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Research Report

Value-Based-Management in Non-Life Insurance

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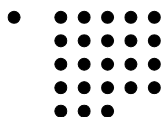
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Forschung am IVW Köln, 5/2013

Institut für Versicherungswesen

Value-Based-Management in Non-Life Insurance

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Zusammenfassung

Die klassische Form der Unternehmenssteuerung durch einfache Unternehmenskennziffern ist inzwischen fast überall durch wertorientierte Steuerungssysteme ersetzt worden, die Risiko und Rendite in sinnvoller Weise gegenüberstellen. In diesem Zusammenhang ist die korrekte Ermittlung des Kapitalbedarfs als dem relevanten Faktor zur Produktion von Versicherungsschutz unverzichtbar. Um hierbei die einzelnen Einflussgrößen adäquat separieren zu können, sollte eine adäquate Performancemessung vorgenommen werden.

Abstract

The classical way of steering a company by simple performance indicators has become increasingly substituted by value-based-management systems that combine risk and return in a reasonable manner. In this context, the precise determination of the capital requirement as the most relevant factor in producing insurance cover is inevitable. In order to separate the different influences suitably, an adequate performance measurement should be carried out.

Foreword

The classical way of steering a company by simple performance indicators has become increasingly substituted by value-based-management systems that combine risk and return in a reasonable manner. In this context, the precise determination of the capital requirement as the most relevant factor in producing insurance cover is inevitable. In order to separate the different influences suitably, an adequate performance measurement should be carried out.

Internal models in non-life insurance usually focus on the stochastic economic capital after one year in order to determine the capital required. In life insurance, the Market Consistent Embedded Value is believed to define a suitable concept for an economic entity value. In non-life insurance, this concept also works quite well as an alternative fair value approach.

This paper has been produced as a result of a long term project that has been initialized and executed by myself together with the other editors with further participation and contribution of

Stefan Arens
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Anna Naumova
Anne Neu
Jan Poll
Ivana Simic
Christoph Wiebe

The target of this project was to introduce the topic “Value Based Management in Non-life Insurance” step by step to as many people as possible enabling a profound understanding without requiring too much mathematical knowledge. Therefore, lots of examples have been developed, which are not only as simple as possible, but also as complex as necessary.

This project would not have succeeded, if it had not been supported by so many involved parties. Especially, the engagement of the co-editors of this publication has to be pointed out in this context.

Furthermore, we would like to thank Mr. Robert G. Price for his careful revision of the original English document.

Cologne, March 2013

Maria Heep-Altiner

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1 Introduction to Value-based Management

The concept of value-based management (VBM) arose from the fact, that at the end of the last century companies were becoming more and more complex. Managers started to consider the capital used for investments as well as the capital costs. Alfred Rappaport is regarded as one of the co-founders of value-based management. His classic book "Creating Shareholder Value", which set corporate strategy in relation to the shareholder value, was published in 1986. Nowadays, this management approach is defined as follows:

"Value-based management is an approach to management whereby the company's overall aspirations, analytical techniques, and management processes are aligned to help the company maximize its value by focusing management decision-making on the key drivers of shareholder value."¹

The focus of VBM is on the **shareholder** value. We have to bear in mind that this is a one-sided approach, which does not consider the perspective of other **stakeholders**.

Important for a value-based management approach is the rate of return, demanded by the shareholders from the insurance company. Due to several risks which influence the shareholder value, an effective value-based management always includes a comparison of risk and the generated value.

The answers to the following questions provide the basis for a successful value-based approach:

- How can risks and values be defined, measured and compared?
- Which parameters and techniques increase the shareholder value?
- Do the shareholders get a risk adjusted rate of return for their capital?
- Does the rate of return exceed the capital costs?

On the basis of those aspects the management of an insurance company has to decide, how to steer the business according to a value-based approach:

- Regarding new business → premium calculation (premium risk).
- Regarding existing business → reserve setting (reserve risk).

¹Scarlett 2001, Value Based Management, p. 2.

Before focusing on the different aspects of value-based management in the following chapters, it is necessary to understand the insurance business model. In the basic construction of insurance business we find the reasons not only for the profitability of the business model but also for the difficulties with respect to other business models.

1.1 Business Model of Insurance Production

For a good understanding of the business model of insurance the differences between insurance and a typical consumer good (e.g. cars) should be outlined. In the following figure the differences regarding production and sale in connection with the allocation of risks are shown.

	Production	Sale
Consumer Good	Pre Sale Transparency of production, costs are almost certain. → relatively small risk	Post Production Volume of sales is ambiguous. → relatively high risk
Insurance Cover	Post Sale No transparency of production, production costs are ambiguous (amount and date of payment). → relatively high risk	Pre Production Volume of sales is known, possibly minimal volume needed. → relatively small risk

Figure 1: Insurance Cover versus a Typical Consumer Good

If you consider a typical material good (e.g. a car), the production has to be finished before it can be purchased. The costs of production are covered by the producer of the good and have already been paid before the car goes on sale. So there is a risk of sale, which implies the possibility that the producer cannot sell the cars he has produced for the price that covers the production costs.

In contrast an insurance product is an immaterial good, which is produced after the contract has been signed.

If during an agreed period of insurance, a specified uncertain event occurs, the insured person will be indemnified by the insurer for the financial loss.² Because

²Carter; Lucas; Ralph 2000, Reinsurance, p. 3.

there is no visible production of insurance and the only physical item the consumer receives is the policy, the achievements of insurance cover very often seem quite nontransparent. Those aspects especially imply that neither the policyholder nor the insurer knows

- whether the insured event will occur,
- when it will occur and
- how (and to which extent) it will occur.

As a result of this uncertainty it is difficult to calculate the claims payments and to determine the premium. Due to the risk transfer between the insured person and the insurance company the insurer needs an estimation of the expected claims and their distribution over time. Because claims often occur after a time lag, the insurer has to establish a **reserve**. The accounting is performed on an accrual basis.

The premium in non-life insurance is normally paid for a period of one year and is charged directly or within a short period after the insurance contract has been signed or renewed.

All in all the premiums have to cover the costs of the insurance company, which can be divided into three types:

- **Acquisition costs** (at the beginning of the contract),
- **administration costs** (during the contract) and
- **claims payments** (after a time lag - sometimes of several periods).

So the underwriting of insurance includes the risk that the premium could be calculated too low to cover the costs and claims payments over time. This uncertainty is called **underwriting risk**.

To cover the underwriting risk, the insurer needs financial supply: on the one hand by the premiums of the insured, on the other hand by additional capital supply. To summarize:

The amount and point in time of future claims payments are uncertain and have to be secured by capital. So capital is the most important production factor of insurance production.

In the following, the roles of insured persons and capital suppliers in order to finance insurance cover are described:

Capital Supplier

- Supplies capital to secure the insurance risks.
- May lose capital.
- May demand an adequate **extra dividend**.

Insured

- Finances the expected claims amount.
- Finances the costs of the collective.
- Finances the adequate extra dividend.

For the insurer it is important to consider the interests of the capital suppliers as well as the interests of the insured persons. The insured expects to be well protected against financial disadvantages and the capital supplier requires a risk-adequate interest rate.

If a single person had to keep the capital for the expected claims by him- or herself, this amount would be very high. How insurance can be a substitution of required capital is shown in the next section by a calculation example.

1.1.1 Capital Efficiency due to Synergy

In which way a collective system of risk transfer affects the required capital from each member to cover his or her risk is shown in the following. In this context it is important to understand the effects of synergy.

For example, let us imagine that every consumer would have to protect a claims experience with an expected value (EV) of 500 and a **standard deviation** (STD) of 10,000 with a security level of 99.5% in an obligatory manner.

If all risks are assumed to be independent from each other and normally distributed than the required capital (RC) per person with respect to a 99.5% Value at Risk (**VaR_{99.5%}**) results as follows:

<u>For N persons:</u>	RC per person	$= \text{VaR}_{99.5\%, N} - \text{EV}_N$ $= 2.5758 \cdot \text{STD}_N$ $= 2.5758 \cdot 10,000 / N^{0.5}$
<u>For one person:</u>	RC per person	$= \text{VaR}_{99.5\%, 1} - \text{EV}_1$ $= 2.5758 \cdot \text{STD}_1$ $= 2.5758 \cdot 10,000 = 25,758.$

In the case of a single person, the assumption of a normally distributed claims experience is quite unrealistic because of the high probability of negative values. Thus we have to keep in mind that the example is only a very rough approximation until we reach a high number of (independent) risks e.g. $N = 10,000$. The results for several numbers of risks are illustrated in the following figure.

Number of Risks	Expected Value	Standard Deviation	Required Capital	Total
1	500	10,000	25,758	26,258
10	500	3,162	8,145	8,645
100	500	1,000	2,576	3,076
1,000	500	316	815	1,315
10,000	500	100	258	758
100,000	500	32	81	581
1,000,000	500	10	26	526

Figure 2: Efficiency due to Synergy (1)

The figure above shows the effect that under a capital perspective collectivization of risks is more efficient than bearing the risk by a single person. If we consider for example $N = 10,000$ persons, we obtain:

$$\text{RC per person} = 2.5758 \cdot 10,000 / 10,000^{0.5} = 258.$$

The example clarifies that you can never diversify the average (so that the total required capital never drops under 500), but you can diversify the standard deviation. The main reason for this effect is the non-proportionally increasing standard deviation with respect to the size of the collective. This effect will be denoted as synergy. The more independent risks a collective includes, the less capital will be needed per person for an overall protection at the desired risk level.

In this example every member of the collective has to provide the expected value of 500 and an extra capital in the amount of 258 – in total 758. In this case the assumption of normal distributed claims becomes realistic, see the next figure.

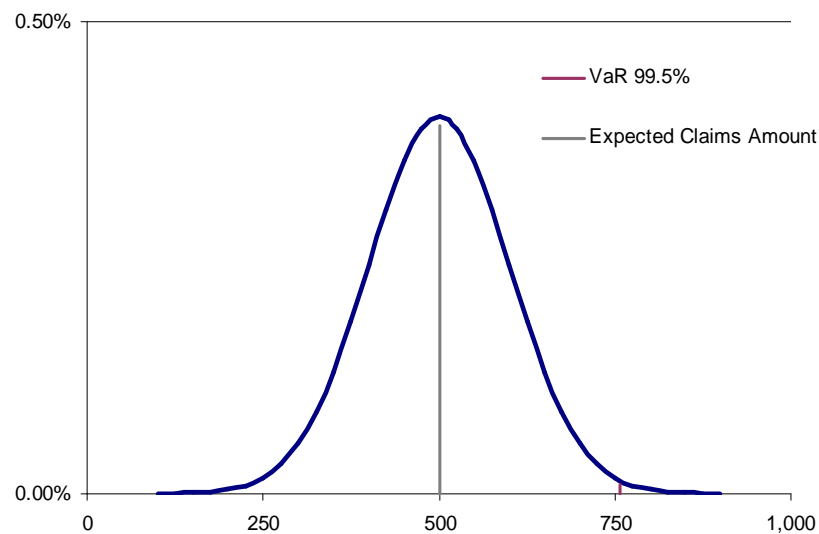


Figure 3: Distribution of the Claims Amount for N = 10,000

As it can be seen, you need a large number of risks for a high effect of synergy. Because the organization of such a big collective requires a high administrative effort, it seems to be almost impossible to manage this privately. Therefore, we will consequently focus on a professionally managed collective (e.g. an insurance company). Such a professionally managed collective (where the required capital will be provided by a capital supplier) involves the following advantages and disadvantages:

Advantages

- Capital efficiency.
- Efficient claims management.
- Minimal claims costs.

Disadvantages

- Acquisition and administration costs.
- Immaterial (nontransparent) good.
- Moral hazard (because insurance cover creates claims).

Considering a professionally managed collective, you have to add the costs for the company, which organizes the collective, and an extra dividend for the capital suppliers, who bear the insurance risk by capital supply. To give an example we assume the following additional information:

Acquisition and administration costs: 50% of the expected claims amount.

Extra dividend for the capital supplier: 6% of the required capital.

Given $N = 10,000$ risks this leads to the following premium equation:

$$\begin{aligned}
 \text{Premium} &= \text{Expected Claims Amount} \\
 &+ \text{Total Costs} \\
 &+ \text{Extra Dividend} \\
 &= 500 + 50\% \cdot 500 + 6\% \cdot 2.58 \cdot 10,000 / N^{0.5} \\
 &= 500 + 250 + 6\% \cdot 258 = 765.
 \end{aligned}$$

In the following figure the results for several numbers of risks are listed.

Number of Risks	Expected Value	Costs	Required Capital	Costs of Capital	Premium
1,000	500	250	815	49	799
10,000	500	250	258	15	765
100,000	500	250	81	5	755
1,000,000	500	250	26	2	752

Figure 4: Efficiency due to Synergy (2)

One insured person has to pay a premium of only 765 instead of providing a total amount of 26,258 all on his own (see the first example).

As a result, under the same cost conditions the premium decreases with the increasing size of the collective due to the synergy effect. This example illustrates that insurance can be interpreted as capital substitution for the insured.

1.1.2 Risk Mitigation by Reinsurance

Even after consideration of the synergy effect specified before the risk portfolio of an insurer, there is still a **probability of additional major losses**. The risks within the collective may be equalized over time, but the underwriting risk still exists. Reinsurance can be used as a further instrument of risk mitigation.

The relationship between insurer and reinsurer is similar to the one between insured and insurer. The primary insurer (cedent) transfers a probability distribution of losses to the reinsurer (cessionary).

Through this process, the cessionary supplies additional capital and the ceding company increases its underwriting capacity.

For covering the risk, the reinsurance company will demand a premium due to the fact that a total loss is possible. Similar to the premium calculation for the insured, the premium for the first insurer includes the financing of expected claims, costs of managing the collective and the required extra dividend.

By placing reinsurance contracts, the ceding company saves required capital and capital costs. Buying reinsurance is efficient, if the return on net required capital is higher than the return on gross required capital.

1.1.3 Additional Synergy due to Investment

The insurer has the possibility to invest the liquidity resulting from in- and outflows of an insurance contract in the capital markets³ in order to earn interests.

Besides risk underwriting, asset management is therefore also an important field of activity for insurance companies. The synergy between risk underwriting and asset management defines another type of risk mitigation.

The figure below shows the different in- and outflows of a non-life insurance contract for a single accident year.

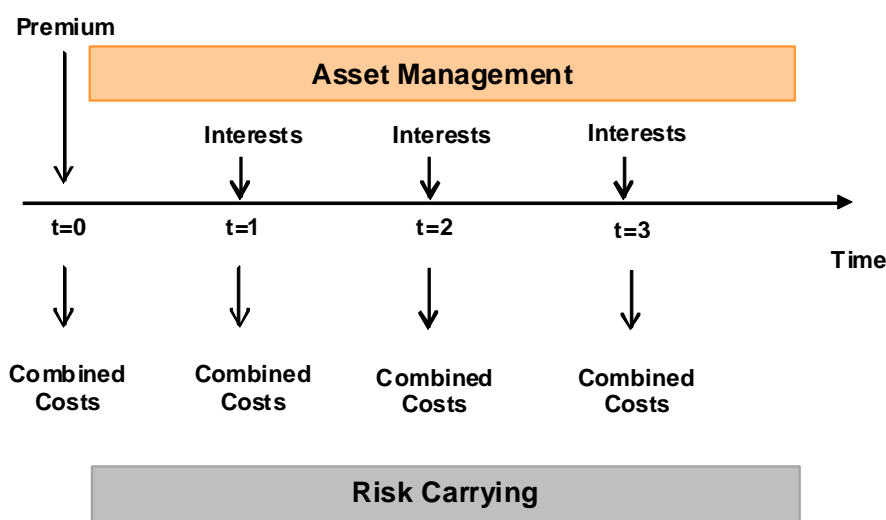


Figure 5: In- and Outflow of an Insurance Contract

The first insurer collects the premium and pays the administration costs at the beginning of the contract. On the other hand, combined costs⁴ that arise from carrying the risk are spread over time (see the figure above). Through the asset management, the insurer can invest money into assets until liquidity is needed for claims payments. So it is possible to obtain some extra income by clever asset management.

There are some restrictions to the asset types for insurance companies which have to be taken into account because assets also create an additional risk for the insurer. But if the asset risks are not highly correlated to the underwriting risks, it constitutes a risk synergy effect and an additional risk diversification can be achieved.

³Under the assumption, that the insurance contract generates a positive result.

⁴Combined Costs = Acquisition Costs + Administration Costs + Claims Payments.

1.1.4 Legal Framework

To protect the insured persons and policyholders, authorities world-wide control the solvency of insurance companies. Solvency means that the risks are covered with a sufficient amount of capital to meet the policyholder liabilities.

In the European Union the concept of value-based management started more or less with the upcoming of Solvency II. Prior to that, the concept of risk was not well developed and insurers used steering parameters such as volume, profit or premium that had no relation to the underlying risk. Solvency II is a new approach in considering the individual risk within an insurance company. The Solvency II approach covers three pillars similar to the approach for the bank sector (Basel II⁵) but has been adapted for insurance companies.

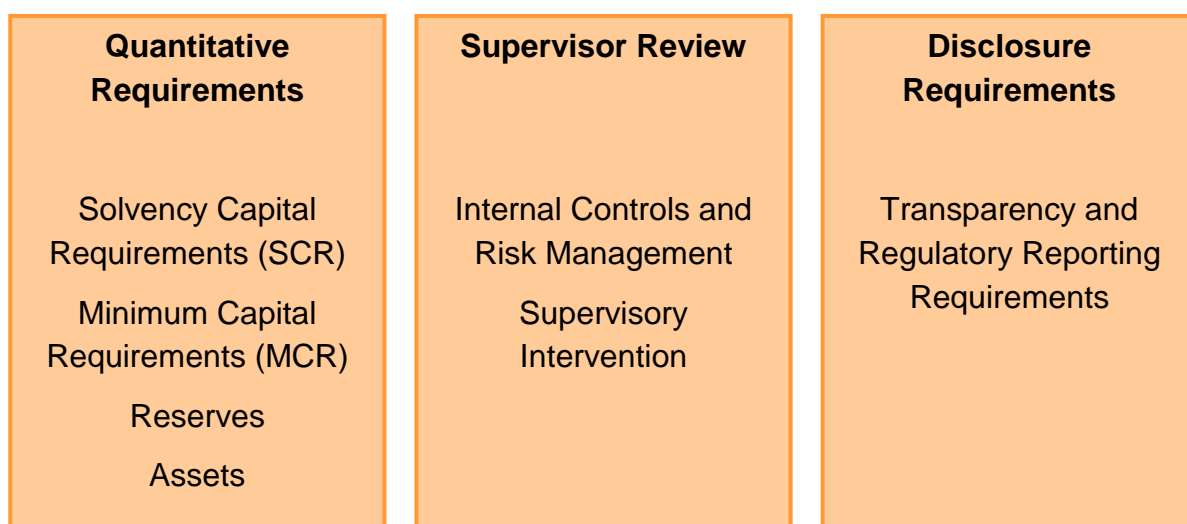


Figure 6: Three Pillar Approach according to Solvency II

The first pillar includes the quantitative requirements for the capital requirement and the models of risk calculation. European insurance companies have to calculate the Minimum Capital Requirement (**MCR**) and Solvency Capital Requirement (**SCR**) which consider the current risk situation and which have to be observed by the company.⁶

The examination by the European authorities is ruled by the qualitative requirements of the second pillar. The third pillar covers the reporting and transparency obligations.

⁵Current standard for European bank regulation.

⁶Altenähr; Nguyen; Romeike 2009, Risikomanagement kompakt, p.11.

1.2 Value and Risk-based Models

To implement a value-based management, special models are needed to measure risk and value. As a consequence, the management of an insurance company can derive decisions from the current value and risk situation.

1.2.1 Traditional Steering Parameter

Traditional steering parameters are often based on the balance sheet information of an insurance company that is publicly available. Examples for steering indices are (net) profit and its relation to volume. Others are premium volume, cost ratio and combined ratio.

But all these traditional steering parameters normally disregard the underlying risk of an insurance undertaking. Because of the fact, that the consideration of risk is basic for a value-based approach, new risk based steering parameters must be implied.

1.2.2 Risk-based Steering Parameter

The focus of value-based management is a sufficient risk analysis, as it helps to assess the solvency of an insurance company and to increase the shareholder value. In the following, modern and well known metrics for a risk-based performance evaluation are introduced.

Return on Risk Adjusted Capital (RORAC)

As an alternative to the traditional Return on Equity (ROE), RORAC is a risk adjusted steering parameter where the following relation holds:

$$\text{RORAC} = \text{Return} / \text{Required Capital}.$$

The RORAC shows the relation between return and the required capital and is important for risk adjusted performance measuring. To consider the risk, the economic return is favored in comparison to the return based on book values (e.g. the German GAAP return). If the insurer increases risk without changing the profit situation, the RORAC decreases because more capital is required.

Economic Value Added (EVA⁷)

Another risk adjusted steering parameter is the Economic Value Added where the following relation holds:

$$\begin{aligned}\text{EVA} &= \text{Return} - \text{Cost of Capital} \\ &= \text{Return} - \text{Required Capital} \cdot \text{CoC Ratio}.\end{aligned}$$

The EVA as an absolute number shows the return of a business line minus costs of capital. A positive number implies an added value whereas a negative EVA shows a value destruction. The costs of capital are the product of capital required and the cost of capital ratio. The cost of capital ratio is the extra dividend ratio the investor demands and is influenced by external and internal effects. If the risk increases without changing the profit situation, more capital will be needed and the EVA will decrease. If the return is smaller than the required capital costs, the EVA will become negative and the business unprofitable. This is somewhat crucial if the CoC ratio is chosen artificially high.

Risk Adjusted Return on Capital (RAROC)

A further risk adjusted parameter is the Risk Adjusted Return on Capital where the following relation holds:

$$\text{RAROC} = \text{EVA} / \text{Available Capital}.$$

To calculate the RAROC the required capital and a model of capital costs are needed. The RAROC is an index without dimension whereas the EVA is an absolute number.

1.2.3 Required Capital versus Available Capital

The task of value-based management is to compare the available and required capital. In a sufficient situation the available capital is equal to the required capital or even higher.

⁷ Stern Stewart & Co. has trademarked the abbreviation EVA.

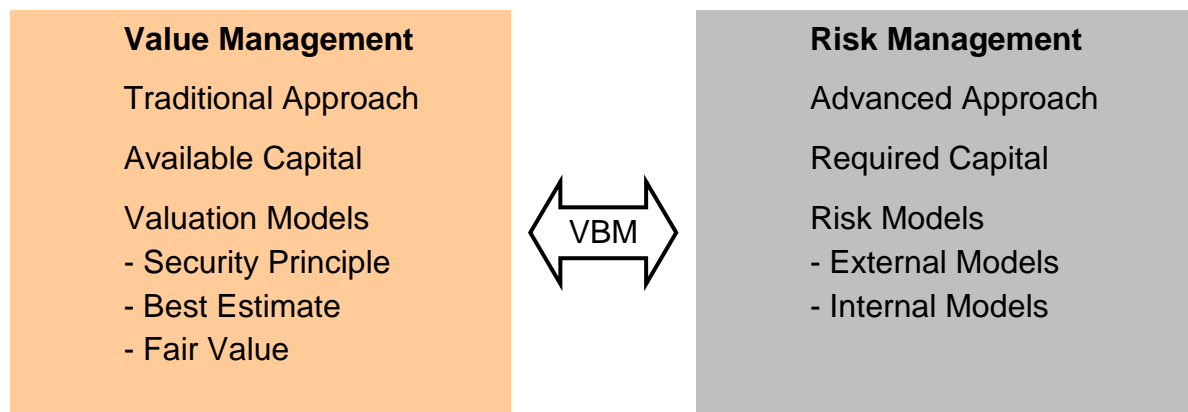


Figure 7: Value Management versus Risk Management

On the one hand, an evaluation of the available capital is needed to analyze the actual value. Thus valuation models like the security principle (e.g. German GAAP), best estimate (e.g. US GAAP and partly IFRS actual status) or fair value (e.g. IFRS final status) are used to determine the available capital. Those are quite traditional valuation approaches which do not consider any risks.

On the other hand, the required capital specifies the amount of capital which is needed to cover the risks taken by the insurance company. Within Solvency II context, the required capital is defined as the capital needed to protect the company at 99.5% security level. Risk models to determine the required capital are described in the next chapter.

If the amount of available capital is lower than required capital, the underwriting of new business will not be possible in the same way as before. In such a case, the insurer can undertake the following options to continue business:

Reduction of risk

The risk of a gross portfolio can be reduced by different techniques which are described below:

Decrease of Volume

The risk volume can be decreased through cancellation of contracts or products, through risk exclusion or through limit (sum insured) decrease. But less volume may lead to less profit.

Increase of Premiums

If possible, increasing the premium is the best solution to increasing the available capital. Although the volume remains the same, the capital and profit situation is improved. But market competition has to be taken into account.

Change of Risk Structure

In order to improve the risk structure, the insurer can check its risk portfolio and make changes to the underwriting. In the example mentioned above, the standard deviation was 10,000 but if it is possible to reduce this to 8,000 by risk-adjusted underwriting, the portfolio size remains the same but becomes less of a risk for the insurer.

Purchase of reinsurance

Reinsurance reduces the risk, but it affects the profit-situation. This will be analyzed in more detail in the next chapter.

Increase of capital

The last option is injection of new capital from the shareholders but this reduces the profit situation.

The first insurer has to develop and improve methods for measuring risk and capital, which is necessary to secure the risk correctly. The return should be adequate to a special risk structure. For the evaluation of available capital the balance sheet capital (e.g. German GAAP or IFRS) or the (virtual) economic capital (Embedded Value in life insurance, shareholder's net asset value in non-life insurance) can be used.

2 Required Capital

The profit and loss situation for insurance companies fluctuates from year to year on the basis of risks caused by random fluctuations, errors and changes. If those risks occur significantly – considerably higher claims payments than expected, errors in the calculation of premiums, changes in external influences (e.g. judicial decisions, price levels) – then the previously collected premiums are insufficient and a considerable loss arises. If the claims (and administration) payments are higher than the premiums in such years, the exaggeration of loss must be covered by the insurer's capital. The greater a company's capital, the lower the danger of insolvency and therefore the higher the probability of a lasting guarantee of given performance promises. This is economically desirable, because insolvency of an insurance company has an impact on the whole economy. As the supply of capital requires costs, insurers try to determine the (minimal) amount of capital which is appropriate according to the risk. Thus – as already mentioned in the previous chapter – the required capital is very important for the value based management of an insurer.

To determine the required capital, there are several approaches. These approaches can be divided into

- external models and
- internal models.

In some countries, such as Switzerland and the United States, internal models are not authorized by the government. In the EU both models are permitted within the framework of Solvency II regulations.

The following will explain the differences between external and internal models for determining the required capital. The external models are only outlined briefly, whereas focus will be placed upon the internal models as these have at least the same requirements as the external models. Furthermore, internal models are more adequate for corporate management. The section about the internal models will be divided into the three sub-chapters:

- Basic approach,
- stochastic profit & loss account and
- required capital

After explaining the basic approach for the internal models, the individual components of a stochastic profit & loss account will be clarified. On this basis, the method of determining the required capital will be illustrated.

2.1 External Models

As mentioned above, external models provide a more simplistic view of the risk situation than internal models, because they are characterised by closed formulas and simplified bottom-up-approaches are usually factor models.

Bottom-Up-Approach in this context implies that the capital requirement must be determined separately first for each category of risk. Afterwards, the capital requirements from the individual risk categories are aggregated to an overall capital requirement.

Based on a specific time horizon, **factor models** compare the available capital with the required capital resulting from the insurance company's risk position. The disadvantage of a factor model is that it does not describe any qualitative connections. Thus no statements can be made about the insurance company's actual position in relation to risk. External models can be divided into:

- solvency models (as the Solvency II model) and
- rating models (as the Standard & Poor model – S&P model)

Rating models for instance are relatively similar to the solvency models in their calculation, but may not be used to determine the required capital. They only serve for rating purposes.

Solvency Models

Solvency models indicate solvability rules for capital adequacy of insurance companies. Besides the already mentioned Solvency II model, which applies to the insurance companies in the EU, there are other solvency models worldwide, such as the Swiss (Swiss Solvency Test) and the US-American (RBC standards) solvency model.

To regulate capital resources, Solvency II, for example, uses a two-stage approach which consists of a Solvency Capital Requirement (stage 1) and a Minimum Capital Requirement (stage 2).

The Solvency Capital Requirement (SCR) corresponds with the capital which the insurance company should have at its disposal in order to have a high probability (at least 99.5%) of not being technically ruined by the losses occurring during the

following period of one year. The Minimum Capital Requirement (MCR) reflects the provision of a minimal level of the insurance company's own funds and corresponds with the amount of capital, below which the continuance of the insurance business can be endangered. A breach of the Minimum Capital Requirement leads to serious measures, which can culminate in a withdrawal of the business license.

The amount ordinarily required to be maintained by the insurance company corresponds to the Solvency Capital Requirement (target capital). According to Solvency II, this may be determined either by a uniform so called "Standard Formula" as an external solvency model or by an internal model which will be explained in later sections.⁸

For a sufficient capitalization an insurance company must have at its disposal available capital of at least the same amount as required capital, i.e.

$$\text{Available Capital} / \text{Required Capital} \geq 100 \%.$$

Concerning the model structure, solvency models have changed over time but there are four main risk categories that determine the general model framework.

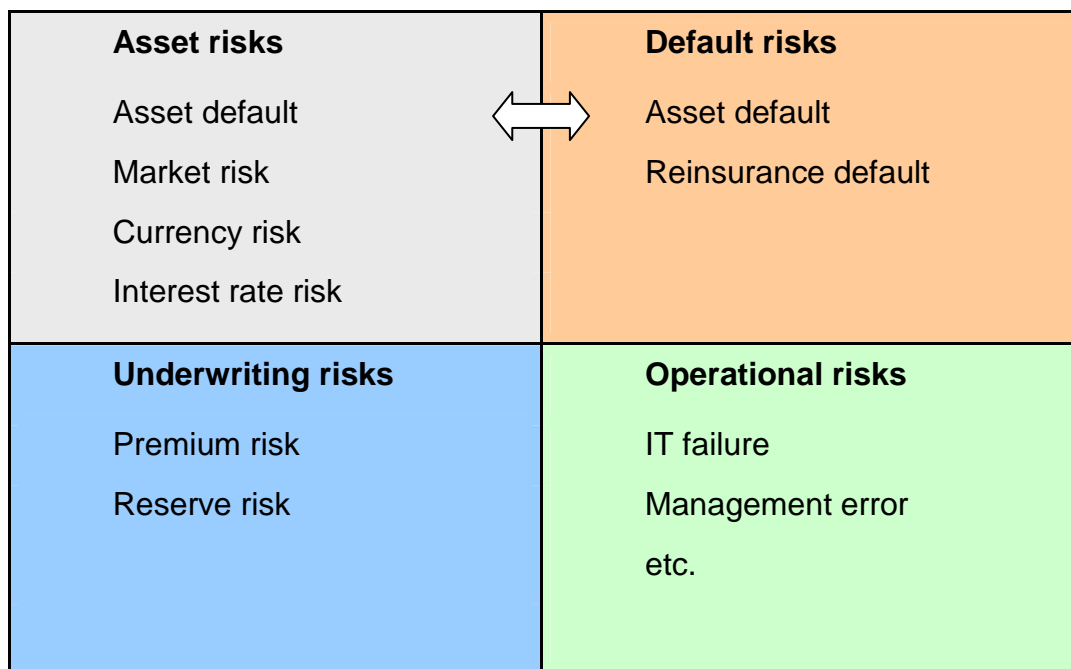


Figure 8: Risk Categories for Solvency Models⁹

⁸Heep-Altiner a.o. (2010), p. 8-11; Heep-Altiner a.o. (2011), p. 5-9.

⁹Heep-Altiner a.o. (2010), p. 12.

The table above illustrates the four main risk categories covered by solvency models (and that must be covered by all other models at least) which will be explained in the following.

Asset Risks

Asset risks are subdivided into special subcategories, e.g. asset default, market risk, (foreign) currency risk and interest rate risk. The asset default can also be categorized as default risk.

Default Risks

In principle those risks include the default of assets as well as the default of reinsurance (regarded as an asset), but within the framework of solvency models the asset default risk has been classified as an asset risk. In order to reduce the risk of reinsurance default, a minimum rating should be required with respect to the reinsurer chosen.

Underwriting Risks

Underwriting risks are divided into premium risk and reserve risk. The premium risk is limited exclusively to incorrectly calculated premiums or unusually high losses from new business. The reserve risk is the risk that the reserves for outstanding claims of the existing business are too low. An underwriting loss therefore arises, if the calculated premium or the accrued reserves are lower than needed.

Operational Risks

Operational risks are not originally insurance-specific risks. They include all operating risks which can cause losses in a business. For example, management errors or the failure of administrative systems belong to this category.

For each group of risks considered, a separate capital requirement is calculated. The individual capital requirements are aggregated to obtain the total capital requirement where different correlations are taken into account. The aggregation of the individual risks can be distinguished conceptually between two assumptions:

1. The risks R_1, \dots, R_k with the capital requirements C_1, \dots, C_k are assumed to be fully dependent on each other as well as on the residual risk.
2. The risks R_{k+1}, \dots, R_n with the capital requirements C_{k+1}, \dots, C_n are assumed to be correlated with the correlations ρ_{ij} .

In summary the following general aggregation formula can be established:

$$C_{\text{total}} = C_1 + \dots + C_k + (\sum_{i>k} C_i^2 + \sum_{i,j>k} \rho_{ij} \cdot C_i \cdot C_j)^{1/2}$$

This aggregation rule shall be illustrated in the following example for an insurance company with the following values:

Operational Risk	(OR)	100.0,
Underwriting Risk	(UW)	400.0,
Asset Risk	(A)	300.0.

The capital requirements due to underwriting risk and asset risk are considered to be totally independent where the following assumptions hold with respect to the capital requirements due to operational risk:

<u>Totally Independent OR:</u>	$C_{\text{total}} = [C_{\text{UW}}^2 + C_{\text{A}}^2 + C_{\text{OR}}^2]^{1/2}$ $= [400.0^2 + 300.0^2 + 100.0^2]^{1/2}$ $= 509.9$
<u>Fully Dependent OR:</u>	$C_{\text{total}} = [C_{\text{UW}}^2 + C_{\text{A}}^2]^{1/2} + C_{\text{OR}}$ $= [400.0^2 + 300.0^2]^{1/2} + 100.0$ $= 600.0$

This example shows how much influence the dependence structure has upon the determination of the capital requirement. The capital requirements of the subgroups are identical in both variants but their dependency is different. Thus different total capital requirements result.¹⁰

Rating Models

In the following, the rating models will be explained on the basis of the S&P model. The S&P model (like solvency models) is a factor model and also results from a bottom-up approach. Concerning the underwriting risk, this model represents a simple approach consisting of an entity factor, a premium factor and a reserve factor for the determination of the capital requirement. It is used for ratings purposes.

¹⁰Heep-Altiner a.o. (2010), p. 11-14; Heep-Altiner a.o. (2011), p. 7-11.

The **entity factor** depends on the level of security targeted at the individual company level. The following diagram shows the entity factors for the relevant rating categories according to S&P.¹¹

Rating Class	Entity Factor	Financial Security
AAA	Above 175 %	Outstanding
AA	150 % - 174 %	Excellent
A	125 % - 149 %	Very good
BBB	100 % - 124 %	Good

To obtain a stable S&P rating, a company should orient towards the higher limit of a range in the calculation of its capital resources. Thus, possible negative events can be absorbed without being downgraded to a lower rating. Accordingly, an entity factor of 125 % would indicate a stable BBB rating rather than an A rating.

The premium and reserve factors depend on the risk structure of a segment. These factors are provided as fixed values by S&P. The following describes the **capital allocation** system according to S&P:

$$\begin{aligned}
 RC(1) &= \text{Entity Factor} \cdot \text{Premium Factor} \cdot \text{Premium}, \\
 RC(2) &= \text{Entity Factor} \cdot \text{Reserve Factor} \cdot \text{Reserve at the Begin of Period 2}, \\
 &\dots \\
 RC(t) &= \text{Entity Factor} \cdot \text{Reserve Factor} \cdot \text{Reserve at the Begin of Period } t.
 \end{aligned}$$

At the beginning of the first period, the capital requirement is calculated by the multiplication of the entity factor with the premium factor for each segment and the premium (as volume measure). In the following periods, the multiplication takes place with the reserve factor and the residual reserve at the beginning of the new period (as volume measure) instead of the premium factor and the premium.¹²

2.2 Internal Models – Basic Approach

Within the Solvency II framework insurers can also establish their own internal models instead of using external models to determine their capital requirements in order to reflect their business risks which have been described in the previous

¹¹Heep-Altiner a.o. (2010), p. 56.

¹²Heep-Altiner a.o. (2010), p. 55-57.

chapter. They are allowed to use these internal models insofar as the respective internal models have been previously checked and certified by the supervisory authorities.

