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Arbitrage-free approximation of call price surfaces and input data risk

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Abstract

In this paper we construct arbitrage-free call price surfaces from observed market data by locally constrained least squares approximations. The algorithm computes derivatives of the call surface accurately so that implied volatility, local volatility and transition probability density can be obtained at no additional cost. Observed input data are afflicted by a price uncertainty due to the bid–ask spread, quote imprecision and non-synchrony and cause an input data risk on the computed call surface and subsequently on the implied volatility surface. We model the input risk and perform an analysis to study and measure the effect of the input risk on the surfaces. With this analysis we can determine the trustworthiness of the computed results and their implications for option pricing a posteriori.

Keywords:

Volatility surfaces | Implied volatilities | Moving least squares | Input data risk

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Notes

†Define the function $f(K, \tau) \coloneqq C(Ke^{(r-q)\tau}, T + \tau)e^{q\tau}$, then $\partial f/\partial \tau|_{\tau = 0}$ corresponds to the above differential quotient.