Parametric Option Pricing with Fourier Methods

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We propose an interpolation method tailored to parametric option pricing of liquid options in finance. In most of the relevant asset models, prices of liquid options have a representation in terms of the Fourier transform of the distribution of the underlying random variable and of the payoff function. These types of options and methods are used for model calibration, where the same pricing problem needs to be solved for a large set of different parameters. In literature on parametric option pricing the main focus is on Fast Fourier techniques, which typically enables efficient computation of the price for a large set of option's strike and the initial asset value – which is a specific parameter dependence. Additionally, reduced basis for the related parametric Kolmogorov equations, which often are of parabolic type, has been proposed in the literature. In contrast, to benefit from both the recurrent nature of the option pricing problem and the explicitly given Fourier transforms of the option prices, we present a new interpolation method for Fourier prices. For a large variety of option types and models, we provide theoretical error estimates. Our numerical experiments confirm the theoretical findings and show a significant gain in efficiency. Compared to our recent work, [1], where we explore (tenzorized) Chebyshev interpolation for POP, the new interpolation method has two major advantages:

- The error decay can be estimated independently of the dimension of the parameter space.
- The interpolation yields an expansion that is *explicit in the model parameters*.

Our experimental results are illustrated in Figure 1.

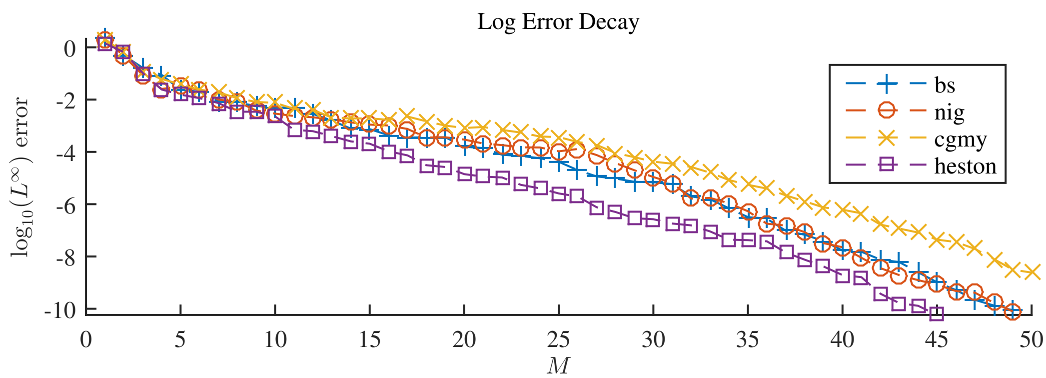

Figure 1: $\log_{10}$ error decay for increasing degree of freedom M during the construction of the interpolation operator on a representative parameter training set for the following models. *bs*: Black & Scholes, *nig*: Normal inverse Gaussian, *cgmy* CGMY also known as KoBoL, *heston*: Heston's model.

References

[1] M. Gaß, K. Glau, M. Mahlstedt, and M. Mair. Chebyshev interpolation for parametrized option pricing. Preprint, 2015.