

Understanding and Pricing Vanilla Options

1 Introduction

Options are financial derivatives that give the holder the right, but not the obligation, to buy (in the case of a call option) or sell (in the case of a put option) an underlying asset at a specified price (the strike price) on or before a certain date (the expiration date). The value of an option is derived from the price of the underlying asset.

2 The Black-Scholes Model

The Black-Scholes model provides a theoretical estimate of the price of European-style options. The model assumes that the price of the underlying asset follows a geometric Brownian motion with constant drift and volatility. The formula for the price of a call option is given by:

$$C = S_0 N(d_1) - K e^{-rT} N(d_2) \quad (1)$$

where:

- C is the price of the call option
- S_0 is the current price of the underlying asset
- K is the strike price
- T is the time to maturity (in years)
- r is the risk-free interest rate (annual rate)
- σ is the volatility of the underlying asset's returns
- $N(\cdot)$ is the cumulative distribution function of the standard normal distribution
- $d_1 = \frac{\ln(S_0/K) + (r + \sigma^2/2)T}{\sigma\sqrt{T}}$
- $d_2 = d_1 - \sigma\sqrt{T}$

3 Numerical Example

Consider an option with the following parameters: $S_0 = 100$, $K = 80$, $T = 0.4$ years, $r = 0.08$ (8%), and $\sigma = 0.9$ (90% volatility). Using the Black-Scholes model, we can calculate the price of a call option as follows:

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Enter the current price of the underlying asset (S): 100
Enter the strike price of the option (K): 80
Enter the time to maturity in years (T): 0.4
Enter the annual risk-free interest rate (r): 0.08
Enter the volatility (sigma): 0.9
Enter the type of option ('call' or 'put'): call
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Current call option price: 33.00
Intrinsic value: 19.95
Time value: 13.05
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The calculated option price is \$33.00, which consists of an intrinsic value of \$19.95 and a time value of \$13.05.

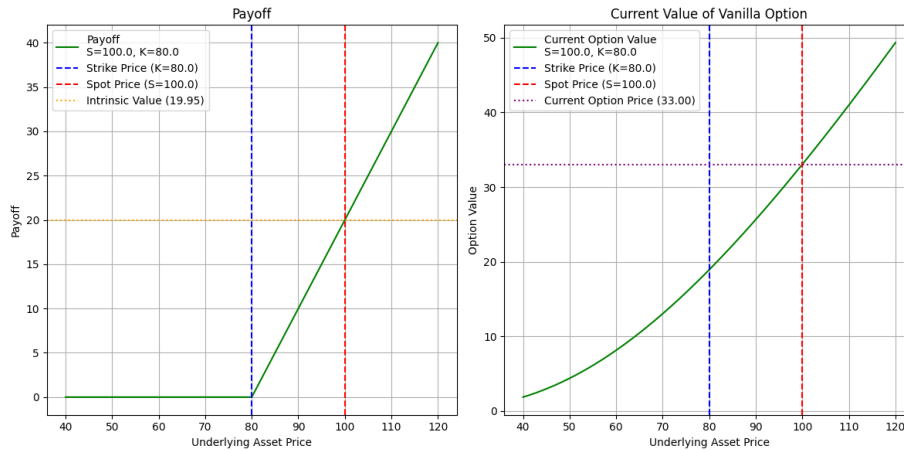


Figure 1: Enter Caption

4 Conclusion

The Black-Scholes model provides a foundational framework for the pricing of European options. By understanding the inputs and assumptions of the model, investors can estimate the fair value of options and make informed trading decisions.