Market Consistent Embedded Value in Non-Life Insurance: How to measure it and why

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Outline

1. Introduction

In the light of the rapidly changing environment in the insurance industry, *value-based management* techniques have become more and more important in recent years (see Liebenberg and Hoyt, 2003). The aim of this paper is to provide a valuable addition to this emerging field of research: We develop and empirically test a concept for the determination of market consistent embedded value in non-life insurance. We believe that the concept can be helpful to overcome the traditional differences in performance measurement between life and non-life insurance business, which might make our concept a powerful management tool on an insurance group level.

Roughly speaking, life and non-life are the two main business models in the insurance industry, both with their own unique structure of cash flows and with large differences in duration for assets and liabilities. Traditionally, life and non-life are managed as separate entities; in some countries a separation is even required by law (e.g., in Germany and Switzerland). Nevertheless, most large insurers are operating as affiliated groups, i.e., different life and non-life entities are pooled in an insurance group and the group managers need to decide in which direction resources to allocate in order to improve shareholder value. These management tasks can only be achieved with constant monitoring and transparent measurements of performance.

The traditional separation of life and non-life business has, however, also resulted in different management techniques for these two types of companies. While the *Economic Value Added* (*EVA*; see Malmi and Ikäheimo, 2003) and the *Return on Risk Adjusted Capital* (*RORAC*; see Nakada et al., 1999) are very popular performance metrics in non-life insurance, the life insurance industry has focused on the so called embedded value methodology in recent years and developed the concept of *Market Consistent Embedded Value* (*MCEV*; see European Insurance CFO Forum, 2008). In the context of value and risk-based management the change of MCEV from one calendar year to the next (Value Added, VA) can be the basis for quantifying return and risk capital. Especially given the theoretical concern that a separate optimization of different business units does not necessarily lead to a global optimum on a group level, the use of different performance metrics is very problematic from a group manager's point of view. For example, the different measures are not directly comparable and it is not possible to combine the different concepts in one management tool on a group level.

To provide a solution for this unfavourable situation, we argue that the *MCEV* is a consistent valuation concept not only for life, but also for non-life insurance. The idea of this paper is thus to transfer the *MCEV* Principles from life to non-life insurance. This simple idea, however, becomes much more complicated in the light of the large differences between life and non-life insurance. In the first step we therefore consider the specific characteristics of the two businesses, including structure of asset and liabilities as well as the various types of risks and their relevance for life and non-life. A good example is the difference in the duration of the contracts. While most life insurance products are multiyear contracts with monthly or yearly premium payment, non-life insurance products typically have a maturity of one year. A substantial amount of these contracts, however, are automatically renewed and an appropriate valuation of this mechanism must be found to derive the factual value of the in-force business. After deriving the special characteristics of the non-life contracts and their consequences for embedded value calculation, we develop a mathematical model that reflects this special character as well as principles underlying the *MCEV* determination. An example based on empirical data of a German non-life insurance company will be used to illustrate the concept and its usefulness for management purposes.

The contribution of this paper is to develop a new valuation technique for non-life insurance that is easy to use, simple to interpret and directly comparable to life insurance. We built upon ideas developed in a working group of the German Actuarial Society on market consistent embedded value in non-life insurance. The paper is thus not only grounded in recent academic literature, but also of high importance for practitioners and policymakers. Especially in Europe, with the Solvency II regime becoming effective, European insurers face significant changes in almost all aspects of their business including risk management practices, disclosure requirements, and many more. Among these also are management techniques on a group level. The *MCEV* is also relevant for North American life insurance companies. A survey among chief financial officers showed that embedded value methodologies like *MCEV* are becoming more and more popular (see Towers Perrin, 2008). To date embedded value methodologies are thus important valuation concepts and are the basis of performance metrics for value creation in the life insurance industry; our hope is to provide a perspective for their use in non-life insurance.

The rest of this paper is organized as follows. We first describe the concept of embedded value, which originates from valuation of life insurance companies (Section 2). Then we consider the specific characteristics of life and non-life insurance businesses (Section 3). In

Section 4 we develop a mathematical model that reflects this special character of non-life insurance business as well as the requirements for MCEV determination. In Section 5, an example based on empirical data of a German non-life insurance company will be used to illustrate the concept. Finally, Section 6 concludes.

2. Idea of market consistent embedded value

The idea of embedded value calculation originates from valuation literature and can be traced back to Anderson (1959). It is important to emphasize that embedded value is not a performance measure, but a valuation technique. Simplified, the embedded value estimates the value of a life insurance company taking into account future cash flows from existing insurance contracts. It is closely related to discounted cash flow based valuation techniques.[1] However, the concept of embedded value is a promising basis for developing a performance metrics. For this purpose, the embedded value in t=0 and t=1 is compared (so called value added analysis) and the main drivers for the change of embedded value are identified.

Recently, embedded value received new significance and international attention due to the emerging new accounting and regulatory rules, especially the International Financial Reporting Standards (IFRS) and Solvency II. Under both these concepts, insurance business should be evaluated based on market values, which is especially new for many European insurers with a traditionally conservative/prudent accounting philosophy based on historical values rather than on market values (see Post et al., 2007). Accordingly, a set of different proposals and principles have been developed, all with different assumptions and methods to address the problem.

In order to bundle these different streams of research and to develop a standard for embedded value calculation, the Chief Financial Officers of 20 major European insurance companies created a discussion group called CFO Forum. Focusing on consistency and transparency of embedded value reporting, the CFO Forum published the European Embedded Value (EEV) Principles in May 2004 (see European Insurance CFO Forum, 2004). More recently, the CFO Forum launched the Market Consistent Embedded Value Principles (MCEV; see European

[1] More precisely embedded value can be defined as an insurance specific application of discounted cash flow techniques as both rely upon a projection of future cash flows. An important difference between discounted cash flow techniques and embedded value, however, is that embedded value only determines the value of present business and neglects the value of future new business. Thus, only a closed fund consideration is made without any additional arguable assumptions about future new business. The main reason for this is that incorporating future new business would provide many degrees of freedom and reduce comparability across insurers.

Insurance CFO Forum, 2008a), a further development of the EEV Principles. The use of these embedded value guidelines will be compulsory for financial reporting of the CFO Forum members. The 17 MCEV principles serve as a general framework for embedded value calculations of life insurers. The MCEV is defined as “a measure of the consolidated value of shareholders’ interests in the covered business” (MCEV principle 1; see European Insurance CFO Forum, 2008a). Thereby, covered business needs to be clearly identified and disclosed (MCEV principle 2), whereas in general covered business means short- and long-term life insurance business.

As mentioned, the concept of embedded value originates from valuation of life insurance companies and there are three main sources of value in a life insurance company: (1) The net asset value, (2) the present value of the profits from in-force business, and (3) the present value of profits from future sales. The *MCEV* is calculated by adding the net asset value and the present value of the profits from in-force business, i.e., (1) and (2), while the additional consideration of future sales, i.e. (3), is called appraisal value (see Risk Management Metrics Subgroup, 2001).

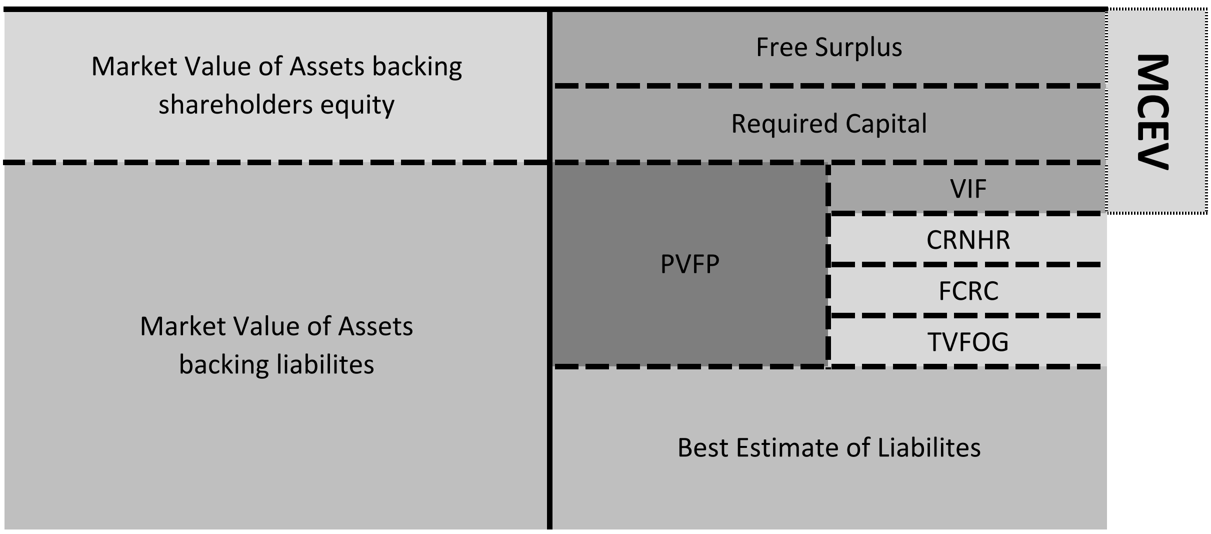

Figure 1: MCEV Elements

Figure 1 illustrates the MCEV elements as described in European Insurance CFO Forum (2008a). According to principle 3, the market consistent embedded value is the present value of shareholders’ interests in the earnings distributable from assets allocated to the covered business. Thereby, sufficient allowance for the aggregate risk must be made. The MCEV consists of the three elements free surplus (FS), required capital (RC), and the value of the in-force business (VIF).

For this purpose, assets allocated to the covered business are split between assets backing shareholders’ equity and assets backing liabilities where liabilities are valuated based on local regulatory requirements. The market value of assets backing shareholders’ equity is called shareholder´s net worth and corresponds to the sum of free surplus (FS) and required capital (RC) (see European Insurance CFO Forum, 2008a, p. 25).

