Market-Consistent Embedded Value in Non-Life Insurance: How to Measure it and Why

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Abstract: The aim of this paper is to transfer the concept of market-consistent embedded value (MCEV) from life to non-life insurance. This is an important task since the differences between management techniques used in life and non-life insurance make management at group level very difficult. Our methodology might be a way out of this unfavorable situation. After explaining the idea of MCEV, we derive differences between life and non-life 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 for management purposes. Furthermore, we illustrate the value implications of varying loss ratios, cancellation rates, and costs within a sensitivity analysis, and the use of MCEV as a performance metric within a value added analysis. We also embed our MCEV concept in a simplified model for an insurance group to derive group MCEV and to outline differences between local GAAP, IFRS, and MCEV.

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

1. Introduction

In light of the rapidly changing environment in the insurance industry, *value-based management* techniques are becoming increasingly important (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 illustrate a concept for determining market-consistent embedded value in non-life insurance. We believe that the concept is helpful in overcoming traditional differences in performance measurement of life and non-life insurance business, making our concept a powerful management tool at insurance-group level.

Generally, life and non-life are the two main business models in the insurance industry, each with their own unique structures of cash flows and with large differences between the two as to the duration of their assets and liabilities. Traditionally, life and non-life are managed as separate entities; in some countries, this separation is required by law (e.g., in Germany and Switzerland). Nevertheless, most large insurers operate as affiliated groups, i.e., different 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.[1] These management tasks can be successfully achieved only by constant monitoring and transparent performance measurement.

The traditional separation of life and non-life business, however, has resulted in different management techniques for these two types of companies. *Economic value added* (*EVA*) (see Malmi and Ikäheimo, 2003) and *return on risk-adjusted capital* (*RORAC*) (see Nakada et al., 1999) are very popular performance metrics in non-life insurance. The life insurance industry, however, 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- and risk-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 very problematic from a group manager's point of view.[2/3] 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.

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[1] For example, the 15 largest life and the 15 largest non-life insurance companies in Germany all act as affiliated insurance groups (see BaFin, 2009). Nineteen of the 20 member companies of the European Insurance CFO Forum are part of multi-line insurance groups. Elango et al. (2008) state that group affiliation is increasingly common and Outreville (2008) also notes that most of the largest insurers are organized as insurance groups with multi-line businesses.

[2] As such, the type of problem considered here is related to many other topics in academic literature, e.g., enterprise risk management (see, e.g., Nocco and Stulz, 2006), asset liability management (e.g., Haugen, 1971; Kahane, 1977, 1979), dynamic financial analysis (e.g., D'Arcy et al., 1997; Philbrick and Painter, 2001; D'Arcy and Gorvett, 2004; Eling and Parnitzke, 2007), management of financial conglomerates (e.g., Gatzert et al., 2008), capital allocation (e.g., Valdez and Chernih, 2003; Ibragimov et al., 2010), and regulation (e.g., Klein and Wang, 2009; Harrington, 2009). 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 point of view.

[3] The German Actuarial Society (DAV) set up a working group with the overall goal of finding a consistent performance metric at the insurance-group level, which underlines the practical relevance of this problem. Towers Watson (2009) claims that using a consistent approach to performance measurement of a multi-line insurance group enables management to make better decisions.

We provide a way out of this unfavorable situation by arguing 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 to transfer the *MCEV* methodology from life to non-life insurance. This simple goal, however, becomes quite complicated in light of the large differences between life and non-life insurance. Therefore, in the first step, we consider the specific characteristics of the two businesses, including the structure of assets and liabilities as well as the various types of risks and their relevance for life and non-life.[4] After deriving the special characteristics of non-life contracts and their consequences for embedded value calculation, we 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 our model in a simplified insurance group model in order to derive a group MCEV.

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 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 be effective, European insurers face significant changes in almost all aspects of their business, including, among others, risk management practices and disclosure requirements (see Eling et al., 2009), as well as management techniques at the 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). 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 foundation for their use in non-

4 A good example is the difference in the duration of contracts. Most life insurance products are multiyear contracts with monthly or yearly premium payments; non-life insurance products typically have a maturity of one year. A substantial number 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.

life insurance. Despite the growing policy interest in embedded value, there has been limited academic attention paid to this methodology. Our hope is thus also to encourage further discussion on this topic in academia.

The rest of this 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 this special character of non-life insurance business, as well as the requirements for MCEV determination. In Section 5, the concept is applied to a German non-life insurance company and the MCEV concept is embedded into a simplified insurance group in order to illustrate its usefulness for management on a group level. Section 6 concludes.

2. Concept of Market-Consistent Embedded Value

The idea of embedded value calculation originates in the valuation literature and can be traced back to Anderson (1959). Put simply, embedded value estimates the value of a life insurance company by taking into account future cash flows from existing insurance contracts. It is closely related to discounted cash-flow-based valuation techniques.[5] The embedded value itself is thus not a performance measure, but a valuation technique. However, the concept of embedded value might be a promising basis for developing a performance metric. For this purpose, the embedded value in t=0 and t=1 is compared (so-called value added analysis or analysis of change) and the main drivers for the change of embedded value are identified.

Embedded value is achieving new significance and international attention due to new accounting and regulatory rules, especially the International Financial Reporting Standards (IFRS) and Solvency II (see, e.g., Olivieri and Pitacco, 2008; De Mey, 2009; Eling and Top-

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

lek, 2009; Klein and Wang, 2009). Under both these regimes, insurance business is to be evaluated based on market values, which is new for many European insurers, since these have traditionally followed a conservative/prudent accounting philosophy based on historical values rather than on market values (see Post et al., 2007). Accordingly, many different proposals and principles have been developed, all with different assumptions and methods for addressing the problem.

To combine these different streams of discussion and develop a standard for embedded value calculation, the chief financial officers of 20 major European insurance companies created a discussion group called the 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, in response to a general trend towards market-consistent valuation (see Sheldon and Smith, 2004), the CFO Forum launched the Market Consistent Embedded Value (MCEV) Principles (see European Insurance CFO Forum, 2009a), a further development of the EEV principles. The use of these embedded value guidelines will become compulsory for financial reporting by the CFO Forum members.[6] The 17 MCEV principles serve as a general framework for embedded value calculations by 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, 2009a). Thus, covered business needs to be clearly identified and disclosed (Principle 2), and, in general, "covered business" encompasses both short- and long-term life insurance business.

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[6] In the light of the recent financial crisis, the CFO Forum decided to conduct a review of the MCEV principles and to defer mandatory reporting until 2011; the particular areas under review include implied volatilities, the cost of nonhedgeable risks, the use of swap rates, and the effect of liquidity premia. While implied volatilities do not play an essential role in non-life insurance business, the remaining issues might have some impact on MCEV calculations in non-life insurance. However, they mostly refer to parameterization issues and do not affect the general valuation framework. Overall, these recent discussions are related to IFRS 4 on fair value/high volatility oriented accounting approaches versus amortized cost/low volatility oriented accounting approaches (see Post et al., 2007) and emphasize the high relevance of MCEV in practice.

