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The Valuation of Guaranteed Lifelong Withdrawal Benefit Options in Variable Annuity Contracts and the Impact of Mortality Risk

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Abstract

In light of the growing importance of the variable annuities market, in this paper we introduce a theoretical model for the pricing and valuation of guaranteed lifelong withdrawal benefit (GLWB) options embedded in variable annuity products. As the name suggests, this option offers a lifelong withdrawal guarantee; therefore, there is no limit on the total amount that is withdrawn over the term of the policy because if the account value becomes zero while the insured is still alive, he or she continues to receive the guaranteed amount annually until death. Any remaining account value at the time of death is paid to the beneficiary as a death benefit. We offer a specific framework to value the GLWB option in a market-consistent manner under the hypothesis of a static withdrawal strategy, according to which the withdrawal amount is

always equal to the guaranteed amount. The valuation approach is based on the decomposition of the product into living and death benefits. The model makes use of the standard no-arbitrage models of mathematical finance, which extend the Black-Scholes framework to insurance contracts, assuming the fund follows a geometric Brownian motion and the insurance fee is paid, on an ongoing basis, as a proportion of the assets. We develop a sensitivity analysis, which shows how the value of the product varies with the key parameters, including the age of the policyholder at the inception of the contract, the guaranteed rate, the risk-free rate, and the fund volatility. We calculate the fair fee, using Monte Carlo simulations under different scenarios. We give special attention to the impact of mortality risk on the value of the option, using a flexible model of mortality dynamics, which allows for the possible perturbations by mortality shock of the standard mortality tables used by practitioners. Moreover, we evaluate the introduction of roll-up and step-up options and the effect of the decision to delay withdrawing. Empirical analyses are performed, and numerical results are provided.

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