In contrast to solvency and rating models which start with the capital requirements due to the individual risks and aggregate those requirements to a total capital requirement (bottom-up approach) internal models establish the total capital requirement due to the company's risks and reallocate the required capital to the individual risk categories afterwards (top-down approach). The following relation should hold:

$$\text{Available Capital} - \text{Required Capital} \geq 0.$$

In contrast to external models, internal models are normally not factor models, but stochastic models, in which economic target functions such as capital, capital return or profit and loss account should be optimized. Subsequently, the profit and loss account should serve as an economic target function and thus the stochastic economic capital at the end of the period should be optimized. A stochastic profit and loss account will be obtained by the simulation of numerous possible profit and loss accounts for the end of the current period. From a solvency point of view there is a risk that a considerable loss occurs at the end of the period and that capital is needed to balance this.¹³

The starting point of the stochastic profit and loss account is the **deterministic capital** at the beginning of the period. This capital is not simulated. Usually the economic capital (EC) which is based on a fair value valuation of all assets and liabilities will be chosen in this context. Following this, deterministic capital is changed by the result of the stochastic profit and loss account and the **stochastic capital** at the end of the period is obtained in the following way:

$$\begin{array}{rcl} \text{Stochastic EC at } t = 1 & = & \text{Deterministic EC at } t = 0 \\ & + & \text{Technical Result} \\ & + & \text{Non-technical Result} \end{array}$$

The stochastic profit and loss account contains the ordinary profit and loss effects in relation to the technical and non-technical result, which have already been considered in the business' budget account, as well as the extraordinary profit and loss effects due to risks. Thus the non-technical result can be subdivided further into

¹³Heep-Altiner a.o. (2010), p. 15-16; Heep-Altiner a.o. (2011), p. 11-12.

- result due to assets,
- result due to extraordinary risks and
- result due to tax such as ordinary tax application and extraordinary tax depreciation.

In order to construct an internal model, we need the following “relevant components”:

- Fair value approach for the economic capital,
- ESG scenarios as external input parameters and
- Monte Carlo simulations as a technique for the stochastic model,¹⁴

where ESG denotes “Economic Scenario Generation”. In the next section, the fair value approach to evaluate the available capital is outlined.

Fair Value Approach

Internal models usually intend to evaluate assets and liabilities by their fair value. The fair value approach implies the measurement of a stochastic cash flow to establish a (sometimes virtual) market price. Relative to a fair value valuation, there are the following different approaches:

- Mark-to-Market Approach with
 - market values or
 - values of a replicating portfolio.
- Mark-to-Model Approach with
 - real world valuation,
 - risk neutral valuation or
 - cost of capital valuation.

According to the **mark-to-market approach**, the fair value results from a market value or – if there is no direct market value available – the value of a replicating

¹⁴Heep-Altiner a.o. (2010), p. 16-18; Heep-Altiner a.o. (2011), p. 12-15.

portfolio. A replicating portfolio is a market portfolio which has the same cash flows as the original portfolio and which is traded in “deep and liquid” markets.

Claims reserves in non-life insurance are neither traded on an active market nor reproduced by market values of traded securities, thus a **mark-to-model approach** must be established in order to produce a virtual transaction value.

Different techniques to establish a fair value according to a mark-to-model approach are explained below in a very simplified manner, whereby all three approaches should lead to the same result in theory. In practice differences result due to the parameters of the models, which are chosen differently.

Real World Valuation (Risk Adequate Discount)

In a real world valuation, the expected value of the cash flow is calculated due to the real probability measure P . The cash flows are discounted with a risk adequate discount rate (rdr), which is made up of the risk-free interest rate (rf) and an interest spread (s). For the valuation of a risky cash flow X concentrated at the duration D the following relationship is given:

$$FV_{RW}(X) = E_P[X] / (1 + rdr)^D = E_P[X] / (1 + rf \pm s)^D.$$

If we evaluate a risky asset cash flow the spread s is positive; if we evaluate a risky liability cash flow the spread s is negative.

In the following example, the fair value of an asset with two possible results (i.e. a higher and a lower value) is established with reference to a real world probability measure.

Higher value:	1,200	with (real) probability	60.0 %
Lower value:	700	with (real) probability	40.0 %
Risk free interest rate (rf):	4.0 %		
Risk spread (s):	4.1 %		
Risk discount rate (rdr):	8.1 %		
Duration (D):	1.0		
$E_P[X]$	$= 1,200 \cdot 60.0\% + 700 \cdot 40.0\% = 1,000$		
$FV_{RW}(X)$	$= 1,000 / 1.081 = 925$		

The example calculation is typical for the valuation of assets. By valuing liabilities, the risk spread should be subtracted from the risk-free interest rate, so that the risk discount rate can even be negative.

Risk Neutral Valuation (Equivalent Martingale Measure)

In the risk neutral valuation the real probability measure P is replaced by an equivalent martingale measure Q, such that the expected value due to the measure Q of the risky cash flow can be discounted with the risk-free rate instead of the risk adequate discount rate. Thus the application of a risk spread can be avoided, because the probability measure is changed in such a way that all cash flows deliver risk-free returns. For our simplified assumption the following relation holds:

$$FV_{RN}(X) = E_Q[X] / (1 + rf)^D.$$

Given risky asset cash flows the measure Q “puts” higher probabilities on low values; given risky liability cash flows the measure Q “puts” higher probabilities on high values.

Concerning the example of the asset with two possible results which was considered above, the following valuation approach (analogous to the previously established fair value on the basis of a real world valuation) is obtained:

Higher value:	1,200	with (risk neutral) probability	52.4 %
Lower value:	700	with (risk neutral) probability	47.6 %
Risk free interest rates (rf):	4.0 %		
Duration (D):	1.0		
$E_Q[X]$	$= 1,200 \cdot 52.4\% + 700 \cdot 47.6\% = 962$		
$FV_{RN}(X)$	$= 962 / 1.04 = 925$		

In the case of a liability, the equivalent martingale measure has the effect that the probability of the higher value is raised such that more weight is given to the higher value.

Cost of Capital Valuation (Transaction Value)

Analogous to the real world valuation, the determination of the transaction value is based on the real (simulated) probability measure. However, it is discounted with the risk-free interest rate. To take account of the risk, costs of capital (as a risk margin) are applied. Thus the following relationship is given:

$$FV_{CoC}(X) = E_P[X] / (1 + rf)^D \text{ --/+ CoC.}$$

The costs of capital have a reducing effect given risky asset cash flows and an increasing effect given risky liability cash flows. Because this approach reproduces a transaction mechanism, it is appropriate to commitments, whereby the problem lies in choosing the correct parameters.

If we consider again the example of the asset with both events, we obtain the following cost of capital approach:

Higher value:	1,200	with (real) probability	60.0 %
Lower value:	700	with (real) probability	40.0 %
Risk free interest rates (rf):	4.0 %		
Duration (D):	1.0		
$E_P[X]$	$= 1,200 \cdot 60.0\% + 700 \cdot 40.0\%$		$= 1,000$
$FV_{CoC}(X)$	$= 1,000 / 1.04 - 36$		$= 925$

Concerning the fair value valuation of liabilities by the aid of this cost of capital approach, the cost of capital margin is added to reflect the risk and not subtracted. It has to be noted that the real world approach and the risk neutral approach are normally used for establishing the fair value of risky asset cash flows. The cost of capital approach has gained acceptance for establishing the fair value of risky liability cash flows such as claims reserves.¹⁵

¹⁵Heep-Altiner a.o. (2011), p. 46-53.

Economic Scenarios

A further important field of application for simulations is the modelling of common external market parameters. These are required for the simulation of the fair value of assets and liabilities.

Assets (in contrast to liabilities) are influenced in particular by many external market parameters, as they depend heavily upon overall economic and financial development. It is therefore also necessary to integrate the stochastic development of the capital market into an internal model. In this case we speak of “economic scenario generation”. The following external market parameters should be included in such scenarios:

- Interest rate curves,
- share price indices,
- spreads for bond risks,
- currency exchange rates,
- developments in inflation and
- real estate indices.

These external market parameters can either be generated by simulations within the company’s own internal models or bought from external providers. In the latter case the data must only be included into the internal stochastic model.

The following example calculation gives an illustration. It evaluates the stochastic fair value of a risky zero bond on the basis of a market scenario given the following parameter:

<u>Deterministic FV at t = 0</u>	Nominal Value of the Zero Bond:	1,000.00
	Duration of the Zero Bond:	5
	risk-free Rate (deterministic)	4.0%
	Risk Spread (deterministic)	3.0%
	$FV_0 = 1,000 / (1 + 0.040 + 0.030)^5 = 712.99$	

<u>Stochastic FV at t = 1</u>	Nominal Value of the Zero Bond:	1,000.00
	Duration of the Zero Bond:	4
	risk-free Rate (stochastic → ESG)	6.0%
	Risk Spread (stochastic → ESG)	3.0%
	$FV_1 = 1,000 / (1 + 0.060 + 0.030)^4$	= 708.43
<u>Change in FV at t = 1</u>	$\Delta FV_1 = FV_1 - FV_0 = 708.33 - 712.99$	= - 4.56

In the example outlined, the stochastic fair value of the zero bond after the expiration of the period clearly results from the simulated risk-free interest rate and the simulated interest rate spread.¹⁶

Monte-Carlo Simulations

By the means of Monte-Carlo simulations, an empirical capital distribution at the end of the period can be generated by the simulated stochastic profit and loss account and the deterministic capital at the beginning. It is necessary that as many simulations as possible will be carried out in order to show extremely rare events. Exceptional circumstances, such as operational risks, which occur very rarely and whose consideration is extremely important due to solvency reasons, can only be shown accurately by a multitude of simulations.

The following figure illustrates possible developments towards the stochastic capital after one period (based on a deterministic capital of 500 at beginning) for five simulated paths.

¹⁶Heep-Altiner a.o. (2010), p. 66-68.

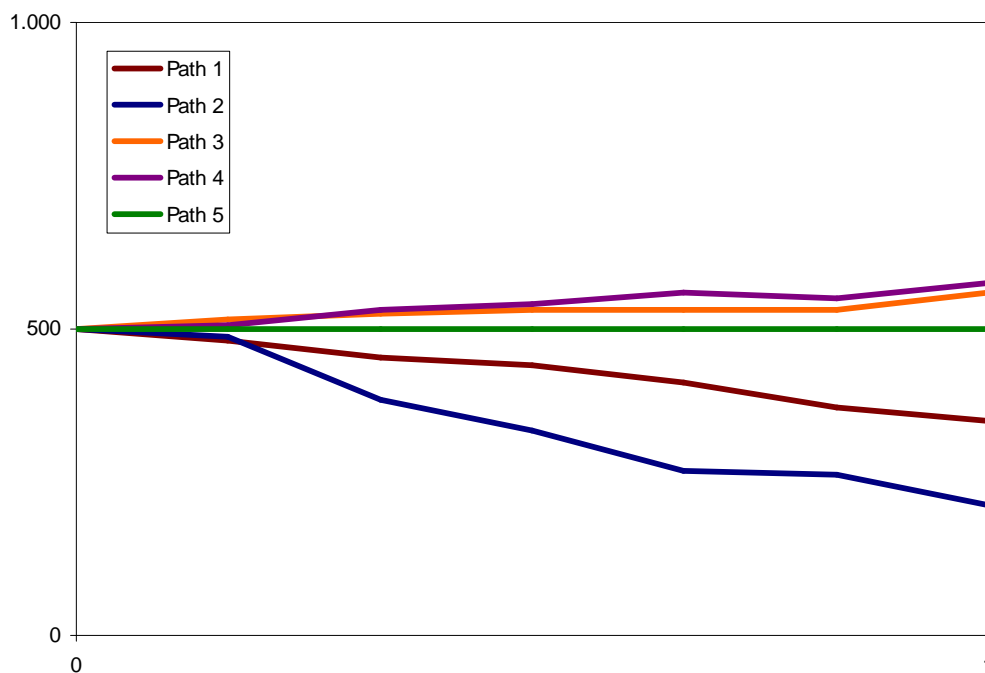


Figure 9: Capital after one Year for given Monte Carlo Simulations¹⁷

For approximating the distribution of the capital after one year as many Monte Carlo simulations of the stochastic profit and loss account have to be carried out as possible. Only then, can very rare events with a highly negative influence on the profit and loss account be considered.

After a sufficient large number of simulations, the majority of the simulations is distributed around the mean value. It can be observed that the distribution of the capital after one year is limited at the positive tail, because the maximal profit after one year is limited. On the other hand, relatively high claims payments may occur so that the distribution is relatively unlimited at the negative tail. As a consequence the distribution is normally left skewed.

From a solvency perspective, the focus lies on the negative tail of the distribution, where the cases are illustrated in which the capital approaches nil and the insurance company is threatened with insolvency. The scenarios in which the capital after one year is above the mean value are less diversified than the scenarios in which the capital is below the mean value.¹⁸

The structure of a capital distribution at the end of the period is illustrated in the following figure. This distribution of capital is typically left skewed. This means that the distribution is limited at the positive tail but runs out at a negative tail.

¹⁷ Heep-Altiner a.o. (2010), p. 63.

¹⁸ Heep-Altiner a.o. (2010), p. 62-64.

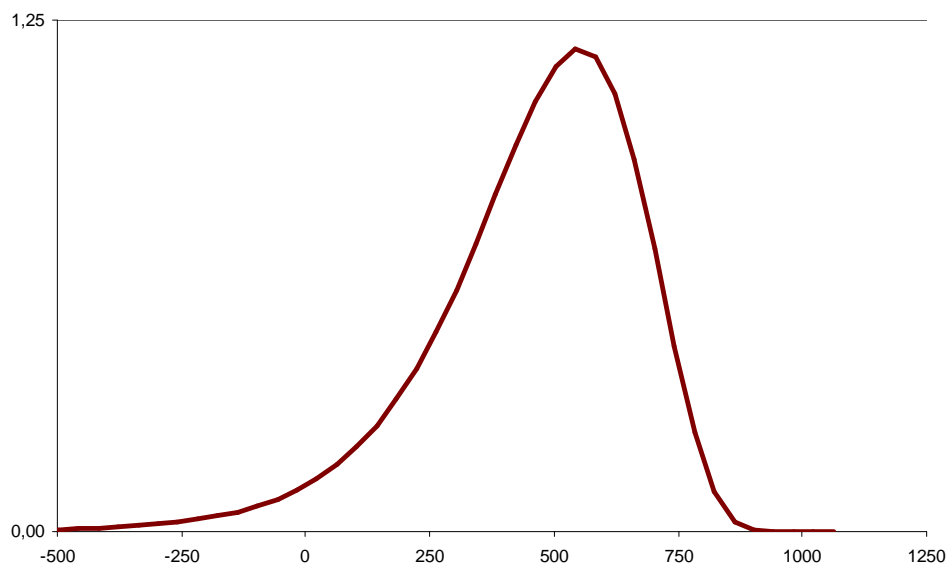


Figure 10: Distribution of the Capital after one Year¹⁹

The costs of modelling a capital distribution by an internal model are hardly justifiable on the basis of the solvency requirements. It is therefore recommendable to use the results for steering purposes, as the simulated distribution provides the following controlling information:

- Technical Ruin → defines the SCR at $t = 0$,
- Minimum Capital Required → defines the MCR at $t = 1$,
- Solvency Capital → defines the SCR at $t = 1$,
- Rating Capital → defines the RCR at $t = 1$.

Technical ruin occurs, if the capital at the end of the period falls below zero. Due to the Solvency II requirements the **capital** at the **beginning of the period** must be high enough such that technical ruin occurs only once in 200 years.

The **minimum capital required** at the **end of the period** defines the next steering level. If the capital at the end of the period falls below this level, this would imply ruin for the shareholder. Even if business activities were not prohibited, the supervisory authorities would take over the management of the business in this case. This would be the equivalent to an “expropriation” of the owner.

The next level is the **solvency capital** at the **end of the period**. If this level is not reached at the end of the period the supervisory authorities would contact the in-

¹⁹ Heep-Altiner a.o. (2010), p. 64.

insurance company and demand adequate actions to solve the problem by the end of the following period.

Another important focus is on securing the **rating capital** at the **end of the period**. The downgrading of a company's rating due to a decrease in capital at the end of the year can have the result that in the following year less business can be written and that the investment returns demanded by the shareholders cannot be not produced.

If (on the base of a simulation model) the probability of falling below an intended level is too high, the company should undertake appropriate management measures.²⁰

Because the minimum capital required, the solvency level, and the rating level have to be evaluated at $t = 1$ it is necessary to simulate the distribution also at $t = 2$ (or to proceed some type of approximation) in order to establish whether the level can be reached in the next period.

By checking the distribution above, it is obvious that the company does not comply with the solvency requirements at $t = 0$. This example will be discussed more intensively in the following sections.

2.3 Internal Models – Stochastic Profit & Loss Account²¹

In this section, we will focus in more detail on modeling different risks within a stochastic profit & loss (P&L) account. A short overview of the risk categories has already been given in the previous section. Concerning stochastic P&L account, there is a split between

- Technical Result (Underwriting Risk) and
- Non-technical Result with underlying
 - Asset Risk,
 - Reinsurance Default Risk,
 - Operational Risk and
 - Other Risks such as Extraordinary Tax Depreciation.

The stochastic P&L is necessary for the determination of the required capital by stochastic simulations. The most important component of the stochastic P & L is the

²⁰Heep-Altiner a.o. (2010), p. 64-66.

²¹ This chapter is a short summary of the chapters 3 to 5 from "Interne Modelle nach Solvency II", Heep-Altiner, Kaya, Krenzlin, Welter.

ordinary P&L due to the yearly business budget. An overview of how to model the underwriting and asset risks is shown in the figure below.

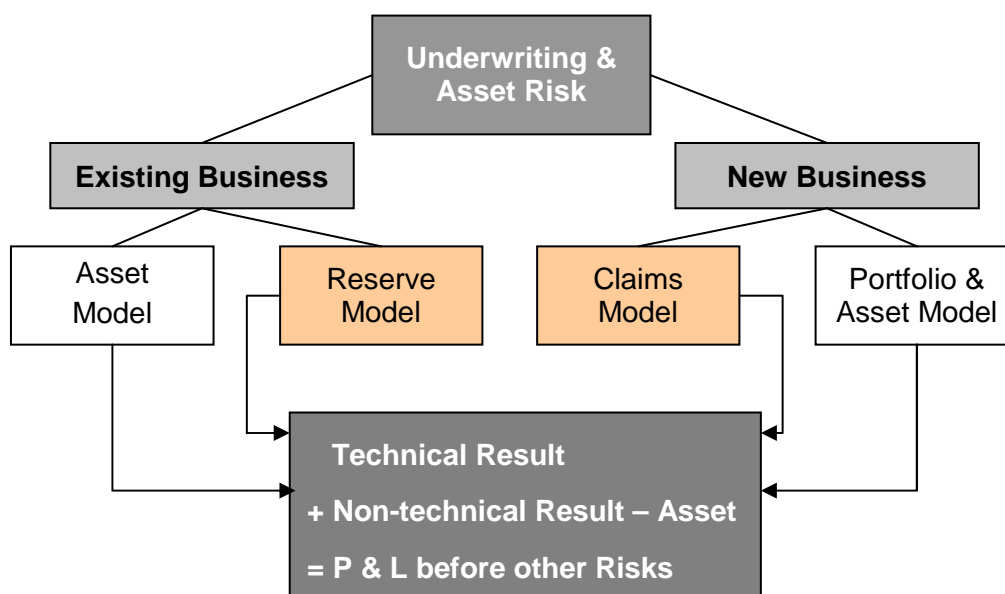


Figure 11: Underwriting and Asset Risk²²

Concerning underwriting and asset risks, we can differentiate between existing and new business. The **existing business** is reflected in the existing reserves and the assets covering those reserves. The reserve risk reflects the possible volatility of the existing business, which occurs due to the change of the reserves. The real claims amount may differ significantly from the estimated value.

The **new business** is reflected in the incoming premium and outgoing claims. It is important to calculate the premium risk-appropriately in order to cover the claims. The premium risk reflects the risk that the premium – even if calculated appropriately – is insufficient to pay an extraordinary claims experience. Within the context of the stochastic modeling, management rules play an important role in any case. Those rules cover aspects like the Strategic Asset-Allocation or the coverage of the solvability²³.

Apart from the underwriting and asset risks there are also other stochastic influences, which affect the P&L result from the non-technical side. The most important of them are reinsurance default and operational risk together with extraordinary tax depreciation. Those aspects should be considered in an internal model.

²² Heep-Altiner, Maria 2011, Internes Holdingmodell nach Solvency II, p. 109

²³ Nikolic, Hrabovszki 2012, Interpretation von Modellergebnissen, p. 3

2.3.1 Technical Result – Underwriting Risk

As already could be seen in the figure above and will be illustrated afterwards, the underwriting risk can be split into

- reserve risk for the existing business and
- premium risk for the new business.

Among the variety of models for reserve evaluation, we can choose for instance a chain ladder model. With the help of a stochastic model, we can see possible developments of our reserves. As a consequence, the chain ladder model is stochastic; thus we obtain stochastic best estimates together with a distribution of these values. In a one-period-model, only the stochastic of the next diagonal is relevant so that the full volatility is not realized.

With a stochastic reserve model, we can measure the reserve risk as well as the run-off risk. The reserve risk reflects the possible deviations from a given best estimate and the run-off risk reflects the possible volatility of the payment pattern.

A claims model is necessary to determine the premium risk and the run-off risk of the new business. The premium risk reflects the possible insufficiency of the premium to pay the claims. The run-off risk reflects the volatility of the payment patterns of the new business.

Premium and Reserve Risk

Due to solvency requirements, underwriting risk must be split into premium risk and reserve risk. The premium risk reflects the risk of the premium in the current year being insufficient to cover the losses. The reserve risk reflects the risk of the reserve for the existing business at the beginning of the year being insufficient at the end of the year. Consequently the non-technical result net can be structured as follows:

Net Premiums	}	Premium Risk
– Net Costs		
– Net Claims Payments – New Business		
– Allocation to Net Reserves – New Business		
– Net Claims Payments – Existing Business	}	Reserve Risk
+ Change in Net Reserves – Existing Business		

= Net Non-technical Result

Concerning the reserve risk, the expected value of the non-technical result net should be zero. This means that on average the payments should be equal to the changes of reserve for the existing business. Thus, the reserve risk reflects the variability of the existing business result due to payments and change of reserves in the existing business.

Moreover, the premium and reserve risk could be decreased significantly by reinsurance. For solvency requirements, it is very important to measure how the reinsurance decreases the risk and thus the required capital.

The decrease of risk by reinsurance depends on the type of the reinsurance because the risks can be ceded proportionally or non-proportionally. In many cases, it may not be sufficient to buy only proportional reinsurance due to possible big claims amounts in the tail of a claims distribution.

New Business Model

As already mentioned we need a claims model for the new business to analyze the structure of the claims distribution. Moreover, the claims model is necessary in order to see how reinsurance affects the required capital. It may be quite important to model more than the total claims amount in order to analyze the real impact of a reinsurance solution. There should therefore be at least a split into

- Base Claims,
- Nat Cat Claims and
- Major Claims.

This split enables us to check the efficiency of the reinsurance solution. Moreover, different reinsurance treaties should be used to secure those different claims types.

Base claims have a high frequency with low claims amount. Therefore, they need not be reinsured at all or only on a proportional basis. This type of claims can be estimated by a global distribution of aggregate losses using, for example, the panjer recursion.

Nat Cat claims arise from one event and relate to many policy holders. Those events are caused by natural hazards, which are modeled using an event model with event tables from external providers or individually depending on the company's own portfolio structure. The Nat Cat claims are usually reinsured on an XL per occurrence basis.

Major claims have a low frequency, but a high claims amount. They are so very volatile that a stochastic simulation is quite important.

Because of the low frequency and the high amounts, major claims are reinsured on an XL per risk basis²⁴. In order to model this type of claims adequately, they must be split into a claims number and a claims size model. Therefore one needs

- a frequency model for the claims number and
- a severity model for the claims size.

For a better understanding of the impact of the reinsurance on the major claims we will outline those two model types in more detail with an example.

Frequency Model

To model the **frequency** we apply a Poisson model. The Poisson distribution is one of the simplest discrete distributions suitable for a frequency model. This distribution depends only on the Poisson parameter λ . If N is the number of claims, then

$$P[X = N] = (\lambda^N / N!) \cdot e^{-\lambda}$$

$$E[X] = \lambda$$

$$\text{Var}[X] = \lambda$$

The Poisson parameter λ defines the expected value as well as the variance of this distribution. Being an average, λ does not need to be integral. Usually the expected value is not equal to the variance. Therefore, it has to be checked whether the observed parameter fits in the hypotheses “expected value = variance” or not.

The probabilities as well as the accumulated probabilities of a Poisson distribution with parameter $\lambda = 4.32$ are shown in the figure below.

²⁴Heep-Altiner, Maria 2010, Internes Modell nach Solvency II, p. 19.

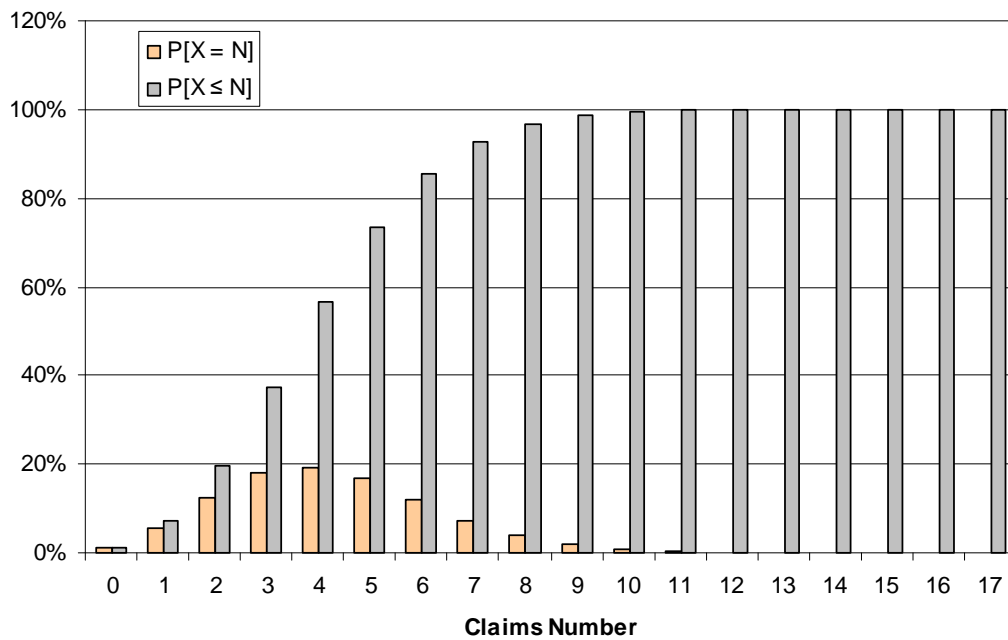


Figure 12: Poisson Distribution

Given this Poisson distribution, a randomly drawn quantile of 62.80% results in an expected claims number of five.

Severity Model

To model the **claims amount** we apply a Pareto model. It is a continuous distribution, which depends on the parameters K (threshold) and α (Pareto parameter). The Pareto parameter α must be positive; it determines how fast the distribution function trends to 100%.

The variance and the expected value depend on the parameters α and K . Moreover, this distribution is very special because if α is less than 1 we do not have an expected value; if α is less than 2 we do not have a variance etc. Especially the following relations hold:

$$\begin{aligned}
 P[X < x] &= 1 - (x / K)^{-\alpha} \\
 E[X] &= (\alpha \cdot K) / (\alpha - 1) \\
 \text{Var}[X] &= (\alpha \cdot K^2) / [(\alpha - 1)^2 \cdot (\alpha - 2)]
 \end{aligned}$$

The Pareto distribution is suitable for modelling the major claims amount, because it starts at a threshold K (corresponding to an excess point of an XL treaty). More-

over, the Pareto distribution has a relatively heavy tail, which can be seen in the figure below:

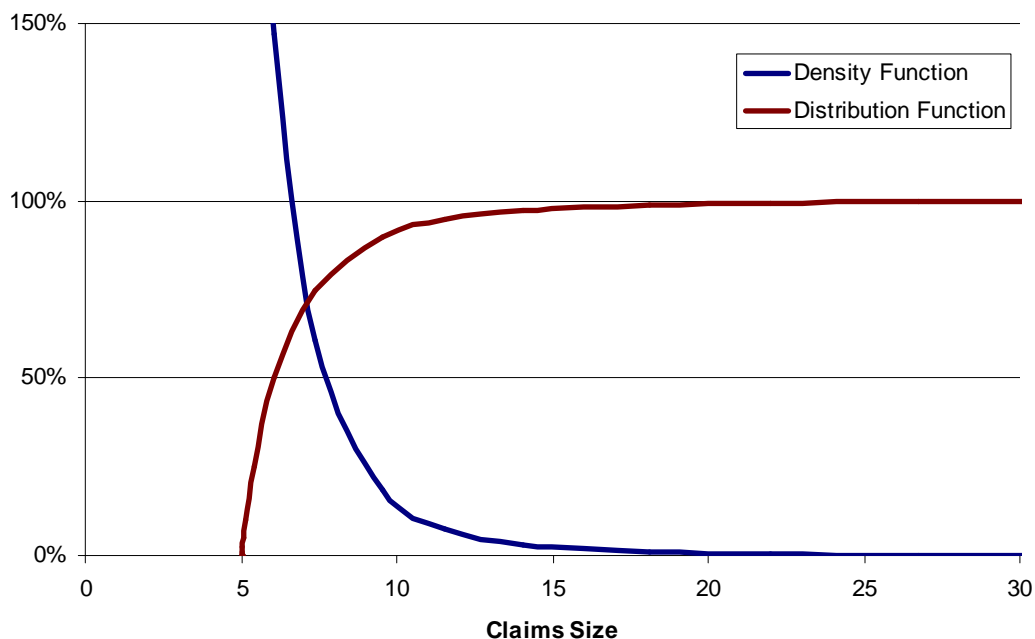


Figure 13: Pareto Distribution

The density function and the distribution function of the Pareto distribution shown in the figure above are based on the following parameter:

Pareto Parameter α	3.57
Threshold K	5.00
$E[X]$	$= (3.57 \cdot 5.00) / (3.57 - 1)$ $= 6.94.$
$Var[X]$	$= (3.57 \cdot 5.00^2) / [(3.57 - 1.00)^2 \cdot (3.57 - 2.00)]$ $= 8.57.$

So far, we have modelled the expected claims number and the expected claims size. Assuming independency between claims number and claims size we obtain

$$E[S] = E[N] \cdot E[X]$$

$$E[S] = 4.32 \cdot 6.94 = 29.98$$

where S denotes the total claims amount. Given a realized claims number of 5 (corresponding to a drawn quantile of 62.80%) the following table illustrates a realization of the total claims amount S.

N	Claims Number	Drawn Quantile	Claims Size
1	1	5.36%	5.08
2	1	68.44%	6.90
3	1	60.52%	6.48
4	1	8.80%	5.13
5	1	53.27%	6.19
Sum	5		29.78

Figure 14: Simulated Gross Claims Amount

For every realized claim, a quantile for the claims size is drawn, e.g. 5.36% for the first claim. Assuming a Pareto distribution with the parameter specified above we obtain:

$$\begin{aligned}
 F[x] &= 1 - (x / K)^{-\alpha} \\
 x &= K \cdot (1 - F[x])^{-1/\alpha} \\
 x &= 5.00 \cdot (1 - 0.6052)^{-1/3.57} \\
 x &= 6.48.
 \end{aligned}$$

Summarizing all realized claims amounts we obtain a realized total claims amount of 29.78 in this scenario.

Reinsurance Efficiency

In many cases, reinsurance is needed in order to protect against high major claims. Furthermore, having reinsurance coverage requires less capital. Therefore, it is important to measure the impact of reinsurance. In order to check the efficiency of a reinsurance solution we regard the Fair Value of ceded reserves defined in the following way:

$$\begin{aligned}
 \text{FV of Ceded Reserves} &= \text{Present Value of Expected Ceded Payments} \\
 &+ \text{Discharge in Cost of Capital} \\
 &- \text{Risk Margin for Reinsurance Default}
 \end{aligned}$$

Normally reinsurance “costs money” at a nominal valuation base, but there should be a positive profit & loss effect at a fair value valuation base. This is the case if a reinsurance solution

- decreases the required capital need and / or
- improves the net result at a fair value base.

Those aspects are illustrated in the table below giving a simplified example how an efficient reinsurance solution may appear.

Position	Gross	Ceded	Net
Return	10.0	3.0	7.0
Risk adjusted Capital	100.0	18.0	60.0
RoRAC	10.0%	16.7%	11.7%

Figure 15: Efficiency of a Reinsurance Solution (1)

As we can see in the table, the insurer is able to decrease its required capital by an amount of 40.0, where the reinsurer needs only a required capital of 18.0 (due to synergy, which is described in the first section). Consequently both insurer and reinsurer have a better return on risk adjusted capital after reinsurance. The amount of gross and net capital required can be estimated by Monte Carlo Simulations.

In order to illustrate this in more detail we will have a further look at the example given before, where we considered a major claims model that enables a check of different reinsurance solutions by stochastic simulations.

Calculation Example – Reinsurance Efficiency

For a given realization, five claims have been drawn with a simulated total claims amount of 29.78. We can check now the impact of a reinsurance treaty with the following characteristics:

Excess Point	5.0
Excess	10.0
Limitation of Claims Number	2

So the reinsurer will pay for the part of a claim exceeding 5.0 million, but only up to 10.0 million where solely the first two claims will be released. In the table below the impact of this reinsurance solution on the given realization is illustrated.

N	Claims Size			
	Gross	Layer	Ceded	Net
1	5.08	0.08	0.08	5.00
2	6.90	1.90	1.90	5.00
3	6.48	1.48	0.00	6.48
4	5.13	0.13	0.00	5.13
5	6.19	1.19	0.00	6.19
Sum	29.78	4.78	1.98	27.80

Figure 16: Simulated Net Claims Amount

If we look at the third claim an amount of 1.48 exceeds the excess point of 5.0 million. This amount will not be ceded, because the reinsurer only covers 2 claims so that the net claims amount equals the gross claims amount. This example for a given realization indicates that the chosen reinsurance solution does not seem to be effective.

A lot of realizations are simulated by Monte Carlo simulations. In the following chart the expected values and important quantiles describing the empirical distributions are illustrated.

	Claims Number	Claims Size		
		Gross	Ceded	Net
Expected	4.4	30.7	3.5	27.2
Quantiles				
75.0%	6.0	40.5	4.8	36.5
90.0%	7.0	51.3	7.5	48.2
95.0%	8.0	60.5	10.0	55.6
97.5%	9.0	65.9	10.9	61.2
99.0%	10.0	75.9	12.3	71.7
99.5%	11.0	79.6	13.0	76.6
99.9%	15.0	115.5	15.9	111.9

Figure 17: Empirical Distributions

It should be noted that you need a sufficient number of simulations in order to obtain a stable parameter. In our example the expected claim size gross is 30.7 million and the expected ceded part is 3.5 million, so that the primary insurer retains in average 27.2 million net.

In the table below we have illustrated the decrease in required capital between the gross and the net values as well as the change between the gross and the net CoC rates.

Position	Gross	Ceded	Net
Expected Value	30.7	3.5	27.2
<i>Duration</i>	<i>2.00</i>	<i>2.50</i>	<i>1.94</i>
Present Value	28.4	3.2	25.2
<i>Quantile Value</i>	<i>90.0%</i>	<i>75.0%</i>	<i>90.0%</i>
Quantile	51.3	4.8	48.2
Required Capital for 1 Period	20.6	1.4	21.0
<i>CoC Rate</i>	<i>10.0%</i>	<i>15.0%</i>	<i>8.9%</i>
CoC per Period	2.1	0.2	1.9
CoC in Total	3.9	0.5	3.4

Figure 18: Efficiency of a Reinsurance Solution (2)

In this example the fair value of the ceded reserves (due to the CoC requirements of the reinsurer) is subtracted from the fair value of the gross reserves (due to the CoC requirements of the first insurer) determining a net CoC ratio where the fair values gross and ceded are defined as

$$\text{Fair Value} = \text{Present Value} + \text{CoC in Total}.$$

A risk margin for reinsurance default has not been considered in this example. For the calculation of the present value PV the expected value EV is discounted with the risk-free interest rate r with respect to the duration D as follows:

$$PV = EV \cdot (1 + r)^{-D}$$

We obtain the required capital for one period RC_1 by subtracting the EV from the quantile values QV according to the following formula:

$$RC_1 = QV - EV$$

Assuming (approximately) a constant capital allocation over the run-off period D we obtain the following relations for the cost of capital for one period CoC_1 and the total cost of capital CoC:

$$\text{CoC}_1 = \text{CoC in \%} \cdot \text{RC}_1$$

$$\text{CoC} = \text{CoC}_1 \cdot (1 - (1 + r)^{-D}) / r$$

Subtracting the ceded fair value from the gross fair value we obtain a net CoC ratio of 8.9% being smaller than the gross CoC ratio of 10.0%. Furthermore, we need more required capital on a net base. This implies that the analyzed reinsurance treaty is quite inefficient.

This simplified example indicates two important criteria for analyzing the efficiency of a reinsurance solution.

