilities—have the property:[20]

$$\sum_{i=1}^{M} e_i \cdot PV\big(L_1^{\text{old},i}\big) = \sum_{i=1}^{M} E_0^{\text{old},i} = E_0^{\text{old}}. \tag{10}$$

Myers and Read interpret the marginal equity requirements of the single line of business i multiplied by the present value of the default-free liabilities in this line as an allocation of equity to line i, $E_0^{\text{old},i}$.[21] From Equation (10) it can be seen that summing up the allocated capital across all M lines of business leads to the company's present equity capital ("adding-up" property).[22] Myers and Read claim that these "capital allocations are unique and not arbitrary. They therefore disagree with prior literature arguing that capital should not be allocated to lines of business or should be allocated uniformly."[23] When using the Myers and Read model framework, however, we have seen that in the context of a perfect capital market, capital allocation to lines of business is neither needed for pricing insurance contracts nor for determining the change in the insurance company's equity capital after it writes a new contract. So, if there appears to be no need for a capital allocation rule, what, then, is the point of discussing such a rule's properties, for example, the "adding-up" property?[24]

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[20] Myers and Read (2001, pp. 554–557). For a numerical example, see the next section "Pricing Insurance Contracts and Frictional Costs."

[21] Myers and Read (2001, p. 554).

[22] Note that the equity capital requirements and the "adding-up" property only hold true for marginal changes of the underwriting portfolio; see Myers and Read (2001, pp. 547–548). For a detailed discussion of the assumptions necessary for the adding-up property, see Mildenhall (2004). Using Euler's theorem on first-order homogeneous functions, Dowd (2002, pp. 159–161) achieves a result similar to that in Equation (10) in the context of a value-at-risk framework.

[23] Myers and Read (2001, p. 545).

[24] This line of reasoning is in accordance with Merton and Perold (1993).

PRICING INSURANCE CONTRACTS AND FRICTIONAL COSTS

According to Myers and Read, the primary purpose of capital allocation rules is determining the allocation of frictional costs, e.g., stemming from double taxation or free cash flow agency costs.[25] However, they do not integrate frictional costs into their analytical derivations and examples.[26] In the Myers and Read framework, equity capital $E_0^{\text{old},i}$ is allocated to line i according to Equation (10). Therefore, if there are frictional costs directly driven by equity capital, the proposed capital allocation procedure should also be usable to allocate these frictional costs to line i. Line i thus "receives" the fraction $(E_0^{\text{old},i}/E_0^{\text{old}})$ of the equity-driven frictional costs that should be covered by the insurance premiums of line i.

Before we comment on this allocation procedure, we will briefly discuss the implications of integrating frictional costs into the presented option-pricing framework. In principle,[27] any frictional costs (not only those driven by equity capital) can be directly integrated into a pricing calculus—analogously to Equation (7). In the case of corporate taxes, this can be shown as follows.[28] The payoff to the government T_1 can be described in a simplified way:

$$T_1 = \tau \cdot \max\left(\left(E_0^{\text{old}} + P^{\text{old}}\right)r + P^{\text{old}} - L_1^{\text{old}}, 0\right), \tag{11}$$

where τ stands for the corporate tax rate. The zero-net-present-value calculus leads to:[29]

$$E_0^{\text{old}} = PV\left(\max\left\{\left(E_0^{\text{old}} + P^{\text{old}}\right)(1 + r) - L_1^{\text{old}}, 0\right\}\right) - PV(T_1). \tag{12}$$

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[25] See, in particular, Jensen (1986). There is a strand of literature that develops and evaluates capital allocation techniques with respect to their ability to mitigate problems stemming from information asymmetries between the board or the owners of the firm and the line management (see, e.g., Harris and Raviv, 1996; Scharfstein and Stein, 2000; Perold, 2001; Stoughton and Zechner, 2004; and Inderst and Laux, 2005). In this contribution, because we are focusing on capital allocation approaches proposed in the literature that do not explicitly try to solve agency problems, we decided not to discuss the emergence or mitigation of this sort of frictional costs in the following.

[26] For this point, see also Venter (2003, pp. 466–467).

