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Abstract

Purpose – The purpose of this paper is to transfer the concept of market-consistent embedded value (MCEV) from life to non-life insurance. This is an important undertaking since differences in management techniques between life and non-life insurance make management at the group level very difficult. We offer a solution to this problem. Design/methodology/approach - After explaining MCEV, we derive differences between life and non-life insurance and develop a MCEV model for non-life business. We apply our model framework to a German non-life insurance company to illustrate its usefulness in different applications. Findings – We show an MCEV calculation based on empirical data and set up an economic balance sheet. We analyze the value implications of varying loss ratios, cancellation rates, and costs within a sensitivity analysis. The usefulness of the model is illustrated within a value added analysis. We also embed our MCEV concept in a simplified model for an insurance group to derive group MCEV and outline differences between local GAAP, IFRS, and MCEV. Practical implications – Our analysis provides new and relevant information to the stakeholders of an insurance company. The model provides information comparable to that provided by embedded value models currently used in the life insurance industry and fills a gap in the literature. We reveal significant valuation difference between MCEV and IFRS and argue that there is a need for a consistent MCEV approach at the insurance-group level. Originality/value – We develop a new valuation technique for non-life insurance that is easy to use, simple to interpret, and directly comparable to life insurance. Despite the growing policy interest in embedded value, not much academic attention has been given to this methodology. We hope that our work will encourage further discussion on this topic in academia and practice.

Keywords: Non-Life Insurance, Value-Based Management, Embedded Value, Value Added

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1 Introduction

Life and non-life are the two main business models in the insurance industry, each with their own unique structure of cash flows and large differences between the two as to the duration of assets and liabilities. Traditionally, life and non-life are managed as separate entities; in many countries, this separation is even required by law (e.g., in Germany and Switzerland). Nevertheless, most large insurers operate as affiliated groups, i.e., life and non-life entities are pooled in an insurance group and the group managers decide how to allocate resources so as to maximize shareholder value.

The traditional separation of life and non-life business, however, has resulted in different management techniques. Economic value added (EVA; see Malmi and Ikäheimo, 2003) and risk-adjusted return on capital (RAROC; see Nakada et al., 1999) are 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) for valuation purposes (see European Insurance CFO Forum, 2009a). In the context of value-based management, the change of MCEV from one calendar year to the next (value added) can be the basis for quantifying performance and risk-based capital. Especially given the theoretical concern that separate optimization of different business units does not necessarily lead to a global optimum at the group level, the use of different performance metrics is problematic from a group manager's point of view.[1] For example, the different measures are not directly comparable and it is not possible to combine the different concepts in one management tool at the group level.

We offer a solution to this problem with our argument that the MCEV is a consistent valuation concept not only for life, but also for non-life insurance. The purpose of this paper is thus

1 This type of problem can be found in various fields of the literature, e.g., enterprise risk management (see, e.g., Gupta, 2011; Hoyt and Liebenberg, 2011), asset liability management (e.g., Tektas et al., 2005; Huang, 2010), dynamic financial analysis (e.g., Ren, 2005; Eling and Toplek, 2009), management of financial conglomerates (e.g., Gatzert et al., 2008; Ojo, 2010), capital allocation (e.g., Powers, 2007; Uryasev et al., 2010; Ibragimov et al., 2010), and regulation (e.g., Powers, 2009; Klein and Wang, 2009; Coppola et al., 2011). All these different streams of literature call for a consistent and integrated concept in managing different entities and thus emphasize that the use of different performance metrics is problematic from a group manager's perspective. Elango et al. (2008) and Outreville (2008) note that most large insurers are organized as insurance groups with multi-line businesses.

to transfer the MCEV methodology from life to non-life. This simple goal, however, becomes complicated in light of the large differences between life and non-life insurance. Therefore, in the first step, we consider the special characteristics of non-life insurance contracts and their consequences for embedded value calculation. We then develop a mathematical model that reflects this special character as well as the principles underlying the MCEV determination. An example based on empirical data from a German non-life insurance company is used to illustrate the concept and its usefulness for management purposes. Furthermore, we embed the MCEV model in a simplified insurance group model in order to derive a group MCEV.

This paper's contribution is the development of a new valuation technique for non-life insurance that is easy to use, simple to interpret, and directly comparable to life insurance. We build on 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 relevance to practitioners and policymakers. Especially in Europe, with the Solvency II regime soon to become effective, insurers face significant changes in almost all aspects of their business, including risk management practices and disclosure requirements (see Elzahar and Hussainey, 2011), as well as management techniques at the group level. The MCEV is also relevant for North American 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). Despite the growing policy interest in embedded value, not much academic attention has been given to this methodology. We hope that our work will encourage further discussion on this topic in academia.

The rest of the paper is organized as follows. We first describe the concept of embedded value, which originates from the 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 the special character of non-life insurance, as well as the requirements for MCEV determination. In Section 5, the MCEV concept is applied to a German non-life insurance company and embedded in a simplified insurance group to illustrate its usefulness for management at the group level. Section 6 concludes.

2 Concept of Market-Consistent Embedded Value

The MCEV is an insurance-specific discounted cash flow technique for market-consistent valuation of assets and liabilities. The idea of embedded value calculation originates in the valuation literature and can be traced back to Anderson (1959). Embedded value is gaining new significance and international attention due to new accounting and regulatory rules, especially the International Financial Reporting Standards (IFRS) and Solvency II. Under both regimes, insurance business is evaluated based on market value, which is a new concept for many European insurers, who traditionally have followed a conservative/prudent accounting philosophy based on historical values rather than market values. Accordingly, many proposals with different assumptions and principles have been developed. To combine these different streams of discussion and develop a standard for embedded value calculation, the CFO Forum, a discussion group of the chief financial officers of 20 major European insurance companies, developed the MCEV principles. We provide only a brief overview of these principles and refer to European Insurance CFO Forum (2009a) for a complete description.

The MCEV is defined as "a measure of the consolidated value of shareholders' interests in the covered business." "Covered business" typically includes both short- and long-term life insurance. MCEV should reflect in-force (i.e. existing) business excluding future new business, but including foreseeable renewals from in-force business (e.g. recurrent single premiums). The MCEV consists of three elements (see Figure 1): required capital (RC), free surplus (FS), and the value of in-force covered business (VIF).

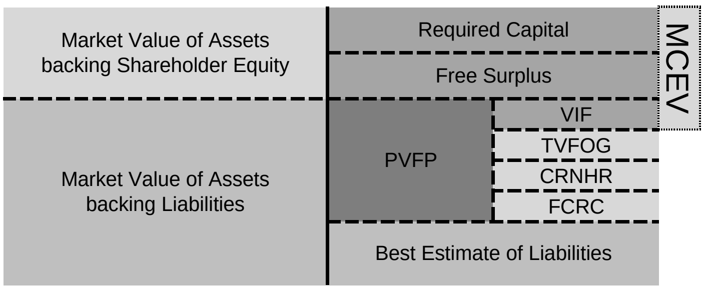

Figure 1: MCEV Elements

"Required capital" is that portion of the assets backing shareholder equity that, due to regulatory requirements, cannot be distributed to shareholders. "Free surplus" is that portion of the assets backing shareholder equity that has no restrictions on its distribution to shareholders. The “value of in-force covered business” is the risk-adjusted valuation of shareholder cash flows arising from in-force business, i.e., the expected present value of future profits under local GAAP determined by market-consistent valuation techniques (see, e.g., Sheldon and Smith, 2004). Hence, to obtain the VIF, the present value of future profits (PVFP) is reduced by the time value of financial options and guarantees (TVFOG), the cost of residual non-hedgeable risks (CRNHR), and the frictional costs of required capital (FCRC). Those reductions reflect an explicit allowance for risk and should be calibrated to match the market price for risk where reliably observable. The TVFOG reflects the impact of financial options and guarantees on shareholder value measured by stochastic techniques (e.g., risk-neutral valuation or deflators). In particular, all hedgeable financial risks must be taken into account. The CRNHR correspond to the impact of all remaining nonhedgeable (financial and non-financial) risks not already accounted for in the TVFOG or the PVFP by using a cost-of-capital approach. The FCRC consist of additional costs of holding the required capital (e.g., taxation and investment costs).