- First, if the net CoC rate is higher than the gross CoC rate than the reinsurance structure is considered to be efficient.
- Second, if the RC net is much smaller than the RC gross, then the reinsurance structure is considered to be efficient, especially if the first insurer does not have sufficient capital without that type of reinsurance.²⁵

An efficient reinsurance treaty must produce a big capital relief by taking a lot of risk at the tail of a claims distribution. In the previously analyzed example the structure should be changed to a much bigger excess without any limitation of claims number.

2.3.2 Non-technical Result – Asset Risk

Insurance covers underwriting as well as asset management. Thus the stochastic P&L is influenced not only by technical risks, but also by non-technical risks.

The technical (underwriting) result may be positive or negative, whereas the asset result as the biggest part of the non-technical result is very often positive. Therefore, there is a good chance to balance a negative technical result or the result according to operational and other risks.

The asset risk comprises different types of risks. In the following part we will focus on the four most important risk influences, which are shown in the figure below:

²⁵Heep-Altiner, Maria 2010, Internes Modell nach Solvency II, p.148-152.

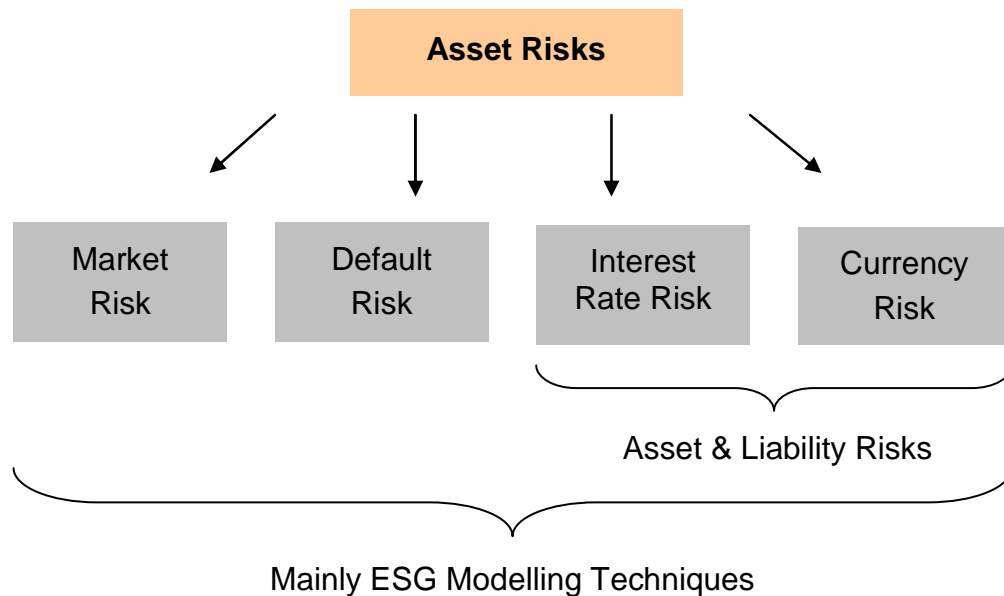


Figure 19: Asset Risks

The **market risk** is the risk that the asset values, stock values in particular, decrease. However, we have to distinguish between the stock risk and the property risk.

The **default risk** implies the risk of a default of a bond. If the issuer is not able to pay, the insurance company may receive nothing or only a part of the nominal amount of the bonds.

The **interest rate risk** is the risk influenced by price fluctuations of bonds, which are based on rising market interest rates. Interest rate risk also occurs on the liability side; it is an asset & liability risk.

The **currency risk** describes the currency fluctuations at the currency market. It includes the risks for assets and liabilities.

Interest and currency changes influence assets and liabilities, in such a way that the risks can be decreased by diversification or hedging. However, a minimization of such risks reduces the chance of extra profits. Another risk influence is given by correlations between assets and liabilities influencing the stochastic P&L.²⁶

Economic Scenario Generation (ESG) is used for modeling the asset risks. ESG generates different market scenarios, e.g. with different market volatility, different market interest rates or with different performances of derivatives. It is important to generate a sufficient number of market scenarios to produce stable conclusions on the distributions.^{27 28}

²⁶ Heep-Altiner, Maria 2011, Internes Holdingmodell nach Solvency II, p. 156-160.

²⁷ Heep-Altiner, Maria 2010, Internes Modell nach Solvency II, p. 66-67.

²⁸ Heep-Altiner, Maria 2011, Internes Holdingmodell nach Solvency II, p. 161-162.

In the following, we would like to demonstrate how the asset risk can influence the FV. We therefore focus on the interest rate risk and the spread risk.

Calculation Example – Interest Rate Risk

In order to demonstrate an example for the interest rate risk we consider a risk-free zero bond given the following parameter:

<u>Deterministic FV at t = 0</u>	Nominal Value of the Zero Bond:	1,000.00
	Duration of the Zero Bond:	5
	Risk-free Rate (deterministic)	4.0%
	$FV_0 = 1,000 / (1 + 0.040)^5$	= 821.93
<u>Stochastic FV at t = 1</u>	Nominal Value of the Zero Bond:	1,000.00
	Duration of the Zero Bond:	4
	Risk-free Rate (stochastic → ESG)	6.0%
	$FV_1 = 1,000 / (1 + 0.060)^4$	= 792.09
<u>Change in FV at t = 1</u>	$\Delta FV_1 = FV_1 - FV_0 = 792.09 - 821.93$	= - 29.83

The increase of the risk-free interest rate from 4.0% to 6.0% produces a loss of 29.83.

Calculation Example – Spread Risk

In the second example we would like to show the impact of a change of the risk spread given the following situation:

<u>Deterministic FV at t = 0</u>	Nominal Value of the Zero Bond:	1,000.00
	Duration of the Zero Bond:	5
	Risk-free Rate (deterministic)	4.0%
	Risk Spread (deterministic)	3.0%
	$FV_0 = 1,000 / (1 + 0.040 + 0.030)^5$	= 712.99
<u>Stochastic FV at t = 1</u>	Nominal Value of the Zero Bond:	1,000.00
	Duration of the Zero Bond:	4
	Risk-free Rate (stochastic → ESG)	4.0%
	Risk Spread (stochastic → ESG)	5.0%
	$FV_1 = 1,000 / (1 + 0.040 + 0.050)^4$	= 708.43
<u>Change in FV at t = 1</u>	$\Delta FV_1 = FV_1 - FV_0 = 708.33 - 712.99$	= - 4.56

The increase of the risk spread from 3.0% to 5.0% produces a loss of 4.56.

2.3.3 Non-technical Result – Reinsurance Default

Any loss arising from reinsurance default basically depends on the probability and the size of such default as well as the volume of reinsurance written. The probability of RI default can be determined by the credit worthiness of reinsurers involved in business relationship with primary insurer.

In its turn, the credit worthiness of a particular reinsurer can be classified according to his credit rating. It is possible that the discharge of CoC given an efficient reinsurance solution can decrease significantly, if the selected reinsurer has a poor credit worthiness.

The ceded part of capital costs represents a discharge in capital costs. The risk margin, on the contrary, is a burden on capital costs; it depends on the reinsurer's credit worthiness or rating. In other words, the risk margin is a price for the potential RI default.

The following table illustrates an example of a possible insurer's RI structure according to the ratings of the reinsurers according to the default probabilities (e.g. provided by rating agencies):

Rating	Default Probability	Share
AAA	0.05%	20.0%
AA	0.10%	20.0%
A	0.20%	20.0%
BBB	0.50%	20.0%
BB	1.00%	10.0%
B	5.00%	7.5%
> B	15.00%	2.5%
Total	1.02%	100.0%

Figure 20: Structure of a Reinsurance Portfolio

As it can be seen, most reinsurance contracts in this example are concluded with reinsurers having ratings from AAA to BBB. The average default probability is 1.02%, which reflects an average BB reinsurance structure. This, however, may be crucial for an industrial insurer.

The overall default probability as well as the RI exposure change after a period of one year and should be modeled stochastically, e.g. in the following way:

<u>Determin. RI default at t = 0</u>	RI Exposure:	1,000.0
	Average Default Probability:	1.02%
	Expected Default:	10.2
<u>Stoch. RI Default at t = 1</u>	RI Exposure:	1,050.0
	Average Default Probability:	5.00%
	Expected Default:	57.5%

The expected default has changed significantly due to a very high stochastic realization of the average RI default probability.

2.3.4 Non-technical Result – Operational Risk

Operational risks additionally affect the P&L result. They arise from business risks and are not insurance specific (e.g. IT-defaults, management mistakes and wrong process organization). Any operational risk affects the balance sheet negatively either as cash flow in the current period or in form of a bad debt reserve at the end of the period.

By law, German insurers for example have to provide information about their operational risks in the appendices to the annual reports – usually in form of a so called

“risk map”. In order to create such a map the insurers have to identify, evaluate, and control their own risks.

However, due to the lack of statistical data this can be done based solely on the systematic self-assessment. An example of a quantitative risk map is shown in the figure below:

Risk No.	Amount	Probab.	Exp. Value	STD with Corr. of 0%
1	10	0.1%	0.01	0.32
2	50	0.1%	0.05	1.58
3	100	0.1%	0.10	3.16
4	500	0.1%	0.50	15.80
5	10	1.0%	0.10	0.99
6	50	1.0%	0.50	4.97
7	100	1.0%	1.00	9.95
8	500	1.0%	5.00	49.75
9	10	10.0%	1.00	3.00
10	50	10.0%	5.00	15.00
Total			13.26	55.64

Figure 21: Quantitative Risk Map

The insurer estimates, according to a self-assessment, the amount A and probability P of a risk occurrence. The expected value EV and the standard deviation STD of a single risk can be calculated as follows:

$$EV = A \cdot P$$

$$STD = A \cdot (P \cdot (1 - P))^{1/2}$$

The expected value is linear; therefore the total value can be calculated by just adding the individual values. The standard deviation does not behave in a linear fashion. However, taking into account an assumed average correlation of 0% the total value can be calculated as follows:

$$STD(X_1 + \dots + X_n) = (VAR(X_1) + \dots + VAR(X_n))^{1/2}$$

In the given example the total expected value of operational risk equals 13.26 and the total standard deviation equals to 55.64. It is very much evident that operational risks have a very high coefficient of variation (defined as $CV = STD / EV$), which

equals 419.9% in this case. For normal P&L risks, the CV is typically below 100%. Because of this, the density function is highly right skewed. In the figure below an approximation of the distribution by a lognormal distribution is illustrated.

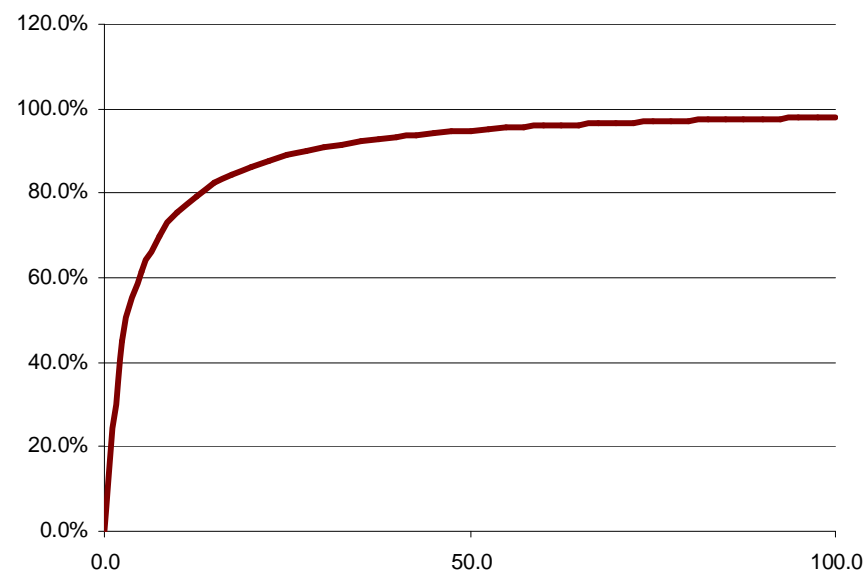


Figure 22: Distribution Function of Operational Risks

The distribution function converges slowly against 100% because of the high coefficient of variation. This distribution reflects the fact that the expected losses due to operational risks are quite low. On the other hand, there are very high realizations having a big impact on the risk situation of an entity. In the following chart the risk map according to the given example is illustrated.

Amount			
high	4	8	
medium	3 2	7 6	10
low	1	5	9
Probability	low	medium	high

Figure 23: Qualitative Risk Map

The amount of possible operational risks is shown on the vertical axis and the probability of their occurrence on the horizontal axis. Both values are divided into three classes: low, medium and high. In total there is a classification in three different risk areas:

- high risks → red area,
- medium risks → yellow area,
- low risks → green area.

The **red area** represents the highest risks. Any risk located in this area occurs with a medium or high probability and causes a middle or high loss. Insurers should take appropriate measures in order to reduce or eliminate the number of such risks or to reduce the amount of loss.

The **yellow area** describes medium risks. These risks have either high probability of occurrence combined with small amount of loss or low probability of occurrence with high level of damage. The insurers should constantly monitor these risks and prevent any movement from the medium risk area into the high risk area.

The **green area** represents a low danger area, where only risks with low probability of occurrence and small amount of expected losses are located. The risks within this area do not really imply a high danger, but they should not move into other areas.

In order to show the impact of operational risks more accurately we will model the equity of an insurer with and without inclusion of operational risks.

Assets		Liabilities	
Assets	1,000.00	350.00 Equity	
		650.00 Liabilities	
Total	1,000.00	1,000.00	Total

Assets		Liabilities	
Assets	1,000.00	336.74 Equity	
		650.00 Liabilities	
		13.26 Bad Debt Reserve	
Total	1,000.00	1,000.00	Total

Figure 24: Balance Sheet Excluding & Including Operational Risks

At first glance it can be recognized that inclusion of operational risks as a bad debt reserve immediately leads to a lower actual capital of 336.74 compared to 350.

All balance sheet positions will be simulated on the assumption of lognormal distribution with the following parameter:

	Expected Value	Coeff. of Variation	Standard Deviation
Assets	1,000.00	10.0%	100.00
Liabilities	650.00	12.5%	81.25
Operational Risks	13.26	419.9%	55.64

The capital excluding operational risks results as difference between assets and liabilities, while the capital including operational risks is additionally reduced by the simulated risks. The results on the basis of 5,000 simulations are shown in the following table:

	Capital Distribution		
	excl. OR	incl. OR	in %
Expected Values	351.97	339.24	96.38%
Ruin Probability	0.67%	1.29%	192.54%
Required Capital	369.22	423.22	114.63%

Figure 25: Simulated Capital & Ruin Probability

The required capital under a VaR approach corresponds to the expected value minus the 0.5%-quantile. The inclusion of operational risks in our example is reflected in the increase of capital required - by 14.6% from 369.22 to 423.22 while the available capital decreases only by 3.6%. Thus, the inclusion of operational risks increases the ruin probability and the capital required disproportionately; operational risks have a considerable impact.

2.3.5 Non-technical Result – Extraordinary Tax Depreciation

The extraordinary tax depreciation occurs only in extreme situations and has a very negative impact on the P&L result.

If a company observes a loss, there is usually a "negative" tax burden in form of a "loss carried forward". This loss can be balanced against future profits. In a market value model this can be treated as a deferred tax asset on the economic balance sheet. If there is no further future profit expected, then this deferred tax asset has to be written off extraordinarily.

Any internal model should include suitable management rules to treat such extraordinary tax depreciation. There is a “minimal rule” to write off if the capital is only covered by deferred tax assets. Compare the figure below.

Assets		Liabilities	
		300.00	Equity
		50.00	Liabilities
Deferred Tax	350.00		
Total	350.00	350.00	Total

Figure 26: Extraordinary Tax Depreciation

In this scenario, the company owns “tax assets” of 350 covering an equity of 300. Given such a situation, the company is more or less insolvent so that deferred taxes of 350 have to be written off. The equity after depreciation equals -50; the company is insolvent.

This example reflects the fact that tax effects do not prevent a ruin. In this case, the company won't be saved from insolvency by the tax authority. Tax effects can only smooth the P & L results, but nothing more.

The extraordinary tax depreciation may produce extreme non-linear effects. Thus, it is by no means clear how much capital a company has to inject (in case of a deficiency) or can extract (in case of a redundancy) according to solvency requirements.

2.4 Internal Models – Required Capital

In the previous chapters, the most relevant mathematical and economic basic principles for an internal risk model have been developed. It has been explained how to model the individual components of a stochastic profit and loss account by Monte Carlo simulations. In this section, all information will be combined to an overall model. To obtain the required capital we have to perform the following steps:

- Merging the individual model components to an overall model by using management rules.
- Performing a simulation run to determine the empirical overall distribution.
- Evaluation of the empirical overall distribution to determine the required capital by the Value at Risk (VaR) or the Tail Value at Risk (TVaR) Principle.
- Allocation of the required capital to the risk influences (top-down approach).

As previously explained, the deterministic capital at the beginning of the period and the stochastic profit and loss account simulated by Monte Carlo simulations are used to calculate the capital at the end of the period where the choice of input parameter is fundamental in this context.

2.4.1 Complete Model & Capital Distribution

The stochastic profit and loss (P&L) due to the basic equation discussed before consists mainly of stochastic profit & loss contributions and the respective input parameter but it is also determined by management rules.

Management Rules

Management rules are non-stochastic elements of an overall model that affect the income statement. They serve as a further basis for business decisions. In the modeling process the corporate strategy should be designed without unnecessary complexity. The following management rules were applied in all our calculations:

- All assets like stocks are considered as accumulated without any liquid dividend outgo.
- All liquid accruals are invested in short term risk-free papers until the end of the year.
- Short loans to cover negative liquidity can also be performed on a risk-free base.
- Dividends from subsidiaries or to parent companies are not taken into account.²⁹

It should be pointed out that the impact of management rules is not very strong in a short term calculation. But in consideration of several periods, management rules can represent significant factors which influence the results.

Input Parameter

With regard to the overall model, the following types of parameter have to be considered:

- Market parameter (e.g. market interest rate).
- Corporate parameter (e.g. tax rate).

²⁹ Heep-Altiner, Erfolgsorientierte Unternehmenssteuerung, Vorlesungsskript, 2012.

- Profit & Loss specific parameter (e.g. assets, premium-income, claims reserve, reinsurance structure).
- Correlation parameter (e.g. between risk-free rate and spread of fixed-income bonds)

After all input parameter and management rules have been established, Monte Carlo simulations can be performed based on the calculation scheme.

2.4.2 Complete Model & Capital Distribution – Calculation Example

In this section a simplified stochastic profit & loss account model will be established and used so that a capital allocation at the end of the period can be determined. Monte Carlo simulations are based on random experiments, which are carried out by using suitable random numbers. It should be noted that a sufficient number of simulations have to be generated, in order to produce stable results. Monte Carlo simulations establish an empirical distribution which serves as an approximation of the theoretical distribution. The quality of the approximation depends on the number of simulations.

Based on the distribution, the capital needs of the company are determined. Finally the capital is allocated by using a top-down approach to individual model components.

The following figure shows the input parameters for the example, which will be analyzed further in more detail.

Parameter	Average	Coeff. of Variation
Market Interest Rate	4%	10%
Capital at Begin	500	
Tax Rate	35%	
Op. Risk (in % of Premium)	5%	250%
Premium	1,000	2%
Cost Ratio	20%	10%
Loss Ratio	70%	35%

Figure 27: Input Parameter for the Calculation Example

In the example described in this section the following components of a P&L account are modelled in a simplified way:

- Technical Income.
- Non-technical Income (Assets).
- Non-technical Income (Operational Risk).
- Non-technical Income (Extraordinary Tax Depreciation).

For this example 10,000 simulations have been performed using lognormal distributions in order to represent the risks adequately. An extract from the simulation results is shown in the following figure.

Scenario Number	Capital at Begin	Premium	Costs	Claims	Techn. Result	Market Interest Rate	Non-Techn. Result
1	500.0	980.1	207.1	910.1	-137.1	4.4%	19.1
2	500.0	1,031.8	207.6	743.8	80.4	4.0%	21.3
3	500.0	1,008.0	154.9	697.5	155.6	4.3%	24.6
4	500.0	989.3	220.9	542.0	226.4	3.7%	22.6
5	500.0	990.9	174.8	765.4	50.8	3.7%	19.3
6	500.0	993.5	217.2	1,210.5	-434.2	4.3%	12.0

Figure 28: Stochastic P&L-Calculation Example (1)

The technical result is derived from the differences between premium income and the sum of costs and claim payments for the current period, e.g. for scenario no. 6:

Premiums		993.5
– Costs	–	271.2
– Claims Payments	–	1,210.5
= Technical Result	=	- 434.2

The non-technical result is obtained as full return on the capital at the beginning of the period together with the return for half a period on the underwriting cash balance (on the base of the market interest rate), e.g. for scenario no. 6:

Capital at Begin · Market Interest Rate		500.0 · 4.3%
+ Technical Result · Market Interest Rate (½ year)	+	½ · (- 434.2) · 4.3%
= Non-technical Result	=	12.0

In each scenario, the capital at the end after tax is obtained as sum of the capital at the beginning, the technical result, the non-technical result (according to asset income), the operational risk result and the tax result.

Scenario Number	operat. Risk Result	Capital at End before Tax	Tax on Overall Result	Tax Sign Off	Tax Result	Capital at End after Tax
1	-62.4	319.6	63.1	0.0	63.1	382.8
2	-205.0	396.7	36.2	0.0	36.2	432.8
3	0.0	680.2	-63.1	0.0	-63.1	617.1
4	0.0	749.1	-87.2	0.0	-87.2	661.9
5	0.0	570.0	-24.5	0.0	-24.5	545.5
6	-171.6	-93.8	207.8	-207.8	0.0	-93.8

Figure 29: Stochastic P&L-Calculation Example (2)

The operational risk is modeled as a bad debt reserve by a lognormal distribution with the parameter specified above. For scenario number 6 a bad debt reserve with an amount of 171.6 has been simulated in such a way that we obtain:

Capital at Begin		500,0
+ Technical Result	+	- 432.2
+ Non-Technical Result	+	12.0
+ Operational Risk Result	+	- 171.6
= Capital at End before Tax	=	- 93.8

Without tax, the company would be ruined in this scenario so that the capital at the end after tax would only be covered by deferred assets. Due to the minimal management rule an extraordinary tax depreciation will be proceeded with the following result for scenario number 6:

Tax on Overall Result		207.8
- Tax Depreciation	-	207.8
= Tax Result	=	0.0
+ Capital at End before Tax	+	-93.8
= Capital at End after Tax	=	- 93.8

After tax depreciation the capital at end before tax equals the capital at end after tax. Deferred tax assets do not prevent the ruin of a company.

2.4.3 Determination of Required Capital

Having carried out a complete simulation run, the determination of the capital requirements at the end of the period is possible. This can be done by using the VaR principle as well as the TVaR principle.

Value at Risk (VaR) Principle

The VaR is a risk measure, which was developed to estimate the risk of loss. The Value at Risk is the loss amount that should not be exceeded within a certain period of time with a certain probability (confidence level). Applied to the stochastic capital at the end of the year, the VaR denotes the level where the capital should not fall below with a given probability.

Solvency II requires a capital (SCR = Solvency Capital Required) with respect to the risk measure VaR. The capital at the end of the period should not fall below zero (technical ruin) with a (ruin) probability of more than 0.5%. Thus a security level $1 - \alpha = 99.5\%$ (99.5%-quantile) is reached.

According to this, an insurance company should only suffer a loss which cannot be covered by capital once in 200 years. Due to the VaR principle the required capital (RC) at the end of the period is calculated as follows:

$$RC_{\alpha} = E[C_1] - VaR_{\alpha}[C_1]$$

RC_{α} Capital after one year given a risk level α

$E[C_1]$ Expected value of the capital after one year

$VaR_{\alpha}[C_1]$ Value at Risk of the capital after one year given a risk level α

The capital requirement is calculated according to the differences between the expected value of capital after one year and the corresponding VaR. It may happen that the expected value for extremely skewed distributions is smaller than the VaR producing a negative capital requirement.

Given the example discussed earlier, Monte Carlo simulations produce a $VaR_{0.5\%}$ of -149.7 and an expected value $E[C_1]$ of 522.1 for the capital at the end of the period. This results in a capital requirement of 671.8, so that this company does not provide sufficient capital.

The required capital specified above is defined according to the distribution after one period. According to Solvency II the required capital has to be specified at the beginning at the period.

Tail Value at Risk (VaR) Principle

As an alternative to the VaR Principle, the capital requirement can be determined by the TVaR principle. The TVaR is defined as the average of all losses exceeding the VaR.

The TVaR corresponds to the conditional expected value and is calculated by the following formula:

$$\text{TVaR}_\alpha [C_1] = E[C_1 \mid C_1 \leq \text{VaR}_\alpha[C_1]],$$

with $E[C_1 \mid C_1 \leq \text{VaR}_\alpha[C_1]]$ being the expected value of the capital after one year under the condition that this capital is less than the Value at Risk at level α .

The problem of skewed distributions concerning the VaR does not exist with respect to the TVaR. The capital requirement after one year on the base of the Tail Value at Risk principle is higher than the capital requirement on the base of the Value at Risk principle. Summarized the following formula holds:

$$\text{RC}_\alpha = E[C_1] - \text{TVaR}_\alpha[C_1]$$

RC_α Capital requirement after one year at level α

$E[C_1]$ Expected value of capital after one year

$\text{TVaR}_\alpha [C_1]$ Tail Value at Risk of the capital after one year at level α

The following table illustrates the difference between the two principles given a risk level of 0.5% according to the Solvency II requirements:

	VaR TVAR Principle	
Expected	522.1	522.1
$\text{VaR}_{0.50\%}$	-149.7	
$\text{TVaR}_{0.50\%}$		-243.3
Required Capital	671.8	765.4

Figure 30: VaR Principle versus TVaR Principle (1)

Due to the fact that the TVaR provides more consistent mathematical results, it is sometimes used in internal models.

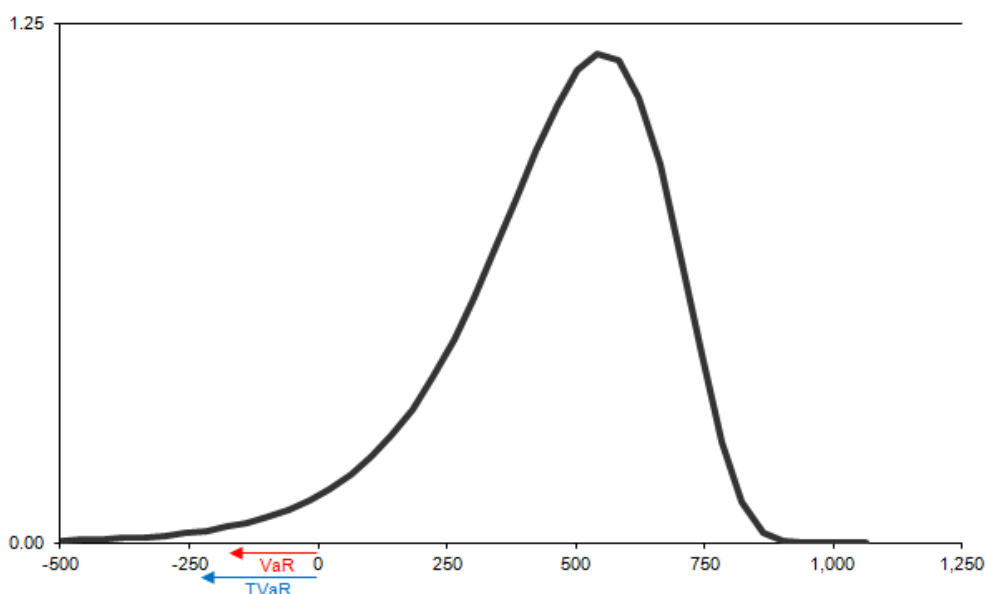


Figure 31: VaR Principle versus TVaR Principle (2)

Excursus: Withdrawal of Excess Capital

In this excursus, it will be explained in detail that the treatment of excess capital (defined as the difference between available and required capital) depends on the (non-linear) effect of extraordinary tax depreciation.

Given a value-based management approach, any holding tries to keep a company's capital as low as possible to reduce costs and to have enough excess capital for further investments.

The executive board of a holding has to keep in mind two aspects, if they want to remove excess capital from a company:

- Complete fulfillment of solvency requirements and
- correct treatment of non-linear tax – effects.

In very special cases it may happen that after the withdrawal of a high amount of excess capital, significant non-linear effects occur due to extraordinary tax depreciation. As a consequence, the required capital “jumps up” as can be seen in the following figure.

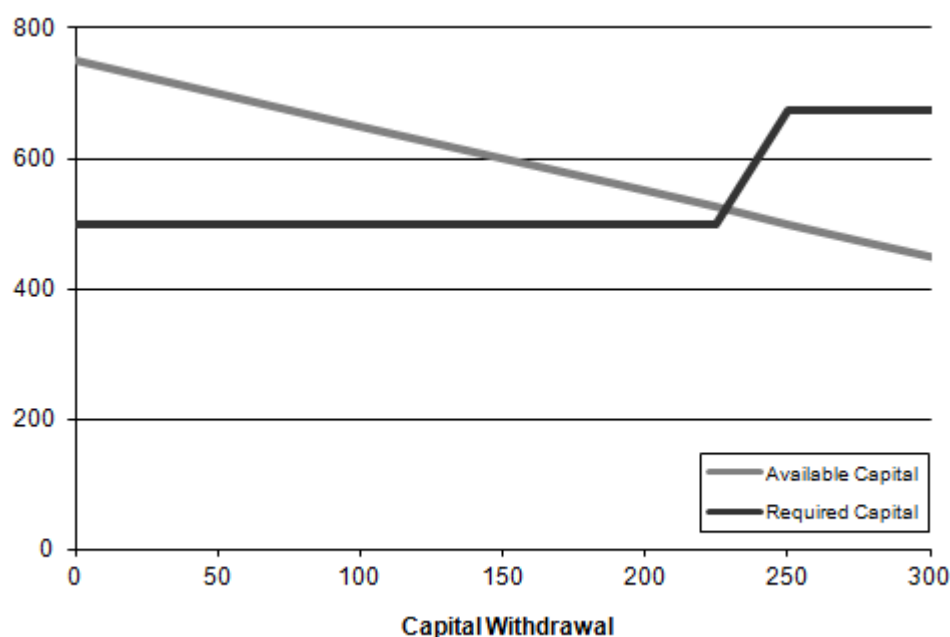


Figure 32: Non-linearity of Excess Capital

Consequently, the amount of excess capital that can be withdrawn in case of redundancy is smaller than estimated. On the other hand, less capital has to be injected in a case of deficiency than estimated. Both effects have to be tested by simulations.

2.4.4 Capital Allocation

After the determination of the required capital, we would like to analyze the contributions of different income positions to the required capital in more detail. The following methods of capital allocation are discussed in particular:

- Proportional Allocation VaR, TVaR Principle
- Adjustment of Risk Level VaR Principle
- Covariance Algorithm VaR, TVaR Principle
- Co-Measure Algorithm TVaR Principle
- Shapley Algorithm

Capital allocation is defined as an assignment of capital to single P&L contributions. An allocation algorithm specifies how to distribute the synergy effects to a single risk influence. It is important to note that high-risk segments require a higher share

of capital than low-risk segments. In consequence, due to their higher capital volume, high-risk segments have to generate more profit (in absolute values).

In the following sections, we would like to outline different mathematical methods to allocate the capital in an insurance company. However, before any method can be applied, we have to determine the required capital where two different approaches can be used according to the Value at Risk or Tail Value at Risk principle. The Value at Risk at a 99.5% security level is used in Solvency II. The Tail Value at Risk is used very often in internal models.

Proportional Allocation

The Proportional Allocation is the simplest approach to allocate the capital in a non-life insurance company without large calculation effort, because the synergy effect is allocated proportionally. Stochastic properties are not considered in this approach. The capital is calculated by using the following mathematical formula:

$RC_{i,mod}$	=	$RC_i \cdot RC_{ges} / \sum RC_i$	where
$RC_{i,mod}$		Capital Allocation per Single Risk	
RC_i		Required Capital per Single Risk (without synergy effects)	
RC_{ges}		Required Capital at Company Level	
$\sum RC_i$		Sum of all Single Required Capital (without synergy effects)	

The disadvantage of this approach is that no risk structure and no dependence between single risks is considered.

Adjustment of Risk-Level

The basic assumption of this approach is the reduction of the security-level for single contributions so that the sum adds to the total capital requirement. With this approach in mind, the following formula applies:

$RC_{i,mod}$	=	$RC_{i,\beta}$	with	$\sum RC_{i,\beta} = RC_{ges,\alpha}$
$RC_{i,mod}$		Capital Allocation per Single Risk		
$RC_{i,\beta}$		Required Capital at a Security Level β per Single Risk		
$\sum RC_{i,\beta}$		Sum of Requ. Capital at a Security Level β for all Single Risks		
$RC_{ges,\alpha}$		Capital Requirement of the company at a Security Level α		

This approach of Risk-Level Adjustment takes stochastic properties into account. In comparison to a proportional allocation, the risk situation in the tail area is modeled more adequately. A disadvantage of this approach is that it is not linear.

Covariance Algorithm

For the Covariance Algorithm, the covariance contributions of the individual components to the overall variance are calculated with the aid of a correlation matrix. The capital is allocated according to the covariance contributions, see the following figure with an allocation algorithm on the base of the RC according to TVaR principle.

	Techn. Result	Non- Techn. Result	operat. Risk	Capital at End after Tax
Required Capital	664.4	13.4	87.7	765.4
<i>in %</i>	<i>86.8%</i>	<i>1.8%</i>	<i>11.5%</i>	<i>100.0%</i>

Figure 33: Covariance Algorithm

All in all, the Covariance Algorithm represents a relatively simple and easily applicable method for the allocation of capital, which considers the risk in an adequate manner. A disadvantage is that this algorithm puts a disproportionate amount of weight on high risks.³⁰

Co-Measure Algorithm

The Co-Measure Algorithm is based on the linearity of the conditional expected value so that the Algorithm is suitable when the capital requirement is determined by the Tail Value at Risk principle. The Co-Measure Algorithm is defined by the following formula:

$$\begin{aligned}
 C_1 &= C_0 + \sum PL_i \\
 E[C_1] &= C_0 + \sum E[PL_i] \\
 TVaR_\alpha[C_1] &= C_0 + \sum E[PL_i \mid PL \leq VaR_\alpha[PL]] \\
 RC_\alpha &= \sum (E[PL_i] - E[PL_i \mid PL \leq VaR_\alpha[PL]]) = \sum RC_{i,\alpha} \\
 C_1 &\text{ Capital after one year} \\
 E[C_1] &\text{ Expected value of capital after one year} \\
 TVaR_\alpha[PL] &\text{ Tail Value at Risk with risk level } \alpha \\
 RC_\alpha &\text{ Capital requirement with risk level } \alpha \text{ after one year}
 \end{aligned}$$

³⁰ Nguyen 2008, Handbuch der wert- und risikoorientierten Steuerung von Versicherungsunternehmen, p. 218.

The Co-Measure Algorithm is a modern statistical approach with good mathematical properties. A disadvantage is that it may allocate extremely high capital requirements to higher risks. Therefore alternative approaches should be considered if necessary, for example the Shapley Algorithm.³¹

Shapley Algorithm

The Shapley Algorithm is a game theoretical method which determines the capital need of a risk throughout the accession to an already existing collective. This method is a combinational procedure where all possible $N!$ combinations of N risks are taken into account. In a portfolio with a wide number of risks this method causes enormous calculation effort.

For clarification, the Shapley Algorithm will be explained with the following example given three risks X , Y and Z . In case of normally distributed risks the required capital is proportional to the standard deviation (STD) in such a way that we focus on this risk measure in the following. We have the following marginal contributions:

1. If X is considered as the first risk:

$$M_X = \text{STD}(X)$$

2. If X is considered as the second risk after the risk Y :

$$M_{X|Y} = \text{STD}(X+Y) - \text{STD}(Y)$$

3. If X is the last risk:

$$M_{X|Y+Z} = \text{STD}(X+Y+Z) - \text{STD}(Y+Z)$$

4. Combination of all risk contributions

$$R_X = \frac{1}{3} \cdot M_X + \frac{1}{3} \cdot \left(\frac{1}{2} \cdot M_{X|Y} + \frac{1}{2} \cdot M_{X|Z} \right) + \frac{1}{3} \cdot M_{X|Y+Z}$$

5. The overall risk is described as followed:

$$R_X + R_Y + R_Z = R_{X+Y+Z} = \text{STD}(X+Y+Z)$$

Overall, the Shapley Algorithm receives a wide range of acceptance. Because of the enormous calculating effort due to the large number of risks, the practical application of this method is questioned. If we use the variance instead of the standard

³¹ Heep-Altiner; Haker; Lazic; Westermann et al. 2011, Internes Holdingmodell nach Solvency II-Schritt für Schritt zu einem internen Holdingmodell, p.26-27.

deviation as a risk measure, then the Shapley Algorithm delivers the Covariance Algorithm.

Comparison of Allocation Methods³²

The following table presents an overview of the main attributes of different allocation methods as well as their advantages and disadvantages.

