



Fair valuation of path-dependent participating life insurance contracts

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Abstract

Fair valuation of insurance contracts, and of options embedded in them, is an important, incompletely understood issue. With the coming IAS insurance contract standard, the valuation of liabilities in life insurance is due to a drastic change. We present a computationally tractable model for fair valuation of participating life insurance contracts with given, almost arbitrary bonus policies. Unlike traditional valuation methods, our model captures several essential features of participating life insurance contracts, such as fair values of interest rate guarantees and of various bonus policies. In the model, fair value of life insurance contracts is understood as the arbitrage free price in the presence of liquid markets for liabilities. In addition to numerical results, the model gives solutions in closed form.

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1. Introduction

Insurance accounting is experiencing a radical shift from traditional valuation of insurance liabilities towards fair valuation of liabilities. This has occurred partly because one side on the balance sheet is valued in market values—the assets—while the other—the liabilities—is not. Another important reason for the change of emphasis on accounting is the need for a better understanding of financial risks, such as interest rate guarantees, and, in general, of valuation of various elements in insurance contracts. This is especially timely now, since low interest rates have made interest rate guarantees an important issue for life insurance contracts. Several insurance companies, such as Nissan Mutual Life, have run into trouble partially as a result of an underestimation of embedded options in their written insurance contracts.

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To address these issues, the forthcoming IAS standard for insurance contracts has adopted a radical way of valuation: insurance liabilities are to be valued as if they were traded in huge numbers among well-informed, independent investors in a liquid marketplace. This is called *fair valuation*, which is formally defined as “the amount for which an asset could be exchanged or a liability settled between knowledgeable, willing parties in an arm’s length transaction”, see IASB (2001). According to the draft IAS standard, liabilities including embedded options, should be valued with stochastically estimated future cash flows and discounted with riskless interest, which is often interpreted as interest of 30-year government bonds.

Although International Accounting Standards Board (IASB) seems to be moving away from demanding use of strict fair valuation, importance of understanding fair valuation is not reduced, since the original motivation for the valuation method—reliable valuation of embedded options and indirect obligations—still remains.

To better understand how fair valuation is feasible, we construct a model for valuation of participating life insurance contracts, by extending the work of Grosen and Jørgensen (2000), and by deriving an analytical solution for the fair value of the contract. For certain simple bonus mechanisms our model produces nice analytic results, but for most bonus policies we get iterated integral representations that yield results only after relying on numerics. Furthermore, the formulation of the model allows easy incorporation of various kinds of bonus mechanisms, thus leading to a more practical and comprehensive approach to the understanding of the value of participating contracts. We shall also briefly consider how to include a known term structure of riskless interest to the model.

It is well known that option valuation models capture well some aspects of market’s valuation process, hence we use them as a starting point. We take it as given that a fair value is the arbitrage free price¹ for assets and liabilities, as in option valuation models. We assume that *liabilities are valued as if a liquid market for the underlying contracts existed*.

2. Background on life insurance contracts

Before going on to the actual modeling, let us first briefly review the primary characteristics of the contracts. The value of a *unit-linked contract* is directly linked to the performance of a portfolio of assets (the unit) associated with the contract. Such contracts may include maturity guarantees that can be interpreted as options giving a right to a certain minimal amount at the end of the contract period. Valuation of such contracts is explained, e.g. in Ekern and Persson (1996).

In *participating contracts* the policyholder is entitled to certain part of the profits generated by the assets associated with the contract. The division of profits between the policyholder, a reserve, etc. is dictated by the bonus policy. The bonus policy often includes some form of guaranteed interest protecting the investor from turbulence of financial markets. This type of contracts are also known as with-profits contracts.

Contracts may also offer the policyholder an opportunity to choose between several bonus mechanisms in the middle of the contract term. The right to switch from one bonus mechanism to another is an embedded option, and it is natural to ask what is the fair value of such right. We call such provisions *switch options*.

Insurance contracts can be called *European* or *American* in the same vein as in the regular option literature, with the tacit understanding that the terms refer to the surrender option. Presence (corr. absence) of surrender option in a contract simply means that the policyholder can (resp. cannot) discontinue the contract before the term. A contract with a surrender option is called American, a contract without a surrender option is called European.

¹ We do not include a market value margin—the margin the market demands for bearing the risk inherent in the contract, see IASB (2001)—into our model.

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