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Power Option Valuation

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A standard power option has a nonlinear payoff at maturity. The payoff of a call is:

$$\text{Power call payoff} = \text{Max}\,[S^i - X, 0]$$

The payoff of a put is:

$$\text{Power put payoff} = \text{Max}\,[X - S^i, 0]$$

Where i is some power (i > 0).

The value of a power call option is given by the following equation (see Heynen and Kat, 1996c; Zhang, 1998; and Esser, 2003):

$$c = S^i e^{\left[(i-1)\left(r+i.\frac{\sigma^2}{2}\right)-i(r-b)\right]T}.N(d_1) - X\,e^{-rT}.N(d_2)$$

Similarly, the value of a power put option is given by:

$$p = X\,e^{-rT}.N(-d_2) - S^i e^{\left[(i-1)\left(r+i.\frac{\sigma^2}{2}\right)-i(r-b)\right]T}.N(-d_1)$$

Where:

$$d_1 = \frac{\ln(S/X^{1/i}) + (b + (i - \frac{1}{2})\sigma^2)T}{\sigma\sqrt{T}}$$

$$d_2 = d_1 - i\sigma\sqrt{T}$$

For example, consider a power call option with three months to maturity. The current underlying price is $10, the strike price is $100, the risk-free interest rate is 7%, the continuous dividend yield is 5.5%, and the expected volatility of the underlying stock is 40%. Raising to power 2, the value of this call would be calculated as follows:

$$d_1 = \frac{\ln\left(\frac{10}{100^{\frac{1}{2}}}\right) + \left(0.015 + \left(2 - \frac{1}{2}\right) \times 0.35^2\right)0.5}{0.35\sqrt{0.5}} = 0.1540$$

$$d_2 = 0.1540 - 2 \times 0.35\sqrt{0.5} = -0.0935$$

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- Digital Option Valuation
- Barrier Option Valuation
- Call Option Valuation
- Put Option Valuation

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