[27] Note that an ad hoc incorporation of frictional costs in an otherwise arbitrage-free pricing model, as it is used in the Myers and Read article, may lead to problems. As an example, an integration of taxes tends to result in a capital market that is incomplete and arbitrage pricing methods, in general, can not be used. Hence, a unanimously supported present value calculus will not exist (Schaefer, 1982, pp. 163–165; Dybvig and Ross, 1986; Ross, 1987). In general, one gets a considerable range of (option) prices. This also holds true for transactions costs that prevent costless dynamic hedging (see Leland, 1985, for an overview of the extensive literature on this issue; see Duffie, 2001, p. 133).

[28] Doherty and Garven (1986, pp. 1032–1034).

[29] Note that in Equation (12) the tax burden is carried by the insured. A rearrangement of Equation (12) leads to:

$$P^{\text{old}} = PV\left(\min\left\{L_1^{\text{old}}, \left(E_0^{\text{old}} + P^{\text{old}}\right)(1 + r)\right\}\right) + PV(T_1).$$

The premium income is once again determined implicitly.

From Equation (12) we obtain different feasible pairs (E_0^{old}; P^{old}) depending on the desired safety level. For a given safety level (measured again by the value of the default put option), Equation (12) leads to a specific combination of fair premiums and needed equity capital of the company. Let us now price a new contract in line i. Under the constraint that the safety level be maintained after signing the new contract, one gets a specific pair ($E_0^{\text{new},i}$; $P^{\text{new},i}$), using again the zero-net-present-value condition given in Equation (12):

$$
E_0^{\text{old}} + E_0^{\text{new},i} = PV\big(\max \big\{ \big(E_0^{\text{old}} + E_0^{\text{new},i} + P^{\text{old}} + P^{\text{new},i} \big)(1+r)
$$
$$
- \big(L_1^{\text{old}} + L_1^{\text{new},i} \big), 0 \big\} \big) - PV\big(\tau \cdot \max \big\{ \big(E_0^{\text{old}} + E_0^{\text{new},i} + P^{\text{old}}
$$
$$
+ P^{\text{new},i} \big) \cdot r + P^{\text{old}} + P^{\text{new},i} - \big(L_1^{\text{old}} + L_1^{\text{new},i} \big), 0 \big\} \big). \tag{13}
$$

Since the frictional costs of double taxation are connected to the scope of the equity capital change due to signing the new contract, the insurance premiums—in contrast to the case without frictional costs—are now company specific. Clearly, the price of a new contract depends on the structure of the preexisting portfolio and the chosen risk management mix.[30] As an example, identical risks will have different prices, depending on the sequence of contracting. Again, for determining the frictional cost loading on the premium, neither a capital allocation to lines of business nor an "adding-up" property is needed. The advantages of a direct integration of frictional costs in the pricing calculus are obvious: in contrast to the Myers and Read approach, this method holds not only for *marginal* changes of the underwriting portfolio, but also for *nonmarginal* ones. Moreover, frictional costs linked to cost drivers other than equity capital can be integrated in the pricing calculus. Furthermore, as is clear from Equation (11), there is in general no proportional relationship between equity capital and the equity-driven frictional costs as would be implied by a cost allocation based on capital allocation. To illustrate this, we give an example showing that loadings according to a Myers and Read frictional cost allocation in the manner described above can differ substantially from the loadings calculated according to Equation (13).

Numerical Example

The example consists of three parts. In Part A we outline a situation that serves as the base case without frictional costs. We herein calculate the allocation factors, according to the Myers and Read (2001) technique, that are needed for allocating frictional costs to the insurance contracts. In Part B we introduce frictional costs of taxation and derive the competitive gross premium income (i.e., including the tax loading) for the whole insurance company given its insurance portfolio and the equity capital from Part A. In Part C we compare the competitive gross premiums for new contracts written in the case of a direct calculation according to Equation (13) with the case of a frictional cost allocation according to Myers and Read (2001).

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[30] The specific risk management mix will be important for the amount of frictional costs, since different risk management measures will be accompanied by different frictional costs.

Table 1

Example of an Insurance Company Running Two Lines of Business

	Line 1	Line 2
Expected claims costs per contract	$1	$1
Standard deviation of claims costs per contract	$0.5	$0.25
Correlation coefficient between the claims costs	0.5	0.25
Number of contracts	600,000	400,000
Competitive premium[a] ($P^{\text{old},i}$)	$597,000	$398,000

[a]For calculation of the competitive premium, Equations (1)–(3) are applied for each line of business.

