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Algorithmic Hessians and the fast computation of cross-gamma risk

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Abstract

This article introduces a new methodology for computing Hessians from algorithms for function evaluation using backwards methods. It is shown, that the complexity of the Hessian calculation is a linear function of the number of state variables multiplied by the complexity of the original algorithm. These results are used to compute the gamma matrix of multidimensional financial derivatives including Asian baskets and cancelable swaps. In particular, the algorithm for computing gammas of Bermudan cancelable swaps is order $O(n^2)$ per step in the number of rates. Numerical results are presented that demonstrate that computing all $n(n+1)/2$ gammas in the LMM takes roughly $n/3$ times as long as computing the price.

Keywords:

Automatic differentiation | Monte Carlo simulation | Greeks | gamma | LIBOR market model | cancelable products

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