Illustration of VaR backtesting

Risk Management in Banking
HSE & LSE

Artem Ilin Dec 23

Value At Risk

- Value at risk (VaR) is a statistic that quantifies the extent of possible financial losses over a specific time frame.

Advantages	Disadvantages
• It is a single easily interpreted number, expressed in % or $. • Can be compared across different types of assets. • Due to popularity, VaR is often included and calculated in various financial software tools.	• No standard protocol for the statistics used to determine the risk, rarely account for extreme or black swan events. • Criticized for offering a false sense of security: most likely outcome isn't always the actual outcome.

Portfolio Construction

BlackRock (BLK)

MOLSON COORS beverage company (TAP)

TESLA (TSLA)

	Asets			Returns			
Date	BLK	TAP	TSLA	BLK	TAP	TSLA	Portfolio
16.12.2021	870,92	42,53	308,97				
17.12.2021	863,38	42,28	310,86	-0,87%	-0,58%	0,61%	-0,19%
20.12.2021	847,99	41,00	299,98	-1,78%	-3,04%	-3,50%	-2,85%
21.12.2021	860,83	42,09	312,84	1,51%	2,67%	4,29%	2,97%
22.12.2021	861,46	42,21	336,29	0,07%	0,27%	7,49%	3,10%
23.12.2021	863,71	43,09	355,67	0,26%	2,08%	5,76%	3,01%
27.12.2021	871,88	43,17	364,65	0,95%	0,20%	2,52%	1,35%
28.12.2021	871,17	43,26	362,82	-0,08%	0,20%	-0,50%	-0,17%
29.12.2021	859,74	43,43	362,06	-1,31%	0,39%	-0,21%	-0,36%
30.12.2021	863,56	43,38	356,78	0,44%	-0,11%	-1,46%	-0,48%
31.12.2021	865,26	43,80	352,26	0,20%	0,98%	-1,27%	-0,15%
03.01.2022	861,64	44,75	399,93	-0,42%	2,16%	13,53%	5,93%
04.01.2022	866,83	46,21	383,20	0,60%	3,27%	-4,18%	-0,51%

Timeseries of prices and returns

$$r_{portfolio} = w_{BLK} \times r_{BLK} + w_{TAP} \times r_{TAP} + w_{TSLA} \times r_{TSLA}$$

Historical Method

$$\text{Historical VaR}_{p\%} = \left|\text{Quantile}_{p\%}(r_1, r_2, \ldots, r_n)\right|$$

CI	Hist VaR (%)	Hist VaR ($)
90 %	2.39	2388.86
95 %	3.26	3256.59
97.5 %	4.27	4272.91
99 %	5.04	5040.18

Advantages	Disadvantages
• Simple and Intuitive • Reflects Real Market Conditions • No Distributional Assumptions • Captures Nonlinearities and Tail Events	• No Forward-Looking Information • Sensitive to Sample Size • Assumes Stationarity • Ignores Structural Changes • No Confidence Intervals

Parametric & Cornish-Fisher Methods

$$\text{Parametric VaR} = |\mu - \text{Z-Score} \times \sigma|$$

$$\text{Modified (Cornish-Fisher) VaR} = |\mu - \text{Adjusted Z-Score} \times \sigma|$$