Allocation Method	Advantages	Disadvantages
Proportional Allocation	<ul style="list-style-type: none"> • Simple handling 	<ul style="list-style-type: none"> • No consideration of stochastic properties
Adjustment of Risk Level	<ul style="list-style-type: none"> • Consideration of stochastic properties 	<ul style="list-style-type: none"> • Relatively complex • No Linearity • Big risks demand high capital
Covariance Algorithm	<ul style="list-style-type: none"> • Consideration of stochastic properties • Genuine acceptance • Application in many standard models • Linear approach 	<ul style="list-style-type: none"> • Big risks demand high capital • Does not fit to the VaR or TVaR principle
Co-Measure Algorithm	<ul style="list-style-type: none"> • Consideration of stochastic properties • Linearity • Coherence 	<ul style="list-style-type: none"> • Big risks demand high capital • Low acceptance of results • Elimination of small risks • Fits only to the TVaR principle
Shapley Algorithm	<ul style="list-style-type: none"> • Intuitive allocation algorithm • Widely accepted • Equality principle 	<ul style="list-style-type: none"> • Highly complex calculation • Calculation time

The Covariance Algorithm is a very manageable approach, because it presents a relatively simple and easily executable method of capital allocation that also con-

³²Heep-Altiner; Kaya; Krenzlin; Welter et al. 2010, Interne Modelle nach Solvency II - Schritt für Schritt zum internen Modell in der Schadenversicherung, 2010, p. 222.

siders the risk in an adequate way. However, the method only represents a linear dependency between the risks that is not adequate in every case.

The use of the Proportional Allocation is very easy, but the dependencies between the risks and the risk situation in the tail area are not considered.

With respect to the Adjustment of Risk-Level, stochastic properties are also considered and the risk situation in the tail area is indicated more accurately. However, this method is not linear.

Other methods like the Co-Measure Algorithm or the Shapley Algorithm seem to be attractive approaches, but they are not always applicable, because business segments carrying big risks demand high capital (Co-Measure Algorithm) or because the method demands a great computing time in case of a high number of risks (Shapley Algorithm).

Cost of Capital

The required capital is the central input factor for the business model of insurance. In this section the determination of the required capital has been explained in more detail. Costs of Capital define the price for providing this input factor. In the following figure the mechanism to calculate the Cost of Capital is illustrated:

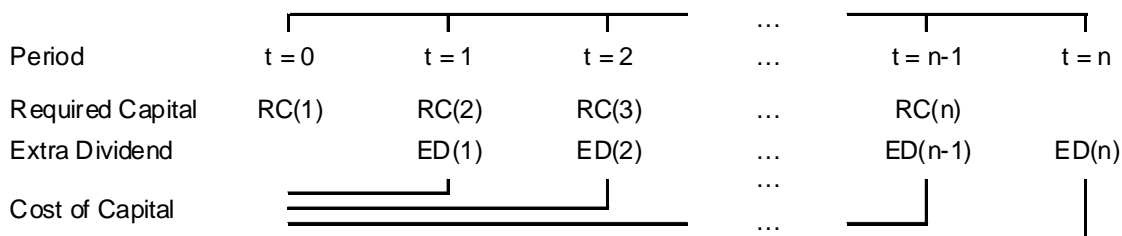


Figure 34: Cost of Capital (CoC)

As the figure illustrates Cost of Capital can be defined as the present value of extra dividends (in the sense of a risk spread) on the Required Capital that is needed to secure the risk coverage. In the following sections the CoC will be described in more detail.

3 Risk-Based Performance Measurement

In the previous section we saw how an insurance company can determine its required capital and how this capital can be allocated to several risk influences. This chapter presents firstly the management of underwriting. Subsequently, it illustrates how insurance companies can control their total portfolio including the capital investment. The last section describes the performance optimization. To sum up, the following topics are treated:

- Underwriting Performance,
- Asset Performance.

Furthermore, the section dealing with underwriting performance is separated into the following two different approaches:

- Traditional Performance Measurement,
- Risk-based Performance Measurement.

In order to understand the difference between those two approaches, detailed examples are discussed.

3.1 Underwriting Performance Measurement

One part of underwriting performance measurement consists in the definition of guidelines to subscribe the risk. Profitability analyses are used to verify the those guidelines. These analyses take place before the underwriting (new business) or afterwards during the execution (existing business). There are two perspectives: “A priori” in order to tariff a new business or “a posteriori” to control an existing business. The figure below illustrates the time horizon of a profitability analysis.



Figure 35: New Business versus Existing Business

The following section focuses on the "a priori" underwriting analysis with respect to new business. There is a consideration of the target values at the beginning of the underwriting period. The following values have to be estimated:

- The claims amount,
- administration and other costs,
- costs of capital,
- risk-free interest rate and
- required capital.

With this input data we can determine the premium and check whether the segment is profitable or not.

3.1.1 Traditional Performance Measurement

This section starts with the traditional approach of premium calculation. It is only based on the results of the underwriting process and does not include the expected investment income. This will be evaluated separately and does not influence directly the premium calculation. In practice, the premium calculation is influenced by more factors e.g. the impacts of competition policy.

New Business

According to the traditional approach the premium has to cover the administration costs, the ultimate claims amount and an additional profit margin. In non-life insurance it is assumed that there is usually a profit margin between two and three percent.³³ The following relation holds:

$$\begin{array}{rcl} & \text{Administration Costs} & \\ + & \text{Ultimate Claims Amount} & \\ + & \text{Profit Margin} & \\ \hline = & \text{Premium} & \end{array}$$

This premium is the basis for assessing profitability. In this assessment, usually the technical result or the combined ratio is calculated. These terms are explained later.

³³ Heep-Altiner (2010), p. 45

Existing Business:

In order to assess profitability the underwriting result is determined. Additionally it might be considered that the expected profit margin could be fulfilled as calculated in the premium. The “a posteriori” underwriting result is defined as follows:

$$\begin{array}{r} \text{Premium} \\ - \text{Administration Costs} \\ - \text{Claims Amount} \\ \hline = \text{Underwriting Result} \end{array}$$

Another method of profitability assessment is the consideration of the combined ratio as a combination of loss ratio and cost ratio. Both, the cost ratio and the loss ratio are already used as an indicator for a portfolio assessment. The loss ratio is the relationship of claims payments to received premiums. The cost ratio represents the relation of administrative costs versus received premiums. The **combined ratio** is calculated as follows:

$$\text{Combined Ratio} = (\text{Administration Costs} + \text{Claims Amount}) / \text{Premium}.$$

In an underwriting perspective, the combined ratio should be less than 100% for delivering a return. In practice, the combined ratio varies widely between different branches.

Both key indicators of the traditional approach are easy to determine and easy to understand. But just the underwriting is considered and not the capital investment. A consideration of the **cash flows** is usually not performed. But for the insurance business, it is characteristic that the payments have to be paid with a time delay to the premium income. Because of that the financial resources are not needed in total and can be invested in the capital market bearing interest. This can compensate a negative underwriting result. But the traditional approach does not consider this aspect adequately.

Therefore the traditional performance measurement may not assess whether an achieved profitability is sufficient.

The examples described in the following assume average claims and cost payments. These are only statistical parameters which may not realize in practice. If these variations cannot be compensated by the collective, the insurance company has to compensate an unfavourable claim experience by the provision of capital. The traditional approach does not show which level of risk should be secured by

capital and how much excess return the insurance company has to generate in order to use this capital. Thus, the traditional performance measurement does not consider all important aspects.

3.1.2 Traditional Performance Measurement – Calculation Example

In this section an example of a liability segment is discussed with respect to the traditional performance measurement with the following input parameter:

Premium	1,000.0
Cost Ratio	25.0%
Loss Ratio	80.0%
<i>Duration</i>	3

The premium income of 1,000 is received at the beginning of the first period. Additional premium payments do not occur. It is assumed that there are costs of 25% of the premium and a loss ratio of 80%. Due to a security principle the claim **reserve** is initially constituted with 900 (over reservation). The duration (e.g. the average payment duration) is 3 years. When the cost ratio and the loss ratio are summed up, it results a combined ratio of 105%. It will be checked if this business can be at all profitable or if the insurance company suffers a loss.

After an example with respect to a **single accident year**, we consider a regular premium income resulting from an increasing or a decreasing portfolio over **several accident years**. Finally, we consider the **impact of interests**.

Profit & Loss Effect – Single Accident Year

This example assumes a constant portfolio on the base of a single accident year. The following table shows the development of the liability segment for the financial years 1 to 4 where the premiums are recorded as an income in the first year. An amount of 25% of the premium is subtracted immediately as costs. Also, a claims reserve of 900 is established.

Financial Year	1		2		3		4		Total	
	Inc.	Exp.	Inc.	Exp.	Inc.	Exp.	Inc.	Exp.	Inc.	Exp.
Premiums	1,000								1,000	
Costs		250								250
Claim Payments								800		800
Claim Reserves		900						-900		
Sum	1,000	1,150						-100	1,000	1,050
Combined Ratio		115.0%								105.0%

Figure 36: Income & Expenses – Single Accident Year

The result in the first year covers an income of 1,000 and expenses of 1,150 and results a combined ratio of 115% for this financial year. In the next two years there are no cash flows, so that the claims reserves remain unchanged until the fourth year. Because of the dissolution of the over reserved claim reserve in this year, the insurance company gets an income of 100. The example ends in the fourth year, because there are no additional incomes / expenses. In total, the insurance company receives an income of 1,000 and expenses of 1,050. There is a combined ratio of 105% in year 4.

Without the consideration of investment income, a segment with a combined ratio above 100% can never produce a positive result.

The example should be modified, because a constant portfolio for only one accident year is not typical for the insurance business.

Profit & Loss Effect – Several Accident Years

We consider now a regular premium income over several accident years which results in an increasing or a decreasing portfolio. Assuming an annual growth of 10%, we obtain the following table:

Financial Year	Growth	1		2		3		4		Total	
		Inc.	Exp.	Inc.	Exp.	Inc.	Exp.	Inc.	Exp.	Inc.	Exp.
Accid. Year	1	1,000	1,150						-100	1,000	1,050
Accid. Year	2			1,100	1,265					1,100	1,155
Accid. Year	3					1,210	1,392			1,210	1,271
Accid. Year	4							1,331	1,531	1,331	1,398
Accid. Year	5									1,464	1,537
Sum		1,000	1,150	1,100	1,265	1,210	1,392	1,331	1,431	6,105	6,410
Combined Ratio			115.0%		115.0%		115.0%		107.5%		105.0%

Figure 37: Income & Expenses – Several Accident Years, 10% Increase

The combined ratio in the first financial year is again 115%. Because of the constant increasing costs and premium income, the combined ratio does not change in the next two financial years. From the fourth year, when the first claims are settled, the combined ratio of the financial years decreases to 107.5% where the combined

ratio of the accident years is 105% the whole time. The reason for the increase to 107% is the fact that the resolved claim reserve dates back to a previous period with lower claims expenses. But in the year of the reserve release the costs were already adjusted to the growing portfolio. To sum up, an increasing portfolio shows a negative impact on profitability.

In a portfolio with a decrease of 10% the combined ratio of the financial years stabilizes at 101.3%. Now the effects are positive. The income from the resolution of the claim reserve is higher than the costs of the decreasing portfolio.

Financial Year Growth	-10%	1		2		3		4		Total	
		Inc.	Exp.	Inc.	Exp.	Inc.	Exp.	Inc.	Exp.	Inc.	Exp.
Accid. Year	1	1,000	1,150						-100	1,000	1,050
Accid. Year	2			900	1,035					900	945
Accid. Year	3					810	932			810	851
Accid. Year	4							729	838	729	765
Accid. Year	5									656	689
Sum		1,000	1,150	900	1,035	810	932	729	738	4,095	4,300
Combined Ratio		115.0%		115.0%		115.0%		101.3%		105.0%	

Figure 38: Income & Expenses – Several Accident Years, 10% Decrease

The two examples cover segments with an over reserving of claims reserves. Alternatively, the insurance companies can underestimate the reserves. If so, they have an additional expense when the claims are finally settled. In total, the over reservation and the under reservation have the following impacts:

- Over Reserving:**
- Higher CR (than on AY base) in increasing portfolios.
 - Lower CR (than on AY base) in decreasing portfolios.
- Under Reserving:**
- Higher CR (than on AY base) in increasing portfolios.
 - Lower CR (than on AY base) in decreasing portfolios.

The following section considers the impact of interests on the available financial resources in order to check whether a combined ratio of over 100% can be compensated by these.

Profit & Loss Effect – Impact of Interests

Two scenarios with different interest rates are considered. The first scenario is a portfolio with a decrease of 10% where a **risk-free interest rate** of 2% is applied.

Financial Year		1	2	3	4	5	6	7	8	Total
Growth	-10%	Cash Flow Result								
Accid. Year	1	750			-800					-50
Accid. Year	2		675			-720				-45
Accid. Year	3			608			-648			-41
Accid. Year	4				547			-583		-36
Accid. Year	5					492			-525	-33
Sum		750	675	608	-253	-228	-648	-583	-525	-205
Acc. Interest	2%	757	1,454	2,097	1,883	1,691	1,070	502	-18	

Figure 39: Income & Expenses – Impact of 2% interest

Similar to the previous examples 25% of the premium incomes are costs. Furthermore, there is an over reserved claims reserve of 900. In the second year the liquid balance decrease to 675 due to the decreasing portfolio. As a consequence; there is a cumulative cash flow of 1,454 (including interest income) at the end of this year. This development continues until the fourth year when we observe the first claims payments. These claims payments have to be considered in the cash flow.

The claim payment of 800 in the fourth year is still based on the original portfolio size of 1,000. Because of the decreasing portfolio, this claims payment is confronted with an income of 547. Thus, we have a negative cash flow in this year for the first time. This development continues because the claims reserves decrease delayed. At the end, the cumulative cash flow decreases becomes negative in year 8 because there has been no new business since year 6. A risk-free interest rate of 2% is not sufficient to achieve a positive result in this example.

The second example treats a 10 % increasing portfolio with a risk-free interest rate of 3%, compare the figure below.

Financial Year		1	2	3	4	5	6	7	8	Total
Growth	10%	Cash Flow Result								
Accid. Year	1	750			-800					-50
Accid. Year	2		825			-880				-55
Accid. Year	3			908			-968			-61
Accid. Year	4				998			-1,065		-67
Accid. Year	5					1,098			-1,171	-73
Sum		750	825	908	198	218	-968	-1,065	-1,171	-305
Acc. Interest	3%	761	1,621	2,591	2,870	3,177	2,290	1,278	128	

Figure 40: Income & Expenses – Impact of 3% Interest

The cash flow grows because of the growing portfolio in each financial year until the third year; afterwards, the first claims are settled. All in all there is a positive result at the end.

The example generates a positive cash flow with an interest rate of 3%. Thus, this interest rate can compensate the negative technical result. The segment is profitable, but in the traditional performance measurement it is not possible to indicate to what extent.

3.1.3 Risk-based Performance Measurement

The traditional view does not consider the earned investment income or capital costs. Due to this fact, there should be a modification. In this modified approach the **capital costs** as well as the investment income are included in the premium calculation and in the profitability-analysis.

New Business

Due to the equivalence principle for premium calculation we obtain the following relation covering expected (risk-free) investment income as well as capital costs:

$$\begin{aligned} & \text{Present Value of Administration Costs} \\ + & \text{Present Value of Claims Amount} \\ + & \text{Present Value of Extra Dividend} \\ \hline = & \text{Present Value of Premiums} \end{aligned}$$

The present value of extra dividend is denoted as Cost of Capital (CoC). This modified approach also results in a different treatment of existing business.

Existing Business

In order to have a profitable business there should be a (sufficient) positive **present value** of **amount of coverage**. This present value is calculated as follows:

$$\begin{aligned} & \text{Present Value of Premiums} \\ - & \text{Present Value of Administration Costs} \\ - & \text{Present Value of Claims Amount} \\ \hline = & \text{Present Value of Amount of Coverage} \end{aligned}$$

It is now possible to check if the profitability is sufficient by comparing it with the Cost of Capital required by the company as follows:

Present Value of Amount of Coverage \geq CoC \rightarrow Sufficient Profitability,
Present Value of Amount of Coverage $<$ CoC \rightarrow Insufficient Profitability.

An insufficiently unprofitable business does not lead directly to a withdrawal of capital. The level of target achievement has to be considered, too.

3.1.4 Risk-based Performance Measurement – Calculation Example

The following section deals with a profitability analysis for general liability insurance and partially comprehensive insurance. The analysis for both segments is calculated with the traditional and the modified perception in the same way. Due to the fact that the general liability and the partially comprehensive insurance are different in their cash flow, the impact of the claims payment duration will be clear. Both examples are based on the following input data:

Premium	1,000.0
Expense Rate	25.0%
Combined Ratio	105.0%
Market Interest Rate	4.0%

The first segment which is going to be calculated is the general liability. The results are compared afterwards with partially comprehensive insurance.

General Liability

The general liability insurance segment is characterized by a long claims payment duration caused by two different facts:

- The probability of late claims is very high and
- the claim settlement often takes a lot of time.

The table below illustrates the traditional view on the segment based on nominal values. There is a premium income of 1,000 and costs of 250 in the first period. Further on, there is an expenditure of 800 in the fourth period because of the claims payments. There is an overall negative technical result of -50.

Period	CF in %	Average Duration	Nominal Values				
			Premium	Costs	Claims		Result
					Incurred	Future	
1	100.0%	0.5	1,000.0	250.0			750.0
2							
3							
4						800.0	-800.0
5							
Total	100.0%	3.5	1,000.0	250.0		800.0	-50.0

Figure 41: Nominal Cash Flow for General Liability with CR = 105.0%

If one just looks at the underwriting result, the business does not seem to be profitable. The question is whether it will be profitable under a modified view. Such a view considers the different payment dates by using different discount factors, see the next figure.

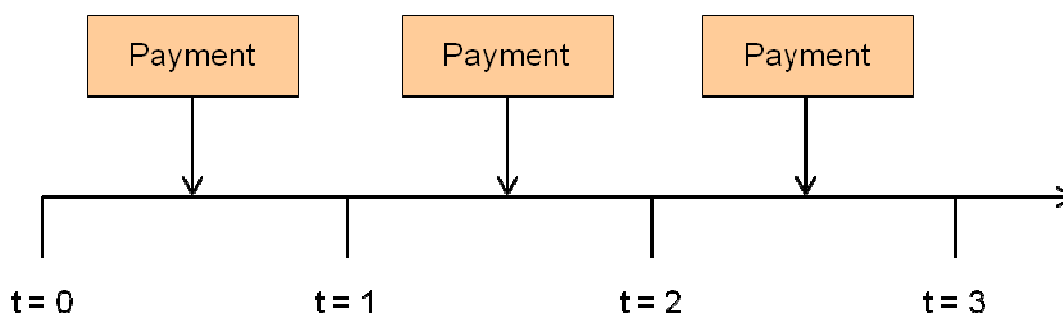


Figure 42: Nominal Claims Cash Flow – Illustration

Assuming that the claims payment occurs in average in the middle of a period, then – given a risk-free rate r – the payment in the period t is discounted with a discount $D(r, t)$ defined as follows:

$$D(r, t) = 1 / (1 + r)^{t-0.5}$$

The table below shows the calculation of the discounted premium, claim settlements and capital costs in order to find the present value of the amount of coverage.

Period	Accumul. Discount Middle of the Period 4.00%		Discounted Values				
			Premium	Costs	Claims		Result
					Incurred	Future	
1		98.06%	980.6	245.1			735.4
2		94.29%					
3		90.66%					
4		87.17%				697.4	-697.4
5		83.82%					
Total			980.6	245.1		697.4	38.0

Figure 43: Discounted Cash Flow for General Liability with CR = 105.0%

By using the modified perception a positive liquid result is obtained at the end of the fifth period, because the discounted cash flow is taken into account. That means that the liquid result at the end of period one is:

$$750 / (1 + 0.04)^{0.5} = 735.4.$$

This results from the assumption that the insurer earns a risk-free income on assets. Therefore the liquid result of 750 is discounted with the discount-factor as can be seen below. The same is applied to the claims payments in period 3.5:

$$800 / (1 + 0.04)^{3.5} = 694.4.$$

Consequently, after discount a positive liquid result of 38.0 is obtained. Therefore the segment is profitable even if the underwriting result is negative.

That leads to the question of whether the business is profitable enough. In order to find an answer, it is necessary to work with a required capital model, e.g. the S&P-Model where the premium at begin and the reserve at the beginning of a period are the base for the **allocation of capital**.

Period	Accumul. Discount Middle of the Period 4.00%		Base for Capital Allocation			
			Premium	Claims		Reserve
				Single	Accum.	
1		98.06%	1,000.0			
2		94.29%				800.0
3		90.66%				800.0
4		87.17%		800.0	800.0	800.0
5		83.82%			800.0	
Total				800.0		

Figure 44: Base for Capital Allocation for General Liability with CR = 105.0%

In this example, a S&P-capital-allocation-model with the following input data is used:

S&P Company Level	125.0%
S&P Premium Rate	27.0%
S&P Reserving Rate	10.0%
Extra Dividend Rate	6.0%

The allocation of capital demonstrates the risk-related capital demand for different lines of business. The amount of allocated capital depends on the considered segment and on the company's target rating. The chosen multiplier of 125% is used for companies with a strong BBB-rating as target rating. Cost of Capital of 6% is required to compensate the risk bearing, analog to the Swiss solvency model.

Period	Base for Capital Allocation			Capital Allocation due to S&P			
	Premium	Claims	Reserve	Prem. Fact.	Res. Fact.	Total	Ent. Fact.
				27.0%	10.0%		125.0%
1	1,000.0			270.0		270.0	337.5
2			800.0		80.0	80.0	100.0
3			800.0		80.0	80.0	100.0
4		800.0	800.0		80.0	80.0	100.0
5							
Total		800.0					

Figure 45: S&P Allocation of Capital for General Liability with CR = 105.0%

The next step is to calculate the cost of capital. Costs of capital on the required capital provided are required at the end of a period. The CoC is obtained by multiplying the required capital at the beginning of a period with 6%. The discounted extra dividends add up to the Capital Costs in total.

Period	Accumul. Discount Begin of the Period 4.00%		Required Capital	Cost of Capital with CoC Rate 6.0% Nominal Discounted		Amount of Cover.
1		100.00%	337.5			735.4
2		96.15%	100.0	20.3	19.5	
3		92.46%	100.0	6.0	5.5	
4		88.90%	100.0	6.0	5.3	-697.4
5		85.48%		6.0	5.1	
6		82.19%				
Total					35.5	38.0

Figure 46: Required Cost of Capital for General Liability with CR = 105.0%

The present value of amount of coverage and the sum of the discounted cost of capital are now known. They need to be compared in order to discover whether the analysed segment is profitable enough. Obviously, the present value of amount of coverage is higher than the required cost of capital. Thus, the segment is sufficiently profitable.

In the next example the segment motor insurance – fire and theft is considered to illustrate the impact of a different cash flow structure.

Partially Comprehensive

In contrast to the liability segment, the main characteristic of the partially comprehensive segment is the low probability of late claims and the quick claim settlement. Therefore, there is just a short duration in the considered segment. To analyse this segment, the same input data as before is considered:

Premium	1,000.0
Expense Rate	25.0%
Combined Ratio	105.0%
Market Interest Rate	4.0%

The nominal view on this segment results in the same negative technical result of - 50 as before. The different cash flow structure does not play any role at this stage.

Period	CF in %	Average Duration	Nominal Values				Result
			Premium	Costs	Claims Incurred	Claims Future	
1	80.0%	0.5	1,000.0	250.0		640.0	110.0
2	20.0%	1.5				160.0	-160.0
3		2.5					
4		3.5					
5		4.5					
Total	100.0%	0.7	1,000.0	250.0		800.0	-50.0

Figure 47: Nominal Cash Flow for Partially Comprehensive with CR = 105.0%

In contrast to the liability segment, 80% of the claims payments are paid in the first year and 20% in the second year. The next table shows the impact on the amount of coverage by considering the present values.

Period	Accumul. Discount Middle of the Period 4.00%		Discounted Values				
			Premium	Costs	Claims		Result
					Incurred	Future	
1		98.06%	980.6	245.1		627.6	107.9
2		94.29%				150.9	-150.9
3		90.66%					
4		87.17%					
5		83.82%					
Total			980.6	245.1		778.4	-43.0

Figure 48: Discounted Cash Flow for Partially Comprehensive with CR = 105.0%

The consideration of the present values has a positive effect on the liquid result. However, in contrast to the general liability segment, the effect is not positive enough so the result is still negative. Consequently this segment is not profitable even under the modified perception.

The calculation of the present values clarifies that the modified perception only has a low impact on segments with a short duration. The cash flow structure determines the profitability of a business.

The next question is how the combined ratio should be changed to ensure sufficient profitability. The target combined ratio depends on the capital allocation policy of an entity and therefore it is different for different types of insurers. The following parameters in particular determine the target combined ratio:

- Segment characteristics (like volatility or duration),
- company's security level (determining the S&P multiplier),
- required extra dividend and
- market interest rate.

The table below indicates that a positive liquid result derives from a combined ratio of 99.6% in the partially comprehensive segment.

Period	CF in %	Average Duration	Nominal Values				
			Premium	Costs	Claims		Result
					Incurred	Future	
1	80.0%	0.5	1,000.0	250.0		596.5	153.5
2	20.0%	1.5				149.1	-149.1
3		2.5					
4		3.5					
5		4.5					
Total	100.0%	0.7	1,000.0	250.0		745.6	4.4

Figure 49: Nominal Cash Flow for Partially Comprehensive with CR = 99.6%

The smaller combined ratio arises from a reduction of the expected claims payments (due to a relative increase in premium rates). Because of the lower combined ratio the technical result is now positive. The next table illustrates the effect of discounting.

Period	Accumul. Discount		Discounted Values				
	Middle of the Period	4.00%	Premium	Costs	Claims		Result
					Incurred	Future	
1		98.06%	980.6	245.1		584.9	150.5
2		94.29%				140.6	-140.6
3		90.66%					
4		87.17%					
5		83.82%					
Total			980.6	245.1		725.5	9.9

Figure 50: Discounted Cash Flow for Partially Comprehensive with CR = 99.6%

There is now an amount of coverage of 9.9. It should be checked whether this is enough to cover the required costs of capital. As before, this can be controlled by using the S&P- capital allocation model. Therefore, in the first instance, the remaining reserve at the beginning of the second period needs to be calculated.

Period	Accumul. Discount		Base for Capital Allocation			
	Middle of the Period	4.00%	Premium	Claims	Reserve	
				Single		
1		98.06%	1,000.0	596.5	596.5	
2		94.29%		149.1	745.6	149.1
3		90.66%			745.6	
4		87.17%			745.6	
5		83.82%			745.6	
Total				745.6		

Figure 51: Base for Capital Allocation for Partially Comprehensive with CR = 99.6%

The S&P and the CoC model can be used with the same data as before with the exception that there are other S&P factors for partially comprehensive.

S&P Company Level	125.0%
S&P Premium Rate	12.0%
S&P Reserving Rate	12.0%
Extra Dividend Rate	6.0%

The next table illustrates the calculation of the allocated capital based on the premium and reserve factor and the entity factor defining the company's security level.

Period	Base for Capital Allocation			Capital Allocation due to S&P			
	Premium	Claims	Reserve	Prem. Fact.	Res. Fact.	Total	Ent. Fact.
				12.0%	12.0%		125.0%
1	1,000.0	596.5		120.0		120.0	150.0
2		149.1	149.1		17.9	17.9	22.4
3							
4							
5							
Total		745.6					

Figure 52: S&P Allocation of Capital for Partially Comprehensive with CR = 99.6%

Referring to the calculation of the present value of amount of coverage it has to be checked whether the required cost of capital is higher or lower than the amount of coverage, see the following table.

Period	Accumul. Begin of the Period	Discount 4.00%	Required Capital	Cost of Capital with		Amount of Cover.
				CoC Rate	6.0%	
				Nominal	Discounted	
1		100.00%	150.0			150.5
2		96.15%	22.4	9.0	8.7	-140.6
3		92.46%		1.3	1.2	
4		88.90%				
5		85.48%				
6		82.19%				
Total					9.9	9.9

Figure 53: Required Cost of Capital for Partially Comprehensive with CR = 99.6%

It can be seen that the present values of amount of coverage and of costs of capital are equal with respect to the chosen combined ratio. Consequently the business is profitable and 99.6% is the target combined ratio.

3.1.5 New Business versus Existing Business – Calculation Example

In order to find out possible miscalculations in a segment and to start suitable countermeasures afterwards, it is important to compare the actual values with the target values.

General Liability – New Business

“A posteriori” it should be checked, if the parameter estimated “a priori” fit with the realized values up to the point in time t. The input values – such as average claims history or risk-free interest rates – may have evolved differently than predicted before. If there are negative deviations from the expected result, the insurance company should perform a detailed analysis, in order to prevent forecast errors in future.

In case of negative deviations it should distinguished whether underwriting risk or capital investment risk is attributable. Misjudgements of the underwriter regarding damage and loss experience is part of the underwriting risk and fall to the responsibility of the underwriter, but forecast errors in terms of investment should not be attributed to the underwriter.

The figure below illustrates the “a priori” consideration where all future liabilities are only estimated and discounted to the starting point $t = 0$.

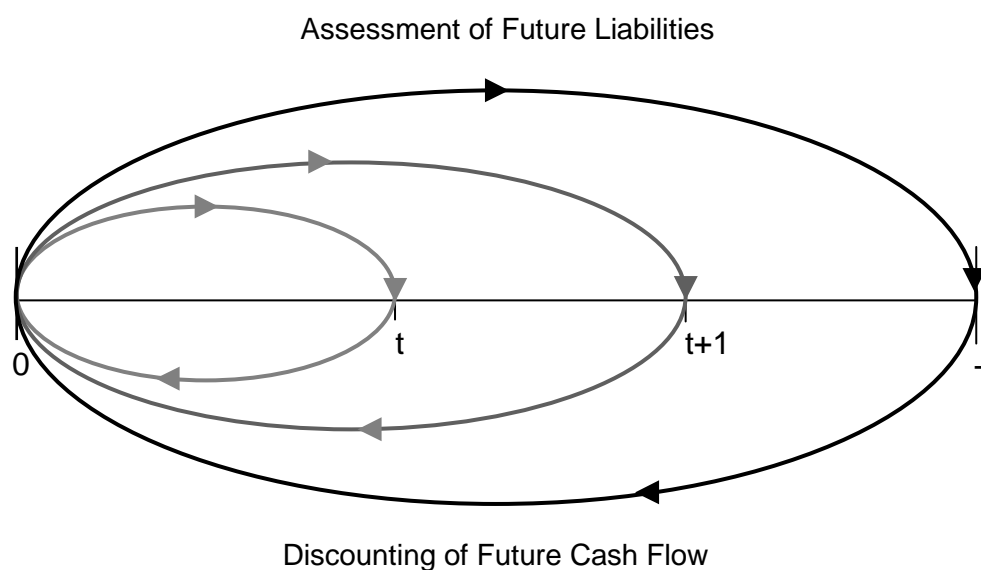


Figure 54: New Business at $t = 0$ ³⁴

The following calculation example illustrates an “a priori” consideration where only estimated values are used. At time $t=0$, the following data input are given:

Market Interest Rate	4.0%
Premium	1,000.0
Cost Ratio	25.0%
Combined Ratio	97.5%
S&P Company Level	150.0%
S&P Premium Rate	27.0%
S&P Reserve Ratio	10.0%
Extra Dividend	12.0%

³⁴ Heep-Altiner, Maria: Ausgewählte Aspekte der wertorientierten Unternehmenssteuerung in der Schadenversicherung; p. 63.

The required extra dividend of 12% and the capital allocation of 150% refer to the target values of an industrial insurer, because there are increased requirements with respect to the return in contrast to a mutual insurance company. The following table illustrates the estimated cash flow situation at the beginning of the consideration time period.

Period	CF in %	Average Duration	Premium	Costs	Nominal Values Claims		Result
					Incurred	Future	
1	30.0%	0.5	1,000.0	250.0		217.5	532.5
2	25.0%	1.5				181.3	-181.3
3	20.0%	2.5				145.0	-145.0
4	15.0%	3.5				108.8	-108.8
5	10.0%	4.5				72.5	-72.5
Total	100.0%	2.0	1,000.0	250.0	0.0	725.0	25.0

Figure 55: Nominal Cash Flow at t=0

In the first step the nominal cash flow is calculated. Independent on the duration of the liabilities the total cash balance is 25.0.

Period	Accumul. Middle of the Period	Discount 4.00%	Premium	Costs	Discountend Values Claims		Result
					Incurred	Future	
1		98.06%	980.6	245.1		213.3	522.2
2		94.29%				170.9	-170.9
3		90.66%				131.5	-131.5
4		87.17%				94.8	-94.8
5		83.82%				60.8	-60.8
Total			980.6	245.1	0.0	671.2	64.2

Figure 56: Discounted Cash Flow at t=0

In the second step the discounted cash flow is calculated. In this case (depending on the duration of the liabilities) the cash balance will increase up to 64.2. It must be checked whether the calculated cash balance is sufficient enough with respect to the extra dividend requirements. In the next table the capital allocation according to Standard & Poors model is calculated at time t=0.

Period	Base for Capital Allocation			Capital Allocation due to S&P			
	Premium	Claims	Reserve	Prem. Fact. 27.0%	Res. Fact. 10.0%	Total	Ent. Fact. 150.0%
1	1,000.0	217.5		270.0		270.0	405.0
2		181.3	507.5		50.8	50.8	76.1
3		145.0	326.3		32.6	32.6	48.9
4		108.8	181.3		18.1	18.1	27.2
5		72.5	72.5		7.3	7.3	10.9
Total		725.0					

Figure 57: Capital Allocation at t=0

The required costs of capital are calculated in the following table according to the required cost of capital ratio of 12% in order to check the target fulfillment.

Period	Accumul. Begin of the Period	Discount 4.00%	Required Capital	Cost of Capital with CoC Rate 12.0%		Amount of Cover.	Target Fulfillment in %
				Nominal	Discounted		
1		100.00%	405.0			522.2	
2		96.15%	76.1	48.6	46.7	-170.9	
3		92.46%	48.9	9.1	8.4	-131.5	
4		88.90%	27.2	5.9	5.2	-94.8	
5		85.48%	10.9	3.3	2.8	-60.8	
6		82.19%		1.3	1.1		
Total					64.3	64.2	100.0%

Figure 58: Target Fulfillment at $t=0$

The table shows the target fulfillment in the “a priori” consideration at about 100.0%.

General Liability – Existing Business

“A posteriori” the cash flows CF_1, CF_2, \dots, CF_t for past liabilities have realized and the cash flows $CF_{t+1}, CF_{t+2}, \dots, CF_T$ for future liabilities have to be estimated according to a modified forecast. The past cash flows must be accumulated up to t where the future cash flows have to be discounted back to t , see the figure below.

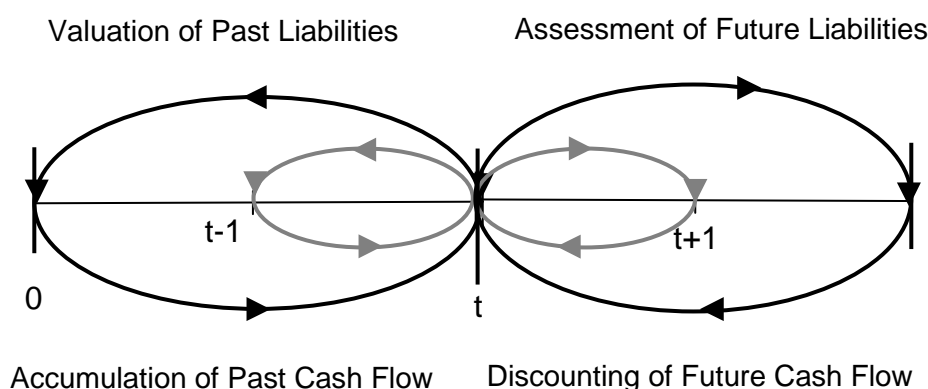


Figure 59: Existing Business at t ³⁵

In the case that the realized and future cash flows are unknown or difficult to estimate, the following approximation scheme can be used:

³⁵ Heep-Altiner, Maria: Ausgewählte Aspekte der orientierten Unternehmenssteuerung in der Schadenversicherung; p. 63.

- The “a priori” estimated cash flow pattern until time t can be calibrated to 100% and used as cash flow pattern for the incurred liabilities.
- The “a priori” estimated cash flow pattern starting from time $t + 1$ can be calibrated to 100% and used as cash flow pattern for the future liabilities.

The realized cash flows until time t must be accumulated with the realized risk-free interest rates r_1, r_2, \dots, r_t , and the estimated future cash flows from time t must be discounted with the estimated risk-free interest rates $r_{t+1}, r_{t+2}, \dots, r_T$.

In this context, it can be worked approximately with a fixed average interest rate for the past and a fixed average interest rate for the future. As an approximation, it is also possible to “fix” the capital allocation to the “a priori” allocation.

In the example considered before, the claims and interest rate experience and estimation have developed at time $t = 2$ in the following way:

Realized Market Interest Rate	3.75%
Estimated Future Interest Rate	3.50%
Realized Incurred Claims Payment	400.0
Estimated Future Claims Payment	350.0

At $t=2$ the realized market interest rate of 3.75% is different to the initially estimated risk-free market interest rate of 4%. The prospective market interest rate is estimated with 3.5%. The expected loss ratio over the total run-off period is estimated as 75%. Those developments will have a negative impact on profitability.