There are three main sources of value in a life insurance company: (1) the net asset value, (2) the present value of profits from the in-force (i.e., the existing) 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 profits from in-force business, i.e., (1) + (2); adding to this the value of future sales (i.e., (3)), would be called appraisal value (see, e.g., Risk Management Metrics Subgroup, 2001).

Figure 1 illustrates the MCEV elements as described in the European Insurance CFO Forum (2009a). According to Principle 3, the MCEV is the present value of shareholders' interests in the earnings distributable from assets allocated to the covered business. Thus, sufficient allowance for the aggregate risk must be made. The MCEV consists of three elements: free surplus (FS), required capital (RC), and the value of the in-force business (VIF).

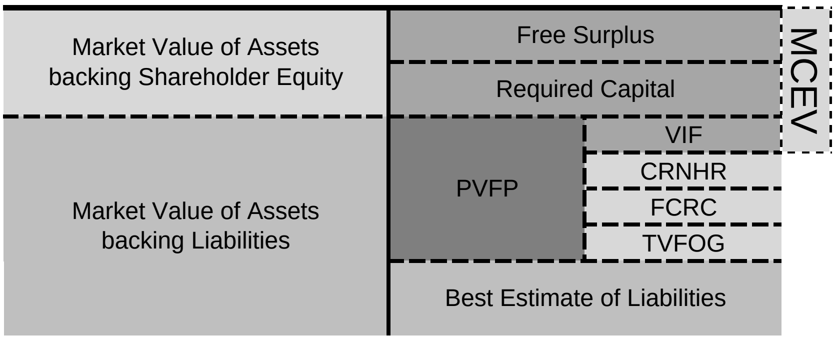

Figure 1: MCEV Elements

Assets allocated to the covered business are split between assets backing shareholder equity and assets backing liabilities, where liabilities are valuated based on local regulatory requirements. The market value of the assets backing shareholder equity is called shareholders' net worth and is the sum of free surplus (FS) and required capital (RC) (see European Insurance CFO Forum, 2009a). The *required capital* (Principle 5) is that portion of the assets backing shareholder equity that due to regulatory requirements cannot be distributed to them. The amount of required capital must comply with 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* (Principle 4) is that portion of the assets backing shareholder equity that is not needed to support the in-force covered business at the valuation date and that has 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. The present value of profits overestimates the true value of the in-force business, because investors have to bear frictional costs and because insurance contracts typically include a number of options and guarantees. These are all costs that investors would not have to bear by directly investing in the capital market and for that reason the present value of the future profits needs to be adjusted so as to arrive at a market-consistent value. The value of the in-force business (VIF) is thus determined by considering four components (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 nonhedgeable risks* (CRNHR).

The *present value of future profits* reflects the projected shareholder cash flows from the in-force covered business and the assets backing the associated liabilities. Profits are determined 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* (Principle 7). These two components show that the CFO Forum demands mark-to-market valuation (Principle 3), i.e., insurance liabilities must be valued as though 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 that vary linearly with, or are even independent of, market movements, both investment returns and discount factors are determined in a deterministic framework. In particular, this 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 (Principle 13). As a reference rate, the European CFO Forum prescribes use of the swap yield curve appropriate to the currency of the cash flows (Principle 14).

Additionally, allowance must be made for the *frictional costs of required capital* (Principle 8). Frictional costs occur through taxation and investment costs on the assets backing required capital and should be independent of the nonhedgeable risk allowance. Finally, *cost of residual nonhedgeable risks* (Principle 9) must be considered when calculating the value of in-force business. These costs can be divided into nonhedgeable financial risks and nonhedgeable nonfinancial risks.[7] A suitable approach for determining the cost of residual nonhedgeable risks must be employed, i.e. an approach that provides sufficient disclosure to enable a comparison to a cost of capital methodology (see Exley and Smith, 2006).[8]

The value of the in-force covered business can be divided into new business and existing business (Principle 10). New business is comprised of all contracts written within the last 12 months. Existing business comprises all contracts written more than 12 months ago. The value of future new business is excluded from the MCEV. However, the VIF should anticipate renewal of in-force business. More specifically, renewals should include expected levels of contractual renewal in accordance with policy conditions, noncontractual variations in premiums where these are reasonably predictable, or recurrent single premiums where the level of premium is predefined and reasonably predictable.

From a modeling perspective, the determination of VIF can be broken down into three steps. The first step is to develop a mathematical model of the environment, i.e., the capital market (e.g., a stochastic process for interest rates, such as the Vasicek (1977) model), the mortality

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7 Nonhedgeable financial risks result from illiquid or nonexistent markets where the financial assumptions 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.

8 Note that the MCEV does not reflect the shareholders' default put option that results from their limited liability. More precisely, it is implicitly assumed that the shareholders will make up any deficit arising in the future, with no upper limit on the amount of such deficit.

(e.g., a stochastic process for mortality, such as the Cairns, Blake and Dowd (2006) model), and other external factors (e.g., cancellation behavior[9] and exercise of other options; see Brockett et al., 2008; Gatzert and Schmeiser, 2008). Building on the stochastic environment model, the second step is to model the cash flows 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 (premiums, earnings on investments) minus cash outflow (benefits to policyholders, costs, taxes) is what is left for the shareholders and constitutes the present value of future profits. Note that according to the MCEV definition (Principle 3), the focus is on distributable earnings, i.e., the present value of future profits has to reflect 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 (TVFOG, CRNHR) that investors have to bear compared to a direct investment on the capital market.

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 shareholder interests in covered and noncovered business at the group level (Principle 17). 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). However, adjustments may be necessary to ensure consistency between values assigned to covered and noncovered business.

In our opinion, combining market-consistent values with IFRS balance sheet values is not a consistent and appropriate way to calculate embedded values at the group level. Instead extending the MCEV principles from covered (life) business to noncovered (non-life) business appears to be a feasible and much more consistent approach. The aim of this paper is thus to transfer the embedded value methodology from life to non-life insurance business.

[9] There is no standard terminology in the literature for the event of premature termination of insurance contracts. Alternative terms are cancellation, surrender, and lapse. In this paper, we use the term "cancellation."

To underline the different purposes of IFRS and MCEV and the resulting inconsistencies in valuation, Table 1 describes the fundamental principles of IFRS and MCEV. We also consider German local GAAP as a statutory basis since determination of liabilities under IFRS can still rely on local GAAP.[10]

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 values	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.[11] Furthermore, 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 for the embedded value concept present value of future profits from existing business are taken into account. All these differences typically lead to the following relationship between the three valuation approaches: equity (German local GAAP) < equity (IFRS) < MCEV.[12] The result is that consideration of IFRS will underestimate the value of an insurance group as measured by a consistent MCEV approach. In our application (Section 5), we illustrate the difference between local GAAP, IFRS, and MCEV to point out that the valuation difference can be quite substantial.[13]

[10] Currently, the International Financial Standards Board is revising the valuation of claim reserves. While under the current phase 1, insurers are allowed to use, e.g., local GAAP or US GAAP, phase 2 shall include a fair value principle. However, the fair valuation of insurance liabilities is still under discussion and thus it is very unclear at the moment what kind of valuation technique will finally be used. Furthermore, it is unclear when phase 2 will be implemented (currently scheduled for 2013).

