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Modeling Partial Greeks of Variable Annuities with Dependence

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Abstract

Dynamic hedging used to mitigate the financial risks associated with large portfolios of variable annuities requires calculating partial dollar deltas on major market indices. Metamodeling approaches have been proposed in the past few years to address the computational issues related to the calculation of partial dollar deltas. In this paper, we investigate whether the additional complication of modeling the dependence between the partial dollar deltas improves the accuracy of the metamodeling approaches. We use several copulas to model the dependence structures of the partial dollar deltas and conduct numerical experiments to compare different metamodels. Depiste the evidence of strong dependence in the estimated models, our numerical results show that modeling the dependence structures in the metamodels does not improve the accuracy of the estimations at the portfolio level. This is becasue the dependence between the partial dollar deltas is well captured by the covariates used in the marginal models. This finding suggests that we should focus more on marginal models than specifying the dependence structure explicitly.

Keywords: Variable annuity, Portfolio valuation, Metamodeling, Gamma distribution, Copula

1. Introduction

A variable annuity (VA), as known in the U.S., is a long-term life insurance contract between an individual and an insurer. Variable annuities are referred to as unit-linked products and segregated funds in Europe and Canada, respectively. A typical variable annuity has two phases: the accumulation phase and the distribution phase. In the accumulation phase, policyholders accumulate assets by allocating the premiums to several subaccounts of the insurer's separate account. A subaccount is similar to a mutual fund. In the distribution phase, policyholders can withdraw money in a lump sum or as a series of payments over