In this example, the cash flow pattern will be approximated in the way previously described. The change in claims experience leads to nominal liquid balance of zero.

Period	Cash Flow in %		Nominal Values				Result
	Incurred	Future	Premium	Costs	Claims Incurred	Claims Future	
1	30.0%		1,000.0	250.0	218.2		531.8
2	25.0%				181.8		-181.8
3		20.0%				155.6	-155.6
4		15.0%				116.7	-116.7
5		10.0%				77.8	-77.8
Total	55.0%	45.0%	1,000.0	250.0	400.0	350.0	0.0

Figure 60: Nominal Cash Flow at $t=2$

In a second step the incurred values will be accumulated until $t=2$ with the realized market interest rate of 3.75% as following:

- For period 1: $(1+0.0375)^{1.5} = 1.0568$,
- For period 2: $(1+0.0375)^{0.5} = 1.0186$.

The estimated future cash flows will be discounted to $t = 2$ with the estimated future risk-free interest rate of 3.50% as follows:

- For period 3: $(1 + 0.035)^{-1/2} = 0.9892$,
- For period 4: $(1 + 0.035)^{-3/2} = 0.9497$,
- For period 5: $(1 + 0.035)^{-5/2} = 0.9176$.

Accumulation of incurred past cash flows and discount of estimated future cash flows results to an overall discounted cash balance of 41.7.

Period	Accumul. Middle of the Period 3.75%	Discount 3.50%	Discountend Values				Result
			Premium	Costs	Claims		
					Incurred	Future	
1	105.68%		1,056.8	264.2	230.6		562.0
2	101.86%				185.2		-185.2
3		98.29%				152.9	-152.9
4		94.97%				110.8	-110.8
5		91.76%				71.4	-71.4
Total			1,056.8	264.2	415.8	335.1	41.7

Figure 61: Accumulated / Discounted Cash Flow at $t=2$

Although the liquid balance after accumulation and discounting is positive, it must be checked however, whether the liquid balance is sufficient with regards to the required capital costs. The following table illustrates the reserve at the beginning of the period, which is needed as a base for the capital allocation.

Period	Base for Capital Allocation			Capital Allocation due to S&P			
	Premium	Claims	Reserve	Prem. Fact.	Res. Fact.	Total	Ent. Fact.
				27.0%	10.0%		150.0%
1	1,000.0	218.2		270.0		270.0	405.0
2		181.8	531.8		53.2	53.2	79.8
3		155.6	350.0		35.0	35.0	52.5
4		116.7	194.4		19.4	19.4	29.2
5		77.8	77.8		7.8	7.8	11.7
Total		750.0					

Figure 62: Capital Allocation at $t=2$

To make a re-examination of the profitability at $t=2$, the considerations of the previous steps have to be combined. The target fulfillment is calculated as the accumulated / discounted required extra dividends in relation to the accumulated / discounted cash flow. In the example considered, the target fulfillment at $t = 2$ equals 59.1%.

Period	Accumul.	Discount	Required Capital	Cost of Capital with		Amount of Cover.	Target Fulfillment in %
	Begin of the Period 3.75%	3.50%		CoC Rate Nominal	12.0% Discounted		
1	107.64%		405.0			562.0	
2	103.75%		79.8	48.6	50.4	-185.2	
3		100.00%	52.5	9.6	9.6	-152.9	
4		96.62%	29.2	6.3	6.1	-110.8	
5		93.35%	11.7	3.5	3.3	-71.4	
6		90.19%		1.4	1.3		
Total					70.6	41.7	59.1%

Figure 63: Target Fulfilment at $t=2$

The realized market interest rate of 3.75% and the prospective market interest rate of 3.5% do not match the predicted value of 4% at the beginning. Furthermore, there is an adverse claims development. All those aspects have a negative impact on the profitability of the segment.

General Liability – Conclusion

To manage a segment profitably, it must be checked at different points of time during the whole run-off period whether there is sufficient profitability according to the requirements which were applied at the beginning.

A profitability analysis with respect to the traditional view does not provide any meaningful result and no efficient segment control. This type of analysis is quite simple, but does not match the risk.

A modified view with the consideration of investment income together with costs of capital shows a more realistic and accurate result.

An “a priori” consideration at $t=0$ is based on estimated liabilities. An “a posteriori” check at $t > 0$ serves as a control of the incurred values until t and the estimated values starting from t .

The comparison of the incurred values with the initial values helps to find miscalculations in a segment and enables the start of countermeasures early enough to avoid negative developments on the balance sheet.

3.1.6 CoC Requirements and Target Combined Ratios

There is no unique system to specify CoC requirements or an adequate CoC ratio. In the following section, some characteristics for the specification of those requirements are discussed:

- CoC ratios are dependent on the risk-free interest rate, the security level and other individual factors of the insurance company.
- CoC ratios are always positive, because they represent the risk premium paid to investors.
- CoC ratios normally decrease in the case of capital increase (due to the usual risk / return relations). If there is no risk at all, the CoC ratio must be zero. Low risk investors can only expect a low risk premium.
- There may be different risk / return levels due to different markets. In a market with a restricted number of participants (e.g. industrial lines insurer or reinsurer) there may be higher risk / return profiles than in a competitive market (e.g. private lines insurer).
- The CoC ratios will increase if the risk-free interest rate increases, because higher market rates are responsible for higher CoC requirements. It could be the case that the CoC requirements increase disproportionately to the market interest rate because a lower market interest rate is faster exceeded than a higher rate.

Typical models to specify the CoC requirements can be expressed by the following formulae:

$$ED = a \cdot e^{-b \cdot SL},$$

$$ED = c + d \cdot r$$

ED extra dividend ratio,

SL security level,

a, b, c, d model parameter and

r risk-free interest rate.

In the table below “typical” CoC requirements for different types of insurers are illustrated where those insurers represent different markets. Therefore one observes that the highest capital requirements (representing the lowest risk) are combined with the highest return requirements. At a first sight this seems to be a contradiction to the normal risk / return relations.

Branch	Private Insurer	Commercial Insurer	Reinsurer
Target rating	BBB	A	AA
Entity factor	125.0%	150.0%	175.0%
Security level	99.5%	99.8%	99.9%
CoC Rate	7.50%	11.25%	15.00%

Figure 64: CoC Requirements at 4% Market Interest

Having specified CoC models as in the table above, target combined ratios can be calculated depending on the chosen parameter. The influence of the CoC requirements and the security levels on the target combined ratios will be shown in the following tables.

In all these examples we keep the CoC ratios fixed and do not link them to the risk-free interest rates. In this case the target combined ratios are highly dependent on the risk-free interest rate level. In a later section, it will be analyzed that the target combined ratios can be stabilized if the CoC ratios are linked to the risk-free interest rates, e.g. in form of a linear equation.

	Duration			
	1	2	3	4
Private insurer	97.9%	98.6%	99.4%	100.0%
Commercial insurer	95.6%	95.8%	96.1%	96.3%
Reinsurer	92.8%	92.4%	92.0%	91.6%

Figure 65: Target Combined Ratios at 2% Market Interest

The target combined ratios of the private line and commercial insurer increase when the average payment duration increases due to the discounting effect. Therefore, the insurer can afford a higher claims experience than an insurer with lower average claims payment duration.

However, this effect is not observed for the target combined ratio of the reinsurer given an interest rate of 2%. The target combined ratio decreases when the duration of the claims payment increases. This is due to the high capital provision over a long period of time and the consequentially high Cost of Capital requirements. At a market rate of 2% this effect cannot be compensated by discounting.

	Duration			
	1	2	3	4
Private insurer	98.6%	100.8%	103.1%	105.5%
Commercial insurer	96.3%	98.0%	99.6%	101.3%
Reinsurer	93.5%	94.5%	95.4%	96.3%

Figure 66: Target Combined Ratios at 4% Market Interest

The table above illustrates the discounting effect at a market interest of 4%. Due to the results the following conclusions can be pointed out:

- All companies can afford a higher target combined ratio than in the scenario with a market rate of 2% in every case.
- All insurance companies still need a target combined ratio below 100% at the duration of one year.
- The discounting effect compensates the high capital requirements for the reinsurer so that the target combined ratio also increases in the case of a higher duration.

It is evident that the CoC requirements and the target combined ratios are mainly dependent on the businesses model and the market interest rates (due to the discounting effect).

3.2 Asset & Underwriting Performance Measurement

The main focus in the previous section has been on the success of underwriting. However insurance products are a combination between underwriting and asset management. Therefore the asset management should also be taken into account.

3.2.1 Asset Performance

Private investment companies are free to allocate their assets. They optimize their assets due to their own risk-taking. In comparison to private investment companies, insurance companies are subject to special governmental restrictions, because they have technical liabilities from the insured on the liability side of the balance sheet. Therefore the insurance company has to ensure that the liabilities can be paid at any time. This affords an appropriate asset liability management.

In order to have a better understanding of the aspects of an asset liability management one first starts with the optimization of an asset portfolio according to the Markowitz theory.

Calculation Example – Risk return Analysis

An investment company with two assets or asset classes will firstly be examined where the following input data are given:

Correl. 10%	Volume at Begin	Value after one year expected	STD
Asset 1	1,000	1,100	100
Asset 2	1,000	1,200	300

Figure 67: Input Data given two Assets

The optimal allocation of both assets will be evaluated. Therefore, the standard deviation and expected return given different allocations will be examined. In order to simplify this example, the asset allocation can only be changed within 10% levels.

First of all, the expected returns of Asset 1 and 2 are examined. The return with a% asset 1 and (1 – a)% asset 2 of a portfolio is calculated by the weighted average of both returns:

$$R_a = a \cdot R_1 + (1 - a) \cdot R_2$$

R_a return of the mixed portfolio,

R_1 return of 100% asset 1,

R_2 return of 100% asset 2.

The following calculation shows the expected return of a portfolio consisting of 90% of Asset 1 and 10% of Asset 2:

$$R_{90\%} = 90\% \cdot 10\% + 10\% \cdot 20\% = 11\%.$$

The standard deviation is calculated as the square root of the variance

$$\text{VAR}(R_a) = (a \cdot \sigma_1)^2 + ((1 - a) \cdot \sigma_2)^2 + 2 \cdot \rho \cdot a \cdot \sigma_1 \cdot (1 - a) \cdot \sigma_2$$

with σ_1 , σ_2 the standard deviation of the returns of Asset 1 and Asset 2 as well as ρ the correlation between both assets. For the chosen example, we obtain the following result:

$$\begin{aligned}\text{VAR}(R_{90\%}) &= (90\% \cdot 100)^2 + (10\% \cdot 300)^2 + 2 \cdot 10\% \cdot 90\% \cdot 100 \cdot 10\% \cdot 300 \\ &= 9,540.\end{aligned}$$

Therefore the standard deviation is calculated as $\sigma_{90\%} = 9,540^{0.5} = 98$. The following table illustrates the complete risk / return analysis.

Share Asset 1	Expected	STD	Expected Return
100%	1,100	100	100
90%	1,110	98	110
80%	1,120	105	120
70%	1,130	119	130
60%	1,140	139	140
50%	1,150	163	150
40%	1,160	188	160
30%	1,170	215	170
20%	1,180	243	180
10%	1,190	271	190
0%	1,200	300	200

Figure 68: Risk / Return Analysis given two Assets (1)

The allocation with 100% of Asset 1 is inefficient because the allocation with 90% of Asset 1 creates a higher return in combination with a lower standard deviation. Therefore, the first allocation is dominated by the second one. This is due to the diversification effect.

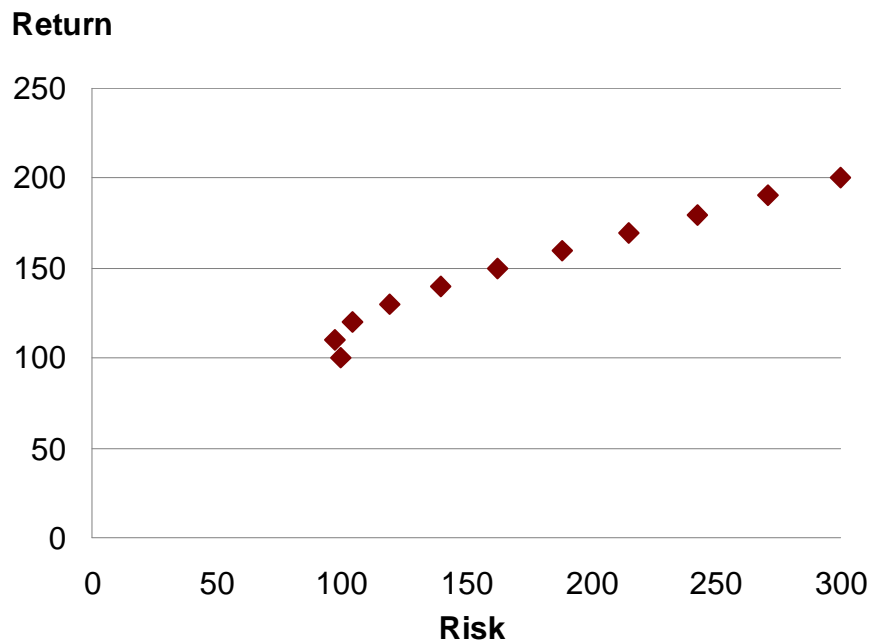


Figure 69: Risk / Return Profile given two Assets

Obviously the combination with 90% of Asset 1 generates a minimal risk (expressed in terms of the standard deviation). The figure above shows a typical Markowitz allocation with the efficient boarder and one inefficient combination. Only the allocations on the border are efficient.

Calculation Example - Preference-Systems

There are a lot of different efficient portfolios. However, which allocation should a company choose? The chosen portfolio should fit with the individual company preferences. A proper allocation can be determined by using preference functions. Two classic preference functions (in the context of value based management), which were introduced in the first chapter, will be determined after one year and will be used to find out the best solution:

$$\begin{aligned} \text{RORAC} &= \text{Expected Value} / \text{Required Capital} \\ &\approx E / (t_{\alpha} \cdot \text{STD}), \\ \text{EVA} &= \text{Expected Value} - \text{Capital Costs} \\ &\approx E - k \cdot t_{\alpha} \cdot \text{STD} \end{aligned}$$

with α the risk level and E the expected value. In the following, a private lines insurer will be examined by using these two preference systems. This insurer invests in the two asset classes as before and concentrates only on risk life insurance. In this case, there is a (relatively) safe outflow of liabilities with the amount of 1,100 and a standard deviation near to zero. We also assume a cost of capital ratio of 7.5% and a BBB- rating (conforming to the Solvency II – Security Level of 99.5%).

Share Asset 1	Expected Value			STD
	Assets	Liabilities	Result	
100%	1,100	1,100	0	100
90%	1,110	1,100	10	98
80%	1,120	1,100	20	105
70%	1,130	1,100	30	119
60%	1,140	1,100	40	139
50%	1,150	1,100	50	163
40%	1,160	1,100	60	188
30%	1,170	1,100	70	215
20%	1,180	1,100	80	243
10%	1,190	1,100	90	271
0%	1,200	1,100	100	300

Figure 70: Risk / Return Analysis given two Assets (2)

In this case, the risk return profile is quite similar to the risk return profile of the investment company only investing in two assets with the difference that all expected cumulated values are reduced by 1,100, where, with respect to the combination of 0% Asset 1 and 100% Asset 2, we obtain the following results:

$$\begin{aligned} \text{RC} &= 2.58 \cdot 300 &= 773 \\ \text{RORAC} &= 100 / 773 &= 12.9\%, \\ \text{EVA} &= 100 - 7.5\% \cdot 773 &= 42 \end{aligned}$$

In the following table, all RORAC and EVA combinations are listed in such a way that an optimal value can be derived.

Share Asset 1	STD	RC 99.50%	RORAC	EVA 7.50%
100%	100	258	0.0%	-19
90%	98	252	4.0%	-9
80%	105	270	7.4%	0
70%	119	308	9.8%	7
60%	139	359	11.1%	13
50%	163	419	11.9%	19
40%	188	485	12.4%	24
30%	215	554	12.6%	28
20%	243	625	12.8%	33
10%	271	699	12.9%	38
0%	300	773	12.9%	42

Figure 71: Capital Allocations – Private Line Insurer

Although different methods were used, the same optimal results can be observed in this calculation example. According to RORAC, the allocation with 0% of Asset 1 and 100% of Asset 2 is the most profitable with 12.9% extra dividend. The maximum EVA is also observed given 100% Asset 2.

RORAC as well as EVA provide preference systems in order to find an optimal decision among all efficient portfolios.

3.2.2 Asset & Underwriting Performance

Looking at a private line insurer with two Assets and two lines of business (LoB) in this section, the following input situation can be assumed:

Correl. 10%	after one year		Correl. 10%	after one year	
	expected	STD		expected	STD
Asset 1	1,100	100	LoB 1	1,075	100
Asset 2	1,200	300	LoB 2	975	300

Figure 72: Input Data given two Assets and two LoB

A correlation of 10% is given between the assets as well as between the liabilities, excluding a correlation between assets and liabilities.

Because of four variables, there are many different possible combinations. Due to this fact, we will only take into account allocations with 50% steps. In the following table the expected values and standard deviations are listed but only for 0% 50% and 100% combinations:

Share		STD			Exp.
Asset 1	LoB 1	Assets	Liab.	Total	Result
100%	100%	100	100	141	25
50%	100%	163	100	191	75
0%	100%	300	100	316	125
100%	50%	100	163	191	75
50%	50%	163	163	230	125
0%	50%	300	163	341	175
100%	0%	100	300	316	125
50%	0%	163	300	341	175
0%	0%	300	300	424	225

Figure 73: Risk / Return Analysis given two Assets and two LoB

Given a y% share of asset 1 and a x% share of liability 1 we obtain the following formulas:

$$\begin{aligned}
 E &= (y \cdot 1,100 + (1 - y) \cdot 1,200) - (x \cdot 1,075 + (1 - x) \cdot 975), \\
 \text{VAR}(A) &= (y \cdot 100)^2 + ((1 - y) \cdot 300)^2 + 2 \cdot 10\% \cdot y \cdot 100 \cdot (1 - y) \cdot 300 \\
 \text{VAR}(L) &= (x \cdot 100)^2 + ((1 - x) \cdot 300)^2 + 2 \cdot 10\% \cdot x \cdot 100 \cdot (1 - x) \cdot 300 \\
 \text{VAR} &= \text{VAR}(A) + \text{VAR}(L)
 \end{aligned}$$

Given a combination with 50% of Asset 1 and 50% of LoB 1 we obtain the following results:

$$E = (50\% \cdot 1,100 + 50\% \cdot 1,200) - (50\% \cdot 1,075 + 50\% \cdot 975) = 125$$

$$STD = (163^2 + 163^2)^{0.5} = 230$$

Please notice that the standard deviation of 163 given a combination of 50% Asset 1 has been calculated before. (The same calculation applies to the standard deviation given a combination of 50% LoB 1.)

Calculation Example – Private Line Insurer

In the following section, different business models will be checked with respect to the given input data – a private line insurer and a reinsurer. The results for the private line insurer are listed below with respect to all combinations of 0%, 50 % and 100 % of Asset 1 or LoB 1.

Share		Exp. Result	RC 99.50%	RORAC	EVA 7.50%
Asset 1	LoB 1				
100%	100%	25	364	6.9%	-2
50%	100%	75	492	15.2%	38
0%	100%	125	815	15.3%	64
100%	50%	75	492	15.2%	38
50%	50%	125	593	21.1%	81
0%	50%	175	879	19.9%	109
100%	0%	125	815	15.3%	64
50%	0%	175	879	19.9%	109
0%	0%	225	1,093	20.6%	143

Figure 74: RoRAC and EVA Optimum – Private Line Insurer

The RoRAC optimum is achieved in “the middle” given a combination of 50% Asset 1 and 50% LoB 1 where the EVA optimum is achieved at “the boundary” given 0% Asset 1 and 0% LoB 1. This is a quite extreme combination with a high capital requirement and it is not clear, if such a high capital amount is available.

In total, the situation is much more complex and less transparent than in the case of two assets. On the one hand it is still possible to exclude inefficient allocations but on the other hand an efficiency curve cannot be easily identified.

Looking at the risk return profiles of the combinations previously analyzed, “visually” efficient combinations can be identified, but there are still a lot of inefficient combinations. In the figure below all combinations of 0%, 25%, 50%, 75% and 100% Asset 1 or LoB 1 are listed.

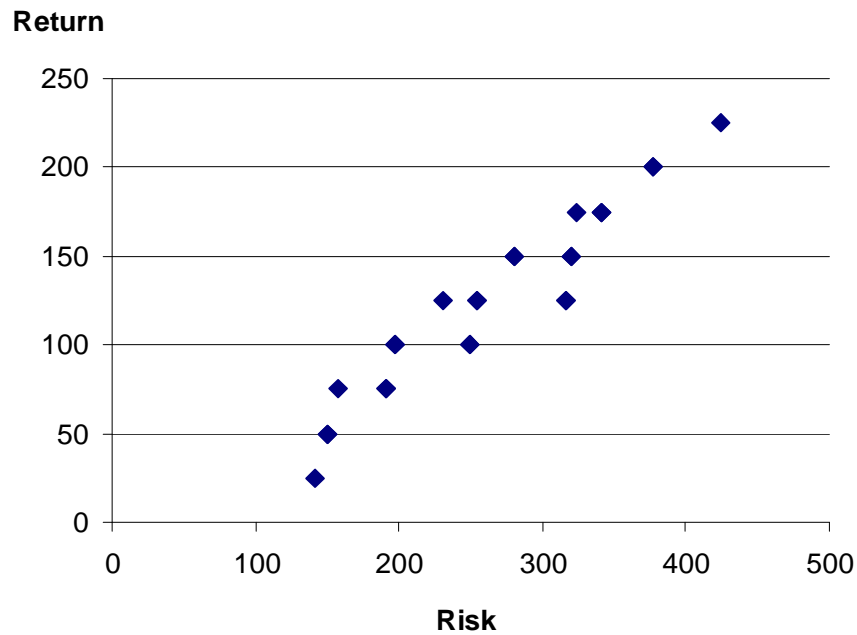


Figure 75: Risk / Return Profile given two Assets and two LoB

In the next calculation example the RoRAC and EVA optima for a reinsurer with different CoC parameter is analyzed.

Calculation Example - Reinsurer

The results for the reinsurer are listed in the table below. As previously stated, only combinations with 0%, 50% and 100% of Asset 1 or LoB 1 are shown in the figure. The RORAC optimum is achieved for a combination with 50% Asset 1 and a 50% LoB 1. The EVA optimum is achieved for the “extreme” combination with 0% Asset 1 and 0% LoB 1. The optimal combinations are the same as before whereas the optimal values are different.

Share		Exp. Result	RC 99.90%	RORAC	EVA 15.00%
Asset 1	LoB 1				
100%	100%	25	437	5.7%	-41
50%	100%	75	590	12.7%	-14
0%	100%	125	977	12.8%	-22
100%	50%	75	590	12.7%	-14
50%	50%	125	711	17.6%	18
0%	50%	175	1,055	16.6%	17
100%	0%	125	977	12.8%	-22
50%	0%	175	1,055	16.6%	17
0%	0%	225	1,311	17.2%	28

Figure 76: RoRAC and EVA Optimum – Reinsurer

A portfolio with two risky branches and two risky asset classes creates a different return structure than a portfolio with two risky assets and one more or less risk-free liability. The situation in the second case reflects the classical Markowitz approach whereas the (more complex) situation in the first case is more realistic.

Calculation Example - Conclusion

The capital cost rate is predefined by the management. But there is an uncertainty about the achievability of this goal. The decisive factor is the market, which can be hardly influenced by the insurer. In order to achieve a specified target, the insurer would have to increase the premium or the capital market returns. But the insurer has to focus on the market prices and the competitors in order to be competitive. Nevertheless, a relatively low capital cost rate would be unattractive for potential investors. As a consequence, companies are forced to set almost unachievable goals.

Let's have a look at the previously examined reinsurer with a security level of 99.9% and a capital cost rate of 15%. It is questionable whether this capital cost rate is appropriate. At this security level the insurer expects one default within 1,000 years. If you compare that fact with the relatively high capital cost rate the proportionality between risk and return is doubtful.

The rate of return defined by the management is often outside the efficiency curve. There are two possible measures to "produce" achievable combinations: Firstly, the insurer can reduce the aimed extra dividend. However, the insurer is in a competitive situation and investors could be dissatisfied with the return on investment. Therefore, it is not so easy to reduce the rate of return. Secondly, they could take more risks, but then the targeted security level would not be reached.

By using the EVA method some questions occur. Is it reasonable to define a negative EVA value as a destruction of capital? In order to specify this issue one could look at the figure above. An extra dividend of 12.8% (additionally to the risk-free return) with negative EVA is observed. The RORAC produced is quite high, so the interpretation as capital destruction seems to be doubtful.

3.2.3 Asset & Underwriting Performance – Separate Treatment

In the previous section it was demonstrated how the simultaneous optimization of underwriting and capital investment can be managed in an insurance company. Due to the fact that insurance is a co-product, you can virtually split an insurance company into two parts: Underwriting and asset management. Regarding the asset management, the following assets are assumed in the following:

	Expected		Std. Deviation	
	Return	Accum.	CV	Absolute
Asset 1	4.0%	1,040	0.0%	0
Asset 2	10.0%	1,100	30.0%	330

Figure 77: Input Data – Available Asset Portfolio

It is obvious that Asset 1 represents a risk-free asset. Therefore no capital is needed to secure this asset. In contrast to this, Asset 2 is a risky asset which demands capital to secure the asset. With this in mind, two strategies will be checked:

In the first case, the insurer only invests in the risk-free asset (**Strategy 1**). Alternatively, the insurance company invests also in the risky asset (**Strategy 2**). Comparing those two strategies enables a proper steering of the portfolio according to underwriting and investment impact on the risk. These strategies will be discussed on the basis of the following questions:

- What is the required capital of both strategies at a default level of 0.2 %?
- Which strategy provides a higher return on Risk Adjusted Capital?
- Which strategy is the best?

Taking into account a risk-free investment of the required capital at the beginning of the period as well as the expected result due to investment and underwriting, we obtain the following relationships for both strategies:

$$RC = (t \cdot STD - (E(A) - E(L)) / (1 + r)$$

STD the overall standard deviation,

E(A) the expected value of the assets at the end of year,

E(L) the expected value of the liabilities at the end of the year and

r the risk-free interest rate.

These relationships are derived from the distribution of the capital at the end of the period under an assumption of normally distributed assets and liabilities.

Calculation Example – Strategy 1 with risk-free Assets

As previously stated, the insurance company invests solely in a risk-free asset, for example a government bond with a default risk of almost zero. We assume that the total premium income is at the beginning of the year. Furthermore all cost expenditure is at the end of the year. As a result of this assumption, the premium income can be fully invested over a period of one year. (This assumption can be achieved in any case by consideration of suitable present values.)

		Expected		Std. Deviation	
				CV	Absolute
Asset 1	100.0%	4.0%	1,040	0.0%	0
Asset 2	0.0%	10.0%	0	30.0%	0
LoB 1	100.0%	98.5%	985	15.0%	148
Total			55		148

Figure 78: Input Data – Strategy 1

For Asset 2 and the line of business, a normal distribution is assumed. Moreover there is no correlation between assets and liabilities. The required capital is calculated according to the previously specified formula where for a security level of 99.8 % the factor t equals to 2.88 so that

$$RC = (2.88 \cdot 148 - 55) / 1.04 = 357$$

$$RORAC = (E(A) - E(L)) / RC = 55 / 357 = 15.4\%$$

$$\text{Total Return} = r + RORAC = 4.0\% + 15.4\% = 19.4\%$$

The insurance company needs a required capital of 357 based on a default risk of 0.2 %. An average total RoRAC of 19.4% is achieved.

Calculation Example – Strategy 2 with risky Assets

In this case the insurance company invests 65% in the risk-free asset and 35% is invested in the risky asset class. The data needed for the following calculations are listed in the table below.

		Expected		Std. Deviation	
				CV	Absolute
Asset 1	65.0%	4.0%	676	0.0%	0
Asset 2	35.0%	10.0%	385	30.0%	116
LoB 1	100.0%	99.0%	990	15.0%	149
Total			71		188

Figure 79: Input Data – Strategy 2

For completeness it should be noted that in strategy 2 there is also no correlation between capital investment and the line of business. Due to the risky asset, the company has to provide more capital. Furthermore, the additional costs for the complex asset management are reflected in the combined ratio, which is 0.5 percentage points higher than for strategy 1.

Based on those results it is possible to calculate the required capital and the return on investment. Concerning the previously mentioned formula, we can calculate with respect to the 99.8% security-level as follows:

$$\begin{aligned} \text{RC} &= (2.88 \cdot 188 - 71) / 1.04 = 452 \\ \text{RORAC} &= 71 / 452 = 15.7 \% \\ \text{Total Return} &= 15.7 \% + 4.0 \% = 19.7 \end{aligned}$$

If the results of the different strategies are compared, the following differences can be observed. Following strategy 1, the company has to provide capital of 357 and achieves a total RoRAC of 19.4%. Under strategy 2, a higher capital of 452 must be provided because of the risky assets. This is rewarded with a marginally better return on investment of 19.7%. Does this result imply that strategy 2 is better than strategy 1? In the following section it will be verified whether the results stay valid when the parameters are changed.

Calculation Example – Impact of Parameter Change

To analyze the impact of parameter change, the principal scenarios for both strategies are maintained, but the following parameters are changed:

- Reduction of the risk-free interest rate.
- Increase of the Combined Ratio.
- Reduction of the expected return of asset 2.
- Increase of the standard deviation of asset 2
- Increase of the standard deviation of the LoB.

Due to those changes, both strategies must be analyzed with respect to total RoRAC and the default risk. The following table shows the impact of the parameter changes (with unchanged capital at start):

Parameter	Value		RoRAC	Ruin Prob.
	Old	New		
Risk Free Interest Rate	4.0%	3.0%	15.6%	0.26%
Combinded Ratio	98.5%	99.5%	16.6%	0.26%
Expected Return Asset 2	1,100	1,075	19.4%	0.20%
Std. Deviation of Asset 2	330	550	19.4%	0.20%
Std. Deviation of Branch	15.0%	20.0%	19.4%	1.52%

Figure 80: Impact of Parameter Changes (1)

Due to the fact that strategy 1 invests only in risk-free assets, there is no impact on the RoRAC and the default risk when the expected return decreases and the standard deviation increases with respect to asset 2. Relative to this scenario, only the increase of the LoB volatility produces crucial results.

In the following table the impacts of the parameter changes are illustrated for the second strategy:

Parameter	Value		RoRac	Ruin Prob.
	Old	New		
Risk Free Interest Rate	4.0%	3.0%	17.3%	0.24%
Combinded Ratio	99.0%	100.0%	17.5%	0.25%
Expected Return Asset 2	1,100	1,075	17.8%	0.30%
Std. Deviation of Asset 2	330	550	19.7%	1.30%
Std. Deviation of Branch	15.0%	20.0%	19.7%	0.91%

Figure 81: Impact of Parameter Changes (2)

Strategy 2 is highly affected by the risky asset, in such a way that any increase of the standard deviation produces another crucial impact in this case.

Before the consideration of parameter changes, strategy 2 seemed to provide a (slightly) better performance than strategy 1. After the consideration of parameter changes strategy 2 seems to be more volatile and to produce more crucial situations with respect to the solvency requirements.

Asset & Underwriting Performance – Separate Treatment of Performance

Investment exclusively in risk-free assets is not in any case satisfactory for insurance companies and their ambitious return targets. Due to this fact, a company must sometimes invest in risky asset to increase the profitability due to synergy effects. In such a case, it is important to differentiate between the performance of the underwriting and of the asset management. In the following it will be discussed how underwriting and asset management contribute to an overall performance, see the following table.

	Required Capital	Return	Income	RC after Synergy	Return
Underwriting	357.0	19.4%	69.3	254.4	27.2%
Asset Management	277.2	7.1%	19.8	197.6	10.0%
Total	452.0	19.4%	89.1	452.0	19.7%

Figure 82: Separate Assessment of Performance (1)

The additional income created by asset management is obtained from the difference of income between strategy 1 and strategy 2. Because there is no correlation between assets and liabilities in the example, the required capital for the asset management will be allocated due to the covariance principle as follows:

$$\begin{aligned}
 RC^2 &= RC_A^2 + RC_{UW}^2. \\
 RC_A^2 &= (452^2 - 357^2)^{0.5} = 277.2 \\
 RORAC &= 19.8 / 277.2 = 7.14 \%
 \end{aligned}$$

Due to synergy, the total capital requirements are less than the sum of the capital requirements of underwriting and asset management. The resulting synergy effect can be allocated to the different segments as illustrated in the following table:

	Required Capital	Return	Income	RC after Synergy	Return
Underwriting	357.0	19.4%	69.3	254.4	27.2%
Asset Management	277.2	7.1%	19.8	197.6	10.0%
Total	452.0	19.4%	89.1	452.0	19.7%

Figure 83: Separate Assessment of Performance (2)

If a company allocates the synergy effects, then this results in reduced targets for the underwriting and the asset management. This may enforce the competitive strength of the company. On the other hand, it must be pointed out that even with a restricted performance of the asset management, investing in risky assets may enable the production of a higher overall return. This happens because of the synergy effect.

3.3 Asset & Underwriting Performance Optimization

The traditional assessment of performances in non-life insurance is effected by the combined loss and expense ratio. Via internal models, it is possible to achieve suit-

able aims, so that one generates an adequate return on risk adjusted capital including the returns of free liquidity.

The statements in the following section represent an extract from the paper “Performance Optimization in Non-Life Insurance” from February 2011 published by the Institute for Insurance Studies, Cologne University of Applied Sciences.³⁶

3.3.1 Preliminary Remarks

Sometimes, it is not possible to achieve a required target without restrictions. In some cases, the insurance market does not provide the needed premium level with regards to a specified target. Therefore, one has to check the possibilities of finding a convenient business strategy with respect to the risk return profile.

With the help of internal models, different business strategies can be checked and compared with each other with respect to the risk return profile, see the figure below.

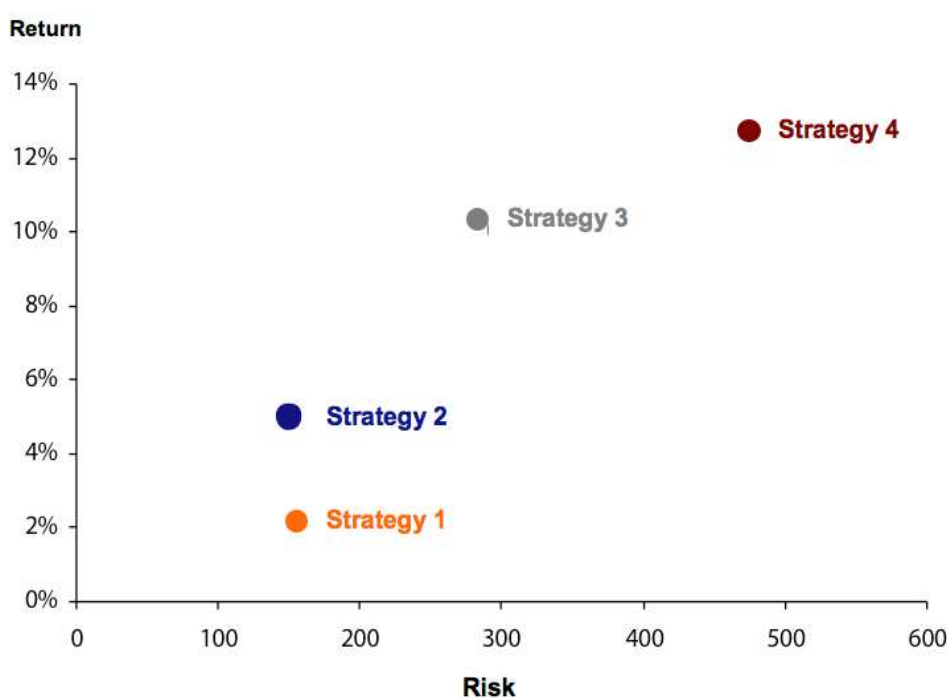


Figure 84: Risk / Return Profile given Different Business Strategies

This design of the risk-return-profile in the figure above is based upon the classic approach of Markowitz, which has been a standard approach describing the composition of asset-portfolios for a long time. Applying this approach, the risk is normally defined by the standard deviation. It is obvious that this simple illustration

³⁶Heep-Altiner, 2011, Performanceoptimierung des (Brutto) Neugeschäfts in der Schadenversicherung.

shows that strategy 1 is inefficient in comparison to strategy 2, because strategy 2 takes less risk and gets more return. Between the strategies 2, 3 and 4, it cannot be decided which one is the best. For this purpose a risk preference structure is required. An investor who is adverse to risk would choose strategy 2, whereas an investor willing to take risk would decide on strategy 3 or 4.

The correct quantification of a risk-preference-structure is normally not as simple as it may seem. But in the context of value-based management there are some “natural” preference systems, as follows:

- There are (legal) minimum conditions for the exposure of risks, e.g. according to solvency or rating.
- A value-based management is based on determined risk-return key performance indicators (KPI), e.g. RORAC (=“Return on Risk Adjusted Capital”) or EVA (=“Economic Value Added”).