Part A. Let us assume[31] a company with two lines of business. To keep things simple, we assume a risk-neutral world and a risk-free rate of return of zero. The investment portfolio return of the insurer is risk free. Furthermore, all random variables, i.e., the claims distributions, are normally distributed. The insurance company's default-value-to-liability ratio is set at $d = 0.5$ percent (see Equation (3)). The data for the example are given in Table 1.

We assume a correlation coefficient of 0.25 for any two claims, one from each line, resulting in expected claims costs for the whole underwriting portfolio of $1,000,000 and a standard deviation of $250,000.187.[32] In analogy to Equation (7), the necessary amount of equity capital yielding a net present value of 0 for the shareholders in the initial situation is given by[33]

$$E_0^{\text{old}} = E\left(\max\left\{ E_0^{\text{old}} + P^{\text{old}} - L_1^{\text{old}}, 0 \right\} \right) \approx \$420,763.305. \tag{I}$$

Using the Myers and Read approach,[34] the data given so far lead to $e_1 = 0.628604581$ and $e_2 = 0.109001392$ (see Equation (8)). Equation (10) results in the following relationship:

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[31] For the calculation of the competitive premium, Equations (1)–(3) are applied for each line of business.

[32] The standard deviation of the claims costs of the whole underwriting portfolio is calculated in the following way. Let ρ_1 (ρ_2) denote the correlation coefficient between the claim costs in Line 1 (Line 2). Furthermore, $\rho_{1,2}$ stands for the correlation coefficient of any two claims, one from each line. The standard deviation of one claim in Line 1 (Line 2) is denoted by σ_1 (σ_2). The number of contracts in Line 1 (Line 2) is given by N_1 (N_2). Hence, the standard deviation of the claims costs of the underwriting portfolio based on the two lines of business generates from the following expression:

$$\sqrt{N_1\sigma_1^2 + \left(N_1^2 - N_1\right)\rho_1\sigma_1^2 + N_2\sigma_2^2 + \left(N_2^2 - N_2\right)\rho_2\sigma_2^2 + 2N_1N_2\rho_{1,2}\sigma_1\sigma_2} \approx \$250,000.187.$$

[33] With L_1^{old} being normally distributed, a closed-form solution for Equation (I) is available (Winkler, Roodman, and Britney, 1972, p. 292).

[34] See Myers and Read (2001, p. 578 (bottom)) and footnote 19.

$$0.628604581 \cdot \$600,000 + 0.109001392 \cdot \$400,000 = E_0^{\text{old}}. \tag{II}$$

Hence, the allocation factors $(E_0^{\text{old},i}/E_0^{\text{old}})$ can be derived from:

$$\frac{E_0^{\text{old},1}}{E_0^{\text{old}}} = 0.896377474; \ \frac{E_0^{\text{old},2}}{E_0^{\text{old}}} = 0.103622527. \tag{III}$$

Part B. We focus on a case with a marginal tax rate τ of 50 percent. Given the equity capital and loss distributions described in Part A, an application of Equations (11) and (12) leads to a competitive gross premium of $1,065,482.582 for the whole insurance portfolio (without taxation we had a premium income of $995,000; see Table 1). However, the safety level measured by the default-value-to-liability-ratio (d) has now improved from 0.500 percent (in the base case) to about 0.246 percent. This is because the tax loading on the premium helps collateralize the liabilities. The net premium with $d = 0.246$ percent is given by $997,543,179. Hence, the frictional costs of taxation for the insurer's entire portfolio are $67,939.403.

Part C. Let us now derive the premium for new contracts written in Lines 1 and 2, respectively. We first look at 100 new contracts in Line 1. According to the Myers and Read method, one would allocate frictional costs of $67,939.403 \cdot 0.896377474 = $60,899.351 to Line 1. Therefore, the 100 new contracts, approximately a marginal change for the insurance company, have to carry a loading of ($60,899.351/600,000) $\cdot$ 100 = $10.150. Using the direct way of calculation according to Equation (13) and keeping the safety level unchanged (i.e., $d = 0.246$ percent) leads to a tax-driven loading of $9.554. Hence, the Myers and Read loading is 6.236 percent higher.