[11] According to German local GAAP, claim reserves are based on a separate, prudent, and conservative valuation, which means that claim reserves under German local GAAP usually exceed best estimate claim reserves. Furthermore, equalization reserves are set up. The German local GAAP is thus an example of the low-volatility-oriented accounting approaches, in contrast to the fair value accounting approaches adopted in the United Kingdom and the United States. See Post et al. (2007) for more details on accounting differences and Maurer and Somova (2007) for more details on the German insurance industry.

[12] We reviewed the disclosures of 14 member companies of the European Insurance CFO Forum for 2007, 2008, and 2009 and found that on average IFRS (net asset value) is 30% lower than MCEV. Disclosures for the remaining six member companies of the European Insurance CFO Forum were not publicly available.

[13] Differences between MCEV and IFRS are critically analyzed in the literature. For example, De Mey (2009) illustrates the similarities, but also a number of significant differences, between the MCEV and IFRS and discusses the need to harmonize these two frameworks so as to develop a consistent framework for financial

3. Differences between Life and Non-Life and Consequences for MCEV Determination

In this section, we outline the main differences between life and non-life insurance and derive 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.

Criteria	**Life**	**Non-Life**
Contract duration	many years	usually one year, but renewal on rolling basis
Main type of services	intermediation (saving and dis-saving)	risk pooling
Secondary services	risk pooling, financial services	intermediation, financial services, non-financial services
Structure of assets	long-term-oriented portfolio	short-term-oriented portfolio
Structure of liabilities	limited degree of uncertainty with regard to claim payments and reserves (to the extent this is linked to underwriting risks)	high degree of uncertainty with regard to claim 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	substantial use, depending on the line
Surrender value	yes	usually no
Cancellation behavior	analyzed in literature	not analyzed in literature
Reserves	policy reserves, reserves for premium refund (in some countries), interest maintenance reserves (U.S.), and asset valuation reserves (U.S.)	claim reserves, equalization reserves (in some countries)
Financial options and guarantees	essential part	nonessential part
Diversification between lines of business	typically very low, not many LoBs	typically very high, many LoBs (many different types of contracts)
Conclusions	**Life**	**Non-Life**
Dynamic of the balance sheet comes from…	assets & liabilities	mainly liabilities
Relevance for modeling….		
- Capital markets	++	+
- Catastrophes	+	++
- Biometric risk	+	no relevance
- Options & guarantees	++	no relevance
- Underwriting risk	+	++
- Market risk	++	+
Main challenges for MCEV determination	capital market conditions (interest rates), biometric risk, implicit options, cancellation	claim number and severity, modeling of catastrophes, renewal decision

Table 2: A Comparison of Life and Non-Life Insurance

Determining MCEV is based on a present value calculus, i.e., we calculate the present value of future cash flows. This is a complicated task even in the case of manufacturing (with given order book and production capacity), but can be even more so for insurance companies in large part due to the high uncertainty of future cash flows. The uncertainty is inherent in both

reporting. The analysis of De Mey (2009) supports our line of argumentation since it makes clear that there are significant differences between MCEV and IFRS that lead to inconsistencies in both management and financial reporting and that it would be better to have one common concept (as proposed by our joint MCEV approach).

the inflow, for example, premiums and returns from the capital market, as well as in the outflow, for example, claim payments and operating costs. In this context, substantial differences can be identified between life and non-life insurance, especially in terms of operations, investment activities, duration of liabilities, and vulnerabilities (see Brockett et al., 1994). The insurers' liabilities as well as the structure of assets depend on the line of business with respect to duration, degree of risk, and risk-determining factors.

Life insurance is a long-term business with a long planning horizon. Given the saving and dissaving process in many contracts, the intermediation component is the most important service provided by life insurers (for different types of services provided by insurance companies, see, e.g., Cummins et al., 2004; Jeng and Lai, 2005). Present values are discounted future cash flows, so the longer the time horizon, the more important the interest rate component. For this reason, 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., 2009), are of central concern for life insurers. Traditionally, life insurers profited by insureds' adverse exercise behavior with regard to the numerous product options, such as cancellation of the contract. However, recent research has shown the substantial risk potential of these embedded options (see, e.g., Gatzert and Kling, 2007; Gatzert and Schmeiser, 2008), which is why these need to be quantified when calculating MCEV and risk-based capital for life insurers (see, e.g., Plat and Pelser, 2009). The long-term nature of life insurance products results in a robust structure of liabilities and emphasizes the importance of value-based management, since decision making today has an impact long into the future.

Non-life insurance is much more short-term oriented than life insurance although there are also long tail lines of business 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 six to seven years (see CEIOPS, 2008). While life insurers are said to function as “financial intermediaries,” the main type of services provided by non-life insurers is risk pooling (see Chen and Wong, 2004). Mayers and Smith (1982) suggest that non-financial services are also an important determinant of corporate demand for non-life insurance. Claim distributions are much more volatile than benefits to life insurance policyholders, especially in lines of business that are exposed to catastrophes. Modeling of catastrophes is thus an important issue in non-life, while product options in contracts are hardly relevant.[14] Although the contracts are set up for one year, the yearly policy renewal is very common. For life insurance, cancellation 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.

The drivers affecting the cash outflow, i.e., the benefits paid to policyholders, are very different between life and non-life. In life insurance, the benefits to policyholders mainly depend on biometric risks, investment returns, and cancellation of the policy; 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 a significantly higher dynamic and uncertainty in non-life insurance compared to life insurance. A good example is storm insurance, which typically has a very low number of claims in most years. However, in some years, storms result in a high number of claims so that storm insurers need to build up adequate reserves in good years so as to be able to pay claims in big storm years (many countries such as Germany use special kind of reserves called equalization reserves for exactly this purpose). Compared to non-life, life insurers have rather precise estimates of mortality rates (mortality tables) so that annual cash flow

[14] Product options in non-life policies such as cancelation or bonus-malus scales are usually not linked to capital markets (for a detailed description of bonus-malus scales, see Pitrebois et al., 2006). Financial options and guarantees, however, are defined as features of the covered business whose behavior is linked to financial markets (see European CFO Forum, 2009a). Thus, for the time value of financial options and guarantees components of the MCEV, these options are not relevant.

