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İSTANBUL

ITU Volatility Theoretical Pricing Handbook

Central Counterparty Department

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VOLATILITIES CALCULATED BY ITU VOLATILITY MODEL AND THE THEORETICAL PRICING PROCESS

The settlement prices of the option contracts traded in Borsa Istanbul Futures and Options Market are calculated by using the Black & Scholes pricing model out of the option pricing model theories. The following parameters are used in the Black & Scholes pricing model:

S: The spot price of the underlying asset

K: The strike price

rf: The risk free rate

T: The number of days remaining to the maturity

σ : Volatility

As an input to the Black & Scholes model, the volatility parameter also requires a separate calculation. In this calculation, the prices used for the options being traded in the market are taken as the base and the implied volatility value is computed. In determining the final volatility values of each option contract, a volatility surface estimation system development project has been carried out with ITU for the option contracts.

As part of this project, different volatility surface calculation models have been analyzed for volatility surface estimation purposes by taking account of the developments in the literature, and the "Gonçalves & Guidolin" model has been taken as the base among them. The most important feature of the selected model is that when the volatility surface is estimated, it requires less parameter estimation than the models in the literature. Thus, the estimation problems arising from the limited number of data have been reduced to a minimum level by this model. In addition, this model has been considered more successful than the models in the literature in terms of forecast. In order to obtain forecasts as well as accurate volatility surfaces, restrictions compatible with the theoretical expectations have been imposed on the parameters of the Gonçalves & Guidolin model and they have been estimated by way of model optimization. The volatility surface model and estimation stages used in the project are detailed below.

Gonçalves & Guidolin model constituting the basis for ITU Volatility model study is as follows:

$$\sigma_i = b_{1i} + b_{2i} M_i + b_{3i} M_i^2 + b_{4i} T_i + b_{5i} T_i M_i + \varepsilon_i \quad (1)$$

σ_i : Volatility derived from the Black and Scholes formula

M_i : Moneyness (Strike/Spot)

T_i : Time to maturity in years (time to maturity / 365)

The number of parameters to be estimated in the model is 5.

The estimation stages of the model are as follows:

1. The initial volatility has been estimated by using the Black and Scholes model.
2. For the foreign currency and index contracts with high number of trades, the volatility has been weighted based on the trading volume.
3. The number of observations and the observation values related to the variables have been checked, and default volatility values have been assigned for the option contracts whose number of observations has remained below the number of parameters.
4. Optimization has been made by imposing numerical size and sign restrictions compatible with the theoretical expectations on the model parameters.
5. The generated volatility values have been reviewed and the values not falling between certain limits have been adjusted.
6. The final volatility values have been obtained by using the parameters generated by the optimization.
7. RMSE (Root Mean Squared Error) has been calculated by using the generated final volatility values to measure the forecast performance of the model.

The results could be successful in the model given the daily transactions for the foreign currency and index contracts and the thin market-based longer-term transactions for the stock contracts.

The volatilities generated as a result of the ITU volatility system being run each evening are scanned to the BISTECH system and the theoretical prices and consequently the risk arrays are obtained.

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