Options Analytics
Content Overview

Cboe Hanweck is part of **Cboe's Data and Access Solutions**, offering an extensive and comprehensive array of data, analytics, and execution solutions helping participants navigate markets in real-time.

Delivered as a real-time data feed, our Options Analytics show implied volatilities and Greeks as well as model-fitted theoretical prices. These are generated using industry-standard pricing models, sophisticated volatility surface models and the highest quality inputs. This framework underpins the Cboe Theoretical Value, which is available throughout the Cboe Data and Access Solutions product suite.

Implied Volatilities & Greeks

High-Quality, Real-Time Options Risk Sensitivities

- Industry-standard binomial tree with discrete dividends allows for accurate pricing of both European and American exercise styles.
- Real-time implied volatility computed at bid, ask, mid and theoretical prices.
- Delta, Gamma, Vega, Theta and Rho for each option computed from real-time theoretical prices.
- Model fitted volatility surfaces — constant maturity tenors and listed expiry — in multiple forms including delta-relative and price-relative.
- Observed underlier and option market prices at the time of each calculation.
- Implied borrow cost and accumulated dividends for each underlier at each option expiry.

Methodology Highlights

Hanweck delivers cutting-edge options analytics and volatility surface models, which both evolve to react to changing financial markets conditions and use the latest industry standards.[1] Key highlights:

- Model-fitted volatility surfaces generate accurate, responsive, and stable risk analytics under volatile market conditions. Our sophisticated options pricing models accurately represent the shape and dynamics of a wide range of implied volatility surfaces.
- Mixture models extend other more-basic option pricing models and are used to fit complex volatility smiles, including "W"-shaped implied volatility skews.
- Sophisticated time-series smoothing techniques allow us to calibrate options models to real-time data even under extreme market conditions.
- Our models use price proxies for underliers where the quotes are not available or infrequent. Adaptive, time-series statistical methods are applied to quoted underlier prices to adjust for wide bid-ask spreads and missing prices.
- Real-time implied borrow rate curves are derived from the options markets, and real-time discount rate curves are derived from STIR futures.
- Reference data is adjusted for corporate actions in real-time.

[1] Further details on the methodologies in use can be made available on request.

Model-Fitted Methodology Details

Motivation

Navigating through market data can be challenging, especially in the listed options markets. Market participants need accurate and responsive real-time theoretical pricing and analytics that are stable over time.

Deriving responsive, and stable real-time analytics requires:

- Sophisticated options pricing models that can effectively represent the shape and dynamics of the wide range of implied volatility surfaces seen in global derivatives markets;
- Adaptive, time-series, model-fitting methodologies that react to new market conditions while remaining stable in periods of fluctuation; and
- High-performance computing technology to calculate complex analytics in real-time on millions of derivative instruments worldwide.

Mixture Models

Hanweck Options Analytics makes extensive use of mixture models to represent complex volatility skews observed in global markets. Mixture models extend other more-basic option pricing models by combining their asset price distributions into a single, probability-weighted mixture distribution. For example, a mixture of a sufficient number of normal distributions is capable of approximating any distribution to arbitrary precision (Wilkens, 2005).[2] Therefore, mixture models are well suited for fitting complex volatility smiles, including "W"-shaped implied volatility skews. Mixture models provide a flexible, arbitrage-free and computationally efficient framework to value options. Hanweck has implemented mixtures of various options pricing models, including:

- The Black-Scholes Model
- The SABR Model
- The Merton Jump-Diffusion Model

While mixtures of the above models are generally sufficient for representing most listed volatility skews and smiles, additional models may prove more effective in certain circumstances. Hanweck has implemented other option pricing models, including Heston's stochastic volatility model (Heston, 1993),[3] Bates's jump-diffusion with stochastic volatility model (Bates, 1996),[4] Gatheral's Stochastic Volatility Inspired (SVI) model (Gatheral, 2006),[5] and the constant elasticity of variance (CEV) model (Beckers, 1980).[6]

Fitting Methodologies

Hanweck Options Analytics uses advanced Bayesian time-series techniques to calibrate options models to real-time market data. Bayesian time-series techniques provide better, more stable fits to real-time market data than conventional approaches by optimally incorporating new market data with past information in line with the fitting process. The specific technique used by Hanweck Options Analytics is known as the Unscented Kalman Filter (UKF) (van der Merwe, et al., 2001) . The UKF is a Bayesian algorithm for estimating unobserved parameters of a dynamic system from noisy observations in a time-series setting.

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[2] Wilkens, Sascha. 2005. Option Pricing Based on Mixtures of Distributions: Evidence from the Eurex Index and Interest Rate Futures Options Market. *Derivatives Use, Trading & Regulation.* 2005, Vol. 11, 3, pp. 213-231.
[3] Heston, Steven L. 1993. A Closed-Form Solution for Options with Stochastic Volatility with Applications to Bond and Currency Options. *Review of Financial Studies.* 1993, Vol. 6, 2, pp. 327-343.
[4] Bates, David S. 1996. Jumps and Stochastic Volatility: Exchange Rate Processes Implicit in Deutsche Mark Options. *Review of Financial Studies*. 1996, Vol. 9, 1, pp. 69-107.
[5] Gatheral, Jim. 2006. The Volatility Surface: A Practitioner's Guide. *s.l. : John Wiley & Sons, Inc.,* 2006.
[6] Beckers, Stan. 1980. The Constant Elasticity of Variance Model and Its Implications for Option Pricing. *Journal of Finance.* June, 1980, Vol. 34, 3, pp. 661-673.
[7] van der Merwe, Rudolph and Wan, Eric. 2001. The Square-Root Unscented Kalman Filter for State and Parameter Estimation. *International Conference on Acoustics, Speech and Signal Processing*. 2001.

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