



# VaR Introduction III: Monte Carlo VaR

# Monte Carlo VaR

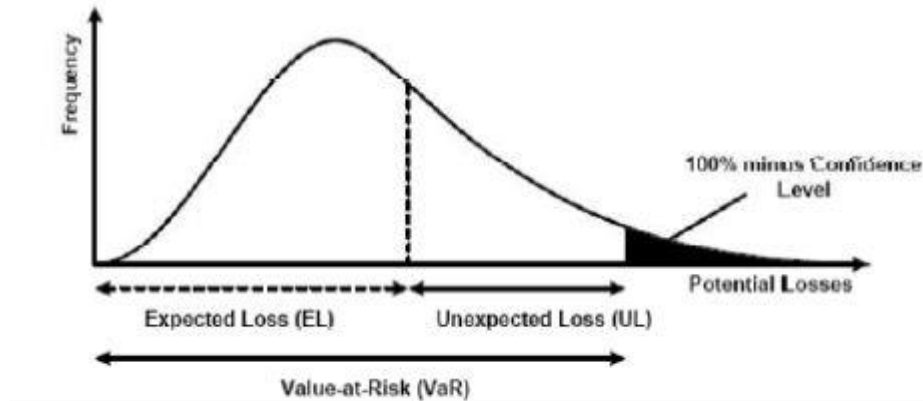
## Summary

- ◆ VaR Definition
- ◆ VaR Roles
- ◆ VaR Pros and Cons
- ◆ VaR Approaches
- ◆ Monte Carlo VaR
- ◆ Monte Carlo VaR Methodology and Implementation
- ◆ VaR Scaling
- ◆ VaR Backtest

# Monte Carlo VaR

## Value at Risk (VaR) Definition

- ◆ The maximum likely loss on a portfolio for a given probability defined as  $x\%$  confidence level over  $N$  days
- ◆  $\Pr(\text{Loss} > \text{VaR}(x\%)) < 1 - x\%$



# Monte Carlo VaR

## VaR Roles

- ◆ Risk measurement
- ◆ Risk management
- ◆ Risk control
- ◆ Financial reporting
- ◆ Regulatory and economic capital

## VaR Pros & Cons

- ◆ Pros
  - ◆ Regulatory measurement for market risk
  - ◆ Objective assessment
  - ◆ Intuition and clear interpretation
  - ◆ Consistent and flexible measurement
- ◆ Cons
  - ◆ Doesn't measure risk beyond the confidence level: tail risk
  - ◆ Non sub-additive

## Three VaR Approaches

- ◆ Parametric VaR
- ◆ Historical VaR
- ◆ Monte Carlo VaR

The presentation focuses on historical VaR.

# Monte Carlo VaR

## Monte Carlo VaR

### ◆ Assumption

Assuming market factors follow certain stochastic processes.

### ◆ Pros

- ◆ Easy back and stress test
- ◆ Good for high confidence level and tail risk

### ◆ Cons

- ◆ Dependent on distribution assumption
- ◆ Calibration required
- ◆ Extensive computation

## Monte Carlo VaR Methodology and Implementation

- ◆ Assume each market factor follows certain stochastic process:  $\vartheta(\sigma_i W_i)$  where  $W$  is a Wiener process
- ◆ Calibrate volatility  $\sigma_i$  for each market factor and pair-wise correlation  $\rho_{ij}$  for any two market factors
- ◆ Simulate market factor changes  $\delta_i$  based on the stochastic processes and correlated random variables.
- ◆ Generate market scenarios  $x_i = x_0 \delta_i$
- ◆ Compute scenario PVs:  $P(x_i)$  and scenario P&L:  $P(x_i) - P(x_0)$
- ◆ Sort all scenario P&Ls. The VaR is the number at 1% lowest level



## VaR Scaling

- ◆ Normally firms compute 1-day 99% VaR
- ◆ Regulators require 10-day 99% VaR
- ◆ Under IID assumption, 10-day VaR =  $\sqrt{10} * VaR_{1-day}$

## VaR Backtest

- ◆ The only way to verify a VaR system is to backtest
- ◆ At a certain day, compute hypothetical P&L. If (hypothetical P&L > VaR) → breach, otherwise, ok
- ◆ Hypothetic P&L is computed by holding valuation date and portfolio unchanged
- ◆ In one year period,
  - ◆ If number of breaches is 0-4, the VaR system is in Green zone
  - ◆ If number of breaches is 5-9, the VaR system is in Yellow zone
  - ◆ If number of breaches is 10 or more, the VaR system is in Red zone



# Thanks!



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