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cf_put_merton

Let

- $T =$ maturity date $\quad (T > t)$
- $K =$ strike price
- $x =$ spot price
- $t =$ pricing date
- $\sigma =$ volatility
- $r =$ interest rate
- $\delta =$ dividend yields
- $\lambda =$ jump intensity
- $\mathbf{E}U =$ the expectation over the random jump variable U
- $\theta = T - t$

We assume [1]that the jump variable U is log-normally distributed with constant mean and variance . Specifically, let $\mathbf{E}[\ln U] = \mu$ and $\mathbf{E}[(\ln U)^2] = \mu^2 + \gamma^2$, such that $\mathbf{E}U = e^{\mu+\gamma^2}$.

Set:

$$d_1 = \frac{\log\left(\frac{x}{K}\right) + \left(r_n + \frac{\sigma_n^2}{2}\right)\theta}{\sigma_n\sqrt{\theta}} \qquad d_2 = d_1 - \sigma_n\sqrt{\theta},$$

where

$$\sigma_n^2 = \sigma^2 + \frac{n\gamma^2}{\theta} \qquad r_n = r - \delta - \lambda\mathbf{E}U + \frac{n}{\theta}\ln(1 + \mathbf{E}U).$$

and N as the cumulative normal distribution function:

$$N(d) = \frac{1}{\sqrt{2\pi}}\int_{-\infty}^{d} e^{-x^2/2}dx.$$

Put Option

PAYOFF	$P_T = (K - S_T)_+$
PRICE	$C(t,x;K) = \sum_{n=0}^{\infty} \frac{(\lambda(1+\mathbf{E}U)\theta)^n}{n!} e^{-\lambda(1+\mathbf{E}U)} [Ke^{-r_n\theta} N(-d_2) - xN(-d_1)]$
DELTA	$\dfrac{\partial C(t,x;K)}{\partial x} = -\sum_{n=0}^{\infty} \dfrac{(\lambda(1+\mathbf{E}U)\theta)^n}{n!} e^{-\lambda(1+\mathbf{E}U)} N(-d_1)$

References

[1] R.C.MERTON. Option pricing when the underlying stocks returns are discontinuous. *Journ. Financ. Econ.*, 5:125–144, 1976. 1