



# On the management of life insurance company risk by strategic choice of product mix, investment strategy and surplus appropriation schemes



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## ABSTRACT

The aim of this paper is to analyze the impact of management's strategic choice of asset and liability composition in life insurance on shortfall risk and the shareholders' fair risk charge. In contrast to previous work, we focus on the effectiveness of management decisions regarding the product mix and the riskiness of the asset side under different surplus appropriation schemes. We propose a model setting that comprises temporary life annuities and endowment insurance contracts. Our numerical results show that the effectiveness of management decisions in regard to risk reduction strongly depends on the surplus appropriation scheme offered to the customer and their impact on guaranteed benefit payments, which thus presents an important control variable for the insurer.

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## 1. Introduction

Management decisions regarding asset and liability composition can considerably impact a life insurer's risk situation and also the fair risk-adjusted compensation for the company's shareholders. Decisions can relate to various factors, including a dynamic adjustment of the portion invested in high-risk assets, the portfolio composition on the liability side as well as the type of surplus appropriation scheme, which at the same time influences the extent of the long-term guarantees typically embedded in these contracts.

Life insurance contracts in many European countries contain a legally enforced participation mechanism through which policyholders participate in the company's surplus. This surplus participation represents an important factor in competition between insurers and is paid in addition to a guaranteed interest rate that is annually credited to the policyholder's account. In addition, it is not only the absolute amount of surplus distributed to the policyholders that has an effect on shortfall risk; the concrete way in which distributed surplus is credited to the policyholders also has a considerable influence on the value of the surplus participation part

of the contracts (see Bohnert and Gatzert, 2012). These so-called surplus appropriation schemes also impact the risk profile of the insurance company due to their varying characteristics of turning surplus into guarantees. Policies may feature various appropriation schemes. In case of an endowment insurance contract, for instance, surplus is used to increase the death as well as the survival benefit, while interest-bearing accumulation increases the survival benefit only (and keeps the death benefit constant). In case of an annuity contract, surplus can be used to increase the annual annuity payments until maturity, or surplus can be directly paid out to the policyholders in the corresponding period (direct payment scheme).

Another important control variable besides the surplus appropriation scheme is the mixture of the product portfolio, e.g., the percentage of annuities and life insurance contracts that a company sells, which impacts liabilities and assets alike due to the different timing and amount of cash in- and outflows. In addition, a dynamic path-dependent asset strategy can be implemented regarding the riskiness of the asset portfolio to improve the insurer's solvency situation, as assets can be more easily adjusted over the contract term as compared to the liability side. The management of assets and liabilities for a life insurer with various product portfolios including a detailed modeling of surplus appropriation schemes can have an important impact on the company's shortfall risk as well as on the risk-adjusted compensation for shareholders.

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Therefore, the aim of this paper is to examine this issue in more depth, thereby ensuring a fair situation for shareholders.

In the literature, various papers examine participating life insurance contracts including surplus distribution mechanisms and interest rate guarantees, focusing on different aspects. The traditional actuarial surplus management focuses on balancing conservatism and fairness (also with respect to the equityholders) of surplus distribution schemes and has been discussed since as early as 1863 by Homans (1863) and by Cox and Storr-Best (1963). In the current literature, one aspect of special interest has been risk-neutral valuation, which has been researched by, amongst others, Briys and de Varenne (1997), Dong (2011), Grosen and Jørgensen (2000, 2002), Hansen and Miltersen (2002), Guillén et al. (2006), Kling et al. (2011), Tanskanen and Lukkarinen (2003), Siu (2005), Schmeiser and Wagner (2011), and Goecke (2013). In addition, several papers have focused on combining risk pricing and risk measurement, including Gatzert and Kling (2007), Kleinow and Willder (2007), and Gatzert (2008). Kling et al. (2007a,b) analyze surplus distribution schemes and their effect on an insurer's risk situation while in Bohnert and Gatzert (2012) different surplus appropriation schemes in participating life insurance are analyzed for the first time from the policyholders' and the insurer's perspectives encompassing mortality and financial risk, thereby also studying the impact on default risk.