The difference in the loadings becomes much more dramatic when we look at Line 2. Leaving Line 1 in the base situation and writing 100 contracts in Line 2 leads to a tax-driven loading, according to the Myers and Read technique, of $1.760, whereas the direct calculation yields a loading of $2.654. The Myers and Read loading is 33.685 percent smaller than the direct approach.

As the example illustrates, when allocating equity and frictional costs based on the existing portfolio in the manner described above, inappropriate pricing results. The reason is that with the sale of each new contract, the portfolio changes and therefore the cost allocation scheme is not correct. Even if we could imagine a method by which the portfolio does not change as contracts are written, however, we do not understand the purpose of undertaking the cost allocation process, given that the existing portfolio already has been priced.

Furthermore, a second important problem exists, which is that equity capital serves as safety capital for the company as a whole. The costs of equity capital are common costs with regard to the single lines of business (and to the single insurance contracts).[35]

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[35] We will come back to the problems of common cost allocation in more detail in the next section, "Performance Measurement and Optimal Capital Budgeting Decisions for Lines of Business."

Of course, all (frictional and nonfrictional) costs must be covered by the sum of the insurance premiums, but we have no nonarbitrary way of allocating them to the lines of business. In this context, the Myers and Read method of allocation is only *one* way of common cost allocation out of many possible ones. Since the thus calculated prices are arbitrary to the extent that common costs are allocated, decisions based on that method—e.g., cutting back on a line of business because the market price of insurance is lower than the calculated price—might be wrong.

From the perspective of a regulatory authority the situation could be different. Its focus may be to provide insurance premiums that do not depend on the specific way a portfolio is being built. Hence identical risks should have the same price that, additionally, guarantees an adequate safety level. Even though both these goals are achieved by the Myers and Read approach, two serious problems remain. First, insurance prices for identical risks are different in different companies because they depend on the specific asset allocation and underwriting structure, as well as the chosen risk management mix, of each company. Therefore, the regulatory authority would have to hypothesize a sort of average or efficient insurance company, including a certain risk management mix, to determine the appropriate capital allocation factors. Myers and Read do, in fact, discuss the issue of such an efficient risk management mix,[36] but offer no practical solution to the problem. Second, after allocating the equity-driven common costs, there is still the problem of allocating common costs that are not equity driven—such as board member salaries—to the lines of business in order to cover them by the insurance contracts. In the context of price regulation, these two problems may lead to the situation where regulations force the premiums to be too low and thus certain insurance coverages are not offered.[37]

PERFORMANCE MEASUREMENT AND OPTIMAL CAPITAL BUDGETING DECISIONS FOR LINES OF BUSINESS

In addition to being used for pricing insurance contracts, capital allocation is often utilized as a basis for determining the performance of business segments, resulting in capital budgeting decisions such as expanding or contracting lines of business.[38] Even though Myers and Read do not propose their allocation method for performance measurement, other papers discussing the Myers and Read approach clearly see profit ranking of lines of business and capital budgeting decisions as appropriate fields of application[39] and, indeed, many insurance companies do use capital allocation methods for these purposes. We will now outline the problems that arise when capital allocation methods are used for profit ranking and capital budgeting decisions. These problems are of a general nature and are not caused by a specific capital allocation method.

The typical procedure when using capital allocation methods for performance measurement and for making capital budgeting decisions involves the following three steps:

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[36] Myers and Read (2001, pp. 570–572).
[37] For this argument, see Friedlaender (1969, p. 133) and Braeutigam (1980, p. 185).
[38] See, e.g., Cummins (2000, p. 9), Venter (2004, pp. 96–97).
[39] Vrieze and Brehm (2003, pp. 480–481), Venter (2003, p. 461).

1. Equity capital is assigned to the firm as a whole based on a certain risk measure (e.g., the ruin probability concept or, as in the Myers and Read case, the default put option value of the firm).[40]

2. The equity capital is then allocated to the different lines of business, using one of a variety of allocation methods found in the literature.[41] The cost of the allocated equity capital is compared with earnings figures for the lines of business.[42]

3. From that comparison conclusions are drawn with respect to capital budgeting decisions, such as whether to expand or contract business segments.