An internal model establishes a KPI based on risk and return for every strategy, which has to fulfil the legal minimum conditions.

An internal model for non-life insurance generally calculates the economic capital after a 1-year-period with the aid of Monte Carlo Simulations in order to model the diversity of stochastically interactions. Without a closed formula, it is not possible to apply classic techniques of optimization. In the context of internal models, optimization implies that predefined combinations are simulated and compared with each other. That identifies better business strategies but it may not be the best solution. Thus, one should try to find better “initial values” for the testing of alternative business strategies with the aid of simpler algorithms.

The following describes an optimization algorithm with respect to a strategy for (gross) new business by a simplified closed formula approach where:

- the underwriting is divided in different lines of business and
- the assets are divided in different asset classes.

Generally, due to the simplicity of this approach it is not always suitable for the optimization of net new business strategies. In this case an application may be useful, if there is a quota reinsurance or if only net numbers are taken into account. The simplified approach consists of the following assumptions:

1. With respect to the new business premium, the shares $y_0 + y_1 + \dots + y_m = 1$ correspond to the lines of business L_0, L_1, \dots, L_m with expected combined ratios $E[L_j] = c_j$. Concerning the business line L_0 the index may be dropped to keep the formulas simple.
2. The new business premium is invested in the asset-classes A_0, A_1, \dots, A_n with the shares $x_0 + x_1 + \dots + x_n = 1$ and expected cumulated returns $E[A_i] = r_i$. Concerning the asset class A_0 the index may be dropped to keep the formulas simple.
3. The new business will be secured by the capital EK_α according to the security level α (e.g. the level appropriate to solvency requirements) which is invested risk-free with an riskless interest rate r_f , so that for the stochastic capital at the end of the period the following relation holds:

$$EK_{1,\alpha}(\omega) = EK_\alpha \cdot (1 + r_f) + P\&L(\omega).$$

4. At least the whole P&L is assumed to be approximately normally distributed, such that

$$EK_\alpha = (t_\alpha \cdot S - E) / (1 + r_f)$$

with $E = E[P\&L]$ the expected value and $S = \text{STD}[P\&L]$ the standard deviation.

It is assumed that all premium income is contained at the beginning of the year and all claims and costs are expended at the end of the year. Also, the premium is fully invested over a period of one year. This assumption can be achieved by a suitable consideration of present values.

The assumptions in (1) and (2) do not take into account legal or intra-company restrictions of the amount of several lines of business or asset-allocations. The model-approach can be modified - but that is not the focus at this stage.

The assumptions in (3) and (4) simplify the model approach and enable closed formulas. Because of legal regulations in non-life insurance about the amount of risky asset categories the constraint (3) constitutes no restriction. With a good diversified portfolio assumption (4) should be achievable.

During the following model approach, tax treatment is not taken into account assuming a proportional taxation. If there are significant differences in the fiscal treatment, the fiscal approaches should be implemented in the parameter. Furthermore, it is possible to have a pure net consideration (unless an optimization of the rein-

surance structure should be achieved) or reinsurance may be treated as a highly correlated asset (unless it can be treated approximately as a quota reinsurance).

If σ_i is the volatility of the asset category i and τ_j is supposed to be the volatility of the combined ratio from the line of business j , the following correlations hold:

$$E = \sum x_i \cdot r_i - \sum y_j \cdot c_j$$

$$S = (\sum x_i^2 \cdot \sigma_i^2 + \sum y_j^2 \cdot \tau_j^2 + 2 \cdot \sum \text{correlations})^{1/2}$$

Both formulas describe a generalization of the classic Markowitz approach. After defining $r_j^* = (-c_j)$, the first equation changes to:

$$E = \sum x_i \cdot r_i + \sum y_j \cdot r_j^*.$$

This is equivalent to a Markowitz approach where a given business volume is invested in one group of asset classes and another business volume is invested in a second group of asset classes.

In the following section, a simplified model approach with uncorrelated assets and liabilities is studied. In this case, the general solution can be described explicitly, so that the most important facts of the solution can be discussed. The general approach will be sketched out afterwards.

3.3.2 Model Approach – Uncorrelated Risks

As already explained, it is possible to eliminate inefficient portfolios immediately according to the criteria of efficiency. To decide between two efficient portfolios (to choose one optimal portfolio) a risk-preference-structure is needed. In the context of value-based management two preference-functions exist. On the one hand, the RORAC (= "Return on Risk Adjusted Capital") and on the other hand, the EVA (= "Economic Value Added"). In the simplified model approach, those are defined as follows:

$$\begin{aligned} \text{RORAC} &= r_f + E / EK_\alpha = r_f + (1 + r_f) \cdot E / (t_\alpha \cdot S - E) \\ &=: r_f + a \cdot E / (t_\alpha \cdot S - E) \end{aligned}$$

$$\begin{aligned} \text{EVA} &= E - (p - r_f) \cdot EK_\alpha \\ &= E - (p - r_f) \cdot (t_\alpha \cdot S - E) / (1 + r_f) \\ &= ((1 + p) / (1 + r_f)) \cdot (E - ((p - r_f) / (1 + p)) \cdot t_\alpha \cdot S) \\ &=: b \cdot (E - c \cdot S) \end{aligned}$$

The parameter p declares the individual target return ratio of the company. With respect to these two preference-functions, the following criteria for an optimal solution is obtained:

$$\begin{aligned}\partial/\partial(*) \text{ RORAC} &= a \cdot (\partial/\partial(*) E \cdot S - E \cdot \partial/\partial(*) S) / (t_\alpha \cdot S - E)^2 = 0 \\ \partial/\partial(*) \text{ EVA} &= b \cdot (\partial/\partial(*) E - c \cdot \partial/\partial(*) S) = 0\end{aligned}$$

This implies the following necessary conditions for an optimum:

$$\begin{aligned}\partial/\partial(*) E / \partial/\partial(*) S &= E / S && \text{for the RORAC if } (t_\alpha \cdot S - E)^2 \neq 0, \\ \partial/\partial(*) E &= c \cdot \partial/\partial(*) S && \text{for the EVA.}\end{aligned}$$

A RORAC optimum is solely dependent on the risk return profile of the asset and liability classes. In addition to that, an EVA optimum is also dependent on a cost of capital parameter c , which is determined by the individual company policy. If the condition $(t_\alpha \cdot S - E)^2 \neq 0$ holds, then the second derivatives will be as follows:

$$\begin{aligned}\partial^2/\partial(*)\partial(**) \text{ RORAC} &= -a \cdot E \cdot \partial^2/\partial(*)\partial(**) S / (t_\alpha \cdot S - E)^2, \\ \partial^2/\partial(*)\partial(**) \text{ EVA} &= -b \cdot c \cdot \partial^2/\partial(*)\partial(**) S,\end{aligned}$$

with a and b positive constants depending on the security level and the cost of capital parameter. Considering the Hessian matrix $H = (... \partial^2/\partial(*)\partial(**) S ...)$, any existing solution is

- always a maximum with respect to EVA and
- a maximum (minimum) with respect to RORAC, if the expected return E is higher (less) than zero.

In a subsequent section, some examples for those solutions will be discussed. In the next section, the treatment of the general case will be outlined.

3.3.3 Model Approach – General Case

So far, we have assumed that all assets and all liabilities were uncorrelated to each other. In the general model approach, we consider assets and liabilities, which are correlated to each other due to a (symmetric) correlation matrix C and check the solutions in such cases.

ρ_{00}	\dots	ρ_{0n}	φ_{00}	\dots	φ_{0m}
\dots	ρ_{ik}	\dots	\dots	φ_{il}	\dots
ρ_{n0}	\dots	ρ_{nn}	φ_{n0}	\dots	φ_{nm}
φ_{00}	\dots	φ_{0n}	ψ_{00}	\dots	ψ_{0m}
\dots	φ_{jk}	\dots	\dots	ψ_{jl}	\dots
φ_{m0}	\dots	φ_{mn}	ψ_{m0}	\dots	ψ_{mm}

Figure 85: Correlation Matrix³⁷

We can trace the general case to the already considered cases by decomposing the symmetric correlation matrix C to $C = M^T \cdot D \cdot M$ (Cholesky decomposition) with M an upper triangular matrix and D a diagonal matrix.

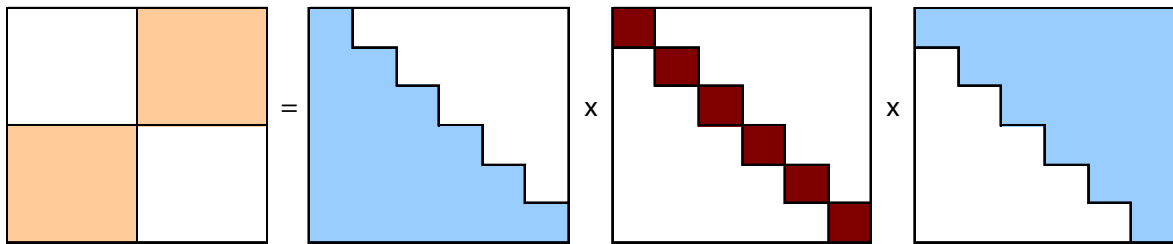


Figure 86: Cholesky Decomposition of the Correlation Matrix³⁸

All variables will be uncorrelated when we transform all assets and liabilities according to the Cholesky decomposition. The transformed combined ratios can be interpreted as combined ratios for a linear combination of the liabilities, but the transformed returns are mixed terms now.

Concerning the general case, we will concentrate on the solutions with respect to the RORAC, because the solutions with respect to the EVA are quite complex. In many cases such a solution does not exist.

Regarding the RORAC optimization in the general case, the following formulas are obtained concerning the partial derivatives of S by x_i or y_j :

$$\partial S / \partial x_i = (\sum (\rho_{ik} \cdot \sigma_i - \rho_{0k} \cdot \sigma) \cdot x_k \cdot \sigma_k + (\sum (\varphi_{il} \cdot \sigma_i - \varphi_{0l} \cdot \sigma) \cdot y_l \cdot \tau_l) / S =: X_i^* / S$$

$$\partial S / \partial y_j = (\sum (\varphi_{jk} \cdot \tau_j - \varphi_{0k} \cdot \tau) \cdot x_k \cdot \sigma_k + (\sum (\psi_{jl} \cdot \tau_j - \psi_{0l} \cdot \tau) \cdot y_l \cdot \tau_l) / S =: Y_j^* / S$$

³⁷Heep-Altiner, 2011, Performanceoptimierung des (Brutto) Neugeschäfts in der Schadenversicherung, p. 9.

³⁸Heep-Altiner, 2011, Performanceoptimierung des (Brutto) Neugeschäfts in der Schadenversicherung, p 10.

The formulas in the uncorrelated case are simplified versions of the general formulas. In the general case, we obtain for all $i, j, k, l > 0$

$$X_i^*/\Delta r_i = X_k^*/\Delta r_k = -Y_j^*/\Delta c_j = -Y_l^*/\Delta c_l$$

$$E \cdot X_1^* = \Delta r_1 \cdot S^2$$

where the first equations are linear ones. Substituting S^2 in a suitable way, another linear equation is obtained

$$(r - c) \cdot X_1^* = \Delta r_1 \cdot (\sigma \cdot (\sum \rho_{0k} \cdot x_k \cdot \sigma_k + \sum \varphi_{0l} \cdot y_l \cdot \tau_l) + \tau \cdot (\sum \varphi_{0k} \cdot x_k \cdot \sigma_k + \sum \psi_{0l} \cdot y_l \cdot \tau_l)).$$

In total, together with the two normalization equations $\sum x_i = 1 = \sum y_j$ we now obtain $(m + n + 2)$ linear equations with $(m + n + 2)$ variables x, x_1, \dots, x_n and y, y_1, \dots, y_m , which are solvable for the general case (i.e. with the exception of singular parameter constellations). Only in special cases can the solution be described explicitly. A solution is not automatically feasible because some coefficients may not be between zero and one.

In some special cases, simplified solutions will be obtained that can be treated in EXCEL. In the next section, some results concerning special cases are discussed.

3.3.4 Calculation Examples

This section discusses some examples. In this context, the term “feasible” optimum implies that a local maximum exists in which all coefficients are between zero and one. Maximum values at the boundaries of allowed combinations are not considered at this point.

Calculation Examples - Uncorrelated Assets and Liabilities

For the first example, the assumption is to invest the new business premium into two risky asset classes, which are not correlated with each other. The following input data is assumed:

	Standard Deviation	Cumulated Return
Asset 1	10.0%	107.5%
Asset 2	20.0%	112.5%

Figure 87: Cumulated Returns

For simplicity, only the underwriting of a single risk-free line of business with a combined ratio of 100.0% is considered (underwriting just a relatively low risk category in a very large collective.) Under these assumptions, the model provides as follows, the classical Markowitz approach for assets:

	Standard Deviation	Return
Asset 1	10.0%	7.5%
Asset 2	20.0%	12.5%

Figure 88: Uncumulated Returns

Concerning the uncumulated returns, the following table provides the RORAC and the EVA optimum given a capital cost parameter of $c = 30.0\%$ with respect to EVA.

	Standard Deviation	Return	RORAC Optimum	EVA Opt. $c = 30.0\%$
Asset 1	10.0%	7.5%	70.6%	35.3%
Asset 2	20.0%	12.5%	29.4%	64.7%

Figure 89: RORAC and EVA Optimum given Risk-free Liabilities

With respect to the EVA optimum there is significantly more investment in the riskier asset class than with respect to the RORAC optimum. Furthermore, only the absolute value is optimized without consideration of the capital requirements. In the specific case, the capital requirement given the EVA optimum is significantly higher than the capital requirement in case of the the RORAC optimum. Possibly, the company is not able to deposit the required capital for the EVA optimum.

The RORAC optimum can be illustrated as a tangent point on the risk / return curve with a line through the origin as follows:

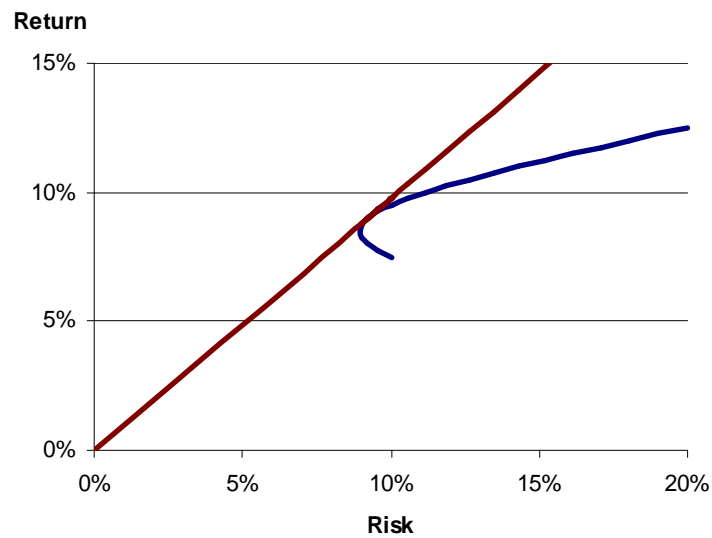


Figure 90: RORAC Optimum

The EVA optimum is defined as a tangent point on the risk / return curve with a line whose slope equals the cost of capital parameter c . Because the slope of the risk / return curve does not fall below an asymptotic value, such a tangent point does not exist for small parameter c , see the following figure.

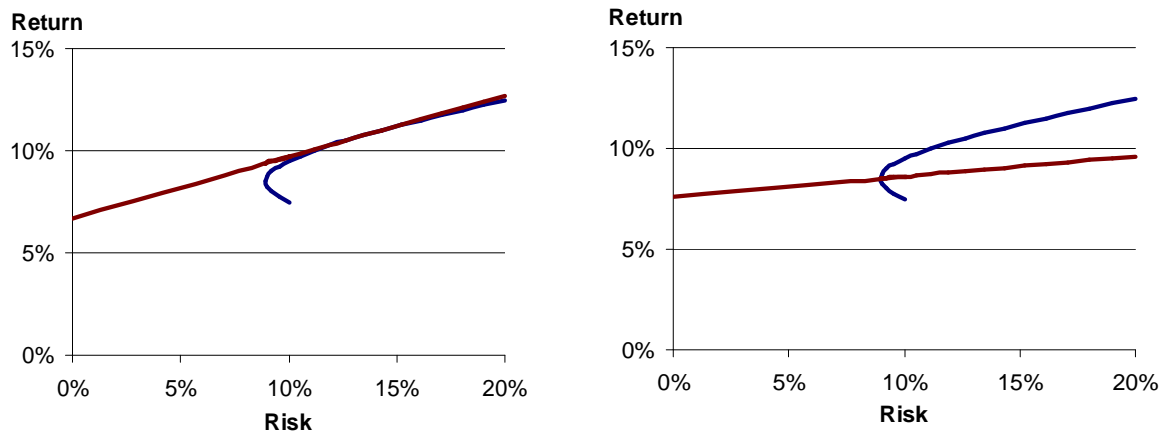


Figure 91: EVA Optimum for $c = 30.0\%$, but no EVA Optimum for $c = 10.0\%$

If the cost of capital parameter c is too small then only a maximum value exists at the boundary with 100% investment in the risky asset – regardless of the amount of capital required.

Now the example will be extended by underwriting two lines of business (uncorrelated with each other and with the asset classes) with the following risk / return profile in the optimization approach:

	Combined Ratio	Standard Deviation
LoB 1	97.0%	20.0%
LoB 2	98.5%	10.0%

Figure 92: Combined Ratios

The following table illustrates the asset and liability shares with respect to the RORAC optimum:

	STD	Cum. Return	Share		STD	Comb. Ratio	Share
Asset 1	10.0%	107.5%	64.5%	LoB 1	20.0%	97.0%	24.7%
Asset 2	20.0%	112.5%	35.5%	LoB 2	10.0%	98.5%	75.3%

Figure 93: RORAC Optimum given Risky Assets and Lines of Business

The shares of the asset classes have changed with the inclusion of the lines of business in the optimization, because the optimization approach (even with uncorrelated assets and liabilities) is not independent of the asset and liability risk / return profiles. In this particular case, there is a maximum because the returns are positive. With the inclusion of risky lines of business, there is a higher weight with respect to the risky asset due to a higher degree of diversification.

An even stronger shift with respect to the weight of the risky asset and liability classes are observed after EVA optimization – regardless of the amount of capital required.

	STD	Cum. Return	Share		STD	Comb. Ratio	Share
Asset 1	10.0%	107.5%	12.9%	LoB 1	20.0%	97.0%	40.1%
Asset 2	20.0%	112.5%	87.1%	LoB 2	10.0%	98.5%	59.9%

Figure 94: EVA Optimum given Risky Assets and Liabilities for $c = 30.0\%$

The tables show that there are significant differences between the EVA and RO-RAC optimum. For the EVA optimization approach there are higher weights for the riskier positions.

It has already been mentioned that in the present model approach the consideration of risk-free assets is no problem because there is usually risk in the liability positions. In fact, it is an independent business decision, to invest the cash flows resulting from the technical result in risky or riskless investments. In this case a risky investment is not necessarily “better” than a risk-free investment.

Thus, the example is extended by including a risk-free asset with an interest rate of 4.0% in order to check how the weights of asset and liability classes will change:

	STD	Cum. Return	Share		STD	Comb. Ratio	Share
Risk Free	0.0%	104.0%	22.4%	LoB 1	20.0%	97.0%	40.1%
Asset 1	10.0%	107.5%	12.9%	LoB 2	10.0%	98.5%	59.9%
Asset 2	20.0%	112.5%	87.1%				

Figure 95: RORAC Optimum given a Risk-free Asset

The risk-free asset only receives a relatively small weight because of the high diversification.

With respect to EVA, the results are quite complex. There is no solution for the (quite realistic) capital cost parameter $c = 30.0\%$. To obtain a solution in the classical sense, the parameter has to be significantly increased, e.g. $c = 60.0\%$.

	STD	Cum. Return	Share		STD	Comb. Ratio	Share
Risk free	0.0%	104.0%	-119.8%	LoB 1	20.0%	97.0%	31.7%
Asset 1	10.0%	107.5%	136.8%	LoB 2	10.0%	98.5%	68.3%
Asset 2	20.0%	112.5%	83.1%				

Figure 96: EVA Optimum given a Risk Free Asset for $c = 60.0\%$

As can be seen in the table above, there is a solution for the EVA approach but it is not feasible in the sense that each share is positive and less than one. There is such a dramatic restructuring of assets that in principle the recommendation is not to buy the risk-free assets, but rather to borrow it, in order to take even more of the

riskier asset classes to the portfolio. This very simple example shows that the EVA optimization may be much more crucial than the RORAC optimization.

Calculation Examples – Correlated Assets and Liabilities

In this section, the effects of correlations will be analyzed. Only the RORAC optimization will be analyzed because of the high complexity of the EVA optimization in connection with very crucial solutions.

For this purpose, the case of the two previously introduced risky assets and lines of business is considered, where it is now assumed that the two assets and liabilities are correlated with 50% to each other. This example already contains essential features of the general case:

	STD	Cum. Return	Share		STD	Comb. Ratio	Share
Asset 1	10.0%	107.5%	63.0%	LoB 1	20.0%	97.0%	11.1%
Asset 2	20.0%	112.5%	37.0%	LoB 2	10.0%	98.5%	88.9%

Figure 97: RORAC Optimum given Risky Assets & Liabilities with 50.0% Corr.

The use of correlations changes the weights, such that the lower-risk positions obtain a higher weight. If the correlations are too high, it is no longer a feasible solution.

In a final step, this example is extended even more by including the risk-free asset with an interest rate of 4.0%. This example will contain the whole complexity of the general case except the correlations between assets and liabilities.

	STD	Cum. Return	Share		STD	Comb. Ratio	Share
Risk Free	0.0%	104.0%	36.4%	LoB 1	20.0%	97.0%	9.1%
Asset 1	10.0%	107.5%	33.3%	LoB 2	10.0%	98.5%	90.9%
Asset 2	20.0%	112.5%	30.3%				

Figure 98: RORAC Optimum with a Risk Free Asset with 50.0% Correlation.

If a risk-free asset in the RORAC optimization is involved (assumed the asset and liabilities are correlated to each other) this asset obtains a high weight. It is also remarkable to see that the inclusion of a risk-free asset influences not only the weight of the assets, but also the weight of the liabilities.

3.3.5 Conclusion

Under some simplified model assumptions, there is always an optimum for risky investments with respect to the RORAC. In the special case of two risky investments, one can represent this as tangential point on the risk / return curve with a line through the zero point.

If the EVA as a preference function is used, then in the simple case of two risky investments there will not always be a feasible solution. In such a case a solution is obtained as a tangential point on the risk / return curve with a line $\text{Yield} = \text{constant} + c \cdot \text{STD}$. This tangent point does not exist if c is too small. Thus, the optimum is the maximum at the boundary – regardless of the capital requirement. Higher cost parameter c produce solutions, but may be unrealistic.

This result indicates some doubts concerning the convenience of the EVA as a useful KPI, because even in the simplest case a solution depends on the choice of the capital cost parameter. The fact that only very high capital cost parameters produce an optimum, should be critically evaluated.

A (simplified) RORAC optimization will generate solutions, which are acceptable but not necessarily in the sense that all parameters are between zero and one. If there are just correlations between assets and liabilities, we will immediately recognize that optimal combinations of assets will be influenced by the characteristics of the assets themselves and the characteristics of the liabilities (and vice versa). It is possible to summarize groups or segments to have a smaller dimension in the optimization approach in order to obtain feasible solutions.

In general, there is a solution for the RORAC optimization problem. It is, however, very difficult to interpret.

As has already been mentioned, the considerations outlined here are not necessarily suitable for the optimization of complex reinsurance structures. The approach presented here can only be used to deliver a simplified model to have better starting values for alternative calculations in internal models. Nevertheless, some implications for value-based management can be identified.

3.4 Treatment of Extra Dividends

In this chapter, the treatment of extra dividends will be discussed. Therefore, it is good to keep in mind the following equivalence equation, which reflects all relevant aspects for tariff rating before a contract is written:

$$\begin{aligned} \text{Present Value of Premiums} &= \text{Present Value of Claims} \\ &+ \text{Present Value of Costs} \\ &+ \text{Present Value for Extra Dividends.} \end{aligned}$$

This chapter concentrates on the correct distribution of dividends to the shareholder after having underwritten the contract. Costs of capital included in the premium should only be distributed to the shareholder when they have been earned. This will be analyzed by means of some calculation examples in the following sections.

3.4.1 Cost of Capital and Target Premium

Extra dividends are defined as the return on required capital above the Risk-free interest rate. The Cost of Capital as present value of all extra dividend depends on the capital allocation at the beginning of a period as well as on the required extra dividend at the end of a period.

We have analyzed in a previous section how target combined ratios and thus target combined premiums depend on different levels of risk-free interest rates with respect to different CoC models reflecting different insurance markets. We did not consider any change in the CoC requirements given different levels of risk-free interest rates, compare the table below.

Market Interest Rate	2.0%	4.0%	6.0%
Extra Dividend	13.0%	11.0%	9.0%
Total Yield	15.0%	15.0%	15.0%
Present Value Claims	88.7	79.6	72.0
Present Value Costs	29.1	28.3	27.6
Present Value Extra Dividends	31.7	24.2	18.0
Present Value Premium	149.5	132.1	117.6
Premium	151.0	134.7	121.1

Figure 99: Target Premiums given a Fixed Total Yield

If the total yield is fixed than there is strong dependency on the different levels of risk-free interest rates with respect to the target premiums.

Market Interest Rate	2.0%	4.0%	6.0%
Extra Dividend	8.0%	11.0%	14.0%
Total Yield	10.0%	15.0%	20.0%
Present Value Claims	88.7	79.6	72.0
Present Value Costs	29.1	28.3	27.6
Present Value Extra Dividends	19.5	24.2	28.0
Present Value Premium	137.3	132.1	127.6
Premium	138.7	134.7	131.4

Figure 100: Target Premiums given a Variable Total Yield

The model with variable total yields results less-volatile target premiums in the case of a change in the risk-free interest rate. This concept could be used to stabilize the premium calculation.

3.4.2 Extra Dividends According to Underwriting Performance

The treatment of extra dividends will be explained by a calculation example. Firstly, the underwriting performance will be taken into account; afterwards the impact of risky investments will be analyzed. Both sides should be considered separately, because underwriting and asset management act independently from each other in an insurance company.

For this example an industrial insurer was chosen. Normally, an industrial insurer has higher yield expectations than an insurer in a personal lines business – for example to get a good “A” rating. The model calculation is based on the following input parameter:

Market Interest Rate	4.0%
Premium	1,000.0
Cost Ratio	25.0%
Claims Ratio	73.3%
Entity Factor	150.0%
Premium Factor	22.0%
Reserve Factor	12.0%
CoC Rate	10.0%

The next figure illustrates the a-priori underwriting cash flows with a target fulfillment of 100.0%. The capital allocation of 330 at the beginning is obtained by multiplying the premium of 1,000 with the entity factor of 150% and the premium factor

of 22.0%. After the first period an extra dividend of 10.0% is expected that results in an amount of 33 to be distributed to the shareholders:

Period	CF in %	Claim Payments		Capital Allocation	Cost of Capital	
		Nominal	Discounted		Nominal	Discounted
1	50.0%	366.4	359.3	330.0		
2	25.0%	183.2	172.7	66.0	33.0	31.7
3	12.5%	91.6	83.0	33.0	6.6	6.1
4	6.3%	45.8	39.9	16.5	3.3	2.9
5	3.1%	22.9	19.2	8.2	1.6	1.4
6	1.6%	11.4	9.2	4.1	0.8	0.7
7	0.8%	5.7	4.4	2.1	0.4	0.3
8	0.4%	2.9	2.1	1.0	0.2	0.2
9	0.2%	1.5	1.1	0.5	0.1	0.1
10	0.1%	0.7	0.5	0.3	0.1	0.0
11	0.1%	0.4	0.2	0.1	0.0	0.0
12	0.0%	0.1	0.1	0.1	0.0	0.0
13	0.0%	0.1	0.0	0.0	0.0	0.0
14	0.0%	0.1	0.0	0.0	0.0	0.0
15	0.0%	0.0	0.0	0.0	0.0	0.0
16	0.0%				0.0	0.0
	100.0%	732.8	692.0		46.2	43.5

Figure 101: "A Priori" Underwriting CF with 100% Target Fulfillment

The following figure illustrates how the values are calculated for the fourth period where all calculations are based on a 4.0% risk-free interest rate.

Position	Value	Comment
CF in %	6.3%	Payment Pattern for the Segment
Nominal Payments	45.8	$= 1.000,0 \cdot 73.3\% \cdot 6.3\%$
Discount. Payment	39.9	$= 39.9 / (1 + 4.0\%)^{3.5}$
Capital Allocation	16.5	$= (45.8 + 22.9 + \dots + 0.1) \cdot 12.0\% \cdot 150.0\%$
Nominal CoC	3.3	$= 33.0 \cdot 10.0\%$
Discount. CoC	2.9	$= 3.3 / (1 + 4.0\%)^{3.0}$

Figure 102: Calculation Example given Target Values.

During contract run-off, the observed values deviate from the target values. The next figure shows an example with a negative deviation from the target values that results in a decreased target fulfilment.

Period	Observed Values		Result before CoC	Present Value Future		CoC Payout	Result after CoC
	Interests	Payments		Payments	CoC		
1	4.0%	366.4					
2	4.0%	219.8	391.2	346.0	45.2	33.0	358.2
3	4.0%	73.3	148.4	173.0	-24.6	-12.8	161.2
4	4.8%	45.8	92.9	86.5	6.4	3.3	89.6
5	4.8%	22.9	47.0	43.3	3.7	1.9	45.0
6	4.8%	11.5	23.8	21.6	2.2	1.1	22.6
7	4.8%	5.7	11.9	10.8	1.1	0.6	11.4
8	4.8%	2.9	6.1	5.4	0.7	0.3	5.7
9	4.8%	1.4	3.0	2.7	0.3	0.2	2.9
10	4.0%	0.7	1.6	1.3	0.2	0.1	1.4
11	4.0%	0.4	0.8	0.6	0.1	0.1	0.7
12	4.0%	0.2	0.3	0.3	0.0	0.0	0.3
13	4.0%	0.1	0.1	0.1	0.0	0.0	0.1
14	4.0%	0.0	0.0	0.1	0.0	0.0	0.1
15	4.0%	0.0	0.1	0.0	0.1	0.1	0.0
16			0.0			0.0	0.0
		751.1	Target Fulfilment CoC		60.4%	27.9	

Figure 103: “A Posteriori” Underwriting CF with 60.4% Target Fulfilment

The next table shows, again, how the values are calculated for the fourth period with respect to the realized values (in contrast to the target values).

Position	Value	Comment
Observed Interest	4.8%	Realized Values
Observed Payments	45.8	Realized Values
Result before CoC	92.9	$= 161.2 \cdot (1 + 4.0\%) - 73.3 \cdot (1 + 4.0\%)^{0.5}$
PV Future Payments	86.5	$= (39.9 + 19.2 + \dots + 0.1) \cdot (1 + 4.0\%)^{3.0}$
PV Future CoC	6.4	$= 92.9 - 86.5$
CoC Payout	3.3	$= 3.3 \cdot 6.4 / ((2.9 + 1.4 + \dots + 0.1) \cdot (1 + 4.0\%)^{3.0})$
Result after CoC	89.6	$= 92.9 - 3.3$

Figure 104: Calculation Example given Realized Values

The present value of extra dividends implies, in a certain sense, a hybrid position. On the one hand, it has been included into the premium in order to allow a planned extra dividend for the shareholders; on the other hand, it has characteristics of a safety cushion for policyholders, because it serves to compensate a negative claim

experience in contrast to a target situation. Due to this hybrid status it has to be checked after each period to establish whether the development of the parameter (losses, costs, interest rates) enables the planned payout of extra dividend or not.

Thus, all realizations have to be accumulated up to the actual point in time in order to check whether all estimated future payments (claims, costs) can be paid. If a positive cash balance remains after that, a dividend can be paid in the current period, but it may be less than targeted. After dividend payout, the remaining cash balance can be accumulated up to the end of the next period when it will be checked again.

If there is no positive cash balance for dividend payout, a refund has to take place, normally by refraining from a dividend payout with respect to other (more profitable) segments or underwriting years.

Thus, a negative development has an impact on the dividend payout, which cannot be realized as targeted and which must be adjusted according to the actual situation.

3.4.3 Extra Dividends According to Asset Performance

Additional to the impact of underwriting performance, the impact of asset performance has to be taken into account. The model calculation is based on the same input parameter as before including a capital factor with respect to the required capital for risky assets.

Market Interest Rate	4.0%
Premium	1,000.0
Cost Ratio	25.0%
Capital Factor	10.0%
Entity Factor	150.0%
Combined Factor	15.0%
CoC Rate	10.0%

With respect to the required capital RC_A for risky assets and the combined factor cf (as a product of entity factor and capital factor) the following relation holds:

$$\begin{aligned}
 RC_A &= cf \cdot (RC_{UW} + TA + RC_A) \\
 &= cf \cdot (RC_{UW} + TA) / (1 - cf),
 \end{aligned}$$

where RC_{UW} denotes the required capital for underwriting and TA the technical assets due to the technical liquid balance. Given those relations, the next figure illus-

trates the non-technical capital allocation where the technical assets at the beginning are defined with respect to the discounted premium income.

Period	Observed Values		Technical Assets	Capital Allocation		
	Payments	Interests		Technical	Non-Techn.	Total
1	366.4	4.0%	980.6	330.0	231.3	561.3
2	219.8	4.0%	358.2	66.0	74.8	140.8
3	73.3	4.0%	161.2	33.0	34.3	67.2
4	45.8	4.8%	89.6	16.5	18.7	35.2
5	22.9	4.8%	45.0	8.2	9.4	17.6
6	11.5	4.8%	22.6	4.1	4.7	8.8
7	5.7	4.8%	11.4	2.1	2.4	4.4
8	2.9	4.8%	5.7	1.0	1.2	2.2
9	1.4	4.8%	2.9	0.5	0.6	1.1
10	0.7	4.0%	1.4	0.3	0.3	0.5
11	0.4	4.0%	0.7	0.1	0.1	0.3
12	0.2	4.0%	0.3	0.1	0.1	0.1
13	0.1	4.0%	0.1	0.0	0.0	0.1
14	0.0	4.0%	0.1	0.0	0.0	0.0
15	0.0	4.0%	0.0	0.0	0.0	0.0
16						
	751.1					

Figure 105: Capital Allocation given Risky Assets.

The next figure illustrates how the values are calculated for the fourth period according to the realized values due to realized underwriting and asset performance.

Position	Value	Comment
Combined Factor	15.0%	Payment Pattern for the Segment
Payments	45.8	Realized - needed for Techn. Result
Riskfree Interests	22.9	Realized - needed for Techn. Result
Technical Assets	89.6	Realized - needed for Techn. RC
Technical RC	16.5	Calculated before
Non-techn. RC	18.7	$= (89.6 + 16.5) \cdot 15\% / (1 - 15\%)$
Total RC	35.2	$= (18.7 + 16.5)$

Figure 106: Calculation Example given Risky Assets (1).

The figure below shows the realized dividend payout with respect to the capital allocation for risky assets if the observed risky interest rate is 6.0%.

Period	Capital Allocation	Cost of Capital		Observed Interests	Result before CoC		CoC Payout	Result after CoC
		Nominal	Discounted		Total	Non-Techn.		
1	231.3			6.0%				
2	74.8	23.1	22.2	6.0%	406.2	15.0	9.4	363.7
3	34.3	7.5	6.9	6.0%	162.1	13.7	7.3	167.6
4	18.7	3.4	3.0	6.0%	103.5	10.7	5.3	94.9
5	9.4	1.9	1.6	6.0%	53.9	6.9	3.6	48.4
6	4.7	0.9	0.8	6.0%	27.9	4.2	2.2	24.6
7	2.4	0.5	0.4	6.0%	14.4	2.4	1.3	12.5
8	1.2	0.2	0.2	6.0%	7.5	1.4	0.7	6.4
9	0.6	0.1	0.1	6.0%	3.8	0.8	0.4	3.2
10	0.3	0.1	0.0	6.0%	2.0	0.4	0.2	1.6
11	0.1	0.0	0.0	6.0%	1.0	0.2	0.1	0.8
12	0.1	0.0	0.0	6.0%	0.4	0.1	0.1	0.3
13	0.0	0.0	0.0	6.0%	0.2	0.1	0.0	0.1
14	0.0	0.0	0.0	6.0%	0.1	0.0	0.0	0.1
15	0.0	0.0	0.0	6.0%	0.1	0.0	0.0	0.0
16		0.0	0.0		0.0		0.0	
		37.8	35.3	Target Fulfillment CoC		81.1%	30.7	

Figure 107: Realized Dividend Payout given Risky Assets

Given a risky interest rate of 6.0%, the total discounted dividend payout equals 30.7, which results in a target fulfillment of 81.7%. The following figure shows how the values are calculated for the fourth period.