fluctuations are less extreme. We can thus conclude that market risk is the most important type of risk for life insurers (as compared to underwriting, liquidity, 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 must be set aside. In life insurance, it is common to set policy reserves. Additionally, some countries (e.g., Germany, Austria) have legal rules for surplus participation, resulting in reserves for premium refunds. In non-life, as mentioned some countries differentiate between the claim reserves and the equalization reserves (e.g., Germany, Switzerland). In these countries, the claim reserves are calculated according to the same principles as the policy reserves, but the countries also allow for equalization reserves to compensate fluctuations in loss ratios over time. The idea here is that especially in those lines of business with significant catastrophes, years with low claim costs act as reserves for paying out in 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	a) Modeling the capital market
	b) Modeling biometric risks	b) Modeling claims (instead of biometric risks)
	c) Modeling cancellation behavior and implicit options	c) Modeling renewals (instead of cancellation 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, cancellation behavior, and biometric risks	a) Based on Step 1, modeling the cash inflow and cash outflow for existing insurance contracts considering capital markets, renewals, and claim statistics
	b) Allowing for company-specific factors, such as costs and taxes	b) Allowing for company-specific factors, such as costs and taxes
	c) The remainder goes to the shareholders	c) The remainder goes to the shareholders
3. Determining the value of the in-force business	Reducing the PV of future profits by - the time value of fin. options and guar. - the frictional costs of required capital - the cost of residual nonhedgeable risks	Reducing the PV of future profits by - the frictional costs of required capital - the cost of residual nonhedgeable risks (time value of fin. options and guar. is 0)

Table 3: Main Modeling Differences between Life and Non-Life

Overall, Table 3 demonstrates that determining MCEV in non-life insurance is not too different from doing so for life insurance. For instance, the difference between a cancellation decision in life and a renewal decision in non-life is only a minor one from an economic point of view. Taking liability insurance and a classic life insurance policy with regular premium payments as examples, in both cases the customer needs to actively terminate the contract. If the customer does nothing, however, the contract will continue.[15]

The main differences between modeling MCEV in life and non-life can now be derived:

(1) There are no periodic premium payments in non-life over several years, whereas this is common in life insurance. This is problematic in the context of MCEV when it comes to distinguishing between existing business and renewal business. According to MCEV Principle 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 (see European Insurance CFO Forum, 2009a). From this wording, we conclude that a reasonable renewal assumption is necessary when modeling MCEV in non-life.

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

(3) Modeling cancellation in life insurance corresponds to modeling renewal in non-life. Option exercise does not play an important role in non-life and can thus be ignored.

4. Modeling of MCEV in Non-Life

The methodology for modeling MCEV in life insurance business is provided by the European Insurance CFO Forum principles. 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 process of the balance sheet and the profit and loss statement according to German local GAAP ("Handelsgesetzbuch").[16] Since many modeling details refer to special German rules and characteristics, we only introduce the main idea of the model in the paper and refer

[15] There is a major difference between the contract renewal process in many European countries and that of the United States. Whereas in Europe, policies will be renewed automatically if the customer does not act, in the United States, policies are automatically cancelled if not explicitly renewed by the customer (see Brockett et al., 2008).

[16] We illustrate our model using German local GAAP, but our calculations could be based on any local GAAP.

to the Appendix for all modeling specifics. In the interests of simplifying the model, we also ignore claims inflation and the use of reinsurance.

We consider a projection horizon of T years with $t = 0, \ldots, T$ and assume a complete settlement of our 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 ($BV_0^{abse} = SE_0$) and assets backing liabilities ($BV_0^{abl} = ER_0 + CR_0$). The risk-free yield curve at t=0 is given by predefined swap rates (spot rates sr_t). Both investment returns (forward rates fr_t) and the discount factors (d_t) are derived from this risk-free yield curve.

Principals for the Calculation of Reserves

Under local GAAP, claim reserves are to be calculated according to the prudence principle. We thus have unrealized gains that will be released over time. In the literature, best estimate claim reserves are analyzed using deterministic and stochastic claims reserving methods (see, e.g., England and Verrall, 2002; Wüthrich and Merz, 2008); however, since the MCEV calculation is based on best estimate assumptions (see European Insurance CFO Forum, 2009a), we need only deterministic algorithms in our model.[17] In this paper, we use the chain-ladder method to calculate the best estimate claim reserves of the existing business at the beginning of the calculations ($\mathrm{BCR}_0^{\mathrm{eb}}$).[18] To this end, everything we know about past claim payments is organized into so-called claims development triangles. Then, with the help of the chain-ladder

[17] Deterministic algorithms for calculating best estimate claim reserves are, e.g., the chain-ladder or Bornhuetter-Ferguson algorithms. Stochastic models quantify the uncertainty that comes with the prediction process in these deterministic algorithms (see Wüthrich and Merz, 2008). Stochastic models thus provide more information in the reserving process, especially in estimating the downside potential and the variability of best estimate claim reserves (see England and Verrall, 2002). A prominent example is the Mack (1993, 1994) model, which reproduces the chain-ladder reserve estimates and quantifies the corresponding standard error, the so-called mean squared error of prediction. Since generally we look only at best estimates, there is no need for predicting variability and therefore no stochastic claims reserving methods are needed. For the CRNHR, however, a cost-of-capital approach is applied and therefore the variability of the claim reserves is taken into account.

[18] We also 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). Use of either method yielded no 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. The results for the other reserving methods are available upon request.

factors, we can obtain forecasts of the ultimate claims (see England and Verrall, 2002). From those forecasts, we are able to derive payment patterns for claim payments of the existing business ($\mathrm{pr}_{\mathrm{t}}^{\mathrm{eb}}$) and for claim payments of the renewal business ($\mathrm{pr}_{\mathrm{t}}^{\mathrm{rb}}$), i.e., we can make an assumption about how the best estimate claim reserves will be paid out over the next few years.

Modeling of Renewals

One of the most important aspects of our model is determination of renewal rates, since there are no periodic premium payments in non-life insurance. 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 total insurance portfolio.[19] We divide the portfolio into three different revenue segments, $m = 1,\ 2,\ 3$ (with proportions given by ac^{m}), that represent different profitability and resulting customer behavior.[20] 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 means of using different weights. Thus we can derive all relevant parameters for each revenue segment: $\mathrm{IC^m = IC * ac^m}$, $\mathrm{cr^m = cr * ci^m}$, $\mathrm{PL^m = PL * pi^m}$ and $\mathrm{lr^m = lr/pi^m}$. 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:[21]

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19 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 Brocket et al., 2008; Barth and Eckles, 2009). In the basic case, we do not distinguish between renewal classes; however, in Section 5, we present additional tests integrating this pattern.

20 Within our model, we choose a simplified approach for integrating customer behavior. In this context, multiple risks that arise from multiple policies and household decision making can play an especially important role and could be investigated further (see, e.g., Bonato and Zweifel, 2002; Dionne et al., 2006; Guillen et al., 2008; Brockett et al., 2008). Moreover, the customer decision to switch insurers is very often based on a great deal of information about the insurance market (see, e.g., Schlesinger and Schulenburg, 1993).

21 We decided to use a simple linear form because this choice fits well with what we would expect to see in insurance markets, but we also performed robustness tests with regard to the renewal function by considering an exponential and a power function as possible alternatives. Results are available upon request.

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

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

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

Modeling of MCEV

Five steps are necessary to derive MCEV: (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*. We now explain each of these steps in detail.