With respect to management discretion, Kleinow and Willder (2007) and Kleinow (2009) analyze the impact of management decisions on hedging and valuation of participating life insurance contracts, while Gatzert (2008) examines different asset management and surplus distribution strategies for participating life insurance contracts. A general asset–liability management framework for life insurance is provided by Gerstner et al. (2008) that allows the company to control the asset base, the bonus declaration mechanism and the shareholder participation. Furthermore, Huang and Lee (2010) deal with the optimal asset allocation for life insurance policies adopting a multi-asset return model that uses approximation techniques. The optimal portfolio composition for immunizing a life insurer's risk situation against changes in mortality has been studied in Gatzert and Wesker (2012) with a focus on endowment insurance contracts and annuities, but without including surplus distribution mechanisms or dynamic asset management strategies. Inspired by the products on the Danish market, Guillén et al. (2013a,b) study the performance of Danish with-profit pension products and life cycle products, where they also account for management decisions such as asset management strategies.

Thus, while asset–liability management, portfolio composition and management rules in general have been researched previously, the effectiveness of management decisions regarding the asset and liability composition for different surplus appropriation schemes has not been examined so far, even though surplus appropriation schemes play a central role in traditional life insurance and can substantially impact shortfall risk and shareholder value due to their consequences for the long-term guarantees promised to policyholders. One major question is, therefore, how surplus appropriation schemes of different products impact the effectiveness of management discretion regarding path-dependent asset management strategies and product compositions on the liability side. Such an analysis will provide important insights in regard to the management of long-term guarantees induced by surplus appropriation schemes as well as complex interactions between assets and liabilities in life insurance and their effect on risk and a fair shareholder position.

Therefore, in this article, we extend previous literature by analyzing the effectiveness of management decisions regarding the asset and liability composition for a life insurance company selling endowment insurance contracts and annuities under different surplus appropriation schemes on the company's shortfall risk

**Table 1**Balance sheet of a life insurance company at time  $t$ .

Assets	Liabilities
$A_t$	$E_t$
	$PR_t^R$
	$PR_t^S$
	$IA_t$
	$B_t$
$A_t$	$A_t$

and on the fair compensation of shareholders. Toward this end, we provide a model setting including the two life insurance products with different surplus appropriation schemes. The smoothing surplus distribution scheme considered in the model is thereby similar to the mechanisms that have been used in, e.g., Denmark for a long time, implying that many important management decisions are now taken on the basis of this type of models. On the liability side, we consider the impact of the portfolio composition, thereby always ensuring a fair risk charge for shareholders. On the asset side, the effectiveness of management rules that modify the riskiness of the investment is studied, i.e., where funds are dynamically shifted from stocks to bonds to reduce volatility and vice versa using a constant proportion portfolio insurance (CPPI)-based investment strategy. These asset feedback mechanisms can have an impact on the overall amount of generated surplus and thus also on the policyholders' surplus participation and the induced increase in guaranteed benefits, which may imply complex interactions.

The remainder of the paper is organized as follows. Section 2 introduces the model framework of the insurance company, along with the management decisions and the surplus appropriation schemes. Numerical results are presented in Sections 3 and 4 concludes.

## 2. Model framework

In what follows, we consider a life insurer that offers two products: temporary annuities and participating life insurance contracts (also referred to as endowment contracts) with different surplus appropriation schemes. We make use of the model framework introduced in Bohnert and Gatzert (2012) for surplus appropriation schemes in participating life insurance and expand their setting in various ways. In particular, we propose various company setups, where the product portfolio composition, surplus appropriation and asset strategies can be studied that are defined at inception of the contracts. The insurer's balance sheet at time  $t$  is laid out in Table 1.

At the beginning of the first contract year ( $t = 0$ ), equityholders make an initial contribution of  $E_0 = l \cdot A_0$  and the collectivity of policyholders pay single premiums of  $(1 - l) \cdot A_0$ .<sup>1</sup> The book values of the policy reserves for the annuities and the traditional endowment insurance contracts are given by  $PR_t^R$  and  $PR_t^S$ , respectively and  $IA_t$  denotes the book value of the endowment insurance contracts' interest-bearing accumulation system. The buffer account  $B_t$  is determined residually by subtracting equity, the policyholders' accounts and dividends paid to the equityholders from the market value of the assets ( $A_t$ ), where equity ( $E_t$ ) is assumed to be constant over time (see also Kling et al., 2007a,b).<sup>2</sup> Furthermore, a run-off scenario without new business is considered.

<sup>1</sup> The initial equity capital  $E_0$  is set equal in case of annual premium payments for comparability reasons.

<sup>2</sup> Thus,  $B_t$  is a hybrid, since it is the difference between market and book values. This is a simplification of the actual procedures in an insurance company (see Grosen and Jørgensen, 2000).

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