In summary, the main methodological foundations of MCEV are (1) to make explicit allowance for risk by calibrating cash flows to market prices instead of using the concept of a risk-adjusted discount rate; (2) the use of a risk-free reference rate for investment returns and discount rates; (3) the (insurance-specific) additional allowance for frictional costs of required capital; and (4) the exclusion of the value of future new business. A variety of projection assumptions are necessary in determining VIF. Non-economic assumptions (e.g., demographic assumptions and expenses) should be entity-specific best estimates based on past, current, and expected future experience. Economic assumptions (e.g., investment returns and discount rates) have to be internally consistent and such that the projected cash flows are in line with market prices, which typically leads to a high volatility of MCEV.

While the traditional embedded value uses the concept of a risk-discount rate (whose choice is very subjective), within the MCEV the discount rate is set objectively by using a risk-free reference rate, which is based on observable market data (see O'Keeffe et al., 2005). In this context the CFO Forum prescribes the use of a swap yield curve instead of a government yield curve (advantages and disadvantages are discussed in the basis for conclusions; see European Insurance CFO Forum, 2009b). For a critical discussion of the choice of a risk-free reference rate we refer to O'Keeffe et al. (2005). Another critical aspect is the freedom to choose parameters such as best estimate mortality and lapse rates, which makes MCEV results difficult to compare. Furthermore, the methodology for deriving the CRNHR (e.g., choice of the cost of capital rate) is not specified either. Finally, the CFO Forum decided to disregard the limited liability put option (LLPO; see Gatzert and Schmeiser, 2012, for an application of this concept). According to O'Keeffe et al. (2005) proponents argue that insurer's promises to policyholders are not 100% credit risk free and this should be considered; opponents argue that for a well capitalized life insurer the LLPO effect might be immaterial. Note that the LLPO is also disregarded for valuations in the context of Solvency II and IFRS.

The MCEV methodology is used to determine the value of short- and long-term life insurance business. Additionally, the CFO Forum defines a group MCEV as a measure of the consolidated value of shareholders' interests in covered and noncovered business at the group level. The CFO Forum proposes that the noncovered business should be valued at the unadjusted IFRS net asset value. The group MCEV, according to the CFO Forum, is thus the sum of the covered business (valued according to the MCEV methodology) and the noncovered business (valued according to IFRS net asset value).

To underline methodological differences, critical assumptions, and the different purposes of IFRS and MCEV and the resulting inconsistencies in valuation, Table 1 sets out the fundamental principles of IFRS and MCEV. The table also includes German local GAAP as a basis for comparison since determination of liabilities under IFRS can still rely on local GAAP.[2]

[2] Currently, the International Financial Standards Board is revising the valuation of claim reserves. Under the current Phase 1, insurers are allowed to use, e.g., local GAAP or US GAAP; however, Phase 2 will include a fair value principle. Fair valuation of insurance liabilities is still under discussion and it is yet not at all clear what type of valuation technique will be implemented, or when (Phase 2 is currently scheduled for 2013).

Criteria	German local GAAP	IFRS	MCEV
Principal approach	Prudent presentation	Fair presentation	Market-consistent presentation
Valuation of assets	At book value	Some at book value, others at market value	At market value
Discounting of claim reserves	0%	0% (still use local GAAP)	Use of market spot rate
Consideration of equalization reserves	Yes (part of debt)	No (part of equity)	No (part of equity)
Consideration of renewals	No	No	Yes

Table 1: Differences Between Local GAAP, IFRS, and MCEV

German local GAAP is very conservative and understates equity to protect creditors, whereas IFRS focuses on the fair presentation for all stakeholders. Furthermore, within IFRS some assets are shown at book value, others at market value. MCEV is a pure market-oriented valuation technique and the only system that considers renewals, since it takes into account the present value of future profits from existing business. All these differences typically lead to the following relationship between the three valuation approaches: equity (German local GAAP) < equity (IFRS) < MCEV. The result is that consideration of IFRS will underestimate the value of an insurance group as measured by a consistent MCEV approach. In Section 5 we numerically illustrate the difference between local GAAP, IFRS, and MCEV, revealing that the valuation difference can be substantial.

3 Differences Between Life and Non-Life and Consequences for MCEV Determination

Determining MCEV is based on a present value calculus, i.e., we calculate the present value of uncertain future cash flows. Uncertainty is inherent in both the cash inflow, for example, premiums and returns from the capital market, as well as the cash outflow, for example, claim payments and operating costs. In this context, there are substantial differences between life and non-life insurance, especially in terms of operations, investment activities, duration of liabilities, and vulnerabilities (see Brockett et al., 1994).

Life insurance is a long-term business. Present values are discounted future cash flows, so the longer the time horizon, the more important the interest rate component and demographic risk measures (see, e.g., Coppola et al., 2011). Thus, interest rates, as well as product options embedded in life insurance contracts, such as minimum interest rate guarantees or policy loan options (see, e.g., Liebenberg et al., 2010), are central value components in life insurance. Traditionally, life insurers profited from insureds' adverse exercise behavior with regard to numerous product options, such as cancellation of the contract. However, recent research shows the substantial risk potential of these embedded options (see, e.g., Gatzert and Kling, 2007; Gatzert and Schmeiser, 2008).

Non-life insurance is much more short-term oriented than life insurance, although there are also long tail lines of business (e.g., third-party liability) with substantial time periods between premium and claim payments. Product options in non-life policies, such as cancellation or bonus-malus scales, are usually not linked to capital markets (see, e.g., Pitrebois et al., 2006). Thus, for the TVFOG component of the MCEV, these options are not relevant. According to Chen and Wong (2004), the main type of service provided by non-life insurers is risk pooling (for types of services provided by insurance companies, see, e.g., Jeng and Lai, 2005). Claim distributions are much more volatile than benefits to life insurance policyholders, especially in lines of business involving coverage of catastrophes.

Most life insurance products are multi-year contracts with monthly or yearly payments; non-life insurance products typically have a maturity of one year. A substantial number of these contracts, however, are automatically renewed and this mechanism must be appropriately valued to derive the actual value of the in-force business. Recent literature contains a fair amount of information on the cancellation of life insurance (see, e.g., Pinquet et al., 2011), but we do not know as much about the premium renewal process in non-life insurance.

Overall, there are three main differences between modeling MCEV in life and non-life insurance. (1) There are no periodic premium payments over several years in non-life, whereas this is common in life. This is problematic in the context of MCEV when it comes to distinguishing between existing business, renewal business, and future new business. Although the contracts are typically drawn up for one year, annual policy renewal is very common and, according to MCEV Principle 10.2, the value of the in-force business should include renewal of in-force business. From this we conclude that a reasonable renewal assumption is necessary when modeling MCEV in non-life. (2) For non-life business, the projection model needs to focus on the development of claims, loss ratios, and claim reserves instead of biometric risks such as mortality (see, e.g., Cairns et al., 2006). Principles for the calculation of reserves need to be reflected since they affect the timing of profits. (3) Financial options do not play an important role in non-life and can be ignored, i.e., the TVFOG is set equal to zero.

4 Modeling of MCEV in Non-Life

The methodology for modeling MCEV in life insurance is based on the principles provided in European Insurance CFO Forum (2009a). Based on these principles, we 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. Our calculations are based on a projection of the balance sheet and profit and loss statement according to German local GAAP (Handelsgesetzbuch). We illustrate the model using German local GAAP, but our calculations could be based on any local GAAP. Since many of the modeling details refer to special German rules and characteristics, we introduce only the main idea of the model here and refer the reader to the Appendix for complete model specifications. In the interests of simplifying the model, we also ignore claims inflation and reinsurance. A commented Excel spreadsheet with a set of all the formulas used is available upon request.