The *required capital* (MCEV principle 5) is the portion of the assets backing shareholders’ equity whose distribution to shareholders is restricted. The amount of required capital has to reflect the local regulatory requirements and other legal restrictions, but should also take into account internal objectives such as internal risk assessment or target credit rating. Correspondingly, the *free surplus* (MCEV principle 4) is the portion of the assets backing shareholders’ equity which is not required to support the in-force covered business at the valuation date and where there are no restrictions regarding distribution to shareholders.

The major challenge for embedded value calculations is to find a best estimate of the present value of the profits from in-force business and the assets backing the associated liabilities. However, the present value of the profits overestimates the true value of the in-force business, e.g., because investors have to bear frictional costs and insurance contracts written typically include a number of options and guarantees. These are all costs that investors would not have to bear by directly investing on the capital market and for that reason the present value of the future profits need to be adjusted in order to estimate the market value. The value of the in-force business (VIF) is thus estimated by considering four components (MCEV principle 6): The *present value of future profits* (PVFP), which is reduced by the *time value of financial options and guarantees* (TVFOG), the *frictional costs of required capital* (FCRC) and the *cost of residual non hedgeable risks* (CRNHR).

The *present value of future profits* reflects the projected cash flows from the in-force covered business and the assets backing the associated liabilities. Profits are considered after taxation and net of reinsurance. Furthermore, by means of a stochastic model for the financial market allowance must be made in the MCEV for the *time value of financial options and guarantees* (MCEV principle 7). These two components show that the CFO Forum demands for a mark to market valuation concept (MCEV principle 3), i.e., insurance liabilities have to be valued as if they are traded assets. Since insurance liabilities usually are not traded on an open market, assets cash flows that most closely resemble the insurance cash flows are used. For this purpose, economic assumptions are set out in principles 12 to 16. In particular, according to principle 13 for those cash flows which vary linearly with, or even do not depend on market movements, both investment returns and discount rates are determined in in a deterministic framework. In particular, this so-called certainty-equivalent approach assumes that all assets earn the risk free reference rate and all cash-flows are discounted using these reference rates. Only where cash flows do not vary linearly with market movements, i.e. cash flows reflecting financial options and guarantees, stochastic models are needed for a proper market consistent valuation (MCEV principle 13). As a reference rate the European CFO Forum prescribes, wherever possible, to use the swap yield curve appropriate to the currency of the cash flows (MCEV principle 14).

Beyond that, allowance must be made for the *frictional costs of required capital* (MCEV principle 8). Frictional costs occur through taxation and investment costs on the assets backing required capital and should be independent of the non-hedgeable risk allowance. Finally, *cost of residual non hedgeable risks* (MCEV principle 9) must be considered when calculating the value of in-force business. In doing so, we can divide into non hedgeable non financial risks and non hedgeable financial risks. A suitable approach to determine cost of residual non hedgeable risks must be applied, providing sufficient disclosures to enable a comparison to a cost of capital methodology.

The value of the in-force covered business can be divided into new business and existing business (MCEV principle 10). Whereas new business means contracts which have been signed within the last 12 months, existing business means contracts that already have been signed more than 12 months ago. The value of future new business is excluded from the MCEV. A typical feature of the business written is the presence of renewal premiums in pricing assumptions. Renewals should include expected levels of contractual renewal in accordance with policy conditions, non-contractual variations in premiums where these are reasonably predictable or recurrent single premiums where the level of premium is pre-defined and reasonably predictable.

From a modelling perspective the determination of VIF can be broken down in three steps (see Table 1): The first step is to develop a mathematical model of the environment, i.e., the capital market (e.g., a stochastic process for the interest rates such as the Vasicek (1977) model), the mortality (e.g., a stochastic process for the mortality such as the Cairns/Blake/ Dowd (2006) model), and other external factors (surrender behaviour, option exercise). Building upon the model of the stochastic environment, the second step is to model the cash flow from the insurance contracts, i.e., the cash inflows and cash outflows. Additionally, firm specific factors such as costs and taxes have to be taken into account. The residual of cash inflow minus cash outflow (taking into account costs and taxes) remains for the shareholders and constitutes the present value of future profits. Note, according to the MCEV definition (MCEV principle 3) we are talking about distributable earnings, i.e., the present value of future profits are equal to statutory profits under local GAAP regulations. The third and final step is to reduce the present value of future profits by the frictional and other costs that investors have to bear compared to direct investment on the capital market.

Step	**To Do´s**
1. Modeling the environment (external)	a) Modeling the capital market b) Modeling biometric risks c) Modeling cancelation behavior and implicit options
2. Modeling the insurance company (internal)	a) Based on Step 1: Modeling the cash inflow and cash outflow for existing insurance contracts considering capital markets, cancelation behavior and biometric risks b) Additional allowance for company-specific factors like costs and taxes c) The remainder goes to the shareholders
3. Determination of the value of the in-force business	Reduction of the present value of future profits (PVFP) by - the time value of financial options and guarantees (TVFOG) - the frictional costs of required capital (FCRC) - the cost of residual non hedgeable risks (CRNHR)

Table 1: Determination of the value of the in-force business

As already mentioned above, covered business may cover short-term as well as long-term life insurance business. The MCEV methodology is used to determine the MCEV of covered business, but the CFO Forum also defines a group MCEV as a measure of the consolidated value of shareholders interests in covered and non-covered business on a group level (MCEV principle 17). The proposal here is that non-covered business should be valued as the unadjusted IFRS net asset value. However, adjustments may be necessary in order to ensure consistency between values allocated to covered and non-covered business. The group MCEV thus is the sum of the covered business (valued according to the MCEV methodology) and the non-covered business (valued according to IFRS net asset value).

However, mixing different methodologies and market values with statutory balance sheet values does not seem a consistent and appropriate way to address the problem. We rather believe that extending the MCEV principles from covered business to those parts that are not covered today, is a feasible and much more consistent way to go. In general, this means to transfer the embedded value methodology from life to non-life insurance business.

3. Differences between life and non-life and consequences for MCEV determination

As mentioned, life and non-life are the two main business models in the insurance industry, both with their own unique structure of cash flows and with differences in duration for assets and liabilities. In this section we outline the main differences between life and non-life and derive their consequences for modeling MCEV. Table 2 sets out a comparison of life and non-life insurers on a number of broad criteria including contract nature, reserve estimation, and balance sheet structure.

The determination of MCEV is based on a present value calculus, i.e., we calculate the present value of future cash flows. While this already is a complicated task in manufacturing (with given order book and production capacity), this can be even much more complicated in insurance companies. This is especially due to the high uncertainty of future cash flows. The uncertainty is relevant both for the inflow, i.e., for example the premiums and the returns from the capital market, as well as for the cash outflow, i.e., for example the claim payments and the operating costs.

In this context, substantial differences can be identified comparing life and non-life. The insurers' liabilities as well as the structure of assets depend on the line of business considered with respect to duration, the amount of risk, and risk determining factors. Life insurance is a long-term business involving a long planning horizon. Given the saving and dissaving process in many contracts, the intermediation component is among the most important types of services provided by life insurers (see, e.g., Cummins/Rubio-Misas/Zi, 2004, for different types of services provided by insurance companies). Present values are discounted future cash flows, so the longer the time horizon the more important is the interest rate component. For this reason the interest rates as well as product options embedded in life insurance contracts (such as minimum interest rate guarantees) are of central concern for life insurers. Traditionally, life insurers profited by an adverse exercise behavior of the insureds with regard to the numerous product options, such as the cancelation of the contract. However, recent research has shown the substantial risk potential of these embedded options (e.g., Gatzert/Kling, 2007; Gatzert/Schmeiser, 2008), which is the reason why these need to be quantified when calculating MCEV and risk based capital for life insurers. Furthermore, long-term orientation within life insurance products will lead to a very robust structure of liabilities, as well as high importance of management rules within value based management, since decision making has an impact on many contract years to come.

Criteria	Life	Non-Life
Contract Duration	many years	usually one year, but renewal on a rolling basis
Main Type of services	Intermediation (saving and dissaving)	Risk pooling
Secondary services	Risk pooling, Financial Services	Intermediation, Financial Services
Structure of Assets	long-term oriented portfolio	short-term oriented portfolio
Structure of Liabilities	limited degree of uncertainty with regard to claims payments and reserves (to the extend this is linked to underwriting risks)	hig degree of uncertainty with regard to claims payments and reserves, especially in lines exposed to catastrophe risk
Duration of Liabilities	long	short-tail lines and long-tail lines
Use of reinsurance	limited use	big use, depending on the line
Surrender Value	yes	no
Cancelation Behavior	analyzed in literature	not analyzed in literature
Reserves	policy reserves, reserves for premium refund	claim reserves, equalization reservse
Financial Options and Guarantees	essential part	no essential part
Structure of Liabilities	very robust	high fluctuation
Diversification between lines of business	Very low, not many Lobs	Very high, many Lobs (many different types of contracts)
Realization of Revenues	normally after many years	normally after one year or over a few years
Conclusions	**Life**	**Non-Life**
Dynamic of the balance sheet comes from…	assets & liabilities	liabilities
Relevance for Modelling….		
- Capital markets	++	+
- catastrophes	+	++
- Biometric riks	+	No relevance
- Options&Guarantees	++	No relevance
- Underwriting Risk	+	++
- Market Risk	++	+
- Management Rules	++	+
Main challanges for MCEV determination	capital market conditions (interest rates), biometric riks, implicit options, cancelation	claim number and severity, modeling of catastrophes, renewal decision

Table 2: A comparison of life and non-life

Non-life insurance is much more short term oriented than life insurance although there are also long tail lines of businesses with substantial time periods between premium and claim payments. The duration is about two years for short tail business such as property insurance where claims are usually made during the term of the policy or shortly after the policy has expired. In long tail lines such as third party liability or motor third party liability the duration can be about 6 to 7 years (see CEIOPS, 2008). Claim distributions are much more volatile than benefits to life insurance policyholders, especially in lines of businesses that are exposed to catastrophes. Modeling of catastrophes is thus an important issue in non-life, while product options in contracts are hardly relevant. Although the contracts are set up for one year, the yearly policy renewal is very common. From an academic point of view an advantage for life insurers is that cancelation and embedded options have been broadly analyzed in literature in recent years, while we do not know as much about the premium renewal process in non-life insurance. Moreover, the structure of liabilities in non-life is characterized by a very high fluctuation due to a short-term orientation within non-life insurance products. Beyond that, management rules within value based management of non-life insurance companies do not have as much impact as for life-insurance companies.

