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Confidence interval estimation of option prices by using the predicted distribution of implied volatility

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Abstract
Many option pricing formulas have been developed to overcome the restrictive assumptions of Black and Scholes models and to give more accurate prices. Most of the methods are focused on a point prediction of option price.
In this paper, we propose a method that predicts a distribution of the implied volatility functions by applying a Gaussian process regression and estimating confidence intervals of option prices using the predicted volatility distributions. To verify the performance of the proposed method, we conducted simulations on some model-generated option prices data and real option market data. The simulation results show that the proposed method performs well with practically meaningful option ranges as well as overcomes the problem of containing negative prices in their predicted confidence intervals by the previous works.

Keywords and phrases: Option pricing, Implied volatility, Gaussian processes, Confidence intervals.

1. Introduction

Since the appearance of the Black and Scholes model in 1973, many option pricing formulas have been developed to overcome the restrictive assumptions of Black and Scholes models and to give more accurate prices (Lajbcygier, 1999). Most of the methods are focused on a point prediction of option price. Since there is always discrepancies between the option prices predicted by the models and the real option market prices due to some market frictions such as bid-ask spreads, noisy information, and etc., it is desirable to have a predictive distribution of option prices. To give a distribution of option prices, the use of a neural network kernel-based Bayesian method is addressed inJung, Kim, and Lee (2006). Han and Lee (2008)suggested the uses of mixed kernels to give more accurate ranges of option prices than other neural networks models inChoi, Lee, Han, and Lee (2004), Gencay and Qi (2001), Hutchinson, Lo, and Poggio (1994) and applied it to pricing one-sided equity-linked warrants (ELWs, only the buy-side is allowed but the sell-side is limited for the investors). However, these previous approaches have serious problems in their predicted confidence intervals (CIs) of option prices. First, some option prices in their ranges can take negative values in the out of the money (OTM) regions. Second, when the moneyness goes to OTM or in-the-money (ITM) regions, the predicted CIs becomes too broad. Finally, the predicted option ranges around at-the-money (ATM) regions becomes too narrow to encompass the high volume of