Position	Value	Comment
Capital Allocation	18.7	Calculated before
Nominal CoC	3.4	$= 34.3 \cdot 10.0\%$
Discount. CoC	3.0	$= 3.4 / (1 + 4.0\%)^{3.0}$
Observed Interest	6.0%	Realized Risky Values
Total Result b. CoC	103.5	$= 167.6 \cdot (1 + 6.0\%) - 73.3 \cdot (1 + 6.0\%)^{0.5} + (6.0\% - 4.0\%) \cdot 67.2$
Non-techn. Res. b. CoC	10.7	$= (103.5 - 92.9) - 92.9 \text{ Technical Result before CoC}$
CoC Payout	5.3	$= 3.4 \cdot 10.7 / ((3.0 + 1.6 + \dots + 0.1) \cdot (1 + 4.0\%)^{3.0})$

Figure 108: Calculation Example given Risky Assets (2)

In the next section the treatment of dividend payout for several accident years is discussed. A lesser dividend payout for one accident year can be compensated for by more dividend payout for another year.

3.4.4 Extra Dividends Given Several Accident Years

The dividend payout is very important in practice. To ensure that the targeted values are applicable, the actual condition should be checked regularly and adapted if necessary. By such a review, it can be warranted that a dividend payout is possible in the long term. This prevents financial burdens for the future. These burdens

could only be balanced out by new business that could no longer produce the targeted returns. Furthermore, it must be taken into account that a balance sheet dividend payout can always be broken down into the dividends of several accident years, which is illustrated in the figure below.

Accident Year	Target Fulfillm.	Growth Rate	Balance Year								Total
			1	2	3	4	5	6	7	8	
1	-100.0%	82.3%	-2.1								
2	-50.0%	86.4%	-2.2	-1.1							
3	0.0%	90.7%	0.0	0.0	0.0						
4	50.0%	95.2%	11.9	6.0	2.4	1.2					
5	100.0%	100.0%	50.0	25.0	12.5	5.0	2.5				95.0
6	50.0%	105.0%		26.3	13.1	6.6	2.6	1.3			49.9
7	0.0%	110.3%			0.0	0.0	0.0	0.0	0.0		0.0
8	-50.0%	115.8%				-28.9	-14.5	-7.2	-2.9	-1.4	-55.0
			57.7	56.1	28.0	-16.2					

Figure 109: Dividend Payout over Several Accident Years

If there is a target failure for previous accident years, it has to be refunded by dividends of later accident years. Otherwise, the target balance sheet dividend payout cannot be achieved.

A correct treatment of dividend payout on an accident year base (as discussed in the examples before) is inevitable in order to prevent future burdens of the balance sheet results.

4 Embedded Value as Fair Value Approach

The on-going change to a value based management requires appropriate key figures and steering systems. Internal models in non-life insurance are usually based on the economic capital after one year as stochastic target function according to the immediate realization of assets and liabilities at market values. That does not always constitute a realistic hypothesis. The direct liquidation of all assets and liabilities would result in high discounts on the assets respectively in high surcharges on the liabilities. Especially the existence of market values for loss reserves seems illusionary. In addition, the tensions in the financial markets lead to distortions in market prices (e.g. in form as a liquidity premium). These circumstances do not reflect adequately the medium to long term value situation of an insurance company.³⁹

Given the Embedded Value EV (as an alternative approach for evaluating corporate economic capital) the fair values of assets and liabilities will be realized only over time according to a virtual run-off. Thus, “modelling” of a virtual external investor of the insurance portfolio is not requested. This approach leads to the following advantages and disadvantages:

- As a consequence of frictional and other costs, the EV is lower than the directly attributable economic value.
- The EV is more realistic because there would be discounts in the case of selling the portfolio.
- The EV reacts less sensitively to market price fluctuations.

Therefore, the EV-approach is well established in the typical long term business of life insurance. In non-life insurance, however, this concept is actually not well established, although there are first applications within the integrated steering of the whole business. Thus, it is consequent to consider also the EV within the value based management in non-life insurance at a middle-term perspective. This will result in a coherent view on risk steering at group level. Especially within the framework of Solvency II the insurance groups are interested in a consistent company steering system. Therefore a harmonization of modelling approaches between the life and non-life segments is required.⁴⁰

This chapter describes in what way and to what extent the EV concept could apply to non-life insurance. First, for a better understanding, the methodology and devel-

³⁹Heep-Altiner, Krause (2012), p. 2.

⁴⁰Heep-Altiner, Berg (2012).

opment of the EV in life insurance will be explained. After that, an approach to transfer the idea to non-life insurance is presented. The following example of the fictional property/casualty insurer named “Feldafinger Brandkasse” will illustrate an EV calculation. Finally, based on the results a conclusion and outlook is given. The explanations and descriptions in this chapter are mainly based on the research results of the cooperation between the working group “Embedded Value Non-life” of the German Association of Actuaries (Deutsche Aktuarvereinigung) and the master students at the Institute of Insurance Studies in Cologne (Institut für Versicherungswesen der FH Köln).⁴¹

4.1 Embedded Value in Life Insurance

The return profile in life insurance distinguishes from other lines of business because of its long-term character. Typically the high acquisition costs at the beginning of a contract will be amortized over time by the profits in future years, see the figure below.

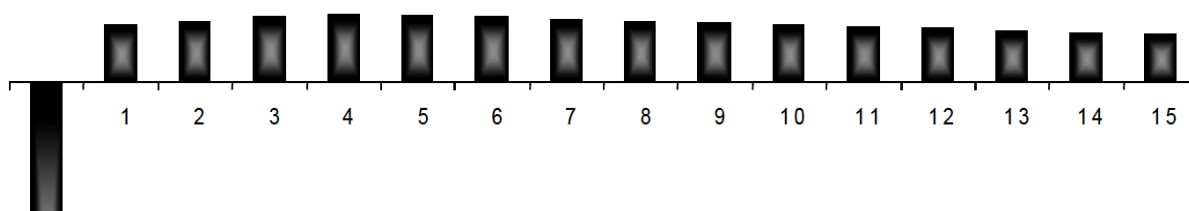


Figure 110: Annual Profit of a Life Insurance Contract⁴²

Therefore, life insurers in a period of growth show an operating loss due to its high rate of new business. It concludes that the annual reported gain from income statements does not reflect the adequate value of the life insurance portfolio. Thus, future cash flows have to be taken into account for the valuation of contracts. The EV considers the present value of all future profits of the insurance portfolio and regards the long-term nature of the business.

To summarize this, the EV is an indicator of the prospective earnings potential of a life insurance company and is the key performance figure for the shareholders and potential investors.

⁴¹Heep-Altiner (2012).

⁴²Gürtler (2012), p. 7.

4.2 Historical Development

James Anderson published the basic conceptual idea in the year 1959.⁴³ Based on his isolated projection of future cash flows the EV approach evolves constantly over time. Today the EV is a generally accepted indicator in life insurance and this is why most companies publish an additional EV report beside the legal reporting requirements.⁴⁴ The EV estimates the value of the company, based on its current net worth plus the present value of future profits minus costs. The estimation of future cash flows requires an extensive set of assumptions. For example, the future interest rates, inflation, policyholder behaviour and mortality have to be considered. Attempts to harmonize and improve the initial concept of the traditional Embedded Value (TEV) led to the concept of the European Embedded Value (EEV) and finally to the Market Consistent Embedded Value (MCEV).⁴⁵

Traditional Embedded Value (TEV)

The TEV corresponds to the value of the adjusted equity (net asset value) plus the Present Value of Future Profits (PVFP) for the covered business minus the Cost of Capital (CoC).

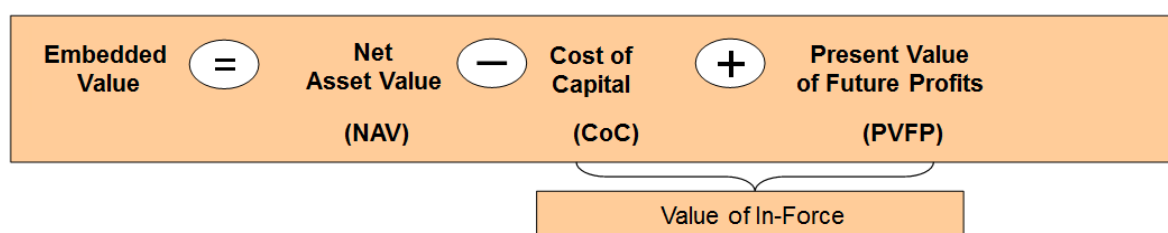


Figure 111: Traditional Embedded Value⁴⁶

The separate components of the traditional Embedded Value are explained in more detail below.

Net Asset Value (NAV)

The NAV is the book value according to generally accepted accounting principles (e.g. German GAAP) of the equity adjusted with valuation reserves (difference between the market values and the accounting values) and the dividends for the shareholders which are included in the balance sheet profit. The NAV is divided into the Required Capital (RC) and the Free Surplus (FS). The RC is demanded for example as a solvency capital by the insurance supervision or by the rating agencies.

⁴³Anderson (1959).

⁴⁴PWC, p. 1.

⁴⁵Heep-Altiner; Krause (2012), p. 7.

⁴⁶Gürtler (2012), p. 8-10.

Cost of Capital (CoC)

The CoC corresponds to an adequate interest on the RC. For the purpose of providing capital for the insurance company the shareholders demand an appropriate return on the invested capital (Risk Discount Rate, RDR). The actual investment income on the RC is usually lower than the expected risk discount rate (RDR). Furthermore, the participation of the policyholders as well as the taxes on the investment income on the RC should be considered.

Present Value of Future Profits (PVFP)

An essential element of the TEV is the deterministic PVFP. For the calculation, the following assumptions are used:

- The insurance portfolio is in run-off.
- The profit and loss account and the balance sheet will be projected over the predefined projection period.
- The future new business will not be considered.
- The investment income on equity is not taken into account.

As a result, the future profits are determined. The following discounting calculation uses the RDR and the PVFP is then identified and quantified.

European Embedded Value (EEV)

An earlier lack of clear guidelines for the determination of the TEV made comparability between the different companies complicated for investors and shareholders. In the year 2004 the so called CFO forum, comprising the 21 chief financial officers of the most important European insurance groups, established the European Embedded Value Principles (EEVP). The EEVP set down 12 general binding rules.⁴⁷ For instance, beside the three components of the TEV, the EEV considers the Time Value of Options and Guarantees (TVOG) as an additional factor, see the figure below.

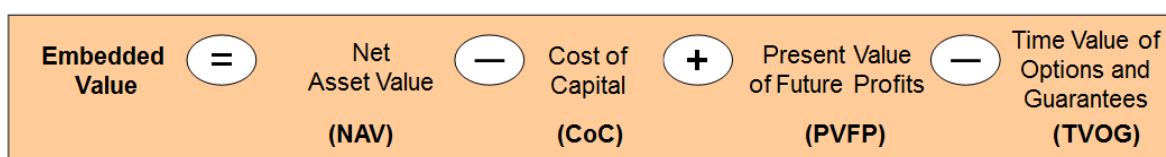


Figure 112: European Embedded Value⁴⁸

⁴⁷ CFO Forum, European Embedded Value Principles.

⁴⁸ Heep-Altiner (2012), p. 18.

The guarantees mainly refer to fixed promised financial guarantees. An example for options is the right of cancellation for policyholders or the lump sum option in annuity insurances. Therefore, the deterministic perspective of capital market scenarios is insufficient for assessing the TVOG appropriately. Especially the evaluation of financial guarantees needs a stochastic asset / liability projection model to reflect the volatility of the financial markets.⁴⁹ It is necessary to develop management rules, e.g. for determining the participation of the policyholders on investment incomes and for an assumption of future policyholders' behaviour. Furthermore, the EEVP requires a consistent calculation for the RDR and homogeneous publication standards.⁵⁰

Market Consistent Embedded Value (MCEV)

The components of the MCEV align with the EEV. Furthermore, costs of non-hedgeable risks must be taken explicitly into account. Because the EEVP did not solve the problem of an appropriate and objective RDR sufficiently, the CFO Forum published the Market Consistent Embedded Value Principles (MCEVP) in June 2008 in order to bring greater consistency and improved disclosure to the EEV. The MCEVP include 17 "Key principles", 145 "Areas of guidance"⁵¹ and a "Commentary on Principles & Guidance (Basis for Conclusions)."⁵² The MCEV is currently the most sophisticated and harmonized EV concept. It values assets and liabilities on a market-consistent basis. Assets are valued at the amount for which they can be sold at the time of valuation. The liabilities, which are not traded and illiquid, are valued by a replicating portfolio or other adequate mathematical techniques. The MCEVP also require a consistent valuation for the TVOG similar to the pricing of options and other derivatives on capital markets (Black & Scholes). Furthermore, costs of non-hedgeable risks must be taken explicitly into account.

But the discussion about the right methodology and assumptions still continues. In October 2009, the CFO Forum published an amendment to the MCEV Principles to allow for the inclusion of an illiquidity premium. Furthermore, in December 2011 a press release was issued by the CFO Forum to take account of the current sovereign debt market conditions in EV reporting as an initial step towards the expected convergence of MCEV with the developing Solvency II regulatory framework.⁵³ However, the discussion is still on-going as to how and to which products such illiq-

⁴⁹CFO Forum, Basis for Conclusions European Embedded Value Principles, p. 15.

⁵⁰Gürtler (2012), p. 10-11.

⁵¹CFO Forum, MCEV Principles & Guidance.

⁵²CFO Forum, MCEV Basis for Conclusions.

⁵³www.cfoforum.nl/embedded_value.html.

uidity premiums should be applied as well as how sovereign debt market conditions should be taken into account under Solvency II.⁵⁴

4.2.1 Application of Embedded Value

The Embedded Value applies in the following areas of the insurance business:⁵⁵

Evaluation of a Company:

The EV is an alternative approach for the evaluation of a life insurance company with a more significant expressiveness than the classical figures. Therefore, it is the main component in the negotiation process of mergers and acquisition transactions.

Company steering:

As the material part of internal life insurance models, the EV determines the required risk capital and is therefore a main part of the risk management, especially considered in the framework of Solvency II. The required capital is calculated based on sensitivities, stress scenarios and the required security level.

Movement Analysis:

With a movement analysis as a tool of a value-added analysis, the separate impacts for a change in the EV could be examined ex post. The Movement Analysis is an important tool for the performance measurement and the evaluation of the management of a life insurance company. Therefore, the MCEV at the end of the year (EoY) will be compared a posteriori with the MCEV at the beginning of a year (BoY). The reasons for the change of the value will be analysed individually. The following figure shows a schematic example for a Movement Analysis.

⁵⁴Munich Re, Market Consistent Embedded Value Report 2011, p. 3.

⁵⁵DAV, Embedded Value in der Schadenversicherung, p. 6.

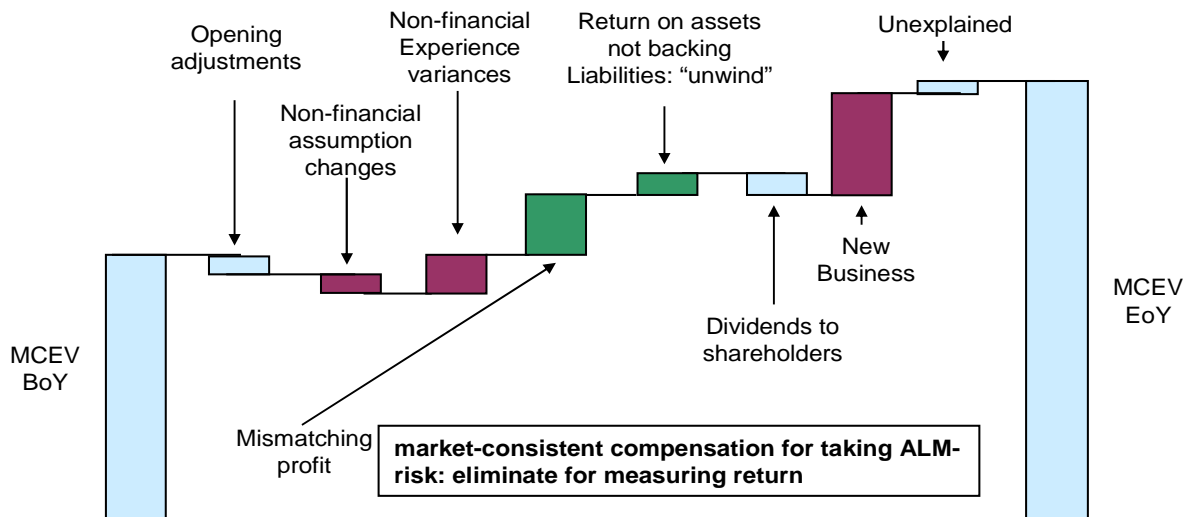


Figure 113: Movement Analysis⁵⁶

Different factors lead to an increasing / decreasing MCEV. For example, the change of the non-financial assumptions with regard to the future has reduced the value. On the other hand, factors like the deviation between the realized and the estimated non-financial assumptions, the overperformance of investment earning and the value added by new business, lead to a higher MCEV at the end of the year.

4.2.2 Market Consistent Embedded Value

The MCEV is the present value of shareholders' interests in the earnings distributable from assets allocated to the covered business after making sufficient allowance for the aggregate risks involved. When calculating the MCEV the following principles have to be considered:⁵⁷

<u>Closed Fund Projection:</u>	In opposite to the Appraisal Value ⁵⁸ (AV) the EV does not consider future new business. The EV and the existing insurance portfolio will be projected in run-off.
<u>Best Estimate:</u>	The calculation is based on realistic assumptions.
<u>Going Concern:</u>	All assumptions base on a continued business operation.
<u>Further Consideration</u>	Regulatory and legal frameworks and continuous management rules have to be taken into account.

⁵⁶ DAV-Arbeitsgruppe EV Sach: Embedded Value in der Schadenversicherung. Bericht an den Ausschuss Schadenversicherung DAV. Stand 16. September 2010.

⁵⁷ Gürtler (2012), p. 7.

⁵⁸ The AV can be interpreted as EV plus Goodwill.

The MCEV components correspond essentially with the EEV but use a closer classification level for the single components. The MCEVP distinguish between the following components of EV.⁵⁹

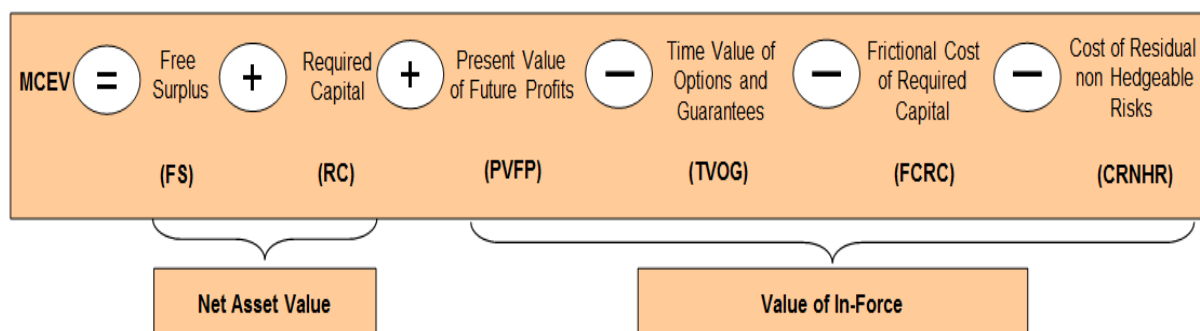


Figure 114: Market Consistent Embedded Value⁶⁰

The different components of the Market Consistent Embedded Value are described in more detail in the following:

Net Asset Value

The Net Asset Value is divided into the components Required Capital (that has to be kept within the company) and Free Surplus (that can be paid out).

Required Capital

RC is the market value of capital allocated to the covered business. It equals at least the regulatory solvency capital, but may be higher to meet internal risk capital models or rating targets. RC is tangible and may be distributed over time as liabilities run-off.

Free Surplus

FS is the market value of capital allocated to the covered business but not required to support the in-force covered business at the valuation date. FS is tangible and may be distributed immediately. The FS is a residual amount. To calculate the FS, an analysis of the whole equity is needed.

⁵⁹CFO Forum, MCEV Principles & Guidance and Munich Re (2011), p. 19 ff.

⁶⁰ Heep-Altiner, Jutzi (2012), p. 23.

Equity of an insurance company is defined as the difference between all assets and liabilities. FS equals the subtraction between equity and RC (under consideration of tax and shareholder dividends).

For a German insurance company, the components FS and RC can be concluded from the German GAAP balance sheet. But an adjustment of the balance sheet positions is necessary to get to the required market value view.

Value of In-Force

The Value of In-Force covered business (VIF) consists of the PVFP, TVOG, FCRC and CRNHR.

Present Value of Future Profits

The PVFP is the present value of future local statutory (e.g. German GAAP) shareholder after-tax profits emerging from the business covered on the condition that all economic and non-economic assumptions are met. Therefore, the following factors are essential to determine the future insurance portfolio development:

- Investment Income,
- development of cost and claims,
- cancellation behaviour of policyholders,
- dynamics on financial markets,
- reimbursement from reinsurance and
- risk discount rate.

The assumptions based on the Best Estimate principle have to be made for each line of business and product individually. Furthermore, the calculation of future profits considers the going concern assumption. The assumptions made are assumed to be adequate for the future as well on an inflation-adjusted basis. Based on the assumptions, the calculation procedure for the PVFP follows these steps:

1. Determination of the net profit before tax, based on the underwriting and investment results.
2. Determination of the net profit after tax for each period under review.
3. Discounting with the RDR to the beginning of the projection.

Time Value of Financial Options and Guarantees

Participating life business is generally characterized by options and guarantees, which are strongly dependent on the financial markets (e.g. a minimum interest rate or a minimum level of bonus is guaranteed to the policyholder). The participating features are usually a combination of contractual or legal constraints and management discretion that has to take competitive pressure or market practice into account. The calculation of TVOG should be based on a stochastic variation of future economic conditions using methods and assumptions consistent with the underlying EV.

Frictional Costs of Required Capital

FCRC reflect the taxation costs for risk-free investment on the assets backing required capital as well as the costs for the investment management for those assets.

Cost of Residual Non-Hedgeable Risks

CRNHR are Cost of Capital for all (residual) risks that have not been considered in the market value of a risk component yet. The following figure illustrates the range of the MCEV components.

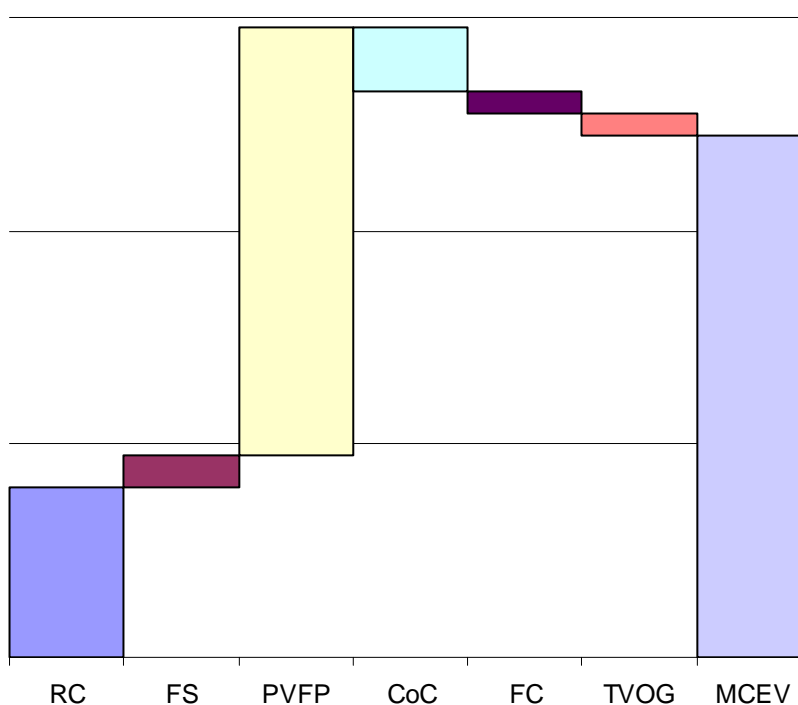


Figure 115: Components of the MCEV⁶¹

⁶¹ Own figure based on Munich Re (2011), p. 4.

In the following section the concept of Embedded Value in life insurance will be transferred to non-life insurance.

4.3 Embedded Value in Non-life Insurance

The concept of MCEV has been used as an evaluation method in life insurance for several years. However, in insurance groups, it is useful to adopt similar steering indicators for all subsidiaries. The following chapters will therefore analyse how this approach can be transferred to non-life insurance.

Furthermore, if reasonably applied, this concept may also establish a more realistic approach for an internal model in non-life insurance than a model based on economic capital. Especially within the framework of Solvency II, insurance groups are interested in a consistent company steering system. Therefore a harmonization of modelling approaches between the life and non-life segments is required.

In conclusion, the EV approach could be an adequate integrated steering concept for a whole insurance group.⁶² Therefore, the possibility of applying the EV concept on non-life is analysed hereinafter.

4.3.1 Differences between Life and Non-life Insurance

Since the MCEV was originally developed for life insurance, problems occur during the transmission from life to non-life. For a better understanding, the most significant differences between life and non-life insurance will be outlined in the following.

Maturity period

Life insurance is a long-term business with maturities e.g. of thirty years and more whereas the maximum duration of a non-life insurance contract is restricted by European law to three years (previously five years). Moreover, after expiry, an annual renewal option is granted to the insurer and the policyholder, resulting in an increasing fluctuation in the portfolio of a non-life insurer. This complicates the assumptions about its future performance.

Premium Adjustment

A premium adjustment in life insurance is limited. In non-life insurance, however, adjustment clauses are common. Additionally, insurers themselves have the right to cancel the contract of the policyholder before expiry in the event of any changes that result in a different approach to risk.

⁶²Heep-Altiner; Jutzi (2012), p. 21.

Dominant Elements of Uncertainty	In life insurance dominant risks are mainly capital market risks such as low interest rates or rapid price movements caused by macro-economic environment changes. In contrast, the main influence in non-life is the uncertainty of the actual total claims expenditure exceeding the expected loss amount (underwriting risk).
Pre-Contractual Acquisition Costs	Payments of acquisition costs occur very early in life insurance, particularly if the long-term character is taken into account.
Underwriting Cycles	Empirical phenomenon that describes cyclical fluctuations of insurance premiums and underwriting results. According to premium adjustment clauses, these cycles are very distinctive in the non-life sector.
Time Horizon for Modelling	In life insurance the time horizon necessarily covers several periods, in non-life insurance usually only one period.
Differentiation of New Business	In the determination of the Embedded Value, future profits from the written business at the valuation date are included. Contracts concluded over several periods are part of the value of in-force business. In non-life insurance, however, this is usually defined as the replacement value. For implementation it is therefore important to make assumptions about the classification of profits.
Provisions	The evaluation of an insurance company takes place from the owner perspective (according to the management rules). Therefore, the distribution capability of the earned profits is relevant. In life insurance, the provision for premium incomes is to consider as well as the equalization reserve in non-life insurance.

After having discussed the differences, it should be checked how the MCEV principles apply to non-life insurance business.

4.3.2 MCEV Principles for Non-life Insurance

It has already been explained how the MCEV principles have emerged as an evolution of the EEV principles. To provide a better overview of these current MCEV principles they are outlined in the following.

I. Definition and Evaluation Approach	
1. Introduction 2. Coverage 3. MCEV Definitions 4. Free Surplus 5. Required Capital 6. VIF 7. Financial Options and Guarantees 8. Frictional Costs of Required Capital 9. CRNHR	In the first part (principles 1 – 9), definitions and measurement approaches are presented, which are used for further calculation of the MCEV. The focus lies on the definition of the underlying components of the MCEV ⁶³ , which differ significantly from usual balance sheet items. For a subsequent transfer of the principles into the model, essential issues in the design of an adequate balance projection arise.

Figure 116: Overview of MCEV Principles (1)⁶⁴

In the first part of the principles definitions and evaluation approaches are specified whereas in the second part individual evaluation issues are treated.

II. Individual Evaluation Issues	
10. New Business and Renewals 11. Non Economic Projection Assumptions 12. Investment Returns and Discount Rates 13. Inflation and Smoothing 14. Reference Rate 15. Stochastic Models 16. Participating Business	In the second part individual evaluation issues are explained in detail with a focus placed on the distinction between in-force business and renewals, as well as the handling of non-economic and economic model parameters.

Figure 117: Overview of MCEV Principles (2)⁶⁵

The last part of the principles deals with disclosure issues because of the fact that many insurance companies disclose their Embedded Value calculations.

⁶³ See chapter 4.1.3

⁶⁴ Based on Heep-Altiner (2012), p. 27 f.

⁶⁵ Based on Heep-Altiner (2012), p. 27 f.

III. Disclosure	
10. Disclosure	The last part deals with the disclosure rules of the MCEV, where problems arise especially with regard to the balance projection. In Germany for instance, German GAAP is relevant for the profit determination, while the MCEV principles are based on the requirements of IFRS. Consequently, evaluation differences occur.

Figure 118: Overview of MCEV Principles (3)⁶⁶

The transmission of the Market Consistent Embedded Value approach to non-life insurance makes it necessary to carry out some adjustments for the application of the MCEV principles. Hereinafter, considerations are made in which form a transmission to the non-life sector is possible, as they have been designed in the first place for life insurance only.

Accounting Approach

The notes to the CFO principles relate primarily to the IFRS accounting. However, IFRS is not established as general accounting principles for the MCEV. According to the CFO principles, all earnings after-tax, which are available for distribution have to be considered, taking all relevant local regulations into account.

For insurance companies with reporting entity in Germany, the profit and loss account based on the provisions under German GAAP for the considered time horizon are crucial: Hereby explicitly stipulated is the inclusion of costs.

For various positions within the German GAAP Balance of a non-life insurer, a transfer to a market value approach is necessary. Just as in life insurance, hidden assets and liabilities must be released and transferred from balance sheet assets at book value to the respective market values over time.

Restriction to Classic Non-Life Insurance Business

In the following, only the classical non-life insurance will be considered. This means that non-life insurance business analogue to life insurance business (e.g. accident insurance with premium refund = APR) is not considered. The targeted transfer

⁶⁶ Based on Heep-Altiner (2012), p. 27 f.

would be even more complex because of the different characteristics of life and non-life insurance, for instance regarding the longevity of the business.

Present Value of Future Profits (PVFP)

In consequence of the long-term consideration, the risk discount rate is of significant importance. The mentioned premium adjustments and volatile developments caused by cancellation of insurance contracts are more likely to be expected in non-life insurance rather than in life insurance.

Claims and Equalization Reserve

The different accounting approaches between German GAAP and IFRS require transfers of Claims and Equalization Reserves as well. While claims reserves are listed both in the German GAAP and IFRS accounting, equalization reserves are not allowed in IFRS. The German GAAP Equalization Reserve is usually determined from the volatility of the underwriting result of the last 15 years according to a fixed algorithm. Therefore, market consistent assumptions for the Equalization Reserve must be made. Further assumptions have to be made how profits or losses are realized over time.

Guarantees and Options

Resulting from an usual one-year insurance period, guarantees and options only play a subordinate role in non-life insurance in comparison to life insurance. Long-term capital market options except for the APR do not exist. Other options (extraordinary termination rights etc.) can be considered as already included in the annual premium. For this reason, a consideration of guarantees and options for the MCEV in non-life insurance (according to current experts' opinion) is largely obsolete. This eliminates the mandatory application of a stochastic method of valuation as requested in the CFO principles, and hence, a deterministic approach seems to be appropriate for all the necessary transfers of the MCEV to non-life insurance.

Cost of Capital (CoC)

According to the CFO principles, the Costs of Capital are the costs of miscellaneous non-hedgeable risks within the MCEV (Cost of Residual non-hedgeable Risks, CRNHR), unless they are not included in market value positions or in the Frictional Costs of Required Capital.

In non-life insurance the CRNHR denote the capital costs of the insurance company for reserve, premium and operational risks. While the CFO principles do not demand a unique method to calculate the CRNHR the application of an economic cost of capital model seems to be reasonable.

The risk measurement is not specified either. For example, in non-life insurance the value-at-risk concept, a confidence level of 99.5% and an observation period of one year can be used.

New Business, Renewals and In-Force Business

The MCEV projects the existing portfolio over the period remaining. In current internal models for non-life insurance one subsequent year is projected where new business is also included.

According to the definition of the MCEV, only renewals of existing business is considered in the evaluation of the insurance business where future new business is not included. In life insurance, this assumption is not crucial because of the long-term nature of its contracts. But for non-life insurance, assumptions must be made on how the annual renewal of the existing business should be treated. Non-life insurance distinguishes between new and continued business:

<u>New business</u>	NB (meaning every new signing of a contract), is neglected in non-life insurance. In motor insurance, this implies that any change of vehicle is considered as new business. For household insurance a change of residence would be thought of as new business.
<u>Continued business</u>	CB is differentiated in an In-Force business at the beginning of the consideration and in renewals. This distinction has no influence on the amount of the value but is required for the calculation later on in the text.

In non-life insurance, the signing of the insurance contract is crucial for the determination of the value of the portfolio.

Based on the portfolio in the initial year of the analysis, automatically renewed contracts caused by a change in premium or other adjustments are attributed to the renewals. The following figure shows the differences between the In-force portfolio and renewals:

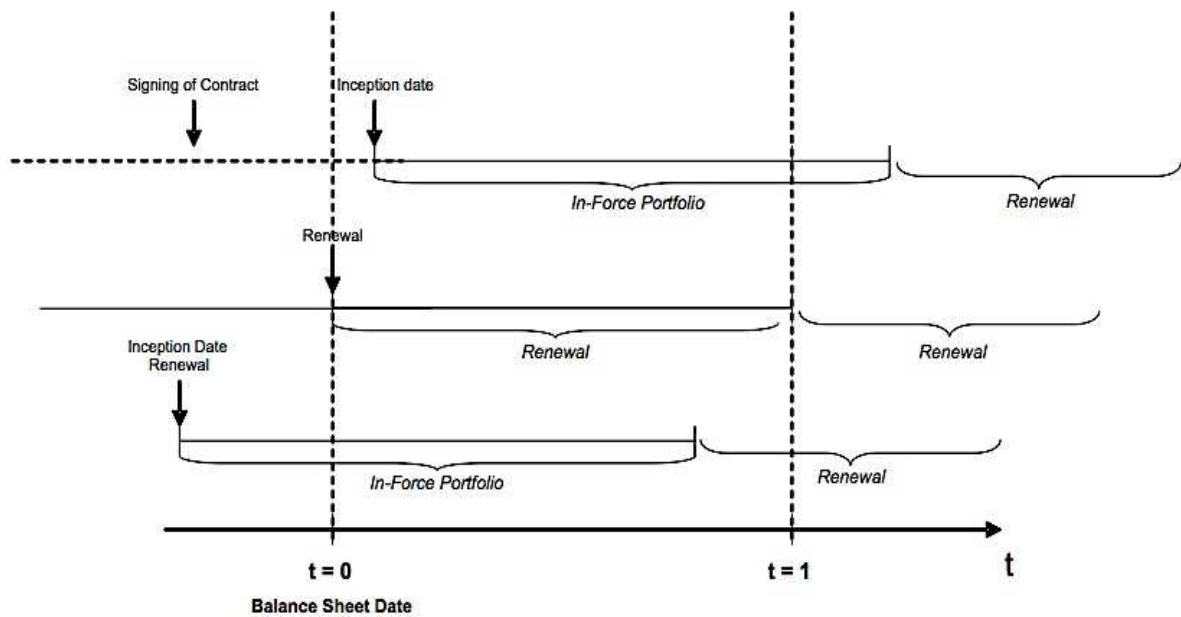


Figure 119: In-Force Business and Renewals⁶⁷

In the first case, the contract is completed before the balance sheet date and thus before the date of the MCEV approach. Therefore, this insurance contract is attributed to the In-Force portfolio until the end of the reporting year.

As can be seen in the second timeline, there is a renewal on the balance sheet date. The contract from the previous year is continued automatically, which implies that this contract is assigned to the renewals and influences the value of the continuing business.

Looking at the third example, the signing of the contract took place before the balance sheet date. The contract is therefore attributed to the In-Force business, beginning at the balance sheet date and ending at the maturity date. After that the contract will be allocated to the renewals.

This distinction of the existing contracts is of enormous importance for the portfolio development in non-life insurance. For example, the portfolio value is influenced by the appropriate assumptions regarding the lapse rate and claims cost. These assumptions must be made individually for every line of business, which also means a high reliance on uncertain planning assumptions and thus a dependency on the business policy of a company.

In motor insurance the loss ratio may increase due to the loss of good risks. Political factors could also lead to wrong assumptions, as they are derived from the past

⁶⁷ Heep-Altiner (2012), p. 48.

and therefore have no validity for the future. The scrapping premium of 2009 led to a significantly higher number of car sales. This would mean a higher portfolio loss as it was calculated for the Embedded Value.

Model Shocks

Model shocks are isolated changes in individual input parameters. They serve for the comprehension (sensitivity) and testing (plausibility) of the calculated MCEV. Especially sensitivities of the MCEV give a good first impression of its value drivers and critical success factors. For parameters that are strongly influenced subjectively, such as the Cost of Capital this is vital. Especially, sensitivities have an added significance as they are published in the IFRS consolidated financial statements⁶⁸.

In life insurance, predefined model shocks have to be applied, indicating a change in single calculation parameters. For non-life insurance, such model shocks are also necessary to achieve a better understanding of the dependency of the Embedded Value to the various input parameters.

