VaR Introduction III: Monte Carlo VaR
Monte Carlo VaR

Summary

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◆ VaR Approaches
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◆ Monte Carlo VaR Methodology and Implementation
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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

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Monte Carlo VaR

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.

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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

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Monte Carlo VaR Methodology and Implementation

- Assume each market factor follows certain stochastic process: \( \theta(\sigma_i W_i) \) 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.

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Monte Carlo VaR

VaR Scaling

- Normally firms compute 1-day 99% VaR
- Regulators require 10-day 99% VaR
- Under IID assumption, 10-day VaR = \( \sqrt{10} \times \text{VaR}_{1\text{-day}} \)

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VaR Backtest

- The only way to verify a VaR system is to backtest
- At a certain day, compute hypothetic P&L. If (hypothetic 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

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