SPAN Risk Manager - Option Pricing Models

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Models Supported

The SPAN Risk Manager currently supports a variety of option pricing models, and is built so that new models can easily be added.

Each pricing model is assigned an identifier - for example, **BS** for the Black-Scholes model.

The descriptions below identify options as being either **European** (meaning exercise is only allowed at expiration) or **American** (meaning exercise is allowed at any time up to and including expiration.)

The models utilize three interest-rate values:

- the **risk-free rate** for borrowing or lending
- the **dividend-yield** -- the yield paid by the underlying asset
- the **cost of carry** -- the rate required to carry a position in the underlying asset.

The cost of carry is defined as the risk-free rate less the dividend yield.

The following pricing models are supported:

- **BS - Black-Scholes:** the basic equation for European options on physicals with no dividends (and hence with cost of carry equal to the risk-free interest rate).
- **B** - **Black:** the analogous equation for European options on futures (and hence cost of carry is zero).
- **M - Merton**: the generic equation for European options, in which risk-free rate and dividend can assume any values. The Black-Scholes model and the Black model are special cases of the Merton model for particular assumptions of interest rate.
- **W - Adesi-Whaley:** the Adesi-Whaley model for American options, also called just the "Whaley" model. Like the Merton model, this model allows risk-free rate and dividend yield (cost of carry) to assume any values.
- **WS - "Whaley-Scholes":** the Whaley model, but for options on physicals with no dividends, *ie*, dividend yield is zero.
- **WB - "Whaley-Black":** the Whaley model, but for options on futures, *ie,* cost of carry is zero.
- **CA** - **Cox-Ross-Rubinstein for American options**: the Cox-Ross-Rubinstein variant on the generic binomial model, for American options
- **CE - Cox-Ross-Rubinstein for European options:** the same thing, but for European-style expirations
- **I** - **Intrinsic Value**: sets option price to intrinsic value.

Calculations in Monetary Terms

The price of an option is not necessarily quoted in the same terms as the price of its underlying. Nor is the option necessarily defined as being only one **one** of its underlying instrument. And the currency of denomination of the option may not be the same as the currency for its underlying.

When running option pricing models in the forward direction (to calculate option prices and greeks) or in the reverse direction (to calculate implied volatilities), it is necessary always to ensure that the option value, underlying value, and exercise value are correctly specified.

To do so, the SPAN Risk Manager always does option pricing calculations in monetary terms. For example, to calculate an option implied volatility:

- The option's monetary value in its settlement currency is determined.
- The exact monetary value of the underlying of the option is determined and is expressed in the settlement currency of the option.
- Similarly, the exercise value for the option is determined, likewise in the settlement currency of the option.
- It is these monetary values which are fed to the option pricing model in order to determine the implied volatility.

The process is analogous for calculating theoretical option prices:

- The true underlying value and the exercise value are calculated in the option's settlement currency.
- These are fed to the option pricing model to determine the option's theoretical monetary value.
- The option monetary value is divided by the contract value factor for the option to calculate the theoretical price.
- The theoretical price is then rounded to the normal precision for quoting prices for that option. For example, if prices for a particular option product family are quoted to two decimal places, then the theoretical price is rounded to the nearest 0.01.
- The option theoretical value is then recalculated by multiplying the **rounded** theoretical price by its contract value factor.

(Given the normal conventions used for assigning the precision of option prices and the contract value factors, this last step ensures the theoretical value is always **exactly** equal to the product of the price times the contract value factor.)