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Valuation of life insurance surrender and exchange options☆

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Abstract

In this paper I analyze two American-type options related to life and pension insurance contract. I use Monte Carlo simulations combined with the Longstaff and Schwartz approach for the valuation of American options to find the value of a typical surrender option. I find that the values may be much lower than previously indicated. This reduction of value is due to a different treatment of bonuses, limiting the customers' ability to forecast the return of their policies. The numerical results show that the value may be higher than the corresponding surrender option.

JEL classification: G18; G22

Keywords: Surrender options; Exchange options; Life and pension insurance

1. Introduction

Most life and pension contracts include some kind of lock-in-effect which tie the customers to the same company throughout the contract. If they are dissatisfied with the company, there may be no way out or the only opportunity may be surrendering the contract against a fee. Surrendering the contract may be very expensive, and there may be tax incentives to not use this option.

As the existing customers are more or less tied to the same company, competition among life and pension companies exist mainly in acquiring new customers. This leaves the old customers more or less defenseless to changes in the strategy of their life and pension provider. The competition authorities are not happy with this situation and try to find ways of unlocking the deadlock.

In Norway, regulators have introduced the right for the customers to change providers of life and pension contracts at any point of time before the expiry of their contracts. Customers are allowed to transfer the book value of their contract to another company, paying only a minimal fee to cover administration costs. This right is obviously helpful if companies decide to change their strategies in the favor of profit to shareholders rather than customers. However, as I will show, even in a situation where the parameters of the contract are left unchanged the book value of the contract may develop in a different fashion than the market value. Hence, even in this scenario the exchange option will have a positive value.

The value of the exchange option will be different from the value of a corresponding surrender option, as the market value of the contract in the new company is different from the book value. Furthermore, the exchange option also includes the right to change back at a later point, further increasing the value of the option.

The literature on embedded options in life and pension insurance has so far concentrated on the bonus payment option. A number of different models have been developed, in order to cover different elements of the life and pension insurance contract. Briys and de Varenne (1994) provide an early attempt to develop a model with life-time guarantees. This is expanded to cover annual guarantees e.g. by Hansen and Miltersen (2002), Miltersen and Persson (2003), and Ballotta et al. (2006). The asset model is expanded to follow the Heath et al. (1992) framework by Miltersen and Persson (1999).

Early attempts to deal with surrender options include Grosen and Jørgensen (1997) who analyze surrender options on a unit-linked-type contract with no bonus participation mechanism. This is extended by Grosen and Jørgensen (2000), analyzing

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a surrender option on a traditional life insurance contract with bonus participation, annual guarantees, and bonus reserves. The valuation is done by applying the Cox et al. (1979) tree methodology. Not surprisingly they find that the surrender option has the highest value in the scenarios where the initial fair value of the contract (without the surrender option) is lower than the corresponding initial price. However, even in scenarios where the value of the contract is high, they find that the surrender option has significant value.

Bacinello (2003) applies the same methodology to a set of Italian policies, taking into account actuarial elements as well as surrender penalties (surrender values lower than the book value of the mathematical reserves). In her settings the value of the surrender option is much lower than indicated by Grosen and Jørgensen, however this may also be due to the fact that Bacinello restricts herself to analyzing a 5 year contract only.

Andreatta and Corradin (2003) try to confirm the finding by Grosen and Jørgensen using the Longstaff and Schwartz (2001) method of pricing American options by simulations. They suggest four different combinations of state variables. Three of these give results close to the results of Grosen and Jørgensen, while the last one has the advantage of giving more realistic results for the sets of parameters where the continuing value is always higher than the surrender value and the surrender option should have no value at all.

On the other hand, Bauer et al. (2006) find a zero value of the surrender option, applying a discretization approach based on Tanskanen and Lukkarinen (2004) on contracts closely calibrated to the German market. The reason for this may be that they find that these contracts are initially favorable to customers, so that the customers will keep them for as long as possible.

In this paper I will concentrate on contracts which are initially fair (i.e., the value of the contract without the exchange and surrender options equals the price). I will compare the value of the exchange option with the value of the corresponding American surrender option and with combinations of these.

The model used in this paper is based on the Miltersen and Persson (2003) model of profit sharing. The difference from the Grosen and Jørgensen framework is that bonuses to customers are more difficult to forecast as they rely less on the level of bonus reserves and more on current returns. Obviously this will reduce the option value as it becomes more difficult to decide whether to leave the company or not. However, I find the Miltersen and Persson model more realistic, as it fits better to the legal requirement in several countries that bonuses shall be at least a certain percentage share of profits in the company.[1]

I let the initial premium paid by customers being equal to the value of the contract at the time of purchase, including all European option elements, but excluding the American ones. I adjust the levels of profit sharing and allocation to bonus reserves such that neither the shareholders nor the customers can expect any economic profit before the surrender and/or exchange options are taken into account.

My findings suggest a lower value of the surrender option than indicated by Grosen and Jørgensen (2000) and Andreatta and Corradin (2003). I find values in the area of 1% of the initial mathematical reserves, depending on the parameters. The reason for this is primarily that the ability of customers to forecast future returns is dramatically reduced. As opposed to the Grosen and Jørgensen model I assume that the company only declare bonuses at the end of the year, when asset returns are known. Furthermore, bonuses are closer connected to the asset returns (which follows a geometric random walk) and less connected to the level of bonus reserves (which is known at the beginning of each year).

The value of the exchange option seems to be a little higher than the value of the surrender option, at least where the companies are very different. The additional value typically comes from the option of changing back at a later point in time. I compare the surrender option and the exchange option by using a combination of the two options, which I call the buy-back option. In this alternative the contract may be surrendered and bought back at a later stage. This option forms both an upper bound for the value of the surrender option and a special case of the exchange option, where one company invest only in the risk-free asset. The results show that the values of the option elements alone are normally in the area of 20–40% higher than the corresponding surrender option and also higher than the corresponding exchange options.

This paper is organized as follows: In Section 2 I present the different elements of the model and show the solution methods. The numerical results of the different types of options are given in Section 3. Section 4 provides implications for policy makers, while Section 5 concludes and gives suggestions for future research.

2. The model

2.1. The economy

I assume a standard no-arbitrage economy with two assets, a risk-free asset, D_t and a risky asset, S_t. The dynamics of the asset classes are given by:

$$dD_t = rD_t dt, \quad D_0 = d \tag{1}$$

$$dS_t = \mu S_t dt + \sigma S_t dW_t, \quad S_0 = s \tag{2}$$

where r is the constant risk-free interest rate, μ is the constant expected return on the risky asset, σ is the constant volatility of the risky asset, and W_t is a standard Brownian motion. A proportion θ is invested in the risky asset. The dynamics of the total asset portfolio A_t given the objective probability measure P is then

$$dA_t = ((r + \theta(\mu - r))A_t)dt + \theta A_t \sigma dW_t, \quad A_0 = a. \tag{3}$$

Design of "fair contracts" is done under the equivalent martingale measure Q (Harrison and Kreps, 1979), given by

$$dA_t = rA_t dt + \theta A_t \sigma dW_t^Q, \quad A_0 = a \tag{4}$$

where W_t^Q is the standard Brownian motion under Q.

[1] E.g., Cummins et al. (2004) state for Norway a legal minimum of 65% (later changed to 80% of a slightly different profit base). Similar requirements exist, based on slightly different profit definitions, e.g., in Germany (90%), France (85%), and Italy (80%).