# Estimating implied volatility surfaces using Bayesian splines under shape restrictions

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**Abstract** The implied volatility can be considered as a measure of the expected future risk of a given underlying asset, as it is calculated using market prices of derivatives and thus incorporates the expectations of market participants. This work develops a statistical model for estimating implied volatility surfaces, using information about the expectations of market agents contained in the market prices of options. The implied volatility curves are estimated by shape-constrained splines, using a Bayesian method (MCMC) that imposes no-arbitrage conditions on the price curve using shape restrictions.

The proposed method permits to obtain a full characterization of the posterior distribution of the estimated quantities - the price curve and the implied volatility surfaces. This property is useful for this specific study, since the variance of the vector of regression coefficients with shape restrictions would not be easily obtained through a frequentist paradigm, since the imposition of restrictions alters the property of estimators. As the shape restrictions are imposing the no-arbitrage restrictions, we obtain full posterior inference under no-arbitrage conditions, and thus constructing flexible non-parametric estimators respecting the necessary financial assumptions needed for derivative pricing.

**Keywords**: Implicit Volatility, Non-parametric Estimation, Bayesian Methods, Market Expectations.

**JEL Codes**: E3, C41, C43.

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