The drivers affecting the cash outflow, i.e., the benefits paid to policyholders, are very different between life and non-life. While in life insurance the benefits to policyholders mainly depend on biometric risks, investment returns and cancelation of the policyholders, in non-life a payment is linked to a concrete claim event and thus depends on the distribution of the number and severity of claims. Especially in lines of business that are exposed to catastrophes, underwriting risk thus exhibits an extremely higher dynamic and uncertainty compared to life insurance. A good example in this context is storm insurance, which typically has a very low number of claims in most years. However, in some years storms result in high number of claims so that storm insurers have to set up adequate reserves (equalization reserves[2]) in good years to be paid to the policyholders in years with big storms. Compared to non-life, life insurers have precise estimates of mortality rates (mortality tables) so that the prediction risk and uncertainty is lower. From this discussion, we can conclude that market risk is the most important type of risk with life insurers (as compared to underwriting risk, liquidity risk or other types of risk). In non-life, especially for portfolios mainly based on catastrophe risk, underwriting risk is often more important than market risk.

The policies in force give rise to potential liabilities for which actuarially calculated reserves have to be set aside. In life insurance, it is common to set up one single policy reserve. Additionally, some countries have legal rules for surplus participation resulting in a reserve for premium refunds. In non-life, some countries differentiate between claim reserve and the equalization reserve. The claim reserve is calculated according to the same principles as the policy reserve, but additionally, these countries allow for an equalization reserve, to

[2] According to German local GAAP, among others, equalizations reserves are build for the purpose of preventing cash-flow depletion compensating unforeseen and often expensive claims. Thus, in good times insurance companies arrange for an additional buffer.

compensate fluctuations in loss ratios in future years. The idea here is that especially in those lines of business with significant catastrophes, years with low claim costs are used to set up reserves and then to pay out policyholders in later years with higher claim costs. We will account for these special characteristics in our modeling approach.

Step	Life	Non-Life
1. Modeling the environment (external)	a) Modeling the capital market b) Modeling biometric risks c) Modeling cancelation behavior and implicit options	a) Modeling the capital market b) Modeling claims (instead of biometric riks) c) Modeling renewals (instead of cancelation behavior; implicit options are not relevant)
2. Modeling the insurance company (internal)	a) Based on Step 1: Modeling the cash inflow and cash outflow for existing insurance contracts considering capital markets, cancelation behavior and biometric risks b) Additional allowance for company-specific factors like costs and taxes c) The remainder goes to the shareholders	a) Based on Step 1: Modeling the cash inflow and cash outflow for existing insurance contracts considering capital markets, renewals and claims statistics b) Additional allowance for company-specific factors like costs and taxes c) The remainder goes to the shareholders
3. Determination of the value of the in-force business	Reduction of the present value of future profits (PVFP) by - the time value of financial options and guarantees (TVFOG) - the frictional costs of required capital (FCRC) - the cost of residual non hedgeable risks (CRNHR)	Reduction of the present value of future profits (PVFP) by - the time value of financial options and guarantees (TVFOG), here 0! - the frictional costs of required capital (FCRC) - the cost of residual non hedgeable risks (CRNHR)

Table 3: Main modeling differences between life and non-life

Based on these discussions, the main differences between modeling VIF in life and non-life can be derived. Table 3 is structured like Table 1 and illustrates that there are three main issues to be considered when modeling non-life instead of life:

(1) Typically there are no periodically premium payments in non-life, whereas this is common in many life insurance policies. This is problematic in the context of MCEV when it comes to distinguish among existing business and renewal business. According to MCEV principle 10 (10.2) the value of the in-force business should anticipate *renewal* of in-force business, including any *reasonably predictable* variations in the level of *renewal* premiums but excluding any value relating to future new business. From this wording, we conclude that a reasonable renewal assumption is necessary when modeling MCEV in non-life. In our model we will address this issue in two steps. At first we will determine the value of the in-force business without renewals (scenario 1, cancelation rate of 100%). Secondly, we will estimate the value of in-force business with a reasonable assumption with regard to renewals. While scenario 1 will provide a lower

bound for the in-force business, scenario 2 (cancelation rate less than 100%) will provide a more realistic estimator of the market consistent embedded value. Note that depending on the profitability of the renewal contracts model 1 must not necessarily provide a lower bound. However, in practical applications we will see that it should be a lower bound.

(2) The modeling of biometric risks needs to be replaced by a model for claims development.

(3) The model for surrender in life insurance corresponds to a model for renewal in non-life insurance. Option exercise does not play an import role in non-life and can be neglected.

Table 3 shows that the determination of VIF in non-life insurance is not too different from that in life insurance. For instance, the difference between a surrender decision in life and a renewal decision in non-life is only a very minor one from an economic point of view. Comparing liability insurance and a classical life insurance policy with regularly premium payments as an example, in both cases the customer needs to actively terminate the contract. If the customer does nothing, however, the contract will be prolongated.

4. Modeling of MCEV in non-life

We now develop a mathematical model that reflects the differences between life and non-life insurance business and allows us to determine the MCEV of a non-life insurance company. We consider a projection horizon of T years with $t = 1, \ldots, T$ and assume a complete settlement of our insurance business in year T. We illustrate our model using German local GAAP as a local statutory basis. However, our calculations can also be based on any other local GAAPS in which necessary adjustments would have to be done. Our starting point is the statutory balance sheet at time period $t = 0$, where the main balance sheet positions on the liability side are shareholders' equity (SE_0), equalization reserves (ER_0) and claims reserves (CR_0), Assets are then proportionally split between assets backing shareholders' equity (BV_0^{abse}) and assets backing liabilities (BV_0^{abl}), (see Figure 2).

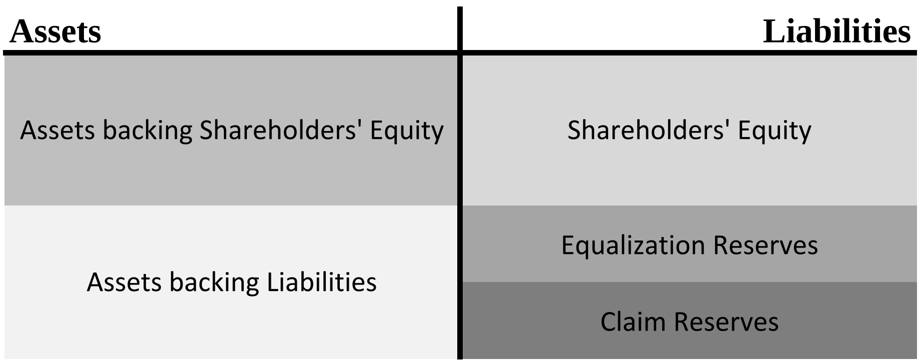

Figure 2: Statutory Balance Sheet

The risk free yield curve at $t = 0$ is given by pre-defined swap rates. Both investment returns (forward ratesfr_t) and discount rates dr_t are derived from this risk free yield curve (for details see Appendix A1). In order to derive the MCEV of a non-life insurance company we need to determine three components, the free surplus (FS), the required capital (RC), and the value of in-force covered business (VIF). Hereby, VIF is calculated as present value of future profits (PVFP) minus time value of financial options and guarantees (TVFOG) minus (FCRC) and minus (CRNHR). Unlike life insurance, non-life insurance contracts have no substantial options and guarantees. We thus set the time value of financial options and guarantees to zero. In a first step, we determine the *(1) present value of future profits* and the *(2) required capital*. In a second step, we evaluate the *(3) frictional costs* and the *(4) costs of residual and non-hedgeable risks*. Finally, *(5) free surplus* is determined.

(1) Present value of future profits

The present value of future profits (PVFP) is the sum of the discounted annual net income NI_t:

$$PVFP = \sum_{t=1}^{T} NI_t * dr_t$$

The annual net income consists of earnings before taxes deducted by taxes paid ($NI_t = EBT_t \cdot (1 - tr)$). Earnings before taxes can be calculated by adding the technical result T_t and the investment result I_t at the end of time period t, ($t \in 1, \dots, T$):

$$EBT_t = T_t + I_t$$

The technical result T_t is calculated as gross premiums earned GPE_t minus changes in claims reserves ΔCR_t ($\Delta CR_t = CR_t - CR_{t-1}$) minus changes in equalization reserves ΔER_t ($\Delta ER_t = ER_t - ER_{t-1}$). We deduct claims payments CP_t, acquisition costs AC_t, claims settlement expenses costs CSE_t and overhead costs OC_t (for a detailed description of each component we refer to Appendix A2):

$$T_t = GPE_t - \Delta CR_t - \Delta ER_t - CP_t - AC_t - CSE_t - OC_t$$

The investment result corresponds to the investment income under local GAAP less the associated investment cost. Under German local GAAP, the book value of assets may differ from the market value of assets and there is some management discretion regarding the realization of gains and losses on assets. In general, there are unrealized gains and losses

(UGL) which correspond to the difference between the market value and the book value of assets.

For determining the investment result I_t, it is therefore necessary to project both book value and market value of the assets backing liabilities (taking into account cash flows related to the insurance contracts and investment cost as well as funding requirements). As a simplified management rule, we assume that the amount of UGL (as percentage of the book value of assets) remains constant over the entire projection horizon. For details on the calculation of I_t, we refer to Appendix A3.

