



# Endogenous model of surrender conditions in equity-linked life insurance

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## Abstract

We propose a model for pricing a unit-linked life insurance policy embedding a surrender option. We consider both single and annual premium contracts. First we analyse a quite general contract, for which we obtain a backward recursive valuation formula based on the Cox et al. [Cox, J.C., Ross, S.A., Rubinstein, M., 1979. Option pricing: a simplified approach. *J. Finan. Econ.* 7, 229–263] *binomial* model. Then we concentrate upon a particular case, that is the famous model with *exogenous* minimum guarantees. In this case we extend our previous analysis in order to take into account the possibility that the guarantees at death or maturity and the surrender values are *endogenously* determined, and provide necessary and sufficient conditions for the premiums to be *well defined*.

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## 1. Introduction

The surrender option embedded in several types of life insurance contracts gives the policyholder the right to early terminate the contract and to receive a cash amount, called *surrender value*. To avoid adverse selection phenomena, this option is usually granted only if the contract provides benefits both in case of death and in case of survival such as, e.g., endowment and whole-life insurance policies.

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The problem of fixing the surrender conditions when designing a new policy is very important, specially if the financial component of the policy is predominant. An over-simplified way to solve the problem could be that of fixing very low or even null surrender values. The (only) advantage of this solution is that the insurance company can completely ignore the surrender option and use consolidated actuarial techniques for pricing (and hedging) the contract. After all, the surrender is a unilateral decision of the policyholder that does not respect the initial terms of the contract and implies a loss of future gains expected by the insurance company. However, this solution may have a disastrous effect from a marketability point of view. First of all, it may spread discontent through those that originally did not consider the possibility of surrender but are forced to abandon their contracts for unexpected events and now feel swindled. Secondly, markets are populated also by investors that do not know exactly their time horizon, for which the surrender conditions may constitute one of the key-elements in the choice of an investment product such as a life insurance contract. For these and similar reasons, among which a very important one is also the market competition between insurers, the insurance company could decide to fix very competitive surrender conditions, but in this case it cannot afford to ignore the surrender option, that constitutes a component of the contract and must be suitably rewarded. Then an accurate valuation of this option, along with the other elements of the contract, is called for.

In particular, given the surrender conditions, the valuation of such an option can be performed by following two different approaches:

- (i) According to the former, the surrender decision is treated just like death, i.e., it is considered an “exogenous” cause of termination of the contract. Actually, such decision can be driven by several “personal” reasons out of the control of the insurance company. For instance, the policyholder can fall into financial difficulties, or he/she can become acquainted with a change in the health status of the insured, checked by the insurance company only at inception. The collection of sufficient statistics on surrenders (called also *withdrawals*) allows to estimate the expected surrender rates and to construct a multidecrement table with two possible causes of elimination: surrender and death. A very natural assumption combined with this approach is the stochastic independence between surrenders and the financial elements.
- (ii) The latter approach merges the contract into a *contingent-claims* framework, characterized by perfectly competitive and frictionless markets, populated by rational and non-satiated agents all sharing the same information. According to this approach, the surrender decision is not at all independent of the financial elements, since it is the consequence of a rational choice. Then, in this framework, the whole contract and, in particular, the surrender option, are typical *American-style*<sup>1</sup> contingent-claims, whose valuation is obtained by merging together the traditional actuarial techniques, based on *pooling* arguments, with the modern financial toolbox, based on the *no-arbitrage* principle.

The above two approaches may appear to be completely incompatible. Nevertheless we are fully convinced that, although most policyholders are very likely induced to surrender their policies by “exogenous” reasons, the correct approach to follow in the valuation of the contract is the second one, because the *fair* value of a right, such as the surrender option, is independent of the behaviour of its owner. In other words, the policyholder has the right to act “optimally” when taking his/her surrender decision, hence no “discounts” are admitted for anticipated non-optimal behaviours. In fact, even if such discounts were allowed, the insurance company could not subsequently forbid the policyholder to act optimally, and this could obviously turn out to be a serious threat to solvency.

The literature concerning the valuation of the surrender option in a contingent-claims framework is not very abundant. The only papers of which we are aware are those by Albizzati and Geman (1994), Grosen and Jørgensen (1997, 2000), Jensen et al. (2001), Steffensen (2002), Bacinello (2003a,b), Tanskanen and Lukkarinen (2003), and Vannucci (2003a,b). Apart from the paper by Steffensen (2002), that acts in a very general framework, the

<sup>1</sup> We mean that the right to abandon the contract can be exercised at any time before its natural termination, that is death or maturity.

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