(1) Present Value of Future Profits

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

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

The annual net income consists of earnings before taxes less, in the event of positive earnings, 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 ($t \in 1, \dots, T$), i.e., $EBT_t = T_t + I_t$.

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 detailed description of each component, refer to 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 book value and market value of the assets backing liabilities (taking into account cash flows related to the insurance contracts and investment costs, as well as funding requirements). 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 the calculation of the investment result.

(2) Required Capital

To calculate the *required capital* (RC_0) we consider the European Union solvency regulations (Solvency I and Solvency II). We take the maximum equity that, according to German local GAAP, would be necessary for covering $SCR\ I$ ($SE_0^{SCR\ I}$), determined according to Solvency I requirements, and the equity necessary for covering $SCR\ II$ ($SE_0^{SCR\ II}$), determined according to the rules currently planned for Solvency II:[22]

$$RC_0 = Max(SE_0^{SCR\ I}; SE_0^{SCR\ II}) \tag{4}$$

(3) Frictional Costs of Required Capital

Frictional costs of required capital ($FCRC_0$) reflect the impact of nondistributable capital (e.g., due to regulatory restrictions) on shareholder value. According to MCEV Principle 8, frictional costs should reflect investment costs and taxation on assets backing required capital. Thus, required capital must be projected appropriately over the lifetime and net income on the assets backing required capital at each point in time has to be taken into account:

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

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

[22] To determine the shareholder equity necessary for covering the solvency capital requirements, we use a predefined 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 cover 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.

(4) Cost of Residual Nonhedgeable Risks

The *cost of residual nonhedgeable risks* ($CRNHR_0$) can be derived using a cost-of-capital approach similar to the risk-margin approach under Solvency II (see European Insurance CFO Forum, 2009a). The internal cost of capital rate ($cocr$) is thus multiplied by solvency capital required under Solvency II ($SCR\ II$) at valuation date t to determine the cost of capital, which is then discounted to t=0:

$$CRNHR_0 = \sum_{t=1}^{T}(SCR\ II_t * cocr * d_t) \tag{6}$$

(5) Free Surplus

The insurance company's *free surplus* capital (FS_0) consists of the difference between the market value of assets backing shareholder equity (MV_0^{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., $MV_0^{abse} = BV_0^{abse} * (1 + ugl)$:

$$FS_0 = MV_0^{abse} - RC_0 \tag{7}$$

5. Application for a German non-life insurer

Model Calibration

To illustrate our framework, we apply the MCEV concept to a German non-life insurance company. All figures and numbers are based on an insurance company considered by the German Actuarial Society Working Group on Internal Models (see DAV-Arbeitsgruppe Interne Modelle, 2008). The model company realistically reflects a company from the German market, but in order to protect the anonymity all data was transformed so as to change the absolute values but not the underlying risk structure (as done in other empirical work; see, e.g., Eling et al., 2009).

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 $\mathrm{BCR}_0^{\mathrm{eb}}$ were derived using the chain-ladder claims reserving algorithm (see

Table B3). With the help of the chain-ladder factors, payment patterns for both existing business and renewal business can be calculated.[23]

As a simplifying assumption, we consider only one line of business—third-party liability motor insurance.[24] We start at a valuation date of December 31, 2008, yielding the statutory balance sheet shown in Figure 2.

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 the renewal rate. In this example, we assume a cancellation rate of 13% (equivalent to a renewal rate 87%), but in later sensitivity tests we will vary this number in order to illustrate the value

[23] Obviously, the payout behavior of the existing business is different from that of renewal business. While the 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.

[24] Most insurance companies operate in more than one line of business. In this case, there is diversification between different lines of business or between different products of one line of business. Analysis of the effects of corporate and product diversification can be found in Liebenberg and Sommer (2008) and Elango et al. (2008).

implications of varying cancellation rates.[25] The renewal of contracts allows generating additional future profits, i.e., *VIF* increases by € 26,036. In this scenario, MCEV thus increases to € 129,438.

Scenario 1

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

Scenario 2

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

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

When comparing Figures 2 and 3, it is important to note the substantial valuation differences between local GAAP, IFRS, and MCEV. The equity according to German local GAAP is only € 48,236 (see Figure 2), while under MCEV it is € 129,438 in the case with renewals.[26] 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 (see Figure 2), if we now assume that 80% of the assets would be reported at market value under IFRS and we have a loading of unrealized gains and losses of 2%, the IFRS net asset value would be € 85,946, which is 34% lower than under MCEV.[27] These valuation differences show that consideration of IFRS net asset value will substantially underestimate the MCEV.

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[25] The cancellation rate of 13% was derived by the working group of the German Actuarial Society and reflects the typical cancellation rate for motor business in Germany. The working group argued that, on average, motor business policies remain in the motor business insurance portfolio for seven to eight years. A renewal rate of 87% also seems reasonable, given that for U.S. non-life insurance firms, the retention rates are around the 90 percent level (see D'Arcy et al., 1997).

[26] The difference between local (German) GAAP and MCEV comes from (1) unrealized gains and losses that lead to an underestimation of the fair value in local GAAP, (2) the equalization reserves, which is not part of the equity under local GAAP, (3) the addition of future profits from existing business, and (4) the addition of future profits from renewals (only in Scenario 2). Correspondingly, the difference between local (German) GAAP and IFRS comes from (1) unrealized gains and losses and (2) the equalization reserves. Aspects (3) and (4) constitute the difference between IFRS and MCEV.

[27] The IFRS net asset value is calculated as $236{,}119 \cdot (80\% \cdot 1.02) + 236{,}119 \cdot 20\% - 153{,}951$. The balance sheet total is 236,119, the claim reserves 153,951. Eighty percent of the assets are now reported at market value (instead of at book value) with unrealized gains and losses of 2%, resulting in a loading of 1.02 on the 80%. Note that this is only a simplified example intended to illustrate the main differences between local GAAP, IFRS, and MCEV. For example, we did not take into account any deferred taxes. However, the example is helpful in outlining some main aspects, e.g., that the valuation difference is substantial and that it is not just due to the addition of renewals.

Economic Balance Sheet

The MCEV can serve as a basis for setting up an economic balance sheet that can be a valuable aid in understanding what creates and what destroys value (see O'Keeffe et al., 2005, p. 452). In contrast to the statutory balance sheet, in the economic balance sheet we consider market values and make allowance for all future cash flows out of our insurance company, 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%).

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*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.