(2) Required Capital

To calculate the required capital, which refers to the amount of assets backing shareholders' equity whose distribution to shareholders is restricted (see MCEV principle 5), we consider the European Union regulatory rules (Solvency I and Solvency II) for solvency considerations. We therefore take the maximum of $SCR\ I$ determined according to the Solvency I requirements and $SCR\ II$ determined according to Solvency II requirements (for a detailed description of each component we refer to Appendix A4):

$$RC = Max(SCR\ I; SCR\ II)$$

(3) Frictional Costs

FCRC reflects the impact on the shareholder's equity value due to the fact that capital has to be held within the company and cannot be distributed right away (e.g., due to regulatory restrictions). According to principle 8 (see European Insurance CFO Forum, 2008a) frictional costs should reflect investment costs and taxation on assets backing required capital. Thereby, required capital has to be projected appropriately over the lifetime (for details on our projection mechanism we refer to Appendix A4). In order to derive the FCRC, we need to take into account the net income on the assets backing required capital ($NIRC_t$) and the release of required capital over the projection horizon ($\Delta RQ_t = RQ_t - RQ_{t-1}$). The present value of these cash flows is then compared to the required capital at t=0:

$$FCRC = RQ_0 - \sum_{t=1}^{T} (NIRC_t - \Delta RQ_t) *\ dr_t$$

The net income on required capital can be determined by considering the forward rate, investment cost rate, tax rate and discount rate:

$$NIRC_t = RQ_{t-1} * (fr_t - icr) * (1 - tr)$$

Note that FCRC is zero if both investment costs (icr) and tax rate (tr) are equal to zero.

(4) Cost of residual non hedgeable risks

The cost of residual non hedgeable risks $CRNHR$ can be derived using a cost-of-capital approach similar to the risk margin approach under Solvency II. The internal cost of capital rate $cocr$ is thus multiplied by $SCR\,II$ at valuation date t to determine the cost of capital which is then discounted to t=0:

$$CRNHR = \sum_{t=1}^{T} (SCR\,II_t * cocr * dr_t)$$

(5) Free surplus

The free surplus capital FS of the insurance company consists of the difference between the market value of assets backing shareholders' equity MV_0^{abse} and the required capital RC. The market value of assets backing shareholders' equity is derived by considering UGL, $MV_0^{abse} = BV_0^{abse} * (1 + ugl)$:

$$FS = MV_0^{abse} - RC$$

5. Application for a German non-life insurer

Model Calibration

In order to illustrate the mathematical framework, we now apply the MCEV concept for a German non-life insurance company. All figures and numbers are based on a fictitious insurance company that was used as a sample by a German task force for internal models (see DAV-Arbeitsgruppe, 2008) to illustrate their findings. For our applications we use parameters set out in Table B1, patterns set out in Table B2, and revenue segments set out in Table B3 (for the respective tables we refer to Appendix B). We start out at valuation date December 31st 2008. This yields to a statutory balance sheet as shown in Figure 3.

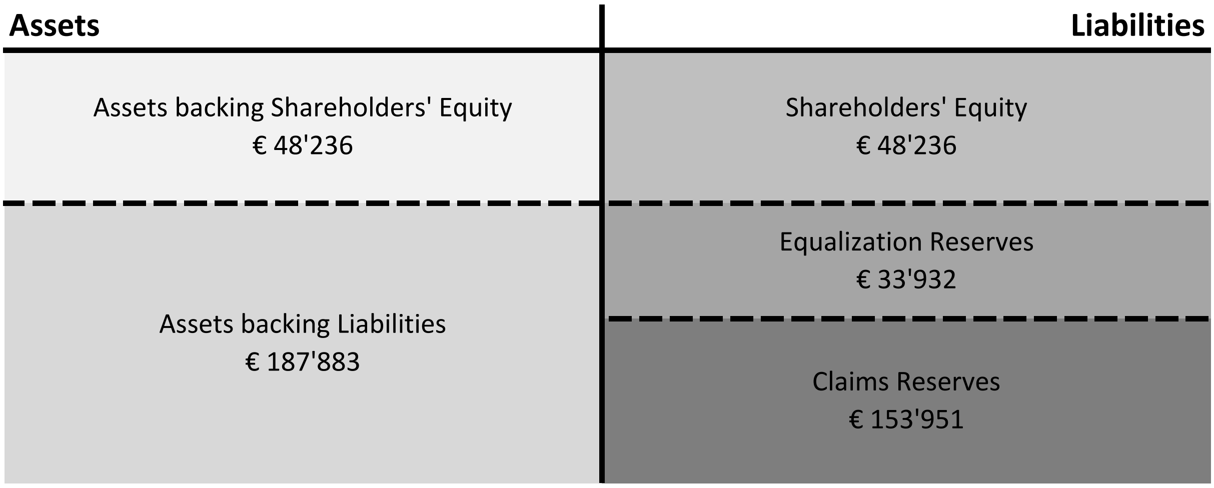

Figure 3: Statutory Balance Sheet

As a statutory balance sheet we use the German local GAAP (Handelsgesetzbuch).Main balance sheet positions are assets (book value of financial investments), shareholders' equity, equalization reserves and claims reserves. For MCEV calculations, we split the assets proportionally between assets backing shareholders' equity and assets backing liabilities. In addition, we derive the market value of assets from the book value and the unrealized gains and losses. Then we can calculate the MCEV using the mathematical model described in section 4.

Determination of MCEV

Free Surplus € 26'720	Required Capital € 22'481	Value of in-forced covered Business € 60'997	Free Surplus € 18'913	Required Capital € 30'288	Value of in-forced covered Business € 88'001
Market Consistent Embedded Value € 110'198			**Market Consistent Embedded Value € 137'202**		

Figure 4: MCEV for a cancelation rate of 100% and 13%

In Figure 4, we consider two different scenarios for MCEV calculations. On the left part (Scenario 1), the cancelation rate is 100%. We thus do not consider any renewals within the next few years but only settle the existing business. This settlement process yields to a total MCEV of € 110'198 where free surplus is € 26'720, required capital is € 22'481 and the value of in-force business is € 60'997.

The right part (Scenario 2) of Figure 4 shows the results for a cancelation rate of 13%. We thus account for the fact that a substantial amount of insurance contracts are automatically renewed each year. This provides a more realistic picture of the value of the insurance company and leads to an increase of the MCEV to € 137’202. While the free surplus decreases by € 7’807 (with a corresponding increase of the required capital), the *VIF* increases by € 19’004.

Figure 5 shows the capital appropriation of our MCEV calculations, i.e., all stakeholders that receive cash flows from the insurance company. In addition to free surplus, required capital and the present value of future profits, frictional costs of required capital (FCRC) reflecting investment costs and taxation must be taken into account. Thus, FCRC would be assigned to the insurance company’s staff (internal beneficiaries) and the tax office (external beneficiaries). Note that this capital appropriation does not include costs of residual and non hedgeable risk (CRNHR) since there is no cash outflow related to this position. Again, we considered two different scenarios for MCEV calculation without (cancelation rate of 100%) and with (cancelation rate of 13%) renewals.

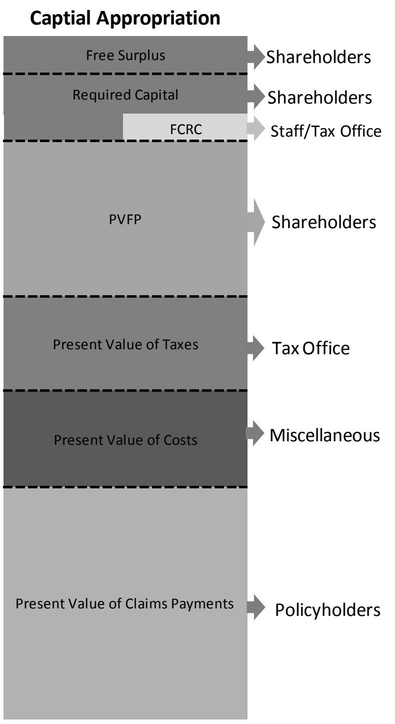

Figure 5: Capital Appropriation (without and with renewals)

For the first scenario (Scenario 1) the total sum of this breakdown yields an amount of € 240’841 (which coincides with the the market value of assets shown in Figure 6). For the second scenario (Scenario 2) the total sum of this breakdown yields an amount of € 633’492. Here, in addition to the market value of assets, we also have to consider the present value of future premiums € 392’651, since we make allowance for renewals.

Figure 6, takes into account all MCEV positions and derives an economic balance sheet (EBS) from our MCEV calculations. Here you can see the total breakdown of the market value of all assets as well as the present value of future premium income, in case of scenario 2 (with renewals). In particular, CRNHR are considered as well.