We consider a projection horizon of T years ($\mathrm{t} = 0, \ldots, \mathrm{T}$) and assume a complete settlement of the insurance business in year T. We start with the statutory balance sheet in t = 0. The main liabilities on the balance sheet are shareholder equity (SE_0), equalization reserves (ER_0), and claim reserves (CR_0). On the asset side, we distinguish between assets backing shareholder equity ($\mathrm{BV}_0^{\mathrm{abse}} = \mathrm{SE}_0$) and assets backing liabilities ($\mathrm{BV}_0^{\mathrm{abl}} = \mathrm{ER}_0 + \mathrm{CR}_0$). In Germany, in addition to claim reserves, equalization reserves play an important role when it comes to the timing of profits. The equalization reserve is a patrimonial reserve, i.e., it corresponds to a patrimonial fund built up in good years, to be released in bad years in order to stabilize the accounting profits. The equalization reserve thus compensates for a volatile order of future claim events. There are strict rules for setting aside or releasing equalization reserves under German local GAAP. In our paper, we use a simplifying assumption for the release of equalization reserves (see Appendix A).

Principles for the Calculation of Reserves

Under local GAAP, claim reserves are calculated according to the prudence principle. We thus have unrealized gains that will be released over time. To calculate best estimate claim reserves of the existing business ($\mathrm{BCR}_0^{\mathrm{eb}}$), we use the standard chain-ladder algorithm to produce an estimate of the mean reserves (see, e.g., England and Verrall, 2002; Wüthrich and Merz, 2008). By means of the chain-ladder factors, we obtain forecasts of the ultimate claims (see England and Verrall, 2002). From those forecasts, we derive payment patterns for claim payments of the existing business ($\mathrm{pr}_t^{\mathrm{eb}}$) and the renewal business ($\mathrm{pr}_t^{\mathrm{rb}}$), i.e., we can make an assumption about how the best estimate claim reserves will be paid out over the next few years. To calculate the CRNHR, a cost-of-capital approach is applied and therefore the variability of the claim reserves is taken into account. Stochastic models quantify the uncertainty that accompanies the prediction process in the chain-ladder algorithm (see Wüthrich and Merz, 2008). A prominent example is the Mack (1993) model, which reproduces the chain-ladder reserve estimates and quantifies the corresponding standard error, the so-called mean squared error of prediction (MSEP).

We conducted robustness tests using the Bornhuetter-Ferguson method (BF method) and the additive loss reserving method (ALR method) as described in Wüthrich and Merz (2008). Neither method resulted in any significant differences. Using the BF method or the ALR method, however, requires additional external information and expert judgment (see England and Verrall, 2002), so we decided to use the chain-ladder method.

Modeling of Renewals

Typically, there are no periodic premium payments in non-life insurance but we need to integrate a reasonable renewal rate into the model to account for the renewal of existing business. We use a simplified additive and linear renewal model with a predefined cancellation rate. Our starting point at $t = 0$ is the existing insurance portfolio containing a given number of insurance contracts (IC). We assume an average cancellation rate (cr) , an average premium level (PL), and a best estimate loss ratio (lr) for the insurance portfolio.[3] We divide the portfolio into three different revenue segments, $m = 1, 2, 3$ (with proportions given by ac^m), intended to represent different customer groups. This model is a simplified approach, but multiple risks that arise from multiple policies and household decision making can be integrated in model extensions (see, e.g., Bonato and Zweifel, 2002; Dionne et al., 2006; Brockett et al., 2008). Moreover, a customer's decision to switch insurers is often determined by the level of available information (see, e.g., Schlesinger and Schulenburg, 1993). We assume that the claims amount is the same for all portfolios, but vary the segments with respect to premium level (pi^m) and cancellation rate (ci^m) by using different weights. Thus we can derive all relevant parameters for each revenue segment: $IC^m = IC \cdot ac^m$, $cr^m = cr \cdot ci^m$, $PL^m = PL \cdot pi^m$ and $lr^m = lr/pi^m$. We then calculate the gross premiums earned for projection year t (GPE_t) and revenue segments 1, 2, and 3 using the following linear function:

$$GPE_t = \sum_{m=1}^{3}([IC^m \cdot \max(1 - t \cdot cr^m; 0)] \cdot PL^m) \quad (1)$$

The total ultimate loss UL_t for projection year t of the three revenue segments can be derived by multiplying GPE_t by the respective loss ratio (lr^m):

$$UL_t = GPE_t \cdot lr^m = \sum_{m=1}^{3}([IC^m \cdot \max(1 - t \cdot cr^m; 0)] \cdot PL^m \cdot lr^m) \quad (2)$$

Modeling of MCEV

Deriving MCEV takes five steps: (1) calculation of the present value of future profits; (2) calculation of the required capital; (3) determination of the frictional costs of required capital; (4) calculation of the cost of residual nonhedgeable risks; and (5) determination of the free surplus. Each step is explained in detail below.

(1) **The present value of future profits** ($PVFP_0$) is the sum of the discounted net income NI_t:

$$PVFP_0 = \sum_{t=1}^{T} NI_t \cdot d_t. \quad (3)$$

[3] One could argue that the loss amount depends on the age of the insurance contract, since, in general, the loss ratio of the policy decreases with increasing age of the policy (see Kaufmann et al., 2001). In this case, we need to differentiate first renewals, second renewals, and subsequent renewals (see D'Arcy and Gorvett, 2004). Furthermore, the literature shows that customer retention depends on the length of time a customer has been with a particular insurer; the longer that period, the higher the persistency rate (see Brockett et al., 2008). In the basic case, we do not distinguish between renewal classes; however, in Section 5, we present additional tests integrating this pattern.

The annual net income consists of earnings before taxes less taxes paid contingent on positive earnings ($NI_t = EBT_t \cdot (1 - tr)$). Earnings before taxes can be calculated by adding the technical result (T_t) and the investment result (I_t), i.e., $EBT_t = T_t + I_t$.

According to Principle 13 of the European Insurance CFO Forum (2009a), for those cash flows that vary linearly with (or which are independent of) market movements, both investment returns and discount rates are calculated in a deterministic framework. This so-called certainty-equivalent approach assumes that all assets earn the risk-free reference rate and all cash flows are discounted using this reference rate. Only when cash flows do not vary linearly with market movements, e.g., cash flows reflecting financial options and guarantees, stochastic models are necessary for a proper market-consistent valuation. In this case economic theory provides two methods, the state-price deflator method or the risk-neutral method (see Sheldon and Smith, 2004). All cash flows that we consider in our paper vary linearly with or are independent of market movements. We thus need a risk-free yield curve at t = 0, consisting of spot rates sr_t for each relevant time to maturity. Both investment returns (forward rates fr_t) and discount factors (d_t) are then derived from this yield curve.

The technical result is calculated as gross premiums earned (GPE_t) minus claim payments (CP_t), acquisition costs (AC_t), claim settlement costs (CSC_t), and overhead costs (OC_t). We also deduct changes in claim reserves ($\Delta CR_t = CR_t - CR_{t-1}$) and changes in equalization reserves ($\Delta ER_t = ER_t - ER_{t-1}$). The technical result is then given as $T_t = GPE_t - \Delta CR_t - \Delta ER_t - CP_t - AC_t - CSC_t - OC_t$ (for a description of each component, see Appendix A1).

The investment result is the investment income under local GAAP less the associated investment costs. 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. In general, there are unrealized gains and losses (ugl), which correspond to the difference between the market value and the book value of assets. To determine the investment result it is therefore necessary to project both the book value and market value of the assets backing liabilities. As a simplified management rule, we assume that the amount of unrealized gains and losses (as percentage of the book value of assets) remains constant over the projection horizon. See Appendix A2 for details on calculation of the investment result.