Possible model shocks (among others), that could have a significant impact on the MCEV, are listed in the following:

- Increase of Costs of Capital,
- increase of Tax rate,
- Increase of Cost Ratios,
- Change in the Risk Discount Rate,
- Increase of Administrative Costs,
- Premium reductions as well as
- Change in Claims Reserves.

The general approach to calculate an Embedded Value in non-life insurance is explained in the next section.

4.3.3 General Approach

In the figure below it is illustrated how the MCEV can be derived as a balance sheet projection over the total projection horizon. The illustration is based on German GAAP, but it is applicable to other generally accepted accounting principles, too.

⁶⁸See IFRS 4, 39A.

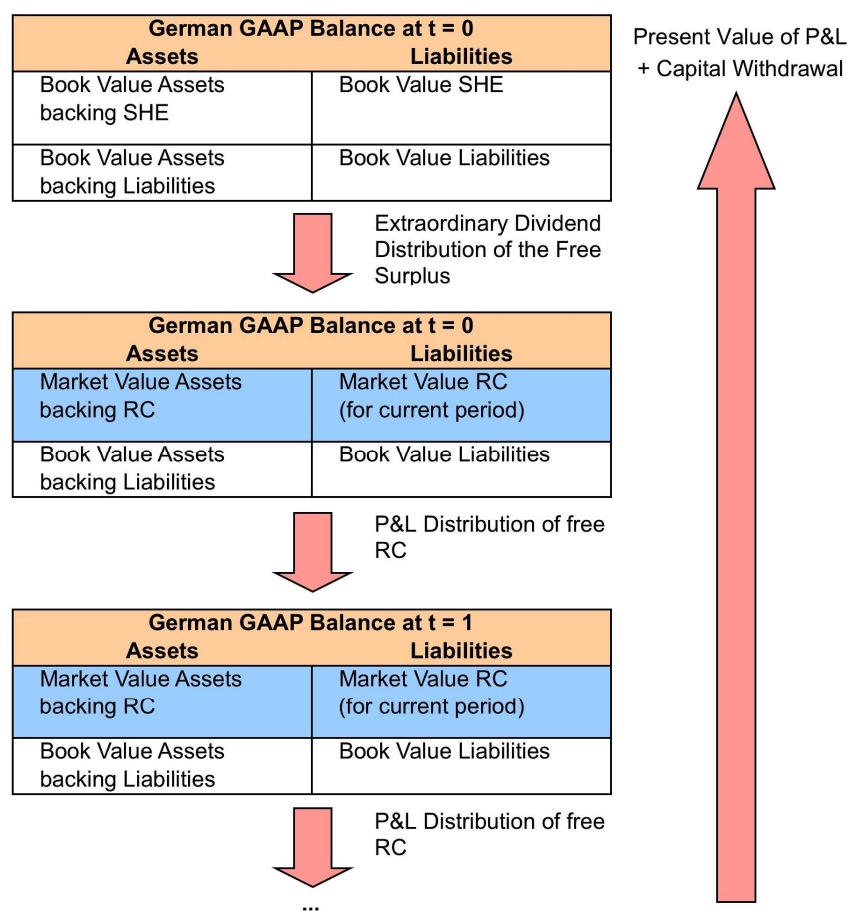


Figure 120: German GAAP Balance Projection for the MCEV Calculation⁶⁹

In a first modelling step, starting with the balance at $t = 0$, a Free Surplus or in a worst case scenario a Free Deficit, is realized as an immediate extraordinary payout. Thus, the company keeps the Required Capital at Market Value afterwards. The extraordinary payout takes place through a realization of hidden reserves or liabilities affecting the net income as well as a withdrawal or injection of capital with respect to the difference between balance equity and Required Capital without affecting the net income.

After the extraordinary payout, the remaining Required Capital is invested risk-free with the result that no hidden reserves will exist in the following periods. In transition to every further period, the balance will be adjusted due to changes in the Profit and Loss Account and the withdrawal of free Required Capital.

At the starting point of the projection no extraordinary payout happens for potential hidden reserves on liabilities as these are disclosed over time. Due to the projections the Required Capital as well as the liabilities are reduced over time.

⁶⁹ Heep-Altiner (2012), p.54.

To get to the Embedded Value, the present value of all profits and losses and all capital withdrawals will be calculated on the basis of the interest rate curve adjusted by the CRNHR.

4.4 Embedded Value in Non-life Insurance – Calculation Example

The aim of this section will be a presentation of the methodical approach to the determination of the MCEV using a fictitious insurance company - the so-called “Feldafinger Brandkasse” (FBK).

Initially, the fictitious model-company will be introduced including its balance and all relevant input parameters, which are needed to determine the MCEV. Followed by a few calculation examples, the transition to the MCEV will be outlined using the calculated key ratios. A comparison between the MCEV and the economic capital will sum up this section.

4.4.1 Example Company

Starting point of the fictitious insurance company is the following German GAAP balance for the FBK.

Assets		Liabilities	
Book Values Assets	236,139	48,236	German GAAP Equity
<i>Assets backing SHE</i>	<i>48,236</i>		
<i>Assets backing Liab.</i>	<i>187,903</i>	187,903	Book Values Reserves
		<i>153,952</i>	<i>Claims Reserves</i>
		<i>33,951</i>	<i>Equalization Reserve</i>
Tax Receivables	0	0	Tax Reserve
	236,139	236,139	

Figure 121: German GAAP Balance at $t = 0$ ⁷⁰

All investments are split virtually into Assets Backing Liabilities (ABL) and Assets Backing Shareholders Equity (ABSE). The book values of ABL with an amount of 187,903 cover the technical provisions. The ABSE amounts to 48,236 and cover the German GAAP equity. Both, ABSE and ABL are assumed to be invested in risk-free zero bonds with redundancies / deficiencies according to the selected yield curve. Moreover, the FBK is subject to a tax rate of 32%. The German GAAP balance sheet of the FBK serves as the starting balance for the projection of surpluses in the projection model.

The next figure lists all relevant input data, such as reserves and premiums, which are crucial for the MCEV determination. It also displays the German GAAP balance

⁷⁰ Heep-Altiner (2012), p.57.

with book values at $t = 0$. Besides this, the fictitious company has only two lines of business, third-party motor vehicle insurance and homeowners insurance.

Position	Third Party	Home Owners	Total
Earned Premiums	92,218	37,485	129,703
Book Value Claims Reserve	142,839	11,113	153,952
Best Estimate Claims Reserve <i>in % of Booked Claims Reserves</i>	88,331 <i>61.8%</i>	7,043 <i>63.4%</i>	95,374 <i>62.0%</i>
Book Value Equalization Reserve <i>in % of Booked Claims Reserves</i>	26,863 <i>18.8%</i>	7,088 <i>63.8%</i>	33,951 <i>22.1%</i>
Book Value Technical Reserve	169,702	18,201	187,903
Book Value Assets <i>Redundancy / Deficiency in %</i>			236,139 <i>2.0%</i>
German GAAP Equity			48,236

Figure 122: Input Data – Example Company⁷¹

Concerning the Best Estimate Reserves of the existing business (evaluated by suitable mathematical algorithms) and the claims experience of the new business the following cash flow assumptions apply:

	Cash-Flow in % after ... Years					
	1	2	3	4	5	6
Old Reserve	26.76%	20.02%	14.56%	10.59%	7.70%	5.60%
New Business	68.54%	10.62%	7.04%	4.66%	3.09%	2.05%

Figure 123: Cash Flow Pattern at $t = 0$ ⁷²

Additionally, there is a further need of input parameter to carry out a MCEV projection, especially

- global parameters,
- projection information and
- Required Capital information including Costs of Capital information.

⁷¹ Heep-Altiner (2011), p.124.

⁷² Heep-Altiner (2012), p.59.

The global parameters comprise a risk-free yield curve where the implicit forward rates can be deducted from the spot rates as illustrated in the following table.

	Duration			
	0	1	2	3
Spotrates	3.92%	4.70%	4.53%	4.51%
Forwardrates		4.70%	4.36%	4.48%

Figure 124: Yield Curve at $t = 0$ ⁷³

Concerning the asset structure at $t = 0$, it is assumed that the FBK has only invested in risk-free zero bonds with the following characteristics:

average duration of fixed income securities	4,57
average interest rate of fixed income security	5.00%
hidden reserves in the book values at $t=0$	2.00%
investment costs in % of the market values	0.20%

The hidden reserves of 2.00% result with respect to the chosen yield curve. The percentage of hidden reserves would change, if it were based on a different yield curve with different interest rate structures.

Further input parameters are needed to determine the Required Capital, which is needed to generate the MCEV of the fictitious company. The following assumptions are made:

- Parameter with respect to the SCR calculation,
- 175% coverage due to Rating Requirements,
- CoC Ratio of 6% with respect to the Solvency Capital.

The determination of the SCR is based on the QIS 5 study⁷⁴. Premium risk, reserve risk and the correlation between both risks depend on the internal model of the FBK.

In the following, the MCEV projections are carried out only for the existing business in order to be consistent with the usual definition of economic capital in non-life in-

⁷³Heep-Altiner (2012), p.61

⁷⁴For more information see <https://eiopa.europa.eu/consultations/qis/insurance/quantitative-impact-study-5/index.html>

surance. Furthermore, we consider a “virtual” run-off (e.g. within other business operations) such that only claims regulation costs (covered in the Best Estimate Reserves) and investment costs occur, but no operational costs for new business. Operational costs are not included in the projections.

The projected development of the Claims Reserves (German GAAP as well as Best Estimate) and the Equalization Reserves is illustrated in the following figure.

Position	Value			
	0	1	2	3
Total Payments		25,518	19,095	13,887
BE-Reserve	95,374	69,855	19,095	36,873
German GAAP Reserve	153,951	112,760	50,761	59,520
Operational Expenses	0	0	0	0
Equalization Reserve	33,951	24,867	18,070	13,126

Figure 125: Projection of Reserves without Renewals⁷⁵

The projected German GAAP Reserves result from the projected Best Estimate Reserve (according to its cash flow pattern) after application of the initial over-reserving percentage (according to the defined management rules), especially

$$\text{German GAAP Reserve (t)} = \text{BE-Reserve (t)} \cdot \text{Over-reserving-Rate (t)}$$

The projected Equalization Reserve results from the projected German GAAP Reserve after application of the Equalization Rate, especially:

$$\text{Equalization Reserve (t)} = \text{German GAAP Reserve (t)} \cdot \text{Equalization Rate (t)}$$

After those reserve projections the projection of the RC and the CRNHR can be performed.

4.4.2 Net Asset Value

In this section, the Net Asset Value (as a sum of the Required Capital and the Free Surplus) will be calculated on the base of the previously specified input parameter of the FBK.

⁷⁵ Heep-Altiner (2012), p.73.

Required Capital

According to the management rules of the FBK, the Required Capital is the maximum of the

- Required Capital to cover the SCR & MCR according to Solvency II and the
- Required Capital to cover the solvency margin according to Solvency I with a required 175% overload.

The figure below shows the projection of the Required Capital for several years:

Position	Period		
	0	1	2
(1) Market Value ABL	191,666	139,997	101,092
(2) Discounted BE Reserve	83,454	61,263	44,426
(3) Projection of Risk Margin	3,454	2,514	1,815
(4) SCR incl. 175% Overload	32,130	23,586	17,104
(5) Required Capital = MAX[(2)+(3)+(4)-(1);0]	0	0	0

Figure 126: Required Capital without Renewals (1)⁷⁶

Required Capital **to cover the SCR** is only needed if the hidden reserves are insufficient to cover the Solvency II requirements. As shown above the ABL market values are sufficient to meet Solvency II requirements such that there is no capital required due to this aspect.

Furthermore, Required Capital **to cover the MCR** should be calculated. The MCR is set as 50% of the SCR based on Solvency II: See the next figure.

Position	Period		
	0	1	2
(1) SCR	18,360	13,478	9,774
(2) MCR = (1) · 50%	9,180	6,739	4,887
(3) Required Capital = (2)	9,180	6,739	4,887

Figure 127: Required Capital without Renewals (2)⁷⁷

As a next step, the Required Capital according to **Solvency I** in combination with a required **coverage of 175%** is calculated as

⁷⁶ Heep-Altiner (2012), p.77.

⁷⁷ Heep-Altiner (2012), p. 78.

$$\text{Required Capital} = 175\% \cdot \text{MAX} [\text{Premium-Index}; \text{Claims-Index}; 2,200].$$

The projections of the Required Capital due to Solvency I with a coverage of 175% are listed in the figure below.

Position	Period		
	0	1	2
(1) Premium Index	21,814	0	0
(2) Claims Index	24,236	15,327	6,337
(3) Solvency Margin = MAX [(1);(2);2,200]	24,236	15,327	6,337
(4) Required Capital = 175% · (3)	42,412	26,823	11,090

Figure 128: Required Capital without Renewals (3)⁷⁸

Finally, all the three steps have to be combined in order to determine the Required Capital in total to fulfil all solvency and rating requirements of the company: See the figure below.

Position	Period		
	0	1	2
(1) Required Capital SCR	0	0	0
(2) Required Capital MCR	9,180	6,739	4,887
(3) Required Capital Solvency I	42,412	26,823	11,090
(4) Required Capital = MAX[(1);(2);(3)]	42,412	26,823	11,090

Figure 129: Required Capital without Renewals (4)⁷⁹

The value of the total Required Capital decreases quickly with respect to the given run-off Scenario. At $t = 3$ the value of the Required Capital already amounts to the minimum. As a result, the fictitious insurance company needs a Required Capital of 42,412 for all underwritten risks in $t = 0$.

Free Surplus

The Free Surplus is the second component determining the Net Asset Value. In the balance at $t = 0$, an initial German GAAP equity of 48,236 is given. From this starting point, the Free Surplus can be calculated by the following approach:

⁷⁸ Heep-Altiner (2012), p. 78.

⁷⁹ Heep-Altiner (2012), p. 79.

- The initial German GAAP equity includes 2% of hidden asset reserves (= 996). By realizing those reserves a tax of 32% has to be paid, which results in an after-tax value of 657.
- The difference between the initial German GAAP equity and the Required Capital can be treated as a tax-free capital withdrawal. The difference between both values is $5,824 = 48,236 - 42,412$.

If we combine all calculations carried out in this section we obtain the following Net Asset Value of the FBK:

$$\begin{aligned}
 \text{Free Surplus} &= 5,824 + 657 \\
 &= 6,481 \\
 \text{Required Capital} &= 42,412 \\
 \text{Net Asset Value} &= 48,893
 \end{aligned}$$

Next, the Value of In-Force Business of the FBK will be calculated by carrying out the German GAAP balance sheet projections over the projection period.

4.4.3 Value of In-Force Business

Calculating the Value of In-Force Business depends on different economic parameters. One way to calculate the VIF is to calculate the Present Value of Future Profits and subtract the sum of Costs of Residual Non-Hedgeable Risks, the Time Value of Options and Guarantees and the Frictional Costs. Another way is shown in the following figure illustrating the projection results at $t = 1$.

Position	Value
(1) Total Result after Capital Removal	40,156
(2) Cost of Capital	1,102
(3) Free Surplus	0
(4) Reproduction of Required Capital	17,581
(5) VIF	$= (1) - (2) - (3) - (4)$
	21,474

Figure 130: VIF Result at $t = 1$ without Renewals⁸⁰

The projection of all discounted VIF results over the projection period results in a total VIF of **67,527**.

⁸⁰ Heep-Altiner (2012), p.105.

The Total Result after Capital Removal consists of profits in the financial year and the capital withdrawal or respectively the capital injection.

Apart from this, the reproduction of Required Capital (within the Total Result) consists of two components,

- the capital withdrawal of free Required Capital at the end of the period and
- the risk-free interests on the Required Capital at the beginning of the period.

It is relatively simple to calculate the VIF in this way, because it corresponds perfectly to a balance sheet projection. In contrast, the calculation of the PVFP is relatively artificial, because it corresponds to a “virtual” profit & loss treatment only on the base of the liabilities. Therefore, for the FBK we have calculated the PVFP of the FBK starting from the VIF.

Present Value of Future Profits

Calculating the PVFP on the base of the VIF we obtain the following equation:

$$\begin{aligned}\text{PVFP} &= \text{VIF} + \text{TVOG} + \text{CRNHR} + \text{FC} \\ &= 67,527 + 0 + 3,454 + 1,848 \\ &= \mathbf{72,828}\end{aligned}$$

The single components of this equation are explained in the following.

Time Value of Options & Guarantees

Due to the initially outlined model assumptions, the Time Value of Options and Guarantees at $t = 0$ is zero (according to the general properties of non-life business).

Cost of Capital

The CRNHR calculation is based on a 6% CoC rate and a discount by the given yield curve, see the following figure:

Position	Sum	Period		
		0	1	2
(1) Discounting Factor		100.00%	95.51%	91.53%
(2) Total SCR		18,360	13,478	9,774
(3) Cost of Capital = (2) · 6%			1,102	809
(4) CRNHR = (3) · (1)	3,454		1,052	740

Figure 131: CRNHR without Renewals⁸¹

For a given projection period we have projected the Total SCR such that we obtain for instance for the period $t = 1$ the following discounted value:

$$\text{CRNHR}_1 = 18,360 \cdot 100\% \cdot 6\% \cdot 95.51\% = 1,052.$$

The sum of the discounted values for all periods ends up with an amount of **3,454** for the CRNHR.

Frictional Costs

The Frictional Costs consist of the expenses for the ABSE and the tax of the non-technical result for ABSE. Each value for a given period will be discounted due to the specified yield curve. The Frictional Costs equal the sum of all discounted values.

The ABSE expenses are obtained by application of the investment costs ratio of 0.20% to the Required Capital at the beginning of a period.

The non-technical result of each period is obtained by application of the forward rate to the Required Capital at the start of the period. Consideration of the tax rate of 32% results in the second part of the Frictional Costs. To summarize:

$$\begin{aligned}
 \text{FC} &= \text{Expenses ABSE} + \text{Tax on Non-technical Result on ABSE} \\
 &= 226 + 1,622 \\
 &= \mathbf{1,828}
 \end{aligned}$$

After having explained all components, the calculation of the PVFP is now fully explained.

⁸¹ Heep-Altiner (2012), p.76.

4.4.4 Market Consistent Embedded Value

After having explained the different components of the MCEV, the evaluation of the MCEV of FBK will be described in more detail. The following figure illustrates the German GAAP profit and loss account in the first projection year.

Position	Value	Comment
(1) Earned Premiums	0	= Run-Off Scenario
(2) Claims Expenses	-15,673	= (2a) + (2b)
a) Claims Payments	25,518	= Portfolio Development
b) Change of Claims Reserve	-41,192	= Portfolio Development
(3) Underwriting Expenses	0	= Run-Off Scenario
(4) Change of Equalization Reserve	-9,084	= Portfolio Development
(5) Technical Result	24,757	= (5a) + (5b)
a) Liquid Balance	-25,518	= (1) - (2a) - (3)
b) Change of Technical Reserve	50,276	= (2b) - (4)

Figure 132: Technical Result without Renewals⁸²

The company generates a positive technical result in the Run-Off Scenario, but the value of the liquid balance is negative because of the absent premium income. Furthermore, the fictitious company has an income as a result of change in technical reserves due to the release of redundancies.

To complete the profit and loss projection for the first period it is necessary to illustrate the non-technical result for the FBK. The next figure shows the complete non-technical calculation for the first period.

Position	Value	Comment
(6) Asset Income	10,795	= (6a) + (6b) + (6c)
a) Income ABSE	1,992	= $RC \cdot FWR$
b) Income ABL	9,395	= Book Values PY * Book Income
c) Dis- / Investment Liquid Balance	-592	= $(5a) \cdot ((1 + FWR)^{0.5} - 1)$
(7) Asset Expenses	443	= (7a) + (7b)
a) Expenses ABSE	85	= $RC \cdot 0,2\%$
b) Other Expenses	358	= Average (ABL) $\cdot 0,2\%$
(8) Extraordinary Income	1,018	= $((8a) + (6b) - (8b)) \cdot (8c)$
a) PV ABL at $t=0$	187,903	= According to Projection
b) PV ABL at Expiration	137,627	= According to Projection
c) Hidden Reserves / Liabilities	1.71%	= According to Projection
(9) Non Technical Result	11,359	= (6) - (7) + (8)

Figure 133: Non-technical Result without Renewals⁸³

⁸² Heep-Altiner (2012), p. 80.

⁸³ Heep-Altiner (2012), p. 81.

The next figure illustrates the total result of the profit and loss account for the first period after capital withdrawal of free Required Capital.

Position	Value	Comment
(10) Total Result	36,128	= (5) + (9)
<i>a) Non Technical Result for ABSE</i>	1,907	= (6a) - (7a)
<i>b) Technical Result</i>	34,221	= (10) - (10a)
(11) Tax Result	11,561	= (11a) + (11b)
<i>a) Non Technical Tax Result ABSE</i>	610	= (10a) · (11c)
<i>b) Technical Tax Result</i>	10,951	= (10b) · (11c)
<i>c) Company Tax Rate</i>	32%	= According to Model
(12) Annual Surplus / Deficit	24,567	= (10) - (11)
(13) Capital Removal	15,589	= RC(t) - RC(t+1)
(14) Total Result after Capital Removal	40,156	= (13) + (14)

Figure 134: Total Result without Renewals⁸⁴

The previous calculations are MCEV components of the fictitious company. This leads to the following MCEV result of 39,055 for the first period.

Position	Value	Comment
(15) Immediate Free Surplus	0	= First Period
(16) Reproduction of Required Capital	17,581	= (16a) + (16b)
<i>a) Capital Removal</i>	15,589	= (13)
<i>b) Risk Free Interest Rate</i>	1,992	= (6a)
(17) Value of in Force Business	21,474	= (17a) - (17b) - (17c)
<i>a) = PVFP</i>	23,270	= (14a) + (17c) - (16)
<i>b) Target Additional Dividend</i>	1,102	= According to Projection
<i>c) Frictional Costs</i>	695	= (7a) + (11a)
(18) MCEV Result	39,055	= (3) + (4) + (5)

Figure 135: MCEV Result without Renewals⁸⁵

At this point the Free Surplus should be considered.⁸⁶ The FBK total MCEV reflects the present value of the whole projection time. By using the discounting factors of the yield curve the MCEV in the Run-Off Scenario is determined as followed:

$$\begin{aligned}
 \text{MCEV} &= \text{Free Surplus} \\
 &+ \text{Required Capital} + \text{Value of In-Force Business} \\
 &= 6,481 + 42,412 + 67,527 = 116,240.
 \end{aligned}$$

⁸⁴ Heep-Altiner (2012), p. 82.

⁸⁵ Heep-Altiner (2012), p. 82.

⁸⁶ See chapter 4.3.2.

In the next section, the MCEV will be compared with the traditional concept of economic capital in non-life insurance.

4.4.5 MCEV versus Economic Capital

The previous sections focused on the calculation of the different MCEV components. Based on the evaluated results, a comparison between the deterministic MCEV without renewals at $t = 0$ and the deterministic economic capital is described below. These explanations should inspire a discussion about the advantages and disadvantages of the different evaluation approaches for an insurance company's economic capital.

The IFRS accounting guidelines focus on investors interests in contrast to the German GAAP guidelines. The German GAAP equity of 48.236 was already discussed above.⁸⁷ The use of IFRS principles results in a higher equity which is illustrated in the following figure.

Assets		Liabilities	
Fair Value Assets	240,868	114,371	IFRS Equity
<i>Assets backing SHE</i>	<i>114,371</i>	<i>42,412</i>	<i>Required Capital</i>
<i>Assets backing Liabilities</i>	<i>126,496</i>	<i>71,959</i>	<i>Excess Capital</i>
		95,374	Best Estimate Reserve
		<i>95,374</i>	<i>Claims Reserve</i>
		31,123	Tax Reserve
Total	240,868	240,868	Total

Figure 136: IFRS Balance at $t = 0$ ⁸⁸

The Fair Value approach for assets generates a higher value because of a direct realization of hidden reserves. The recognition of reserves according to German GAAP is significantly more restrictive than in IFRS. An adjustment of the liabilities is based on the best estimate approach for reserves and the prohibition of an Equalization Reserve. Because of the 32% individual companies tax rate reserves have to be set up.

The economic balance sheet is characterized by market values. In contrast to IFRS, the Fair Value approach for reserves is based on a discounted best estimate calculation including a safety margin.

⁸⁷ See chapter 4.3.1.

⁸⁸ Heep-Altiner (2012), p.158.

Assets		Liabilities	
Market Value Assets	240,868	120,342	Market Value Equity
<i>Assets backing SHE</i>	<i>120,342</i>	<i>42,412</i>	<i>Required Capital</i>
<i>Assets backing Liabilities</i>	<i>120,526</i>	<i>77,929</i>	<i>Excess Capital</i>
		86,594	Fair Value Reserve
		<i>83,454</i>	<i>Claims Reserve</i>
		<i>3,140</i>	<i>Reserve Margin</i>
		33,932	Tax Reserve
Total	240,868	240,868	Total

Figure 137: Economic Balance at $t = 0$ ⁸⁹

In IFRS, the fictitious company accounts assets at Fair Value. In the economic balance the liabilities are also determined via Fair Value using a discounted best estimate modelling approach (Mark-to-Model).

The Fair Value Reserve of 86,594 results in the discounted best estimate claims reserve of 83,454 and the reserve margin of 3,140. Because of a larger realization of hidden reserves, the economical tax reserve is higher than the IFRS tax reserve.

The reserve modelling is based on a present value approach. Therefore, high levelled durations have a significant effect on discounting rates and lead to a bigger reserve realization than in IFRS. The safety margin has an increasing effect on the Fair Value Reserves. Because the margin only covers reserve risk and does not consider other types of risk, the increasing effect is limited.

A critical aspect is the assumption of a deep and liquid market in the economic evaluation. All assets and liabilities could be disposed during the whole time. Because of market illiquidity, this consideration seems to be unrealistic. Therefore an illiquidity premium especially for liabilities should be taken into account.

Based on the German GAAP projection already carried out, the deterministic MCEV is represented in the following figure:

⁸⁹ Heep-Altiner (2012), p.159.

Assets		Liabilities	
Fair Value Assets	240,868	116,420	MCEV
<i>Assets backing SHE</i>	<i>116,420</i>	<i>6,481</i>	<i>Free Surplus</i>
<i>Assets backing Liabilities</i>	<i>124,448</i>	<i>42,412</i>	<i>Required Capital</i>
		<i>67,527</i>	<i>Value in Force</i>
		89,867	Fair Value Liabilities
		<i>83,454</i>	<i>Technical Result</i>
		<i>3,454</i>	<i>CRNHR</i>
		<i>1,111</i>	<i>Asset Management</i>
		<i>1,848</i>	<i>Frictional Costs</i>
		<i>0</i>	<i>TVOG</i>
		34,581	Tax Reserve
Total	240,868	240,868	Total

Figure 138: MCEV at t = 0 without Renewals (1)⁹⁰

According to the CFO requirements, this figure illustrates some net positions, especially with respect to taxes. This results to a tax reserve which is not based on the company tax rate for the realisation of hidden reserves according to German GAAP balance at t = 0. The following figure corresponds to the usual consideration of modifying the German GAAP balance with respect to an alternative valuation approach.

Assets		Liabilities	
FV Assets after Extraordinary Income	240,868	116,420	MCEV
		<i>6,481</i>	<i>Free Surplus</i>
		<i>42,412</i>	<i>Required Capital</i>
		<i>67,527</i>	<i>Value in Force</i>
FV Income Risk Free Return of the RC	5,294	8,748	Dividends
		<i>5,294</i>	<i>Reproduction of RC</i>
		<i>3,454</i>	<i>CRNHR</i>
		84,791	FV Liabilities
		<i>83,454</i>	<i>Technical</i>
		<i>1,337</i>	<i>Total Asset Management</i>
		36,203	Tax Reserve
Total	246,162	246,162	Total

Figure 139: MCEV at t = 0 without Renewals (2)⁹¹

In this balance, the future interest income on RC is activated to reproduce the Required Capital based on the deterministic yield curve at t = 0. The total costs for asset management are not presented as a netted value on the liability side. Moreover, the value of the tax reserve in comparison to the German GAAP Equity can be calculated as

⁹⁰Heep-Altiner (2012), p.160.

⁹¹Heep-Altiner (2012), p.161.

$$36,203 = (246,162 - 84,791 - 48,236) \cdot 32\%.$$

The main differences between the MCEV balance at $t = 0$ and the economic balance $t = 0$ can be described as followed:

- Extra Frictional Costs were adapted from the realization over the time. These costs will decrease gradually due to the reduction of the Required Capital.
- The capital costs increase because operational risks are covered, too.
- Additional investment cost is caused by the ABL realization over time.

The different approaches of German GAAP, IFRS, economic capital and MCEV are compared in the following table.

	German GAAP	IFRS	Market Value	MCEV
Assets	236,139	240,868	240,868	240,868
Liabilities	187,903	95,374	86,594	89,867
<i>Technical Result</i>	<i>153,951</i>	<i>95,374</i>	<i>83,454</i>	<i>83,454</i>
<i>Equalization Reserve, Reserve Margin, CRNHR</i>	<i>33,951</i>	<i>0</i>	<i>3,140</i>	<i>3,454</i>
<i>Frictional Costs</i>	<i>0</i>	<i>0</i>	<i>0</i>	<i>1,337</i>
<i>Asset Management</i>	<i>0</i>	<i>0</i>	<i>0</i>	<i>1,111</i>
<i>Options and Guarantees</i>	<i>0</i>	<i>0</i>	<i>0</i>	<i>0</i>
Tax Reserve	0	31,123	33,932	34,581
Equity	48,236	114,371	120,342	116,420
<i>in % of the economic capital</i>	<i>40.08%</i>	<i>95.04%</i>	<i>100.00%</i>	<i>96.74%</i>

Figure 140: Equity Comparison at $t = 0$ ⁹²

The differences can essentially be attributed to diverging valuation of the liabilities, whereas the differences in asset valuation are rather insignificant. The German GAAP Balance disposes a small Equity value because of higher technical reserves.

As seen in the figure above, the valuations according to the other approaches are more comparable to each other.

The reserve values of the Economic and the MCEV Balance are discounted in contrast to the IFRS reserve. This leads to lower liabilities and higher equity. The discounting effect is modified by the cost and risk margin consideration. Therefore, the MCEV is not essential higher than the IFRS Equity.

⁹² Heep-Altiner (2012), p.162.

4.5 Conclusion

The insurance business, and in particular life insurance, is a long-term business. Insurance companies cover and manage the risk of their customers, which makes a value- and risk-oriented steering absolutely necessary.

While the Embedded Value is well established in life insurance, so far non-life insurance companies have not gained much experience using this approach to evaluate companies' economic capital. The reasons for this are addressed in the short period of non-life insurance contracts and their low dependency on capital-markets regarding options and guarantees. Indeed, these characteristics allow rapid responses to market changes with the result that they can be factored into the insurance premium. But this complicates the long-term forecasts of trends in portfolio development.

Currently non-life insurers use standard internal models which reflect the stochastic development of the economic capital during a financial year. The observation horizon is one year and usually includes new business. These internal models are more appropriate for value-based management in non-life insurance.

The Embedded Value is strongly affected by the underlying assumptions. In particular, the interest rate has a tremendous leverage within a long-term view. But also changes in the composition of the portfolio, customer behaviour and political influences could strongly affect the MCEV considerations.

It should also be noted that due to the annual terms and the existence of price cycles, the parameters assumed for the multi-year projections of the MCEV should be checked intensively.

In summary, it can be ascertained that the Embedded Value can be determined in principle for non-life insurance - this is mainly due to the fact that these models can be created using input data which are typically required for internal models as well.

However, it is critical to note that reliable MCEV calculations require extremely hard work. One could therefore question of whether costs and benefits bear a reasonable relationship to each other.

Also, there may be a problem in the requirements of the MCEV if it was to hold for both internal management and external communication. There will always be a target conflict to the effect that unfavourable trends should be detected and evaluated at an early stage, while only stable figures should be shown to the public. For non-life insurance the MCEV should therefore mainly be used for internal steering.

Nevertheless, one must keep in mind that even the MCEV is only a snapshot. As a result of the volatility of the market data, it cannot serve as the sole basis of management decisions. But still, it represents important information for management and stakeholders.

Especially the large holding companies are striving for a unified model to aggregate the internal models in life and non-life insurance. In this context, the Embedded Value could play an important role in the future of non-life insurance.

Glossary

Acquisition Costs

The total costs for a firm to gain a new client or customer. The acquisition costs include marketing, networking, and other associated costs for example, commissions paid to a broker or fronting company.

Administration Costs

The costs of general services and management (such as accounting, contracting and industrial relations).

Allocation of Capital

Allocation of the risk-based capital demand to different segments.

Amount of Coverage

The amount of coverage is the difference between the present value of the prospective premiums and the present value of the prospective liabilities. It can be positive as well as negative.

Appraisal Value

Can be used to measure the financial performance of insurance companies. The Appraisal Value is based on a projection of future cash flows of an entity from its current and future operations.

Bernoulli Distribution

A distribution used to describe random events with only two possible outcomes: the random event (success) and its complementary event (failure).

Capital Allocation

See: Allocation of Capital.

Capital Costs

Costs which occur by supplying the required capital.

Cash Flow

Balance of effective revenues and expenses in a period.

Chain Ladder Model

This is a model which estimates the reserve for the prospective years by the means of a run-off triangle.

Claims Settlement Costs

The costs that occur when a claim has to be handled and settled.

Combined-Ratio

Claims payments and expenses in relation to premium; important indicator for determining the profitability of a segment.

Cost of Capital Ratio

It is the minimum interest rate which is required by the investor according to the risk. An insurance company requires this for allocating capital.

Cost of Residual Non-hedgeable Risks

Consist mainly of the Cost of Capital unless they were already considered in the fair values.

Degree of Fulfillment

Ratio between observed and required profitability.

Deterministic Capital

Capital which is not simulated.

Diversification Effect

Effect of risk reduction due to volume enlargement.

Duration

Average time of payment.

Embedded Value

Common valuation method used especially for life insurance. It is calculated by adding the adjusted net asset value and the value of in-force business of the company.

European Embedded Value

Explicit rules for the determination of an Embedded Value developed in 2004 by the CFO-Forum.

Excess

The amount above a pre-determined specified value.

Extra Dividend

The dividends companies should pay the shareholders as compensation for their risk of losing capital. Usually the percentage relative to the capital required will be fixed by the management.

Frictional Cost of Required Capital

Taxation and investment costs on the assets backing shareholder equity.

Free Surplus

Market value of the capital allocated to the covered business but not required to support the in-force covered business at the valuation date together with valuation reserves.

Interest Rate

This is a rate which is charged or paid for the use of money over time.

Lognormal Distribution

A distribution with parameters μ (expectation value) and σ (standard deviation) which is normally distributed after logarithmic transformation. Only positive values will occur.

Market Consistent Embedded Value

Advancement of the European Embedded Value.

MCR

The Minimal Capital Required (MCR) is the least amount of capital the authorities require to continue the insurance business. In comparison to the Solvency Capital Required (SCR) it is lower.

Net Asset Value (NAV)

Book value of the equity adjusted by the valuation reserves. The NAV is divided into the Required Capital and the Free Surplus.

Non-proportional Reinsurance

A type of reinsurance where a reinsurer covers risks on a non-proportional base.

Ordinary Profit and Loss (P&L)

The ordinary P&L consists of the technical result (e.g. underwriting risk) and the non-technical result (e.g. asset risk).

Overall-Risk

The Overall Risk is the risk that occurs at the overall level and that considers diversification and concentration effects. To measure the overall risk, the single risks have to be aggregated.

Present Value

Current value of incoming and outgoing payments after discount.

Private Equity

Private equity is an asset class consisting of equity securities in operating companies that are not publicly traded on a stock exchange.

Probability of Loss

The likelihood that a certain event/claim will occur.

Required Capital

Capital which is needed to bear risk.

Reserve (Non-life)

Insurers have to set a reserve for incurred claims which have not yet been (completely) settled.

Return on Equity

The ROE is an index to analyze the profit situation within a financial year: It is the quotient of Net income (after tax) divided by the shareholder equity.

Risk Discount Rate

Rate that shareholders demand for providing capital to the insurance company corresponding to an appropriate (risk) return on the invested (risk-based) capital.

Risk-free Rate

Rate for risk-free investments.

RORAC

Return on risk-adjusted capital.

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List of Abbreviations

A	Asset
A.o.	And others
CoC	Cost of Capital
Corr	Correlation
CV	Coefficient of variation
D	Duration
E.g.	Exempli gratia
ESG	Economic Scenario Generator
Etc.	Et cetera
EU	European Union
EV	Expected value
FV	Fair Value
I. e.	Id est
IT	Information Technology
MCR	Minimum Capital Requirement
No.	Number
OP	Operational
OR	Operational Risk
P	Probability
p.	Page
P&L	Profit and Loss
RCR	Rating Capital Requirement
PO	Probability of occurrence
PV	Present Value
RC	Required Capital
Rdr	Risk discount rate
RI	Reinsurance
Rf	Risk-free
RORAC	Return on Risk Adjusted Capital
S	Risk spread
STD	Standard deviation
S&P	Standard & Poor's
SCR	Solvency Capital Requirement
UW	Underwriting
VAR	Variation
XL	Excess of loss

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