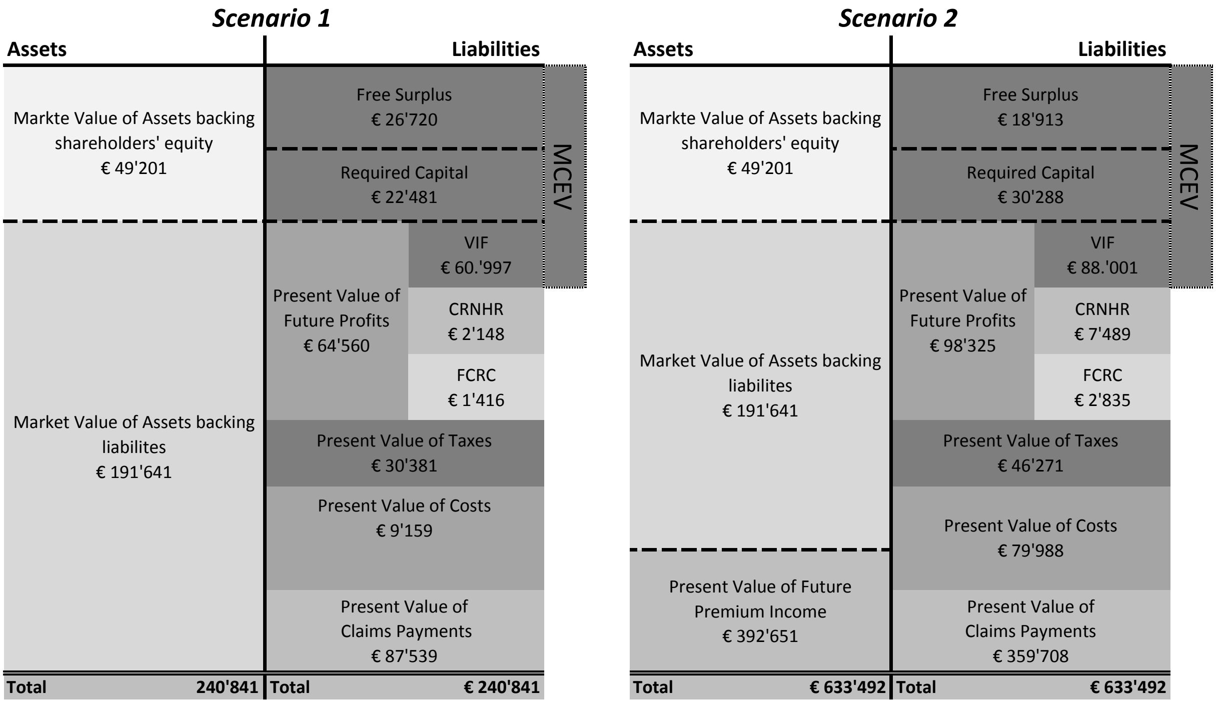

Figure 6: Economical Balance Sheet (without and with renewals)

Sensitivity Analysis

To test the robustness of the model and to analyze the value implications of different model assumptions, we vary certain model parameters.

First, we consider the loss ratio and the cancelation rate (see Figure 7). The higher the loss ratio, the lower is the MCEV as more funds are paid out to the policyholders. It is quite interesting to see the interaction between the cancelation rate and the loss ratio. With a low loss ratio, a reduction of cancellation rates increases the MCEV. But with a very high loss ratio, the increase of cancellation rates can be value enhancing. In this situation, the business underwritten is not profitable. In our example, the turning point would be a loss ratio of approximately 80%. For an unrealistically high loss ratio of 110% and a cancelation rate of 13% we would still have a positive MCEV in the amount of € 25’429. This is due to the fact that a negative value of in-force covered business € 23’772 is balanced out by a quite positive free surplus and required capital. Overall, Figure 7 illustrates the value based management component of the MCEV calculations.

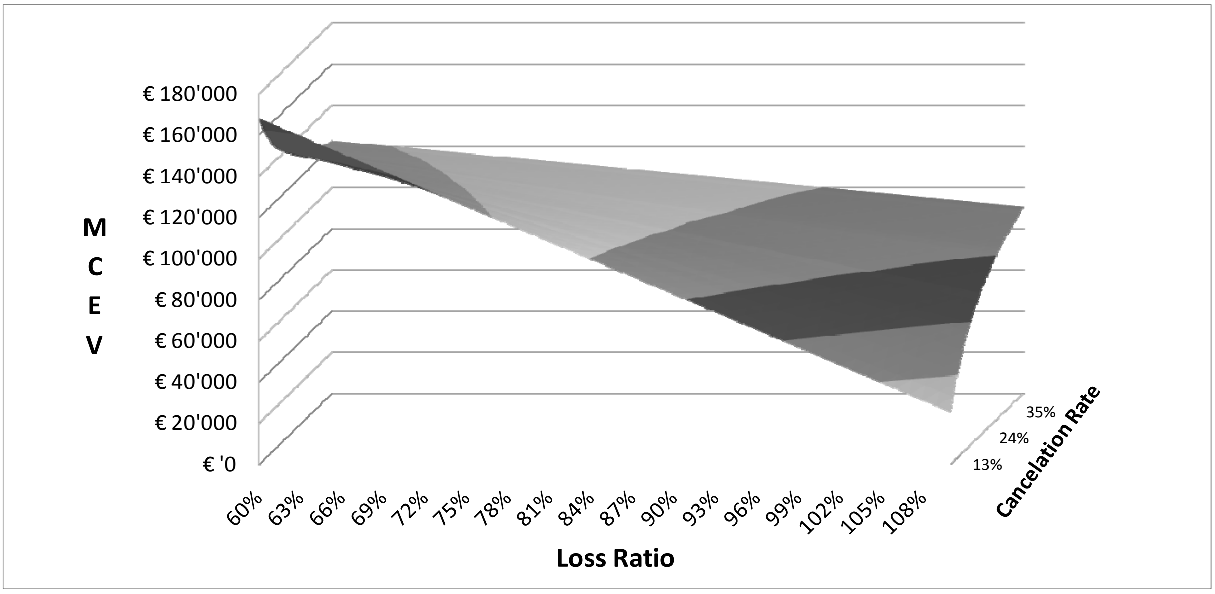

Figure 7: Loss Ratio versus Cancelation Rate

Second, we consider loss ratio and the acquisition costs (see Figure 8) for a given cancelation rate of 13%. Here you can see that there is a linear relationship between these two ratios: the higher the costs and the higher the loss ratio the lower the MCEV (and therefore the lower the VIF). MCEV results range from a maximum of € 167’123 to a minimum of € 740.VIF results range from a maximum of € 118’644 to a minimum of minus € 46’664. For a loss ratio of about 83% and a corresponding acquisition costs rate higher than 33%, the VIF becomes negative and the insurance business is unprofitable.

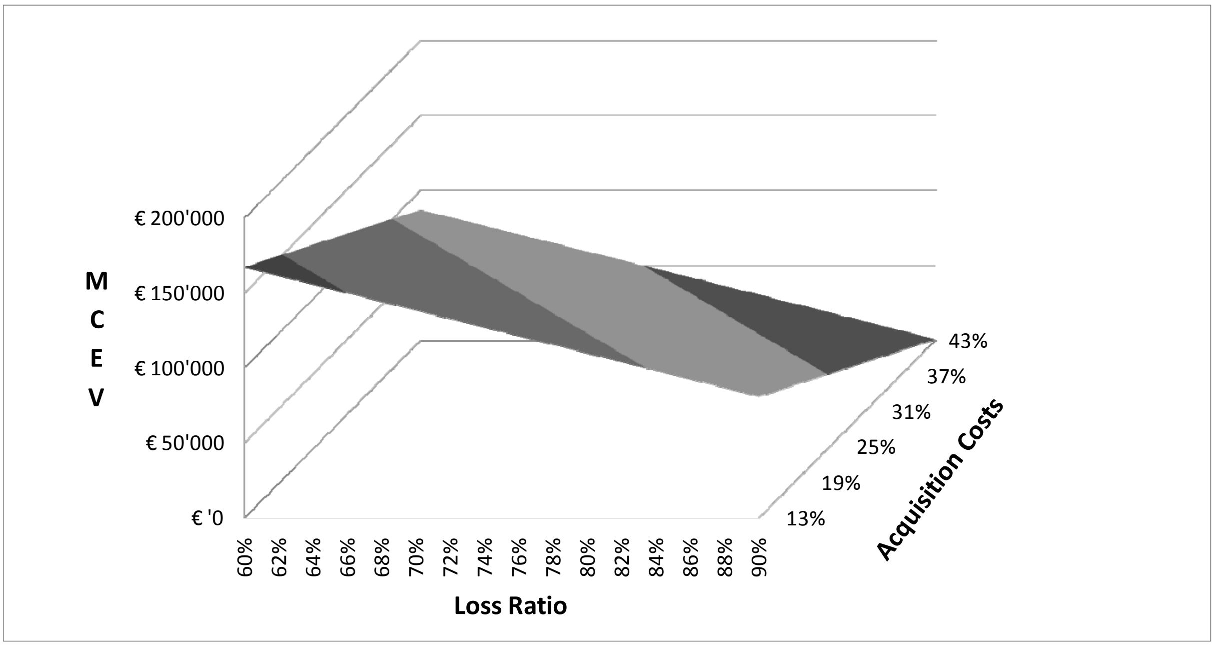

Figure 8: Loss Ratio versus Acquisition Costs

Third, we consider 20 different interest scenarios and vary the cancelation rates (see Figure 9). With a constant loss ratio of 70 % we considered variation within the cancelation rates ranging from 13 % until 32 %. In addition to that we simulated 20 different interest scenarios by an upward parallel shift of our spot rate given in Table B2, in the amount of 1.00 %. Having that, we can see the higher the cancelation rate the lower the total MCEV and the higher the interest rates the higher the total MCEV. We can also see that changing the interest rates would have a linear impact on the total MCEV, whereas changing the cancelation rate would have an exponential impact on the total MCEV. The total change of the MCEV would range from € 118’000 to € 150’000.

