

# Merton's Jump-Diffusion Model

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## 1 Stochastic Differential Equation for $S_t$

In Merton's jump-diffusion model for option pricing, the price process of an underlying asset  $S_t$  is assumed to follow the stochastic differential equation (sde)

$$dS_t = \mu S_t dt + \sigma S_t dW_t + S_t \cdot d \left( \sum_{j=0}^{N(t)} (V_j - 1) \right) .$$

where  $V_j$  are i.i.d. log-normal random variables. This SDE can be solved to obtain

$$S_t = S_0 \exp \left\{ \left( \mu - \frac{1}{2} \sigma^2 \right) t + \sigma W_t \right\} \prod_{j=0}^{N(t)} V_j .$$

Set  $Y_j \equiv \log V_j \sim N(\alpha, \beta^2)$  and rewrite  $S_t$  to obtain

$$X_t \equiv \log \frac{S_t}{S_0} = \left( \mu - \frac{\sigma^2}{2} \right) t + \sigma W_t + \sum_{j=0}^{N(t)} Y_j .$$

## 2 The Characteristic Function of $X_t$

Since  $W_t$ ,  $N(t)$ ,  $Y_j$  are mutually independent, the characteristic function of  $X_t$  is

$$\begin{aligned} \mathbb{E} \left( e^{iuX_t} \right) &= \mathbb{E} \left( e^{iu \left( \mu - \frac{\sigma^2}{2} \right) t} \right) \mathbb{E} \left( e^{i\sigma u W_t} \right) \mathbb{E} \left( \exp \left\{ iu \sum_{j=0}^{N(t)} Y_j \right\} \right) \\ &= e^{iu \left( \mu - \frac{\sigma^2}{2} \right) t} e^{-\frac{\sigma^2 u^2}{2} t} \mathbb{E} \left( \exp \left\{ iu \sum_{j=0}^{N(t)} Y_j \right\} \right) . \end{aligned}$$

# Introduction To Merton Jump Diffusion Model Matsuda Lab

**Y Pai**



**Introduction To Merton Jump Diffusion Model Matsuda Lab:**

*Energy Power Risk* George Levy, 2018-12-10 The book describes both mathematical and computational tools for energy and power risk management deriving from first principles stochastic models for simulating commodity risk and how to design robust C to implement these models

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