(2) To calculate the **required capital** (RC_0) we consider the European Union solvency regulations (Solvency I and Solvency II). We take the maximum of the required capital according to Solvency I ($RC_0^{SCR\ I}$) and Solvency II ($RC_0^{SCR\ II}$):

$$RC_0 = Max(RC_0^{SCR\ I}; RC_0^{SCR\ II}) \quad (4)$$

To determine the required capital necessary for covering the solvency capital requirements, we use a solvency ratio defined as the available capital divided by the solvency capital requirements (see Sharpe and Stadnik, 2008). Since capitalization is one of the main determinants of insurer financial strength ratings (see Gaver and Pottier, 2005; Halek and Eckles, 2010), it is in the insurance company's interest to set this solvency ratio at a reasonably high level, e.g., to receive a target rating. Details on the calculations of solvency capital requirements according to Solvency I and Solvency II are available upon request.

(3) **Frictional costs** of required capital ($FCRC_0$) reflect the impact of nondistributable capital (e.g., due to regulatory restrictions) on shareholder value. Frictional costs should reflect investment costs and taxation on assets backing required capital. Thus, required capital must be projected appropriately over the lifetime:

$$FCRC_0 = \sum_{t=1}^{T} RC_{t-1} \cdot (icr + tr \cdot (fr_t - icr)) \cdot d_t \quad (5)$$

(4) **The cost of residual nonhedgeable risks** ($CRNHR_0$) correspond to the impact of all nonhedgeable (financial and non-financial) risks not already accounted for in the time value of financial options and guarantees or the present value of future profits. Nonhedgeable financial risks include illiquid or non-existent markets where the financial data used are not based on sufficiently credible data; non-financial risks include mortality, longevity, morbidity, persistency, expense and operational risks (see European Insurance CFO Forum, 2009b). Although the actual approach for their valuation is not prescribed by the CFO Forum, the results should be presented as an equivalent average charge on the cost of capital method, which is consistent with the current proposed requirements for determining the risk margin under Solvency II (see European Insurance CFO Forum, 2009b). We thus decided to use the cost-of-capital

approach similar to the risk-margin approach under Solvency II. Hereby, the internal cost of capital rate (cocr) is multiplied by solvency capital required under Solvency II (SCR II) at valuation date t – 1 to determine the cost of capital, which is then discounted to t = 0:

$$\text{CRNHR}_0 = \sum_{t=1}^{T} (\text{SCR II}_{t-1} \cdot \text{cocr} \cdot \text{d}_t) \qquad (6)$$

(5) The insurance company's **free surplus** capital (FS_0) consists of the difference between the market value of assets backing shareholder equity ($\text{MV}_0^{\text{abse}}$) and the required capital (RC_0). The market value of assets backing shareholder equity is derived by considering the unrealized gains and losses (ugl), i.e., $\text{MV}_0^{\text{abse}} = \text{BV}_0^{\text{abse}} \cdot (1 + \text{ugl})$:

$$\text{FS}_0 = \text{MV}_0^{\text{abse}} - \text{RC}_0 \qquad (7)$$

5 Application of the Model to a German Non-Life Insurer

To illustrate our framework, we apply the MCEV concept to a German non-life insurer. All figures and numbers are based on a model insurance company designed by the German Actuarial Society Working Group on Internal Models (see DAV-Arbeitsgruppe Interne Modelle, 2008). The company is based on a real company active in the German market, but to protect anonymity all data were manipulated so as to change the absolute values but not the underlying risk structure (a similar approach is taken in other empirical work; see, e.g., Eling et al., 2009). Although most insurance companies operate in more than one line of business (see, e.g., Liebenberg and Sommer, 2008), as a simplifying assumption, we consider only one line of business, i.e., third-party liability motor insurance.

For the application, we use the parameters and revenue segments set out in Table B1 and the payment patterns set out in Table B2 (see Appendix B). The best estimate claim reserves for existing business BCR_0^{eb} were derived using the chain-ladder claims reserving algorithm (see Table B3). By means of the chain-ladder factors, payment patterns for both existing business and renewal business can be calculated. Expected claim payments for existing business correspond to a mixture of policies from several accident years with a total different state of actual settlement; expected claim payments for renewal business correspond to future accident years with a more or less uniform state of actual settlement. As a starting point, we use the statutory balance sheet shown in Figure 2 (at valuation date December 31, 2008).

Assets		Liabilities	
Assets backing Shareholder Equity € 48,236		Shareholder Equity € 48,236	
Assets backing Liabilities € 187,883		Equalization Reserves € 33,932	
		Claim Reserves € 153,951	
Total	**€ 236,119**	**Total**	**€ 236,119**

Figure 2: Statutory Balance Sheet for the Application

Determination of MCEV

Figure 3 sets out two scenarios for MCEV calculations. In Scenario 1, we determine the value of the in-force business without renewals, i.e., we only settle the existing business (the cancellation rate is 100%, equivalent to a renewal rate of 0%). This settlement process yields a total MCEV of € 103,402. Free surplus is € 14,828, required capital € 34,373, and the value of in-force business € 54,201. In Scenario 2, we estimate the value of in-force business making a reasonable assumption with regard to renewals. This scenario takes into account the fact that a substantial number of insurance contracts are automatically renewed each year and thus provides a more realistic picture of the company's value. A critical parameter is the choice of renewal rate. In this example, we assume a cancellation rate of 13% (equivalent to a renewal rate 87%), but in later sensitivity tests we vary this number to illustrate the value implications of varying cancellation rates. The renewal rate of 87% was derived by the working group of the German Actuarial Society and is a typical cancellation rate for motor business in Germany. This renewal rate also seems reasonable for other countries, e.g., in U.S. non-life insurance firms, the retention rates are around 90% (see D'Arcy et al., 1997). Renewal of contracts generates additional future profits, i.e., VIF increases by € 26,036. In this scenario, MCEV thus increases to € 129,438.

Scenario 1

Free Surplus	Required Capital	Value of in-force Business
€ 14,828	€ 34,373	€ 54,201
Market Consistent Embedded Value € 103,402		

Scenario 2

Free Surplus	Required Capital	Value of in-force Business
€ 14,828	€ 34,373	€ 80,237
Market Consistent Embedded Value € 129,438		

Figure 3: MCEV Without Renewals (Sc. 1) and With Renewals (Sc. 2)

In comparing Figures 2 and 3, note the substantial valuation difference between local GAAP and MCEV. The equity according to German local GAAP is only € 48,236 (Figure 2), while under MCEV it is € 129,438 in the case with renewals. The difference between local (German) GAAP and MCEV is due to (1) unrealized gains and losses on assets that lead to an underestimation of the fair value in local GAAP, (2) the addition of equalization reserves, which is not part of the equity under local GAAP, (3) the addition of future profits from existing insurance business, and (4) the addition of future profits from renewals (only in Scenario 2). Under IFRS, the equalization reserves would be part of the equity and a fraction of the assets would be considered at market value. Starting with the book values shown in the statutory balance sheet (Figure 2), if we assume that 80% of the assets would be reported at market value under IFRS and we have unrealized gains and losses of 2%, the IFRS net asset value would be € 85,946, which is 34% lower than under MCEV (IFRS net asset value is calculated as 236,119·(80%·1.02) + 236,119·20% – 153,951). The difference between local (German) GAAP and IFRS is due to reasons (1) and (2) as described above. The above-mentioned factors (3) and (4) are the reasons for the difference between IFRS and MCEV. Note that this is only a simplified example intended to illustrate the main differences between local GAAP, IFRS, and MCEV. Nevertheless, the example does highlight some important issues, e.g., that the valuation differences can be substantial and that this difference is not simply due to the addition of renewals. These valuation differences thus show that consideration of IFRS net asset value – as currently proposed by the CFO Forum – tends to substantially underestimate the MCEV.

Economic Balance Sheet

Business risk is more and more measured in an economic capital framework (see, e.g., Doff, 2008). The MCEV can serve as a basis for setting up an economic balance sheet that can help in understanding what creates value (see O'Keeffe et al., 2005). In contrast to the statutory balance sheet, in the economic balance sheet we consider market values and make allowance for future cash flows, given the assumption of a complete settlement of our insurance business in year T. In Figure 4, we again consider the two scenarios for MCEV calculation, i.e., Scenario 1 without renewals (cancellation rate of 100%) and Scenario 2 with renewals (cancellation rate of 13%).