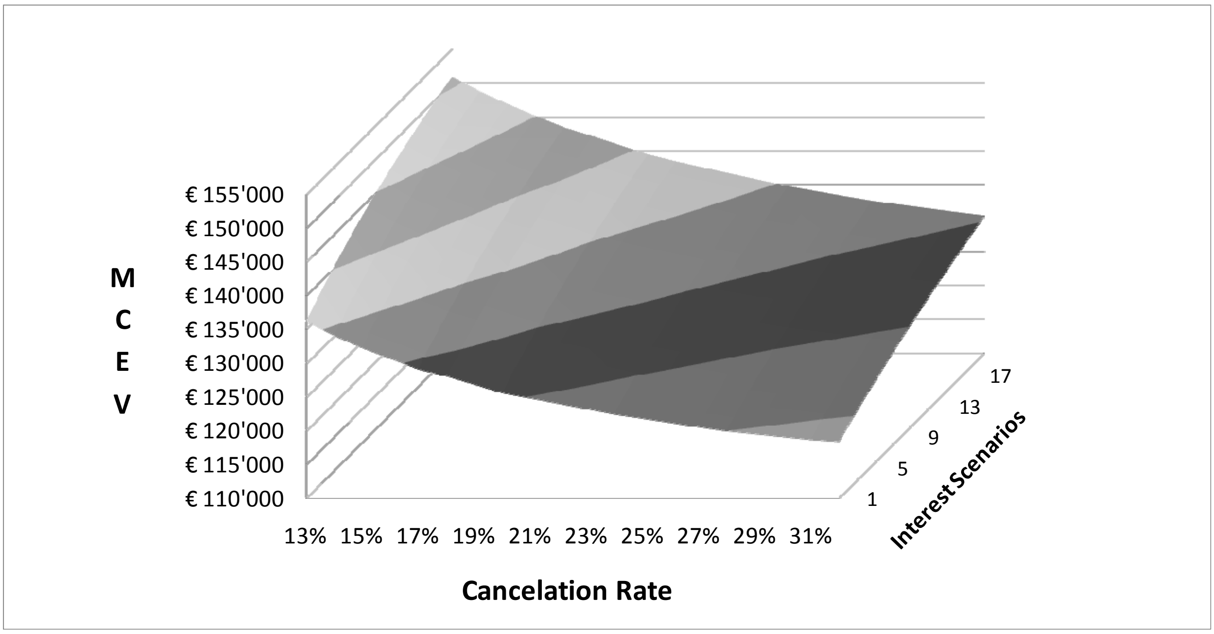

Figure 9: Interest Scenarios versus Cancelation Rate

Value Added Analysis

So far we only considered the MCEV in t=0. We now turn to an analysis of MCEV over time, i.e., we analyze changes in MCEV from t=0 to t=1. The European Insurance CFO Forum (2008a) also describes an analysis of MCEV earnings within a detailed movement analysis template (MCEV principle 17). For our purpose, however, we limit our analysis to a basic breakdown of the value added (VA) consisting of changes within free surplus, required capital, present value of future profits, frictional costs of required capital and costs of residual and non hedgeable risks. For this purpose we choose Scenario 2 with a given cancelation rate of 13%.

In a first step (Step 1), we assume that the actual development of the insurance company over the first year coincides with the development assumed in the MCEV calculation at t=0 (e.g. regarding amount of renewals, investment income, claims payments and reserves). Furthermore, we assume that the economic assumptions underlying the MCEV calculation at t=1 are consistent with those used at t=0. In addition, we do not take into account any value of new business written, but only consider a process that is settling the existing business (including renewals) at the beginning of the year to arrive at an expected status at the end of the year. The MCEV results with a basic breakdown are shown in Table 4.

MCEV Position	t=0	t=1	Delta
Free Surplus	18‘913	27‘432	8‘519
Required Capital	30‘288	21‘769	-8‘519
PVFP	98‘325	64‘760	-33‘565
FCRC	2‘835	1‘954	-881
CRNHR	7‘489	6‘431	-1‘058
Total MCEV	137‘202	105‘576	- 31‘626

Table 4: MCEV Results (Step 1)

The MCEV of the company in t=0 is equal to € 137’202 as reported in the previous section. We now assume that one year has gone and we observe a total MCEV of € 105’576. This means we have a negative *value added* in the amount of € 31’626. At first sight, this result seems to be an unsatisfying development. However, for the change from t=0 to t=1 the insurance company includes the profit of the first year which is € 37’312. This profit is not reinvested but immediately paid as dividends to the shareholders. While the required capital decreases by € 8’519, we have a corresponding increase of the free surplus. This means some portion of the required capital is released and transferred to the free surplus, whereas all the investment income on free surplus achieved from t=0 to t=1 is part of the annual net income in t=1. Considering the exchange within free surplus and required capital, the value added has to be explained by changes within the value of in-force covered business. Hereby the present value of future profits decreases by € 33’565 which almost equals to the discounted net income of t=1 (€ 35.906) considered for the total MCEV in t=0. In addition to that, however, since we now are doing calculations in t=1 we also have to discount the present value of any future profits by 1 year less than in t=0. This leads to a discount effect in the amount of € 2’341. Apart from the decrease of PVFP we also have a decrease within frictional costs of required capital, whereas this decrease is due to the same reasons as stated above. On one side we have to consider the expected frictional costs of t=1 (which would have been an increase by € 202), on the other side due to the fact that one year has gone there are discount effects in the amount of € 1’083; this leads to a total decrease by € 881. Furthermore we also have a decrease within costs of residual and non-hedgeable risks. This is due to a decrease of the projected SCR II (compare to Section 4) and therefore a decrease within cost of capital in the amount of € 1’524 and a compensating discount effect in the amount of € 466; this leads to a total decrease by € 1’058. The actual cost of capital in the amount of € 1’817 that occurred over the year are not reflected in the value added shown above. However, performance metrics such as EVA (see Malmi and Ikäheimo, 2003) do make explicit allowance for a weighted average cost of capital rate. Further discussion is necessary on that.

So far we only considered an analysis based on the assumption that we do not have any variances within the economic assumptions set out in t=0. In a second step (Step 2) we would like to make an analysis with the aim to identify the value added provided by the management of an insurer. The value added observed from t=0 to t=1, however, will always show a combination of external and internal effects. External effects are due to changes in the market environment, i.e., the capital market or the overall loss ratio on the insurance market, among others. Only abnormal deviations from these overall market developments can be attributed to management, i.e. internal effects. Again, we only consider an unwinding process and do not take into account any value of new business written.

Data	Company		Market		Delta Market	Company (external)
	t=0	t=1	t=0	t=1		t=1
Cancelation Rate	13.00%	12.5%	10.00%	9.50%	-5.00%	12.35%
Loss Ratio	70.80%	70.6%	71.00%	70.00%	-1.40%	69.81%
Acquisition Cost Rates	13.00%	12.5%	12.00%	11.00%	-8.33%	11.92%
Claims Settlement Expenses Rates	4.00%	3.90%	5.00%	4.60%	-8.00%	3.68%

Table 5: Economic Assumptions and Market Development

The following calculations are based on the economic assumptions shown in Table 5, where we assume that different economic assumptions have changed within t=0 to t=1 due to some external market development. What is needed to divide external from internal effects is a benchmarking with the market development from t=0 to t=1. We thus now turn to the market data in order to separate the effects that are due to changes in the business environment and that are due to skillful management. Market averages for t=0 and t=1 are also given in Table

5. For example, we assume the average cancelation rate in t=0 to be 10%, a value which is substantially lower than the 13% observed with the company. In t=1, the market average is 9.5%, a value which is 5% lower than the 10% observed as market average in the previous year. The reduction of the cancelation rate with the insurer, however, is only 3.84% (12.5%/13%). It thus seems that in this year the company performed worse than the market because it could not reduce the cancelation rate in the same extend as the market did.

The total results of our MCEV calculations are shown in Table 6. Hereby, we assume that the change of our economic assumptions already took place within calendar year t=0 to t=1. Thus, not only the valuation in t=1 but also the development over the year was based on the new economic assumptions as shown in Table 5.

		Company		Market (external)		Delta (internal)
MCEV Position	t=0	t=1	Delta	t=1	Delta	
Free Surplus	18‘913	27‘207	8‘294	27‘170	8‘257	8
Required Capital	30‘288	21‘994	-8‘294	22‘031	-8‘257	-8
PVFP	98‘325	67‘765	-30‘560	71‘488	-26‘837	-3‘723
FCRC	2‘835	2‘008	-827	2‘020	-815	-12
CRNHR	7‘489	6‘646	-843	6‘689	-800	-43
Total MCEV	137‘202	108‘312	-28‘890	111‘980	-25‘222	-3‘668

Table 6: MCEV Results (Step 2)

The MCEV of the company in t=0 is the € 137’202 already stated above. Calculating MCEV with the new company input parameters for t=1 as shown in Table 5 leads to an MCEV of € 108’312. The overall value added generated from t=0 to t=1 is thus a loss in the amount of € 28’890 (again, without any consideration of the annual net income from t=1). However, it is not quite clear whether this effect is due to internal effects or due to changes in market environment (external effects). In order to separate internal and external effects, we now calculate a hypothetical MCEV of the company based on market data. For this purpose we multiply the company values in t=1 with the changes in market data (e.g., the cancelation ratio of the company (external) in t=1 is given by 13% * (9.5%/10%)=12.35%) and then again calculate MCEV. This results in an MCEV of € 111’980. We now can separate internal and external impacts on value added:

- Overall value added internal and external (Delta MCEV) = 108’312 – 137’202 = -28’890
- Value added due to environment (Delta MCEV external) = 111’980 – 137’202 = -25’222
- Value added due to management (Delta MCEV internal) = -31’975 – (-28’470) = -3’668

If the company had performed as well as the benchmark, i.e., the market, it should have provided a loss of € 25’222 from t=0 to t=1. In fact, however, it even provided a loss of € 28’890. We thus conclude that the value added provided by the management is € -3’505.

Management might claim that they are not responsible for the observed value destruction, e.g., they might claim that their customers are not well represented by the market average. This illustrates that it is important to identify the right benchmark for the value added analysis.[3] However, if the overall customers are not well represented by the market average such a reaction for management could also be interpreted as that the diversification of risk does not work well in this company. Taking care of diversification of risk is a central management task, e.g., by building a sufficiently large portfolio of insurees, by using reinsurance or by using other risk management instruments.

Overall, the presented concept of value added analysis is very close to the concept of economic value added (*EVA*; see Stern et al., 1995) or more generally speaking can be traced back to the residual income concept of Marshall (1890). With economic value added (or the residual income) the annual result is related to the cost of capital (hurdle rate times equity capital).