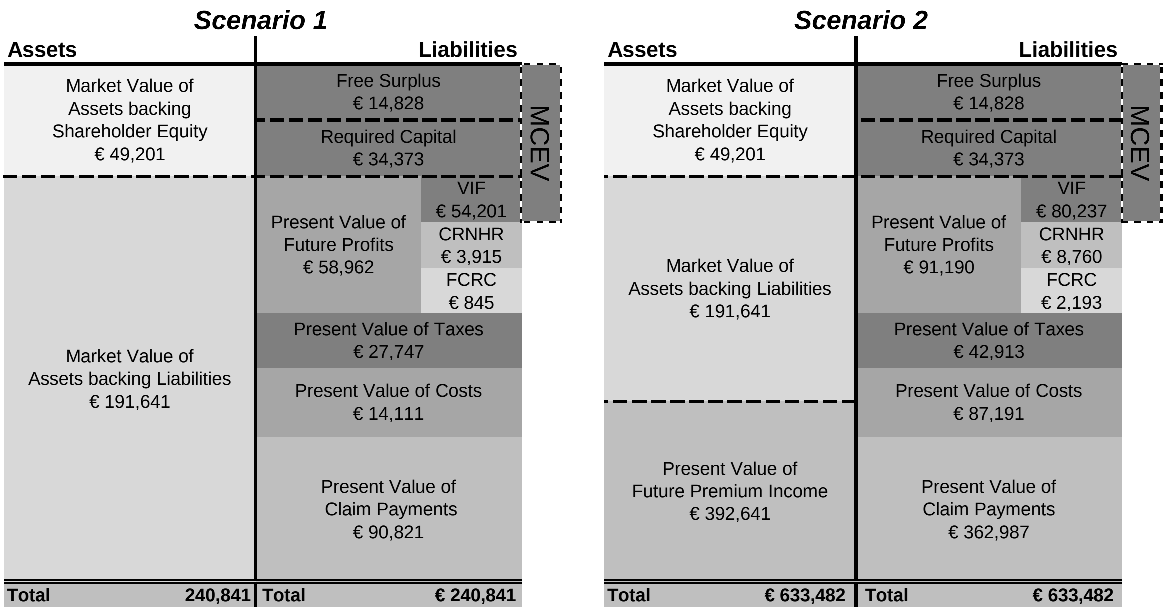

Figure 4: Economic Balance Sheet Without Renewals (Sc. 1) and With Renewals (Sc. 2)

Sensitivity Analysis

We analyze the robustness of the model and the value implications of different model assumptions within sensitivity tests. Here, we only illustrate three simple examples with varying loss ratios, cancellation rates, and acquisition costs. An extended sensitivity analysis is available upon request.

First, we consider different parameter assumptions for the loss ratio and for the cancellation rate in the left part of Figure 5. The higher the loss ratio, the lower the MCEV, as more funds are paid out to policyholders. There is an interesting 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 very 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 approximately 80%. For a very high loss ratio of 100% and a cancellation rate of 13%, we would still have a positive MCEV of € 32,971. This is due to the fact that a negative value of in-force covered business (€ 16,229) is balanced out by a positive free surplus and required capital (€ 49,201).

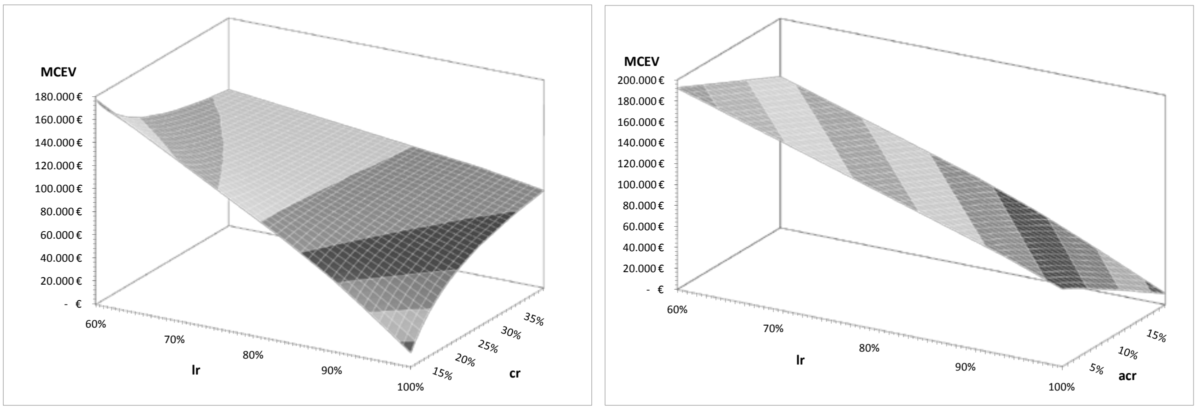

Figure 5: Loss Ratio (lr) versus Cancellation Rate (cr) and Acquisition Costs (acr)

Second, we consider variations in loss ratios and acquisition costs (see right part of Figure 5) for a given cancellation rate of 13%. 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. MCEV results range from a maximum of € 192,445 to a minimum of € 7,021. For a given 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 further analyze the sensitivity of the renewal model with respect to the total MCEV, we measure the impact of time-varying cancellation rates and loss ratios (see Table 4). 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 by 3% leads to an increase/decrease in MCEV of 16,076/16,151.[28] 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; Barth and Eckles, 2009), we derive a total MCEV of 152,631, which corresponds to an increase by 17.92% compared to our basis scenario. Free surplus and required capital are assumed to be unaffected by varying cancelation rates and loss ratios.

Scenario	Free Surplus	Required Capital	Value of In-Force Business	Total 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 4: Time-Varying Cancellation Rates (cr) and Loss Ratios (lr)

Value Added Analysis

To this point, we have only considered the MCEV 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; MCEV Principle 17). 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 from the assets backing the covered business (see European Insurance CFO Forum, 2009a). In this paper, we limit our analysis to a basic breakdown of the value added consisting of changes within free surplus, required capital, present value of future profits, frictional costs of

[28] The increase and decrease of cancellation rates and loss ratios have been calibrated to a yearly change of approximately 4% in order to make the relative changes comparable. The results show that, ceteris paribus, the MCEV is more sensitive to time-varying loss ratios than it is to time-varying cancellation rates. The asymmetry in the results for the cancellation rate is due to composition of our insurance portfolio, i.e., the revenue segments differ with respect to premium level and cancellation rate. Hence, 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.

required capital, and cost of residual and nonhedgeable risks. In the following, we consider Scenario 2 with a cancellation rate of 13%. We do not take into account the value of any new business written, but only consider a process that settles the existing business (including renewals) at the beginning of the year to arrive at an expected status at the end of the year. As a simplified management rule, we assume that free surplus would be distributed to the shareholders right at the start of year 1.

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

Data	**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%	-1.40%	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 5: Change in Operating Assumptions

In the following calculations we therefore analyze changes to the operating assumptions as set out in t=0 (see Table 5). Here we describe both the development of the firm as well as that of the market in year 0 and year 1. What is needed to divide external from internal effects is a benchmarking with the market development from t=0 to t=1. We thus turn to the market data in order to separate the effects due to changes in the business environment from those due to skillful management. For example, we assume the average loss ratio in the market to be 71.00% in t=0, a value that is gradually higher than the 70.80% observed for the company. In t=1, the market average is 70.00%, which is 1.40% lower than the 71.00% observed as a market average in the previous year. The reduction in the insurer’s loss ratio, however, is only 0.28% (70.60%/70.80%). 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.

