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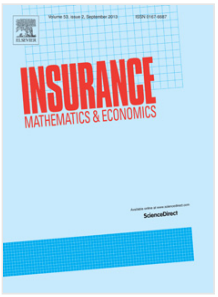

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ACCEPTED MANUSCRIPT

Pricing Guaranteed Minimum/Lifetime Withdrawal Benefits with Various Provisions under Investment, Interest Rate and Mortality Risks

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Abstract

Many variable annuity products associated with guaranteed minimum withdrawal benefit (GMWB) or its lifelong version, a guaranteed lifelong withdrawal benefit (GLWB), have enjoyed great market success in the United States and Asia. The interaction impacts among complex policy provisions and the randomness of the account value of the policy, the prevailing interest rate, as well as the mortality rate may significantly influence the evaluations of GMWBs/GMLBs, especially when the guaranteed payments are made over a long, or even a lifelong, horizon. To deal with aforementioned risk factors and policy provisions, this paper proposes a novel three-dimensional (3D) tree that can analyze how different policy provisions influence the evaluation of GMWB/GLWBs under investment interest rate, and mortality risks simultaneously. The orthogonalization method is used to convert correlated dynamics of the account value of the policy and the short-term interest rate into two independent processes that can be easily simulated by our 3D tree. Besides, the structure of our 3D tree is sophisticatedly designed to avoid the unstable (oscillating) pricing results phenomenon that has characterized many numerical pricing methods. Rigorous numerical experiments are given to analyze the interaction effects among policy provisions and the aforementioned risk factors on the evaluation of GMWBs/GLWBs.

Keywords: Guaranteed Life Withdrawal Benefits; Surrender Option; Variable Annuity; Interest Rate Risk; Mortality Risk

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