This kind of decision making is vulnerable to certain pitfalls. Considering the first point above, it is obvious that the assigned amount of equity capital at the company level will be of great importance for the calculated profitability of the firm as a whole and, subsequently, of the individual business segments. However, in searching the capital allocation literature, one can find a vast variety of possible ways to determine the proper amount of equity capital.[43]

As for the second point, the allocation of costs of equity capital to the existing lines of business leads to a common cost problem. Equity capital serves as safety capital for the company as a whole rather than its individual parts, and if insolvency occurs, it is because liabilities exceed assets for the entire company, not for any particular line. This type of common cost problem has been studied extensively in the economics literature for purposes of pricing goods with common costs, such as those found in agricultural and chemical industries.[44] According to the common cost literature, informational limitations leave us with no nonarbitrary common cost allocation for purposes of performance measurement and pricing.[45] Instead, the generally accepted response is to develop a set of desired properties for the allocation process itself and proceed with the method that best satisfies these properties. It is inherent in such a process, however, that whatever allocation method used will result in distortions and the question future research ought to investigate is the extent to which those distortions exist under various allocation methods. For example, Billera and Heath (1981)—referring to game-theoretical approaches—suggest in their well-known article the properties "adding-up," "additivity," and "fairness."[46] If these properties are fulfilled, the allocation of common costs is indeed unique. But, as Billera, Heath, and Verrecchia (1981, p. 186), clearly state: "Although the results are mathematically elegant, they require the acceptance of a 'constitution,' or set of axioms, the full effect of which may not be entirely understood in terms of the problem at hand."

As mentioned in the Introduction, defining the desired properties of an allocation method is also the procedure found in recent capital allocation literature concerning

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[40] For different risk measures used, see, e.g., Venter (2004, pp. 97–98). Note that the so assigned equity capital will typically differ from the balance sheet equity capital.

[41] For an overview, see Cummins (2000, pp. 11–25), Venter (2004, pp. 98–101).

[42] Cummins (2000, pp. 10–11).

[43] Venter (2004, p. 97).

[44] See, e.g., Braeutigam (1980), Billera and Heath (1981), Billera, Heath, and Verrecchia (1981), Brown and Sibley (1986, pp. 44–60), Tijs and Driessen (1986).

[45] See Billera and Heath (1982, p. 33) and Braeutigam (1980, p. 185), who discuss the economic consequences of different forms of common cost allocation in a regulatory context.

[46] For more details about these properties, see Billera and Heath (1982, pp. 33–34).

financial firms.[47] For instance, Valdez and Chernih (2003, p. 520)—with reference to cooperative game theory—propose the properties of "no undercut," "symmetry," and "consistency."[48] The alleged rationale for this again lies in cooperative game theory[49] where common costs are allocated to single players of a game in a way that gives the players no incentive to abandon that coalitional game.[50] However, this strand of capital allocation literature does not examine how the properties proposed are helpful in reaching the insurer's goals:[51] "prioritizing new capital budgeting projects," "deciding which lines of business to expand or to contract," and "fair assessment of performance of managers of various business units."

Furthermore, different performance measures—e.g., the EVA or the RORAC concept[52]—that have been proposed to evaluate business units use a variety of alternative definitions (e.g., concerning the hurdle rate or the risk adjustment). Under these measures, an earnings figure from a business segment is compared with the cost of capital assigned to this segment. Hence, a profitability ranking between different lines of business depends very heavily on the particular performance measurement used and on the applied capital allocation method. Because there are so very many possible performance measures[53] and capital allocation methods,[54] it is possible to generate almost any profit ranking of business lines of a given insurance company.

In addition to the arbitrary profit ranking derived from capital allocation methods, we see another serious problem. Concerning the third point above, it is in general not possible to draw conclusions from a profitability ranking within a given risk and diversification context of the insurer with respect to a new firm structure. In simpler terms, cutting back on the (allegedly) most unprofitable line might, e.g., destroy a natural hedge[55] within the insurance company if the claims costs of the dismissed line were negatively correlated with the claims of the rest of the company. Then, in order to reestablish the desired safety level, the company might be forced to buy expensive risk management measures that reduce its overall profitability.