The total results of our MCEV calculations are shown in Table 6. 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), a decrease of € 20,903, a seemingly unsatisfactory state of affairs. 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	-56	-193	-93	92	2,790
Release of RC	0	0	0	-4,548	4,548	0
Release of CRNHR	0	0	1,823	0	0	1,823
Release of FCRC	0	477	0	0	0	477
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 6: Total MCEV Results

We use the basic breakdown of the MCEV elements shown in Table 6 to illustrate where the positive net effect comes from. First, due to the fact that we are now making calculations in t=1, we must discount the present value of future profits, frictional costs of required capital, and cost of residual and nonhedgeable risks by one year less than in t=0. This leads to a total discount effect of € 3,145, consisting of a positive effect within PVFP amounting to € 3,574 and a negative effect within FCRC amounting to € 86 and within CRNHR amounting to € 343. The total discount effect corresponds to the unwinding of our insurance business. Second, while the required capital decreases by € 4,548, we have an increase of free surplus in the same amount. Some portion of the required capital is thus released and transferred to the free surplus, which will be paid out to shareholders right at the start of year 2. Hence, the release of RC does not have any impact on our total MCEV earnings. In addition to the discount effect and the release of RC, we also have to take into account the release of FCRC allowance of € 477 and of CRNHR allowance of € 1,823.[29] Besides the unwinding, the release of RC, FCRC, and CRNHR, 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*).[30]

As already mentioned, 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 due to changes in the market environment. To separate out 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 by the changes in market data (e.g., the loss ratio of the company (external) in t=1 is given by 70.80% * (70.00%/71.00%) = 69.80%) and then again calculate MCEV (see Table 5). This allows us to further split both experience variances and assumption changes into market impact and deviations from the market, as shown in Table 7.

	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*	*-56*	*-193*	*-93*	*92*	*2,790*
… market impact	*6,309*	*-47*	*-160*	*-462*	*462*	*6,102*
… deviation from market	*-3,269*	*-9*	*-34*	*369*	*-369*	*-3,312*

Table 7: Market Impact on Change in MCEV

If the company had performed as well as the benchmark (the market), it should have provided MCEV earnings of € 13,610 (= 2,063 + 6,102 + 3,145 + 477 + 1,823) from t=0 to t=1. But in fact it only provided MCEV earnings of € 8,884. We thus conclude that the MCEV earnings attributable to the management are € –4,726 (= –3,312 – 1,414).

Management might claim that it is not responsible for this value destruction, e.g., they might say that its customers are not well represented by the market average. This illustrates the im-

29 The actual cost of residual and nonhedgeable risks correspond to the cost of capital that occurred during the time period t=0 to t=1 (but only for nonhedgeable risks). Performance metrics such as economic value added (EVA; see Malmi and Ikäheimo, 2003) make explicit allowance for a cost of capital rate. A more detailed comparison of MCEV earnings and EVA is necessary to analyze similarities and differences between these concepts.

30 Experience variances and assumption changes could be split further between operative and economic variances/assumptions. In order to more closely distinguish the impact of experience variances from assumption changes further considerations are necessary.

portance of identifying the right benchmark for the value added analysis.[31] However, if it is indeed true that, in general, the insurer's customers are not similar to the market average, such a situation could also be interpreted as showing that this company has not done well at diversifying its risk. Risk diversification, however, is a crucial management task, and so, despite management's objections, once again it could be fairly concluded that the value destruction was its fault.

Overall, our concept of 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 the Marshall's (1890) residual income concept. In the case of economic value added (or residual income), the annual result is related to the cost of capital (hurdle rate times equity capital). One difference between residual income and the concept presented here is that our 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 also ex ante for value-based management and target setting. However, it is important to emphasize that 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 the asset management, by claims management, or by other segments of the insurer's 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 arbitrary assumptions, especially when there is no allocation mechanism for overhead costs (see Gründl and Schmeiser, 2007).

[31] A requirement for the benchmark is that it should be comparable to the insurer's business in terms of risk and return. For criteria appropriate in selecting representative benchmarks, see Sharpe (1992).

Determination of Group MCEV

To illustrate the usefulness of a consistent group-level 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 entity and one life entity. To keep the example for the life entity of the insurance group 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.[32] This leads to the group MCEV and IFRS net asset value shown in Table 8.[33]

	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 8: Group MCEV of a simplified insurance group in 2008

For the non-life entity, we consider the MCEV calculations from the previous value added analysis. Thus, we have a total 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). Overall, we see a substantial underestimation of the group MCEV by using the IFRS net asset value for the non-life entity.

32 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 € 85,946 (see Table 7). Detailed results are available on request.

33 The MCEV principles explicitly do not make allowances for diversification effects between covered and non-covered business. However, in this work we apply the MCEV principles to life and non-life insurance. Both are thus covered business and therefore diversification effects should be taken into account. According to the MCEV principles, it is only within CRNHR that allowance should be made for diversification (see European Insurance CFO Forum, 2009a). In our model, CRNHR are calculated by the use of a cost of capital approach applied to the solvency capital requirements according to Solvency II (formula (6)). Thus, in the aggregation of the capital requirements, diversification effects are considered by means of correlation matrices (see CEIOPS, 2008).

Based on our CFO Forum example, we also calculated 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 comes to € 8,884. Overall, using a consistent group-level approach for MCEV calculations would thus lead to a total return on embedded value of our simplified insurance group of 11.86% (= 28,482/240,198). If we had used the MCEV approach suggested by the CFO Forum, we would have had IFRS earnings for the non-life entity of € 13,920.[34] This would have led to a total return on embedded value of our simplified insurance group of 17.04% (= 33,518/196,706).

Again we see that the use of 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).[35]

6. Conclusions

The aim of this paper was to illustrate the determination of market-consistent embedded value in 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 of the model, 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 with a sensitivity analysis. Finally, the potential usefulness of the model for value-based man-

[34] Using the same simplified consideration 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).

[35] The embedded value report of 2009 from Allianz on p. 16 even implies, that it is not meaningful to sum up the operating and non-operating MCEV earnings calculated on a MCEV basis or operating and non-operating IFRS earnings calculated on an IFRS (net asset value) basis.

agement was illustrated by a value added analysis and the methodology was embedded in a simplified insurance group in order to derive a group MCEV.

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 illustrated 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.

A consistent 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 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 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).[36]

Future research could extend this model in several directions. The presented model can be extended to include inflation, reinsurance, more realistic claim processes, 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 arising 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.

[36] Current research 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 compensation.