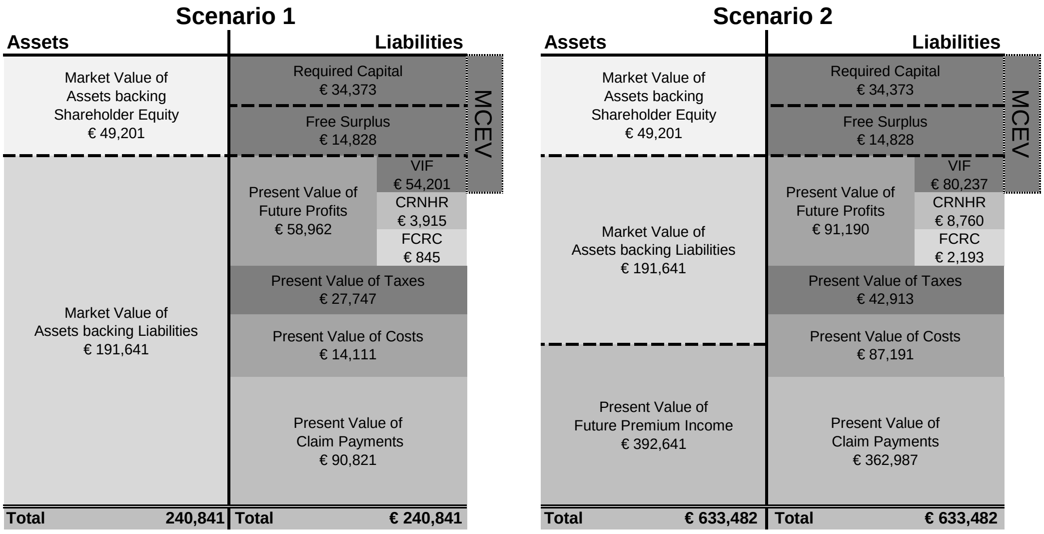

Figure 4: Economic Balance Sheet Without Renewals (Sc. 1) and With Renewals (Sc. 2)

In Scenario 1, the total balance sheet yields an amount of € 240,841 (note, in comparison with the statutory balance sheet, that the economic balance sheet shows market values, i.e., in this case $236{,}119 \cdot 1.02$). In Scenario 2, the total balance sheet is € 633,482. This much larger amount for Scenario 2 is because, in addition to the market value of assets, we also consider the present value of future premiums (€ 392,641) as we are taking renewals into account.

Sensitivity Analysis

We analyze the value implications of different model assumptions with sensitivity tests. Here, we illustrate three simple examples with varying loss ratios, cancellation rates, and acquisition costs (a systematic analysis of elasticities for all input parameters is available upon request).

First, we consider different parameter assumptions for the loss ratio and the cancellation rate (see left part of Figure 5). The higher the loss ratio, the lower the MCEV, as more funds are paid out to policyholders. Note the interaction between the cancellation rate and the loss ratio. With a low loss ratio, a reduction of cancellation rates increases the MCEV, but with a high loss ratio, an increase in 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 80.62%. For a very high loss ratio of 100% and a cancellation rate of 13%, MCEV is still positive (€ 32,971). This is due to the fact that a negative value of in-force covered business (–€ 16,229) is compensated by a positive free surplus and required capital (€ 49,201).

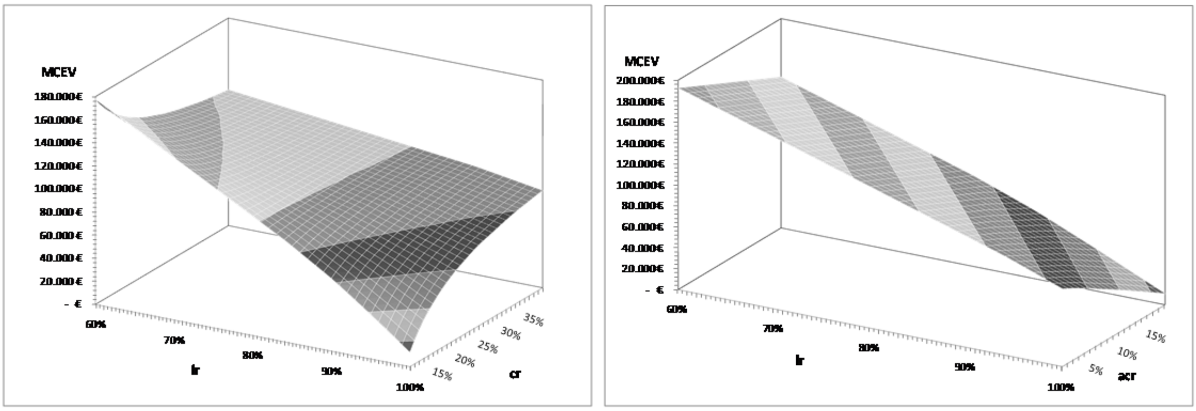

Figure 5: Loss Ratio (lr) Versus Cancellation Rate (cr) and Acquisition Costs (acr)

Second, we consider variations in loss ratios and acquisition costs for a cancellation rate of 13% (see right part of Figure 5). In this situation, there is a linear relationship between these two ratios: the higher the costs and the higher the loss ratio, the lower the VIF and thus MCEV. Results range from a maximum of € 192,445 to a minimum of € 7,021. For a loss ratio of 93% and an acquisition costs rate higher than 17%, the VIF becomes negative, i.e., the PVFP is not sufficient to cover the FCRC and the CRNHR and the insurance business becomes unprofitable.

Third, to analyze the sensitivity of the MCEV with respect to the renewal model, we measure the impact of time-varying cancellation rates and loss ratios (see Table 2). A year-by-year decrease/increase of the cancellation rate by 0.5% leads to an increase/decrease in MCEV of 2,024/1,603. Additionally, a year-by-year decrease/increase of the loss ratio by 3% leads to an increase/decrease in MCEV of 16,076/16,151. The increase and decrease of cancellation rates and loss ratios are calibrated to a yearly change of approximately 4% (e.g., 0.5% = 13% · 0.04) to make the relative changes comparable. The results show that, ceteris paribus, the MCEV is more sensitive to time-varying loss ratios than to time-varying cancellation rates. The asymmetry in the results for the cancellation rate is due to the composition of the insurance portfolio, i.e., the revenue segments differ with respect to premium level and cancellation rate. For increasing cancellation rates, we have only one year less future premium income from renewals, whereas for decreasing cancellation rates, three additional years with renewals are considered.

Scenario	FS	RC	VIF	MCEV
Decreasing cr over time (each year -0.5%)	14,828	34,373	82,262	131,462
Uniform cr (13.0%)	14,828	34,373	80,237	129,438
Increasing cr over time (each year +0.5%)	14,828	34,373	78,634	127,835
Decreasing lr over time (each year -3%)	14,828	34,373	96,313	145,514
Uniform lr (70.8%)	14,828	34,373	80,237	129,438
Increasing lr over time (each year +3%)	14,828	34,373	64,087	113,287
Combination	14,828	34,373	103,430	152,631

Table 2: Time-Varying Cancellation Rates (cr) and Loss Ratios (lr)

In the case of repeating renewal cycles over time, that is, a combination of decreasing loss ratios and decreasing cancellation rates (see D'Arcy and Gorvett, 2004; Brocket et al., 2008), we derive a total MCEV of 152,631, which corresponds to an increase of 18% compared to our basis scenario. Free surplus and required capital are unaffected by varying cancelation rates and loss ratios.

