IIE Transactions ›
Volume 43, 2011 - Issue 12

ORIGINAL ARTICLES

Algorithmic Hessians and the fast computation of cross-gamma risk

Mark Joshi & Chao Yang

Pages 878-892 | Received 01 Aug 2010, Accepted 01 Dec 2010, Accepted author version posted online: 24 May 2011, Published online: 30 Sep 2011

Cite this article https://doi.org/10.1080/0740817X.2011.568040

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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

Acknowledgements

We are grateful to Jeremy Staum and an anonymous referee for their detailed comments on earlier version of this article.

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