Appendix A: Modeling of 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:

$$PVFP_0 = \sum_{t=1}^{T} NI_t * d_t = \sum_{t=1}^{T} EBT_t \cdot (1-tr) * d_t = \sum_{t=1}^{T} (T_t + I_t) \cdot (1-tr) * d_t$$

$$= \sum_{t=1}^{\mathrm{T}} \Bigg(\bigg(\Big\{ [GPE_t * (1-acr)] - \Big[\big[\big(\sum_{k=t+1}^{T} UL_t * pr_{k+1-t}^{rb} \big) - \big(\sum_{i=1}^{t-1} UL_i * pr_{t+1-i}^{rb} \big) - BCR_0^{eb} * pr_t^{eb} \big] * \left[\frac{CR_0^{eb}}{BCR_0^{eb}} + \frac{ER_0^{eb}}{BCR_0^{eb}} \right] \Big] - \Big[\big[BCR_0^{eb} * pr_t^{eb} + \sum_{i=1}^{t} \big(UL_i * pr_{t+1-i}^{rb} \big) \big] * [1 + cscr] \Big] - \Big[\big[BCR_0^{eb} * \big(1 - \sum_{i=1}^{t} pr_i^{eb} \big) + \big(\sum_{i=1}^{t} \sum_{k=t+1}^{T} (UL_i) * pr_{k+1-i}^{rb} \big) \big] * \frac{OC_0}{BCR_0^{eb}} \Big] \Big\} + \Big\{ \Big[\big[BCR_0^{eb} * \big(1 - \sum_{i=1}^{t-1} pr_i^{eb} \big) + \big(\sum_{i=1}^{t-1} \sum_{k=t}^{T} (UL_i) * pr_{k+1-i}^{rb} \big) \big] * \left(\frac{CR_0^{eb}}{BCR_0^{eb}} + \frac{ER_0^{eb}}{BCR_0^{eb}} \right) \Big] * [(fr_t - icr) + ugl * (fr_t - icr) + ugl] - \Big[\big[BCR_0^{eb} * \big(1 - \sum_{i=1}^{t} pr_i^{eb} \big) + \big(\sum_{i=1}^{t} \sum_{k=t+1}^{T} (UL_i) * pr_{k+1-i}^{rb} \big) \big] * \left(\frac{CR_0^{eb}}{BCR_0^{eb}} + \frac{ER_0^{eb}}{BCR_0^{eb}} \right) \Big] * ugl \Big\} \bigg) * (1-tr) * d_t \Bigg) \qquad \text{(A1)}$$

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

The in-force covered business in non-life insurance should contain a reasonable allowance for renewal business when modeling the technical result. Therefore, we conduct two analyses, one for unwinding the existing business and the second containing provisions for 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

$$CP_t^{eb} = BCR_0^{eb} * pr_t^{eb} \qquad \text{(A2)}$$

The development of the (undiscounted) *best estimate claim reserves* BCR_t^{eb} for existing business would then only be the effect of a settlement process, which is given by the future claims paid CP_t^{eb}:

$$BCR_t^{eb} = BCR_{t-1}^{eb} - CP_t^{eb} \tag{A3}$$

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., $CR_t^{eb} = BCR_t^{eb} * c_1$.

<u>Step 2: Derivation of Technical Result for Renewal Business</u>

		Calendar Year j						
		1	2	⋯	j	⋯	T-1	T
Accident Year i	1	$CP_{1,1}$	$CP_{1,2}$			⋯	$CP_{1,T-}$	$CP_{1,T}$
	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 c*laim payments* for renewal business can be represented in a payment process triangle, as shown in Figure A1. Here, we have absolute accident years i ($i = 1, \dots, K$) on one side and absolute calendar years j ($j = 1, \dots, T$) on the other side (with K < T). The future claim payment is 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 claim payments for renewal business at calendar year t, CP_t^{rb} , can now be calculated by summing up all the columns of our payment process triangle:

$$CP_t^{rb} = \sum_{i=1}^{t} CP_{i,t} \tag{A4}$$

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 up the future claims paid $CP_{i,t}$ (as shown in Figure A1): $BCR_{i,t} = \sum_{k=t+1}^{T} CP_{i,k}$. 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:

$$BCR_t^{rb} = \sum_{i=1}^{t} BCR_{i,t} = \sum_{i=1}^{t} \sum_{k=t+1}^{T} CP_{i,k} \tag{A5}$$

To calculate *claim reserves according to local GAAP* ($\mathrm{CR}_t^{\mathrm{rb}}$), 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 ($c_1 = \frac{\mathrm{CR}_0^{\mathrm{eb}}}{\mathrm{BCR}_0^{\mathrm{eb}}}$), i.e., $\mathrm{CR}_t^{\mathrm{rb}} = \mathrm{BCR}_t^{\mathrm{rb}} * c_1$.

<u>Step 3: Derivation of the Overall Technical Result</u>

To obtain the overall technical result, we add the technical result for existing business and renewal business. We assume independence between the claim settlement process of existing business and renewal business. Thus, the sum of claim payments for existing business CP_t^{eb} and claim payments for renewal business CP_t^{rb} lead to total claim payments of CP_t, ($CP_t = CP_t^{eb} + CP_t^{rb}$). In addition, best estimate claim reserves can be shown as the sum of existing and renewal business ($BCR_t = BCR_t^{eb} + BCR_t^{rb}$). For claim reserves according to local GAAP, we also employ a sum ($\mathrm{CR}_t = \mathrm{CR}_t^{\mathrm{eb}} + \mathrm{CR}_t^{\mathrm{rb}}$).

For the settlement process of the *equalization reserves*, we assume that the equalization reserves at the beginning of our calculations ER_0 (taken from the statutory balance sheet) would be equally settled to the best estimate claim reserves.[37] Thus, we need the proportion of these two measures from the beginning of our calculations ($c_2 = \frac{\mathrm{ER}_0}{\mathrm{BCR}_0^{\mathrm{eb}}}$), i.e., $ER_t = BCR_t * c_2$.

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 ($AC_t = GPE_t * acr$). *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 ($CSC_t = CP_t * cscr$). *Overhead costs* are driven by development of the best estimate claim reserves given through $c_3 = \frac{OC_0}{\mathrm{BCR}_0^{\mathrm{eb}}}$ ($OC_t = BCR_t * c_3$).

[37] The presence of equalization reserves occurs due to the fact that MCEV calculations are based on, among other things, the present value of future profits according to local GAAP. In Germany, in addition to claim reserves, equalization reserves play a very important role when it comes to the timing of profits. Usually, 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 the equalization reserves.

Appendix A2: Investment Result

We assume that at time t=0, the amount of unrealized gains and losses (*ugl)* is equal to a pres-pecified percentage of the book value of assets, i.e., $MV_0^{abl} = BV_0^{abl} * (1 + ugl)$. 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 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 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 and 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 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., $MV_t^{abl} = BV_t^{abl} * (1 + ugl)$. This can be achieved by realizing gains/losses equal to $ugl * \left(BV_{t-1}^{abl} - BV_t^{abl}\right)$ so that the overall investment income on book value basis is equal to:

$$I_t = I_t^{MV} + ugl * \left(BV_{t-1}^{abl} - BV_t^{abl}\right) \tag{A6}$$

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

Table B2: Payment and Interest Rate Patterns (In Percent)[38]

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**

Table B3: Claims Development Triangle[39]

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

[39] The claims development triangle is taken from the Working Group of the German Actuarial Association; see DAV-Arbeitsgruppe Interne Modelle (2008).

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