Value Added Analysis

To this point, we have considered the MCEV only in t = 0. We now analyze MCEV over time, i.e., changes from t = 0 to t = 1 (we denote this as value added analysis), based on the detailed movement analysis template provided by the European Insurance CFO Forum (2009a). The goal is to analyze the so-called MCEV earnings, which are defined as the sum of the change in MCEV over a period plus the value of distributions to the shareholders (e.g., dividends) from the assets backing the covered business. Our analysis is limited to a basic breakdown of the value added consisting of changes within free surplus, required capital, present value of future profits, frictional costs of required capital, and cost of residual nonhedgeable risks. We look only at Scenario 2 with a cancellation rate of 13% and do not take into account the value of new business written, but only consider a process that settles the existing business (including a reasonable assumption about renewals). As a simplification, we assume that free surplus is distributed to the shareholders right at the beginning of year 1.

The aim of this analysis is to identify the value added by the insurer's management. 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 insurance market, among others. Only abnormal deviations from these overall market developments can be attributed to management, i.e., internal effects.

We analyze changes to the operating assumptions as set out in t = 0 (see Table 3). Here we describe both the development of the firm as well as that of the market in t = 0 and t = 1. What is needed to divide external from internal effects is a benchmarking with the market development. We thus turn to the market data in order to separate the effects due to changes in the business environment from those due to management. For example, we assume the average loss ratio in the market to be 71.0% in t = 0, a value that is slightly higher than the 70.8% observed for the company. In t = 1, the market average is 70.0%, which is 1.41% lower than the market average in the previous year ($70.0\%/71.0\% - 1$). The reduction in the insurer's loss ratio, however, is only 0.28% ($70.6\%/70.8\% - 1$). It thus appears that in this year the company performed worse than the market because it could not reduce the loss ratio to the same extent as did the market.

Input Parameter	**Company**			**Market**	**Delta Market**	**Company (External)**
	t = 0	t = 1	t = 0	t = 1		t = 1
Loss Ratio	70.80%	70.60%	71.00%	70.00%	-1.41%	69.80%
Cancellation Rate	13.00%	12.50%	13.00%	12.50%	-3.85%	12.50%
Acquisition Costs	13.00%	12.50%	12.00%	11.00%	-8.33%	11.92%
Claim Settlement Costs	4.00%	3.90%	5.00%	4.60%	-8.00%	3.68%

Table 3: Change in Operating Assumptions

The resulting MCEV calculations are shown in Table 4. We assume that the changes to our operating assumptions took place within the calendar year under consideration. As reported in the previous section, the MCEV in t = 0 is € 129,438 (Opening MCEV). We now assume that one year has passed and we observe a total MCEV of € 108,535 (Closing MCEV), which is a decrease of € 20,903. However, at the beginning of year 1, free surplus of € 14,828 is paid out to the shareholders (Opening Adjustment). Additionally, at t = 1 the annual net income of € 14,959 is not reinvested in the insurance company, but paid as dividends to the shareholders (Closing Adjustment). Thus, the net effect of actual payments to shareholders (dividends) and decrease in MCEV (value added) leads to overall MCEV earnings of € 8,884 (= 14,828 + 14,959 – 20,903).

	PVFP	FCRC	CRNHR	RC	FS	MCEV
Opening MCEV	91,190	-2,193	-8,760	34,373	14,828	129,438
Opening Adjustment	0	0	0	0	-14,828	-14,828
Unwinding	3,574	-86	-343	0	0	3,145
Experience Variances	649	0	0	0	0	649
Assumption Changes	3,040	-57	-188	95	-95	2,795
Release of RC	0	0	0	-4,735	4,735	0
Release of CRNHR	0	0	1,817	0	0	1,817
Release of FCRC	0	478	0	0	0	478
Closing Adjustment	-14,959	0	0	0	0	-14,959
Closing MCEV	83,494	-1,858	-7,473	29,732	4,641	108,535

Table 4: Total MCEV Results

We use the basic breakdown of the MCEV elements to illustrate where the positive net effect comes from. First, we now make calculations in t = 1, so we discount the PVFP, FCRC, and CRNHR by one year less. This leads to a total discount effect of € 3,145 (called unwinding), consisting of a positive effect within PVFP amounting to € 3,574 and a negative effect within FCRC (–€ 86) and CRNHR (–€ 343). Second, while the RC decreases by € 4,735, we have an increase of FS in the same amount. Some portion of the RC is thus released and transferred to the FS, which will be paid out to shareholders right at the start of year 2. Hence, the release of RC has no impact on the MCEV earnings. In addition to the discount effect and the release of RC, we also must account for the release of FCRC (€ 478) and CRNHR (€ 1,817). The release of CRNHR corresponds to the cost of capital incurred during the period t = 0 to t = 1 (but only for nonhedgeable risks). Finally, we also have to take into account the fact that experiences in the first year differed from expectations (experience variances) and the impact of changes in our operating assumptions (assumption changes).

The overall MCEV earnings in year 1 are € 8,884. However, it is not yet clear whether this result is due to internal effects or to changes in the market environment. To separate internal from external effects, we now calculate a hypothetical MCEV for the company based on market data. For this purpose we multiply the company values in t = 1 by the changes in market data (e.g., the loss ratio of the company (external) in t = 1 is given by 70.8% · (70.0% / 71.0%) = 69.8%; see Table 3) and then recalculate MCEV. This allows us to further split both experience variances and assumption changes into market impact and deviations from the market, as shown in Table 5.

	PVFP	FCRC	CRNHR	RC	FS	MCEV
Experience Variances	649					649
… market impact	2,063					2,063
… deviation from market	-1,414					-1,414
Assumption Changes	3,040	-57	-188	95	-95	2,795
… market impact	6,309	-53	-154	-28	28	6,101
… deviation from market	-3,269	-4	-34	123	-123	-3,306

Table 5: Market Impact on Change in MCEV

If the company had performed as well as the market, it should have provided MCEV earnings of € 13,604 (= 2,063 + 6,101 + 3,145 + 478 + 1,817). But in fact it had MCEV earnings of only € 8,884. We thus conclude that the MCEV earnings attributable to management are € –4,720 (= –3,306 – 1,414). Management might claim that it is not responsible for this value destruction, e.g., it might say that its customers are not well represented by the market average. This illustrates the importance of identifying the right benchmark for the value added analysis, e.g., one requirement for the benchmark is that it is comparable to the insurer's business risk (for criteria appropriate in selecting representative benchmarks, see Sharpe, 1992).

Overall, the concept of a value added analysis is very similar to the concept of economic value added (EVA) (see Stern et al., 1995), both of which can be traced back to Marshall's (1890) residual income concept. In the case of EVA, the annual result is related to the cost of capital (hurdle rate times equity capital). In our case, the benchmark is not a hurdle rate, but the market average. However, it may 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, and ex ante for value-based management and target setting. However, MCEV ignores future new business and this might distort decision making. The management implications of MCEV must thus be considered very carefully.

Another idea is to break down the value added by management into that attributable to different parts of the company, i.e., how much value added has been generated by asset management, claims management, or other segments of the insurer's business. However, this task is hardly feasible because it leads to problems well known from capital allocation: it is not feasible to allocate capital to different business units without making arbitrary assumptions, especially when there is no allocation mechanism for overhead costs (see Gründl and Schmeiser, 2007).

Determination of Group MCEV

To illustrate the usefulness of a consistent group MCEV approach for management, we now embed the MCEV concept for non-life insurance business in a simplified model of an insurance group that consists of one non-life and one life entity. To keep the example as simple as possible, we consider a scaled and weighted average of the MCEV (life) and IFRS (net asset value) calculations in the accounting year 2008 of 14 major European insurance companies that are members of the European Insurance CFO Forum. For this purpose, we reviewed the 2008 Embedded Value Reports from AEGON, AGEAS, Allianz SE, AVIVA, AXA S.A., CNP-Paribas Assurance, Generali, Hannover Re, Legal & General, Munich Re, Old Mutual, Prudential, Standard Life, and Zurich Financial Services. We then calculated a representative life entity using a weighted average of the reviewed numbers and scaled those average numbers with a factor so that we have an insurance group that consists of 50% life and 50% non-life in terms of IFRS net asset value, i.e., both life and non-life have a net asset value of € 85,946 (details available upon request). These calculations lead to the group MCEV and IFRS net asset value shown in Table 6.