A difference between residual income and the concept presented here is that our benchmark is not a hurdle rate, but the market average. But it might be feasible to transfer the idea of hurdle rate into a concept of MCEV target value (MCEV * (1 + hurdle rate). We then could compare the realized MCEV in t=1 with the MCEV target value. The concept can thus be used ex post for performance measurement, but also ex ante for value based management and target setting. However, it is important to emphasize that MCEV neglects future new business and this might distort decision making. The management implications of MCEV must thus be considered very carefully.

Another idea might be to break down the value added provided by the management to different parts of the company, i.e., we might want to find out, how much value added has been generated by the asset management, by claims management or by other parts of the insurers business. However, this task is hardly feasible because it leads to problems well known from capital allocation, i.e., it is not feasible to allocate capital to different business units without arbitrarily assumptions, especially because you cannot find an allocation mechanism for overhead costs (see Gründl/Schmeiser, 2007).

3 A requirement for the benchmark is that it should be comparable to the insurers business in terms of risk and return. For criteria to select representative benchmarks see Sharpe, 1992.

6. Conclusions

The aim of this paper was to illustrate the determination of market consistent embedded value in non-life insurance. Traditionally, the concept of embedded value determination was used for long term business, such as life insurance. In this paper we have shown how to transfer the embedded value determination from life to non-life. The main idea is to set assumptions for future claims developments instead of future biometric risks. In the empirical application of the model we have illustrated the value implications of varying loss ratios and costs. We also have illustrated how the different value components can be allocated to equity holders, policyholders, and the tax office.

The proposed model framework has a number of important practical implications. First of all, it provides new and relevant information for the stakeholders of an insurance company. The model provides information comparable to embedded value models currently used in life insurance industry and fills a gap in existing literature. The concept of MCEV also has potential for value based management of an insurance company although its management implications must be considered very carefully. Managing insurance companies without a reasonable assumption on future new business might distort managerial decision making and thus lead to dangerous misallocation, especially if the management compensation is linked to MCEV. Nevertheless, embedded value models are already used for compensation in the life insurance industry and future research is needed to analyze the relationship between the MCEV (reflecting current business) and a market consistent appraisal value (reflecting both current business as well as future new business).

Future research might extend this model in various directions. The presented model can be extended to include inflation, reinsurance, more realistic claims processes or a more realistic description of the cost situation in an insurance company. Moreover, one can have a closer look into the premium renewal process in non-life insurance so that the deterministic process can be replaced by a stochastic model. Furthermore, it would be interesting to combine the concepts for life and non-life and to define a *group MCEV*. Furthermore, another emerging question from solvency regulation (Solvency II) is, whether the concept of MCEV can be used to derive capital requirements, e.g., on an insurance group level.

Appendix A: Modeling of MCEV

Appendix A1

As mentioned, for cash flows that vary linearly with market movements a certainty-equivalent approach can be used. Within non-life insurance contracts there are no financial options and guarantees and therefore the certainty-equivalent approach can be adopted. For this purpose, we need the risk free yield curve at t=0 consisting of spot rates sr_t for each relevant time to maturity t, $t = \{1, \dots, T\}$. The corresponding discount rates dr_t are easily derived from the spot rate sr_t by $dr_t = \frac{1}{(1+sr_t)^t}$. Under the certainty-equivalent approach, the investment return for year t ($t = \{1, \dots, T\}$) is given by the implied forward rate fr_t:

$$fr_t = \left(\frac{(1+sr_t)^t}{\prod_{i=1}^{t-1}(1+fr_i)} \right) - 1$$

For $t = 1$ the forward rate fr_1 equals to the spot rate sr_1.

Appendix A2

The in-force covered business in non-life insurance should contain a reasonable proportion of renewal business when modeling the MCEV. Therefore, we decided to do a separate consideration, first for unwinding the existing business and second modeling renewal business.

<u>Existing Business</u>

For the settlement process of our existing business we start out with the (undiscounted) best estimate claims reserves at the beginning of our calculations ($\mathrm{BCR}_0^{\mathrm{eb}}$). This can be derived by deterministic or stochastic reserving methods. In addition to the best estimate reserves we also need a payments pattern $\mathrm{pr}_t^{\mathrm{eb}}$ as an assumption of how the best estimate claims reserves would be paid out within the next few years. Having all that, claims payments from existing business can be derived by:

$$\mathrm{CP}_t^{\mathrm{eb}} = \mathrm{BCR}_0^{\mathrm{eb}} * \mathrm{pr}_t^{\mathrm{eb}}$$

The development of the (undiscounted) best estimate claims reserves $\mathrm{BCR}_t^{\mathrm{eb}}$ for existing business would then only be the effect of a settlement process which is given by the future claims paid $\mathrm{CP}_t^{\mathrm{eb}}$ ($\mathrm{BCR}_t^{\mathrm{eb}} = \mathrm{BCR}_{t-1}^{\mathrm{eb}} - \mathrm{CP}_t^{\mathrm{eb}}$); clearly $\mathrm{BCR}_T^{\mathrm{eb}} = 0$.

We now want to determine the discounted best estimate claims reserve for the existing business BCR_t^{ebDIS}. For this purpose we would sum up the product of discounted future claims payments and then we would project them into the future:

$$BCR_t^{ebDIS} = \begin{cases} \sum_{i=1}^{T} \left(CP_i^{eb} * dr_i \right) & ,t = 0 \\ \left(BCR_{t-1}^{ebDIS} \right) * (1 + fr_t) - CP_t^{eb} & ,t > 0 \end{cases}$$

For the claims reserves $\mathrm{CR}_{\mathrm{t}}^{\mathrm{eb}}$ according to local GAAP, in a simplified management rule, we assume that the management would always ensure that the settlement process would proceed equally (proportionally constant) to the settlement process of best estimate claims reserves BCR_t^{eb} given by a constant percentage c, ($c = \frac{\mathrm{CR}_0^{\mathrm{eb}}}{\mathrm{BCR}_0^{\mathrm{eb}}}$):

$$\mathrm{CR}_{\mathrm{t}}^{\mathrm{eb}} = \mathrm{BCR}_{\mathrm{t}}^{\mathrm{eb}} * c$$

Renewal Business

For the existing business we only considered a settlement process, which means that we did not take into account any future renewals of our insurance contracts. We now would like to make allowance for renewal business and therefore consider future gross premiums earned. Thus, we first have to model the underlying portfolio development.

Our starting point at t=0 is the existing insurance portfolio with a given number of existing insurance contracts IC. Furthermore, we assume an average cancelation rate cr, an average premium level PL as well as a best estimate loss ratio lr for the total insurance portfolio. All of these values are based on experience data. We divide the portfolio into three different revenue segments A, B, and C (with proportions given by ac^m). The segments differ with respect to cancelation rate (ci^m) and premium level (pi^m). This allows us to derive all relevant parameters for each revenue segment at our starting point t=0 ($IC_0^m = IC * ac^m$, $cr_0^m = cr * ci^m$, $P_0^m = PL * pi^m$ and $lr_0^m = lr * pi^m$).

In a second step we determine the remaining number of existing insurance contracts of each revenue segment for the respective accounting year t, $IC_t^m = IC_0^m * \max(1 - t * cr_0^m; 0)$. Having that we are able to calculate the gross premiums earned within accounting year t for the appropriate revenue segment A, B or C:

$$GPE_t^m = IC_t^m * P_0^m$$

The total gross premiums earned at valuation date t GPE_t from all the revenue segments A, B and C can be calculated by the sum of gross premiums earned within the respective revenue segment ($GPE_t = \sum_{m=A}^{C}(GPE_t^m)$).

In a third step, the total ultimate loss of valuation date t can be derived by the sum of the ultimate loss within the respective revenue segment, $UL_t = \sum_{m=A}^{C}(UL_t^m)$. Thereby UL_t^m is the product of gross premiums earned within accounting year t and the respective loss ratio:

$$UL_t^m = GPE_t^m * lr_0^m$$

Claims Payments

		Calendar Year j						
		1	2	⋯	j	⋯	T-1	T
Accident Year i	1	$CP_{1,1}$	$CP_{1,2}$			⋯	$CP_{1,T-1}$	$CP_{1,T}$
	2	0	$CP_{2,2}$					
	⋮	0	0					
	i	0	0	0	$CP_{i,j}$			
	⋮	0	0	0	0			
	K-1	0	0	0	0	0		
	K	0	0	0	0	0	0	$CP_{K,T}$

Figure A1: Payment Process Triangle

Claims payments of renewal business can be represented in a payment process triangle as shown in Figure A1. Hereby, we have absolute accident years i ($i = 1, \dots, K$) on one side and absolute calendar years j ($j = 1, \dots, T$) on the other side (with K < T). This naturally leads to future claims payments of zero in case that the actual calendar year is before the accident year ($CP_{i,j} = 0, j < i$). In any other case, the future claims paid can be calculated by considering the ultimate loss amount of accident year i (UL_i), and a predefined payment pattern for renewal business (pr_t^{rb}), ($CP_{i,j} = UL_i * pr_{j+1-i}^{rb},\ i \leq j$). The total claims payments of renewal business at calendar year j CP_j^{rb} can now be calculated by summing up all the columns of our payment process triangle:

$$CP_j^{rb} = \sum_{i=1}^{j} CP_{i,j}$$

Best Estimate Claims Reserves

The development of the best estimate claims reserves for the respective accounting year i and calendar year j ($BCR_{i,j}$) can then be derived by summing up the future claims paid $CP_{i,j}$ as shown in Figure A1:

$$BCR_{i,j} = \sum_{t=j+1}^{T} CP_{i,t}$$

The total best estimate claims reserves of renewal business at the end of calendar year t BCR_t^{rb} can now be calculated by summing over all past accident years:

$$BCR_t^{rb} = \sum_{i=1}^{t} BCR_{i,t} = \sum_{i=1}^{t} \sum_{k=t+1}^{T} CP_{i,k}$$

