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# VaR Introduction II: Historical VaR

# Historical VaR

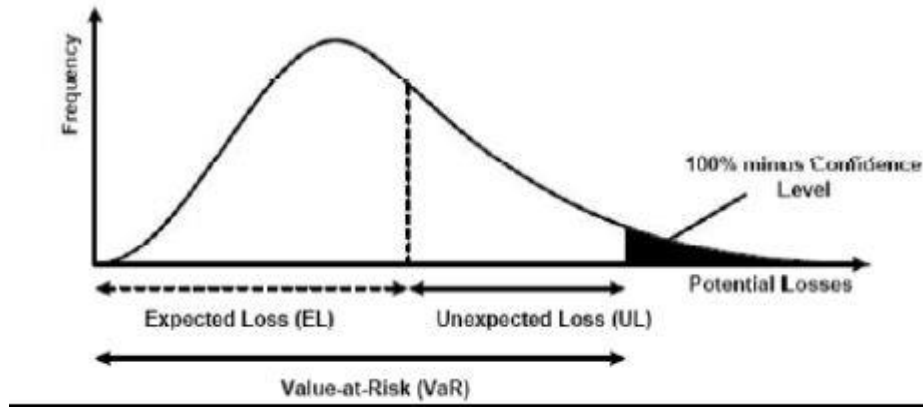
## Summary

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

# Historical 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
- ◆  $\Pr(\text{Loss} > \text{VaR}(x\%)) < 1 - x\%$



# Historical VaR

## VaR Roles

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

# Historical 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

# Historical VaR

## Three VaR Approaches

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

The presentation focuses on historical VaR.

# Historical VaR

## Historical VaR

### ◆ Assumption

The past is a good indicator of the near-future or history repeats itself

### ◆ Pros

- ◆ Simple and intuitive
- ◆ Easy back and stress test
- ◆ No distribution assumption
- ◆ No calibration

### ◆ Cons

- ◆ Poor accuracy for higher confidence level and tail risk
- ◆ Difficult for long horizons
- ◆ Limited scenario

# Historical VaR

## Historical VaR Methodology and Implementation

- ◆ Obtain one year historical value time series of all market factors, such as a stock price time series is  $\bar{x}_1 \cdots \bar{x}_{251}$
- ◆ Assuming today's value is  $x_0$ , generate 250 historical scenarios. The  $i$ -th is  $x_i = (\bar{x}_i / \bar{x}_{i-1} - 1)x_0$
- ◆ Compute base PV at today  $t$  as  $P(x_0)$
- ◆ Compute 250 scenario PVs:  $P(x_i)$
- ◆ Compute 250 scenario P&L:  $P(x_i) - P(x_0)$
- ◆ Sort 250 scenario P&L. The VaR is the average between 2<sup>nd</sup> and 3<sup>rd</sup> lowest (negative) numbers



## 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
- ◆ Hypothetical 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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