	IFRS	MCEV	Ratio	Group MCEV (CFO-Forum)	Group MCEV
Non-Life Entity	85,946	129,438	151%	196,706	240,198
Life Entity	85,946	110,760	129%		

Table 6: Group MCEV of a Simplified Insurance Group in 2008

For the non-life entity, we consider the MCEV calculations from the previous analysis. We thus have a MCEV of € 129,438, whereas the IFRS net asset value is € 85,946. For the life entity, we have a total MCEV of € 110,760. This means that using the group MCEV suggested by the CFO Forum would lead to a total MCEV of € 196,706 (= 110,760 + 85,946), whereas using the same MCEV methodology for both the life and non-life entity would lead to a total MCEV of € 240,198 (= 110,760 + 129,438). We thus see a substantial underestimation of the group MCEV when using the IFRS net asset value for the non-life entity.

Based on this example, for the life entity we also calculate a scaled and weighted average of the MCEV earnings (excluding new business value) in 2009 of € 19,598. This quantity can now be added to the MCEV earnings of our non-life entity (see the previous value added analysis), which was € 8,884. Overall, using a consistent group-level approach for MCEV calculations leads to a total return on embedded value of our simplified insurance group of 11.9% (= 28,482 / 240,198). If we had used the MCEV approach suggested by the CFO Forum, IFRS earnings for the non-life entity would be € 13,920,[4] leading to a total return on embedded value of 17.0% (= (19,598 + 13,920) / 196,706).

Again we see that using IFRS leads to an underestimation of the group MCEV. Furthermore, development of IFRS net asset value usually proceeds differently from development of MCEV, which could result in misguided management incentives. Using a consistent MCEV calculation model for life and non-life entities also enables managers to conduct a detailed movement analysis of change in MCEV from one business year to another for both the life and non-life entities (comparable to the value added analysis presented above).

6 Conclusions

The aim of this paper was to illustrate market-consistent embedded valuation of non-life insurance. Traditionally, embedded value determination is used for long-term business, such as life insurance. In this paper, we transferred the embedded value concept from life to non-life insurance. In our numerical illustration, we showed an MCEV calculation based on empirical data and set up an economic balance sheet. Furthermore, we analyzed the value implications of varying loss ratios, cancellation rates, and costs within a sensitivity analysis. The usefulness of the model for value-based management was illustrated by a value added analysis and the methodology was embedded in a simplified insurance group in order to derive a group MCEV.

[4] Using the same simplified set up for IFRS calculations as described above (80% of the assets are at market value and we have unrealized gains and losses of 2%) enables us to calculate the IFRS net asset value in 2009, which amounts to € 70,079. The corresponding IFRS earnings can now be derived by the change in IFRS (net asset value) between 2008 and 2009 and the additional consideration of any paid dividends (13,920 = 70,079 – 85,946 + 14,828 + 14,959).

The proposed model framework has a number of important practical implications. First, it provides new and relevant information to the stakeholders of an insurance company. The model provides information comparable to that provided by embedded value models currently used in the life insurance industry and fills a gap in the literature. In particular, we revealed a significant valuation difference between MCEV and IFRS and therefore argue that there is a need for a consistent MCEV approach at the insurance-group level. This approach can also be helpful for a risk-based regulation at the insurance group level (see, e.g., Ojo, 2010).

A consistent concept of MCEV also has potential for value-based management at the group level, although its management implications must be considered very carefully. Managing insurance companies without making reasonable assumptions as to future new business might distort decision making and thus lead to dangerous misallocation, especially if management compensation is linked to MCEV. Nevertheless, embedded value models are already used for determining 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). Current research, however, shows a link between management compensation and loss reserve errors (see Eckles and Halek, 2010). Given that estimation of loss reserves is a critical factor for MCEV calculation, great care should be taken when using embedded value concepts for determining compensation.

Future research could extend this model in several directions. The presented model can be extended to include inflation, reinsurance, more realistic claim processes, customer behavior, or a more realistic description of the cost situation in an insurance company. Moreover, by taking a closer look at the premium renewal process in non-life insurance, the deterministic process employed in this paper could be replaced by a stochastic model. Another question to be addressed that arises out of solvency regulation is whether the concept of MCEV can be used to derive capital requirements in a consistent manner at the insurance-group level.

Appendix A: Modeling the Present Value of Future Profits (PVFP)

The PVFP is the sum of the discounted net income (NI_t). The net income is earnings before taxes (EBT_t = technical plus investment result $T_t + I_t$) less taxes (tax rate tr). We thus obtain:

$$PVFP_0 = \sum_{t=1}^{T} NI_t \cdot d_t = \sum_{t=1}^{T} EBT_t \cdot (1-tr) \cdot d_t = \sum_{t=1}^{T} (T_t + I_t) \cdot (1-tr) \cdot d_t = \sum_{t=1}^{T} \Bigg(\bigg(\Big\{ [GPE_t \cdot (1-acr)] - \Big[\Big[\Big(\sum_{k=t+1}^{T} UL_t \cdot pr_{k+1-t}^{rb} \Big) - \Big(\sum_{i=1}^{t-1} UL_i \cdot pr_{t+1-i}^{rb} \Big) - BCR_0^{eb} \cdot pr_t^{eb} \Big] \cdot \Big[\frac{CR_0^{eb}}{BCR_0^{eb}} + \frac{ER_0^{eb}}{BCR_0^{eb}} \Big] \Big] - \Big[\Big[BCR_0^{eb} \cdot pr_t^{eb} + \sum_{i=1}^{t} \big(UL_i \cdot pr_{t+1-i}^{rb} \big) \Big] \cdot [1 + cscr] \Big] - \Big[\Big[BCR_0^{eb} \cdot \Big(1 - \sum_{i=1}^{t} pr_i^{eb} \Big) + \Big(\sum_{i=1}^{t} \sum_{k=t+1}^{T} (UL_i) \cdot pr_{k+1-i}^{rb} \Big) \Big] \cdot \frac{OC_0}{BCR_0^{eb}} \Big] \Big\} + \Big\{ \Big[\Big[BCR_0^{eb} \cdot \Big(1 - \sum_{i=1}^{t-1} pr_i^{eb} \Big) + \Big(\sum_{i=1}^{t-1} \sum_{k=t}^{T} (UL_i) \cdot pr_{k+1-i}^{rb} \Big) \Big] \cdot \Big(\frac{CR_0^{eb}}{BCR_0^{eb}} + \frac{ER_0^{eb}}{BCR_0^{eb}} \Big) \Big] \cdot [(fr_t - icr) + ugl \cdot (fr_t - icr) + ugl] - \Big[\Big[BCR_0^{eb} \cdot \Big(1 - \sum_{i=1}^{t} pr_i^{eb} \Big) + \Big(\sum_{i=1}^{t} \sum_{k=t+1}^{T} (UL_i) \cdot pr_{k+1-i}^{rb} \Big) \Big] \cdot \Big(\frac{CR_0^{eb}}{BCR_0^{eb}} + \frac{ER_0^{eb}}{BCR_0^{eb}} \Big) \Big] \cdot ugl \Big\} \bigg) \cdot (1-tr) \cdot d_t \Bigg) \quad (A1)$$

What complicates calculation of the technical (light shaded) and investment (dark shaded) result is that we project renewal business and realize unrealized gains and losses. We explain this projection process in Appendix A1 for the technical result and in Appendix A2 for the investment result. Appendix B contains definitions of all parameters.

Appendix A1: Technical Result

We conduct two analyses, one for unwinding the existing business and the second considering renewal business. In a third step, these are aggregated to the overall result.

<u>Step 1: Derivation of Technical Result for Existing Business</u>

The claim payments for existing business can be derived by

$$CP_t^{eb} = BCR_0^{eb} \cdot pr_t^{eb} \quad (A2)$$

The development of the (undiscounted) best estimate claim reserves BCR_t^{eb} for existing business would result from a settlement process, which is given by the future claims paid CP_t^{eb}, i.e., $BCR_t^{eb} = BCR_{t-1}^{eb} - CP_t^{eb}$.