The proper and straightforward way to make capital budgeting decisions for lines of business is to directly evaluate whether and to what extent expanding or contracting

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[47] See, e.g., Matten (2000), Denault (2001), Myers and Read (2001), Fischer (2003), Valdez and Chernih (2003), Tsanakas and Barnett (2003), Laeven and Goovaerts (2004), and Tsanakas (2004).

[48] An explicit explanation of these properties is omitted here since it is not important for our line of reasoning.

[49] See Shapley (1971), and Aumann and Shapley (1974).

[50] In this sense, e.g., Tsanakas (2004, p. 228) derives capital allocation methods that "do not produce an incentive for any subportfolio to leave the pool."

[51] See Valdez and Chernih (2003, p. 518).

[52] EVA stands for economic value added. It is defined as the difference between the (expected) earnings of a business unit and the allocated cost of (equity) capital. The cost of equity capital is given by the product of allocated equity capital and the so-called hurdle rate. RORAC stands for return on risk-adjusted capital and is defined as the quotient of earnings of a business unit and the (risk-adjusted) allocated equity capital. RORAC should thus exceed the hurdle rate. For more details, see Matten (2000, pp. 241–244, 283).

[53] Matten (2000, pp. 146–148).

[54] Venter (2004, pp. 98–101).

[55] See Doherty (2000, pp. 270–278) for an example of this pitfall of decision making.

the business, or whether a different pricing policy, will lead to higher or lower profitability of the firm as a whole.[56] In a shareholder value maximization framework, different firm policies must be evaluated regarding their consequences for the shareholders. For instance, suppose that a firm decides to establish a new line of business. Following, in principle, Equations (12) and (13) from the previous section, the new line of business yields an increase of shareholder value if the net present value (NPV) of the cash flow to the shareholders is higher in the new situation (NPV^{new}) than in the initial situation (NPV^{old}):[57]

$$
\underbrace{PV(\max\{E_0^{\mathrm{old}} + E_0^{\mathrm{new}} + P^{\mathrm{old}} + P^{\mathrm{new}})(1+r) - L_1^{\mathrm{old}} - L_1^{\mathrm{new}}, 0\}) - PV(T^{\mathrm{old}} + T^{\mathrm{new}}) - E_0^{\mathrm{old}} - E_0^{\mathrm{new}}}_{NPV^{\mathrm{new}}}
$$

$$
> \underbrace{PV(\max\{(E_0^{\mathrm{old}} + P^{\mathrm{old}})(1+r) - L_1^{\mathrm{old}}, 0\}) - PV(T^{\mathrm{old}}) - E_0^{\mathrm{old}}}_{NPV^{\mathrm{old}}}.
$$

(14)

This procedure avoids the serious shortcomings and pitfalls of common cost allocation because all additional revenues and (frictional and nonfrictional) costs can be directly assigned to new firm policies to be evaluated (in this case the decision to establish a new line of business).

CONCLUSIONS

Myers and Read (2001), whose capital allocation method has been widely discussed in the academic literature, propose using their method for pricing insurance contracts. However, we could not find reasons for allocating equity capital back to lines of business for the purpose of pricing. This holds true for cases that do not integrate frictional costs and also when such costs are considered.

Capital allocation methods also aim to address issues other than pricing insurance contracts. A major field of application is performance measurement and capital budgeting decisions for lines of business. We explained the main difficulties an insurance firm runs into when using capital allocation models for capital budgeting decisions such as expanding or contracting certain business segments. Allocating equity capital to existing lines of business is done in order to allocate the costs of equity capital, but this procedure contains a central pitfall: this cost allocation is a common cost allocation because the equity capital of the insurer serves as safety capital for the whole company. In fact, *every* capital allocation method that distributes the cost of equity capital to the different lines *in the given structure of the company* is an arbitrary way of common cost allocation. The allocation of common costs—together with other serious problems of applying capital allocation and performance measurement for capital budgeting decisions that we discuss—typically leads to wrong decisions by an insurance company.

In different model settings or in regard to different economic questions, capital allocation methods may be quite sensible. For example, such methods may be especially

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[56] For this line of reasoning, see Turnbull (2000), and Venter (2004, p. 101).

[57] As before, *PV* denotes the present value, *E* stands for the equity capital, *P* for the premium income, *L* for the claims costs, *r* for the rate of return of the investment portfolio, and *T* for the tax payments.

useful in mitigating problems of information asymmetry between top and line management.[58] It would certainly be helpful if future discussions of capital allocation methods made it very clear to what end the methods were being applied and also set out specifically whether that particular purpose can, in fact, be achieved with the capital allocation method under investigation.