Discounted Best Estimate Claims Reserves

We now would like to determine the discounted best estimate claims reserves for renewal business at time t (BCR_t^{rbDIS}). This requires appropriate discount rates $dr_{t,k}$ for each point in time t which are applied to the relevant future cash flows occurring at k= t+1, …, T. Under the certainty-equivalent approach, these discount rates can be derived from the forward rates at t=0:

$$dr_{t,k} = \frac{1}{\prod_{j=1}^{k-t}\left(1 + fr_{t+j}\right)}, \qquad (k > t)$$

Relevant cash flows only relate to accident years before the valuation date t. Therefore, the discounted best estimate claims reserves can be derived by:

$$BCR_t^{rbDIS} = \sum_{k=t+1}^{T} \left\{\sum_{i=1}^{t} CP_{i,k}\right\} * dr_{t,k}$$

Claims Reserves local GAAP

To calculate claims reserves for renewal business according to the local GAAP ($\mathrm{CR}_\mathrm{t}^\mathrm{rb}$), again, in a simplified management rule we assume that the settlement process would proceed equally (proportionally constant) to the settlement process of the best estimate claims reserves, given by the same constant c as shown above, ($c = \frac{\mathrm{CR}_0^\mathrm{eb}}{\mathrm{BCR}_0^\mathrm{eb}}$):

$$\mathrm{CR}_\mathrm{t}^\mathrm{rb} = \mathrm{BCR}_\mathrm{t}^\mathrm{rb} * c$$

Overall Results

To get the overall result of the MCEV calculations, we add existing business and renewal business. Hereby we assume independency between the claims settlement process of existing business and renewal business. Thus, the sum of claims payments for existing business CP_t^{eb} and claims payments for renewal business CP_t^{rb} lead to a total claims payments amount of CP_t, ($CP_t = CP_t^{eb} + CP_t^{rb}$). In addition, best estimate claims reserves undiscounted as well as discounted can also be shown as the sum of existing and renewal business ($BCR_t = BCR_t^{eb} + BCR_t^{rb}$; $BCR_t^{Dis} = BCR_t^{ebDIS} + BCR_t^{rbDIS}$). For claims reserves according to local GAAP we also build a sum ($\mathrm{CR_t} = \mathrm{CR_t^{eb}} + \mathrm{CR_t^{rb}}$).

For the settlement process of the equalization reserves we assume that the equalization reserves at the beginning of our calculations ER_0 which comes from the statutory balance sheet would be equally settled to the best estimate claims reserves. Thus, we need the proportion of these two measures from the beginning of our calculations ($c = \frac{\mathrm{ER_0}}{\mathrm{BCR_0}}$):

$$ER_t = BCR_t * c$$

Acquisition costs can be calculated by the product of gross premiums earned and a predefined acquisition cost rate acr_t at valuation date t, ($AC_t = GPE_t * acr_t$). Claims settlement expenses can be calculated by the product of claims payment and a predefined claims settlement expenses rate $cser_t$ at valuation date t, ($CSE_t = CP_t * cser_t$). Overhead costs would be derived by the maximum of a predefined minimum for overhead costs OC^{Min} and the overhead costs development driven by the development of the best estimate claims reserves given through $c = \frac{OC_0}{BCR_0}$ ($OC_t = Max(OC^{Min}; BCR_t * c$).

Appendix A3

We assume that at time t=0, the amount of UGL is equal to a pre-specified percentage of the book value of assets, i.e. $MV_0^{abl} = BV_0^{abl} * (1 + ugl)$.

The derivation of the technical result includes a projection of both the claims reserves and the equalization reserves under local GAAP where the sum of these positions is called book value of liabilities, i.e. $BV_t = CR_t + ER_t$. The book value of assets backing liabilities under local GAAP (BV_t^{abl}) must be greater than or equal to the book value of liabilities (BV_t) in order to satisfy the funding requirements (otherwise the shareholder would need to make additional contributions).

The cash flow at time t corresponds to:

$$CF_t = GPE_t - CP_t - AC_t - CSE_t - OC_t - T_t = \Delta CR_t + \Delta ER_t$$

Note that T_t is paid to the shareholders at time t and is therefore included in the cash flow above. Overall, this shows that $BV_t = BV_{t-1} + \Delta CR_t + \Delta ER_t = BV_{t-1} + CF_t$.

Under the certainty-equivalent approach, the investment income on a market value basis is given by the forward rates rate fr_t for each year t. We assume that investment costs are proportional to market value of assets (icr) and that all cash flows occur at the end of the year. The resulting investment income is called investment result on market value basis and is given by:

$$I_t^{MV} = MV_{t-1}^{abl} * (fr_t - icr)$$

Under German local GAAP, there is some management discretion regarding the realization of gains or losses on assets. Therefore, the investment income on local GAAP basis may differ significantly from the investment income on market value basis shown above.

In a simplified management rule, we assume that management would always ensure that the book value of assets backing liabilities is equal to the book value of liabilities, i.e. $BV_t^{abl} = BV_t$. Furthermore, we assume that UGL would be built up/dissolved such that the ratio of UGL remains unchanged, i.e. $MV_t^{abl} = BV_t^{abl} * (1 + ugl)$. This can be achieved by realizing gains/losses equal to $ugl * (BV_t - BV_{t-1})$ so that the overall investment income on book value basis is equal to:

$$I_t = MV_{t-1}^{abl} * (fr_t - icr_t) + ugl * (BV_t - BV_{t-1})$$

A positive investment income would be paid to the shareholders whereas a negative investment income would require further funds.

Appendix A4

SCR I

According to German law on the supervision of insurance undertakings and local regulation rules $SCR\ I_t$ can be calculated by the maximum of a minimum amount provided by legal regulations MIN, a premium index PI_t, a claim index CI_t and in case of $t > 0$ the adjustment of $SCR\ I_{t-1}$ via the development factor of claims reserves ($SCR\ I_0$ at valuation date $t = 0$ equals to $SCR\ I$):

$$SCR\ I_t = \begin{cases} Max(MIN; PI_t; CI_t) & , t = 0 \\ Max\left(MIN; PI_t; CI_t; \frac{CR_t}{CR_{t-1}} * SCR\ I_{t-1}\right) & , t > 0 \end{cases}$$

The premium index and the claim index are calculated as described in Solvency I. GPE_t denotes gross premiums earned at valuation date t, CP_t denotes claim payments and ΔCR_t denotes changes in claims reserves. The premium index is calculated as: $PI_t = 18\% * Min(53'100; GPE_t) + 16\% * Max(GPE_t - 53'100; 0)$; the claims index is given by:

$$CI_t = 26\% * Min(37'200; CP_t - \Delta CR_t) + 23\% * Max((CP_t - \Delta CR_t) - 37'200; 0)$$

SCR II

According to the current status of the European Union regulatory rules $SCR\ II_t$ can be calculated as sum of the so called basic solvency capital requirements $BSCR_t$ and the solvency capital requirements for operational risks (SCR_t^{or}) (see CEIPOS, 2008). The basic solvency capital requirements can be divided into SCR for premium risk SCR_t^{pr} and SCR for reserve risk SCR_t^{rr}. The Solvency II calculations also include the correlation factor x (see CEIOPS 2008). $SCR\ II_0$ at valuation date $t = 0$ equals to $SCR\ II$:

$$SCR\ II_t = (BSCR_t + SCR_t^{or})$$

$$BSCR_t = \sqrt{\begin{pmatrix} SCR_t^{rr} & SCR_t^{pr} \end{pmatrix} * \begin{pmatrix} 1 & x \\ x & 1 \end{pmatrix} * \begin{pmatrix} SCR_t^{rr} \\ SCR_t^{pr} \end{pmatrix}}$$

For calculating the remaining factors we need the discounted best estimate claims reserves at valuation date t BCR_t^{Dis}, a predefined operational risk rate for the reserve risk orr^{rr} and a predefined operational risk for premium risk orr^{pr}. In addition to that the most important values are the present calculations for the SCR_0^{rr} and SCR_0^{pr}. These can be derived via dynamic financial analysis models and certainly have to fit the original statutory balance sheet as shown in Figure 2:

$$SCR_t^{or} = Max(BCR_t^{Dis} * orr^{rr}; GPE_{t+1} * orr^{pr})$$

$$SCR_t^{rr} = CR_t^{dbe} * \frac{SCR_0^{rr}}{CR_0^{dbe}}$$

$$SCR_t^{pr} = GPE_{t+1} * \frac{SCR_0^{pr}}{GPE_0}$$

Appendix B: Application of MCEV

Parameter	Value	Parameter	Value	Parameter	Value	Parameter	Value
BV_0^{abse}	€ 48’236	tr	32.00 %	cser	4.00 %	MIN	€ 2’200
BV_0^{abl}	€ 187’883	IC	535’471	OC^{min}	€ 500	x	20.00 %
SE_0	€ 48’236	PL	€ 250	OC_0	€ 3’800	orr^{rr}	2.00 %
ER_0	€ 33’932	cr	13.00 %	BCR_0^{eb}	€ 95’374	orr^{pr}	2.00 %
CR_0	€ 153’951	lr	70.80 %	icr	0.20 %	SCR_0^{rr}	€ 17’900
ugl	2.00 %	acr	13.00 %	cocr	6.00 %	SCR_0^{pr}	€ 21’000

Table B1: Parameters

Parameter	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
pr_t^{eb}	69,00	9,60	6,50	3,20	2,50	1,60	1,40	1,00	0,60	4,60	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
pr_t^{rb}	69,00	9,60	6,50	3,20	2,50	1,60	1,40	1,00	0,60	4,60	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
sr_t	3,69	4,07	4,11	4,12	4,13	4,12	4,13	4,14	4,16	4,18	4,21	4,27	4,30	4,33	4,36	4,39	4,42	4,45	4,48	4,51

TableB2: Payment and interest rate patterns (in percent)

Parameter	Revenue segment A	Revenue segment B	Revenue segment C
ac^m	20.00 %	60.00 %	20.00 %
ci^m	1.20	1.00	0.80
pi^m	1.30	1.00	0.70

Table B3: Revenue Segments

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