For the claim reserves according to local GAAP (CR_t^{eb}), in a simplified management rule, we assume that management will always ensure that the settlement process proceeds equally (proportionally constant) to the settlement process of best estimate claim reserves BCR_t^{eb}, given by a constant percentage $c_1 = \frac{CR_0^{eb}}{BCR_0^{eb}}$, i.e., $CR_t^{eb} = BCR_t^{eb} \cdot c_1$.

Step 2: Derivation of Technical Result for Renewal Business

		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

The claim payments for renewal business can be represented in a payment process triangle, as shown in Figure A1. Here, we have absolute accident years i ($i = 1, \dots, K$) and absolute calendar years j ($j = 1, \dots, T$) with K < T. The future claim payments are zero when 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}), ($CP_{i,j} = UL_i \cdot pr_{j+1-i}^{rb}, i \leq j$).

The total claim payments for renewal business at calendar year t, CP_t^{rb} , can now be calculated by summing all the columns of our payment process triangle:

$$CP_t^{rb} = \sum_{i=1}^{t} CP_{i,t} \tag{A3}$$

The development of the best estimate claim reserves for the respective accident year i and calendar year t ($BCR_{i,t}$) can then be derived by summing the future claims paid $CP_{i,t}$, i.e., $BCR_{i,t} = \sum_{k=t+1}^{T} CP_{i,k}$. The total best estimate claim 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, i.e., $BCR_t^{rb} = \sum_{i=1}^{t} BCR_{i,t} = \sum_{i=1}^{t} \sum_{k=t+1}^{T} CP_{i,k}$.

To calculate claim reserves according to local GAAP (CR_t^{rb}), again in a simplified management rule, we assume that the settlement process will proceed equally (proportionally constant) to the settlement process of the best estimate claim reserves, given by the same constant c as shown above ($c_1 = \frac{CR_0^{eb}}{BCR_0^{eb}}$), i.e., $CR_t^{rb} = BCR_t^{rb} \cdot c_1$.

Step 3: Derivation of the Overall Technical Result

To obtain the overall technical result, we add the technical results for existing business and renewal business. We assume independence between the claim settlement process of existing business and renewal business. Thus, summing up leads to total claim payments ($CP_t = CP_t^{eb} + CP_t^{rb}$), total best estimate claim reserves ($BCR_t = BCR_t^{eb} + BCR_t^{rb}$), and total claim reserves according to local GAAP ($CR_t = CR_t^{eb} + CR_t^{rb}$).

For the settlement process of the equalization reserves, we assume that the equalization reserves at the beginning ER_0 would be equally settled to the best estimate claim reserves. Thus, we need the proportion of these two measures from the beginning of our calculations ($c_2 = \frac{ER_0}{BCR_0^{eb}}$), i.e., $ER_t = BCR_t \cdot c_2$. Acquisition costs (AC_t) can be calculated as the product of gross premiums earned and a predefined acquisition costs rate, acr, at valuation date t ($AC_t = GPE_t \cdot acr$). Claim settlement costs (CSC_t) can be calculated as the product of claim payments and a predefined claim settlement costs rate, cscr, at valuation date t ($CSC_t = CP_t \cdot cscr$). Overhead costs are driven by development of the best estimate claim reserves given by $c_3 = \frac{OC_0}{BCR_0^{eb}}$ ($OC_t = BCR_t \cdot c_3$).

Appendix A2: Investment Result

We assume that at time t = 0, the amount of unrealized gains and losses (ugl) is equal to a percentage of the book value of assets, i.e., $MV_0^{abl} = BV_0^{abl} \cdot (1 + ugl)$. Derivation of the technical result includes a projection of both the claim reserves and the equalization reserves under local GAAP, where the sum of these is called the book value of liabilities, i.e., $BV_t^l = CR_t + ER_t$. The investment income on a market value basis is given by the forward rates fr_t for each year t. We assume that investment costs (icr) are proportional to the market value of assets and that all cash flows occur at the end of the year. The resulting investment income is called the investment result on market value basis and is given by $I_t^{MV} = MV_{t-1}^{abl} \cdot (fr_t - icr)$.

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

$$I_t = I_t^{MV} + ugl \cdot \left(BV_{t-1}^{abl} - BV_t^{abl}\right) \quad \text{(A4)}$$

Appendix B: Parameters for Application of MCEV

Description	Parameter	Value
Balance Sheet		
Shareholder Equity	SE_0	€ 48,236
Claim Reserves	CR_0	€ 153,951
Best Estimate Claim Reserves (Existing Business)	BCR_0^{eb}	€ 106,652
Equalization Reserves	ER_0	€ 33,932
Unrealized Gains and Losses	ugl	2.00%
Cost Rates		
Acquisition Costs Rate	acr	13.00%
Claim Settlement Costs Rate	cscr	4.00%
Investment Costs Rate	icr	0.20%
Cost of Capital Rate	cocr	6.00%
Overhead Costs	OC_0	€ 3,800
Tax Rate	tr	32.00%
Modeling of Renewals		
Number of Insurance Contracts	IC	535,471
Average Premium Level	PL	€ 250
Average Cancelation Rate	cr	13.00%
Best Estimate Loss Ratio	lr	70.80%
Revenue Segments		
Proportion Index (Revenue Segment 1)	ac^1	20.00%
Cancelation Index (Revenue Segment 1)	ci^1	1.20
Premium Index (Revenue Segment 1)	pi^1	1.30
Proportion Index (Revenue Segment 2)	ac^2	60.00%
Cancelation Index (Revenue Segment 2)	ci^2	1.00
Premium Index (Revenue Segment 2)	pi^2	1.00
Proportion Index (Revenue Segment 3)	ac^3	20.00%
Cancelation Index (Revenue Segment 3)	ci^3	0.80
Premium Index (Revenue Segment 3)	pi^3	0.70

Table B1: Parameters and Revenue Segments

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
pr_t^{eb}	28.10	16.20	11.60	9.55	7.87	6.77	6.24	5.19	4.59	3.88	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
pr_t^{rb}	67.50	13.86	5.41	2.59	1.92	1.29	1.09	0.83	0.45	0.45	4.61	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
sr_t	3.92	4.70	4.53	4.51	4.53	4.55	4.58	4.61	4.65	4.70	4.74	4.78	4.82	4.85	4.88	4.88	4.88	4.88	4.88	4.88

Note: The interest rate pattern is taken from the Quantitative Impact Studies of Solvency II; see CEIOPS (2008).

Table B2: Payment Rate (pr) and Interest Rate (sr) Patterns in Percent

Accident						Development Years						
Years	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**Ultimate**	**Reserves**
1999	52,891	62,840	67,208	69,443	70,610	71,676	72,711	73,438	73,546	73,895	77,464	3,569
2000	59,173	68,829	72,996	74,919	76,620	77,571	78,326	79,078	79,703		83,949	4,246
2001	60,081	70,980	75,703	78,033	79,753	80,861	81,637	82,218			87,015	4,797
2002	62,711	75,867	81,207	83,272	85,129	86,412	87,582				93,512	5,930
2003	63,284	77,253	82,188	84,963	86,900	88,141					95,220	7,079
2004	64,091	78,776	84,322	86,887	88,774						97,262	8,488
2005	69,727	88,939	94,416	97,198							108,781	11,583
2006	69,092	82,588	88,289								101,763	13,474
2007	66,645	79,289									97,460	18,171
2008	60,576										89,891	29,315
Tail-Factor												1.04830411
CL-Factors	1.2073	1.0664	1.0299	1.0215	1.0142	1.0118	1.0089	1.0048	1.0047	1.2073	**Total**	**106,652**

Note: The claims development triangle is taken from the Working Group of the German Actuarial Society; see DAV-Arbeitsgruppe Interne Modelle (2008).

Table B3: Claims Development Triangle

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