REFERENCES

Aumann, R. J., and L. S. Shapley, 1974, *Value of Non-Atomic Games* (Princeton, NJ: Princeton University Press).

Billera, L. J., and D. C. Heath, 1981, Allocation of Shared Costs: A Set of Axioms Yielding a Unique Procedure, *Mathematics of Operations Research*, 7: 32-39.

Billera, L. J., D. C. Heath, and R. E. Verrecchia, 1981, A Unique Procedure for Allocating Common Costs from a Production Process, *Journal of Accounting Research*, 19: 185-196.

Braeutigam, R. R., 1980, An Analysis of Fully Distributed Cost Pricing in Regulated Industries, *Bell Journal of Economics*, 11: 182-196.

Brown, S. J., and D. S. Sibley, 1986, *The Theory of Public Utility Pricing* (Cambridge: Cambridge University Press).

Butsic, R., 1994, Solvency Measurement for Property-Liability Risk-Based Capital Applications, *Journal of Risk and Insurance*, 61: 656-690.

Cummins, J. D., 2000, Allocation of Capital in the Insurance Industry, *Risk Management & Insurance Review*, 3: 7-27.

Cummins, J. D., Y. Lin, and R. D. Phillips, 2005, An Empirical Investigation of the Pricing of Financially Intermediated Risk with Costly External Finance, Working Paper, Georgia State University.

Denault, M., 2001, Coherent Allocation of Risk Capital, *Journal of Risk*, 4: 5-34.

Doherty, N. A., 2000, *Integrated Risk Management—Techniques and Strategies for Reducing Risk* (New York, NY: McGraw-Hill).

Doherty, N. A., and J. R. Garven, 1986, Price Regulation in Property-Liability Insurance: A Contingent-Claims Approach, *Journal of Finance*, 41: 1031-1050.

Dowd, K., 2002, *Measuring Market Risk* (West Sussex, UK: John Wiley and Sons, Ltd.).

Duffie, D., 2001, *Dynamic Asset Pricing Theory*, 3rd ed. (Princeton, NJ: Princeton University Press).

Dybvig, P. H., and S. A. Ross, 1986, Tax Clienteles and Asset Pricing, *Journal of Finance*, 41: 751-762.

Fischer, T., 2003, Risk Capital Allocation by Coherent Risk Measures Based on One-Sided Moments, *Insurance: Mathematics and Economics*, 32: 135-146.

Friedlaender, A. F., 1969, *The Dilemma of Freight Transport Regulation* (Washington DC: The Brookings Institution).

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[58] For references see footnote 25.

Gründl, H., and H. Schmeiser, 2002, Pricing Double Trigger Reinsurance Contracts: Financial versus Actuarial Approach, *Journal of Risk and Insurance*, 69: 449-468.

Harris, M., and A. Raviv, 1996, The Capital Budgeting Process: Incentives and Information, *Journal of Finance*, 51: 1139-1174.

Inderst, R., and C. Laux, 2005, Incentives in Internal Capital Markets: Capital Constraints, Competition, and Investment Opportunities, *RAND Journal of Economics*, 36: 215-228.

Jensen, M. C., 1986, Agency Costs of Free Cash Flow, Corporate Finance, and Takeovers, *American Economic Review*, 76: 323-329.

Kneuer, P. J., 2003, Review of "Capital Allocation for Insurance Companies, in: Stewart C. Myers, James R. Read Jr., eds., *The Casualty Actuarial Society Forum, Fall 2003 Edition*, Download (2005/07/26): www.casact.org/pubs/forum/03fforum/03fftoc.htm, 377-390.

Laeven, R. J., and M. J. Goovaerts, 2004, An Optimization Approach to the Dynamic Allocation of Economic Capital, *Insurance: Mathematics and Economics*, 35: 299-319.

Leland, H. E., 1985, Option Pricing and Replication with Transactions Costs, *Journal of Finance*, 40: 1283-1301.

Matten, C., 2000, *Managing Bank Capital—Capital Allocation and Performance Measurement*, 2nd ed. (West Sussex, UK: John Wiley and Sons, Ltd.).

