Abstract

A Neural Network Approach to Efficient Valuation of Large VA Portfolios

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Variable annuity (VA) products expose insurance companies to considerable risk because of the guarantees they provide to buyers of these products. Managing and hedging the risks associated with VA products requires intraday valuation of key risk metrics for these products. The complex structure of VA products and computational complexity of their accurate evaluation has compelled insurance companies to adopt Monte Carlo (MC) simulations to value their large portfolios of VA products. Because the MC simulations are computationally demanding, especially for intraday valuations, insurance companies need more efficient valuation techniques.

Existing academic methodologies focus on fair valuation of a single VA contract, exploiting ideas in option theory and regression. In most cases, the computational complexity of these methods surpasses the computational requirements of MC simulations. Recently, a framework based on Kriging has been proposed that can significantly decrease the computational complexity of MC simulation. Kriging methods are an important class of spatial interpolation techniques. In this thesis, we study the performance of prominent traditional spatial interpolation techniques. Our study shows that traditional interpolation techniques require the definition of a distance function that can significantly impact their accuracy. Moreover, none of the traditional spatial interpolation techniques provide all of the key properties of accuracy, efficiency, and granularity. Therefore, in this thesis, we present a neural network approach for the spatial interpolation framework that affords
an efficient way to find an effective distance function. The proposed approach is accurate, efficient, and provides an accurate granular view of the input portfolio. Our numerical experiments illustrate the superiority of the performance of the proposed neural network approach in estimation of the delta value and also the solvency capital requirement for large portfolios of VA products compared to the traditional spatial interpolation schemes and MC simulations.