Merton, R. C., and A. F. Perold, 1993, Theory of Risk Capital in Financial Firms, *Journal of Applied Corporate Finance*, 6(3): 16-32.

Meyers, G. G., 2003, The Economics of Capital Allocation, in: *The Casualty Actuarial Society Forum, Fall 2003 Edition*, Download (2005/07/26): www.casact.org/pubs/forum/03fforum/03fftoc.htm, 391-418.

Mildenhall, S. J., 2004, A Note on the Myers and Read Capital Allocation Formula, *North American Actuarial Journal*, 8(2): 32-44.

Myers, S. C., and J. A. Read Jr., 2001, Capital Allocation for Insurance Companies, *Journal of Risk and Insurance*, 68: 545-580.

Perold, A. F., 2001, Capital Allocation in Financial Firms, Working Paper No. 98-072, Harvard Business School.

Phillips, R. D., J. D. Cummins, and F. Allen, 1998, Financial Pricing of Insurance in the Multiple Line Insurance Company, *Journal of Risk and Insurance*, 65: 597-636.

Ross, S. A., 1987, Arbitrage and Martingales with Taxation, *Journal of Political Economy*, 95: 371-393.

Ruhm, D. L., and D. E. Mango, 2003, A Method of Implementing Myers-Read Capital Allocation in Simulation, in: *The Casualty Actuarial Society Forum, Fall 2003 Edition*, Download (2005/07/26): www.casact.org/pubs/forum/03fforum/03fftoc.htm, 451-458.

Schaefer, S. M., 1982, Taxes and Security Market Equilibrium, in: W. F. Sharpe and C. M. Cootner, eds., *Financial Economics: Essays in Honor of Paul H. Cootner* (Englewood Cliffs, NJ: Prentice Hall), 159-178.

Scharfstein, D. S., and J. C. Stein, 2000, The Dark Side of Internal Capital Markets: Divisional Rent-Seeking and Inefficient Investment, *Journal of Finance*, 55: 2537-2564.

Shapley, L. S., 1971, Cores of Convex Games, *International Journal of Game Theory*, 1: 11-26.

Stoughton, N. M., and J. Zechner, 2004, Optimal Capital Allocation in Banking, Working Paper, University of Vienna. Download (2005/07/26): http://www.bwl.univie.ac.at/bwl/fiwi3/members/zechner/publications/raroc.pdf.

Tijs, S. H., and T. S. Driessen, 1986, Game Theory and Cost Allocation Problems, *Management Science*, 32: 1015-1028.

Tsanakas, A., 2004, Dynamic Capital Allocation with Distortion Risk Measures, *Insurance: Mathematics and Economics*, 35: 223-243.

Tsanakas, A., and C. Barnett, 2003, Risk Capital Allocation and Cooperative Pricing of Insurance Liabilities, *Insurance: Mathematics and Economics*, 33: 239-254.

Turnbull, S. M., 2000, Capital Allocation and Risk Performance Measurement in a Financial Institution, *Financial Markets, Institutions and Instruments*, 9: 325-357.

Valdez, E. A., and A. Chernih, 2003, Wang's Capital Allocation Formula for Elliptically Contoured Distributions, *Insurance: Mathematics and Economics*, 33: 517-532.

Venter, G. G., 2003, Discussion of "Capital Allocation for Insurance Companies, in: Stewart C. Myers, James R. Read Jr., eds., *The Casualty Actuarial Society Forum, Fall 2003 Edition*, Download (2005/07/26): www.casact.org/pubs/forum/03fforum/03fftoc.htm, 459-478.

Venter, G. G., 2004, Capital Allocation Survey with Commentary, *North American Actuarial Journal*, 8(2): 96-107.

Vrieze, K. J., and P. J. Brehm, 2003, Review of "Capital Allocation for Insurance Companies" by Stewart C. Myers and James R. Read Jr.—Practical Considerations for Implementing the Myers-Read Model, in: *The Casualty Actuarial Society Forum, Fall 2003 Edition*, Download (2005/07/26): www.casact.org/pubs/forum/03fforum/03fftoc.htm, 479-491.

Winkler, R. L., G. M. Roodman, and R. R. Britney, 1972, The Determination of Partial Moments, *Management Science*, 19: 290-296.