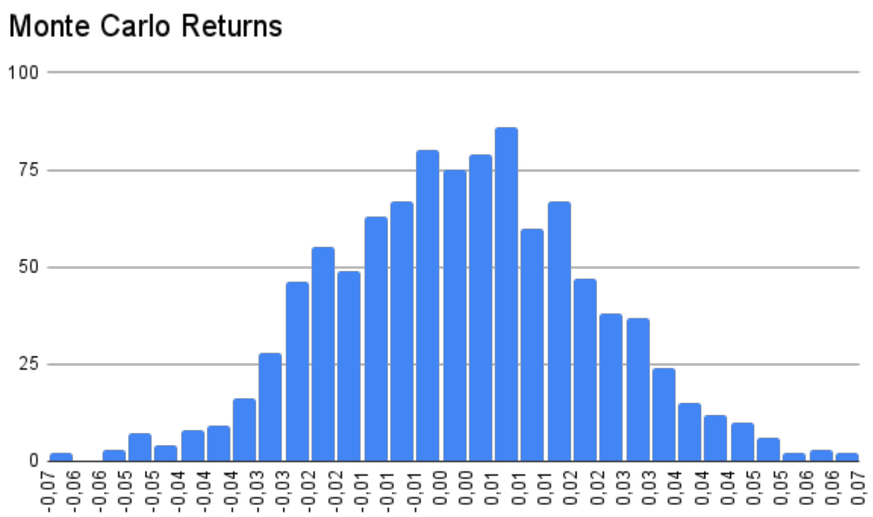
$$\text{Adjusted Z-Score} = \text{Z-Score} + \frac{1}{6}(\text{Z-Score}^2 - 1) \times \text{Skewness} + \frac{1}{24}(\text{Z-Score}^3 - 3\text{Z-Score}) \times \text{Kurtosis} - \frac{1}{36}(\text{Z-Score}^4 - 6\text{Z-Score}^2 + 3) \times \text{Skewness}^2$$

VCV	
Advantages	**Disadvantages**
• Analytical and Efficient • Useful for Normally Distributed Returns • Provides Confidence Intervals	• Normality Assumption • Sensitive to Outliers • Not Robust to Non-Normal Distributions • Ignores Changes in Volatility

CF	
Advantages	**Disadvantages**
• Adjustment for Non-Normality • Improved Accuracy • Tailored to Portfolio Characteristics •	• Sensitivity to Extreme Values • Assumption of Stationarity • Complexity

Monte Carlo Method

$$\text{MC VaR} = |\text{Quantile}(\text{Portfolio Returns})|$$

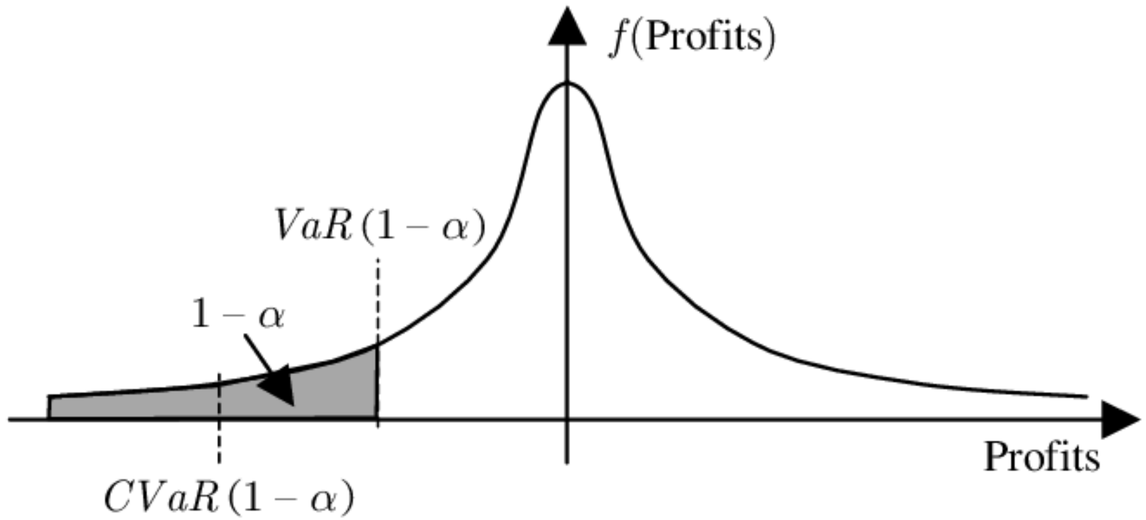


MC Simulation on 1000 Scenarios

Advantages	Disadvantages
• Flexibility • Incorporation of Tail Risk • Scenario Analysis • Handling Non-Normal Distributions	• Computational Intensity • Data Requirements • Potential for "Garbage In, Garbage Out”

Conditional Value At Risk

- The Conditional Value at Risk (CVaR), also known as Expected Shortfall (ES), is the expected value of losses exceeding the Value at Risk (VaR).



VaR & CVaR Illustrations

Kupiec & Standard Coverage Tests

- The Kupiec test is based on the binomial distribution, it assesses whether the observed number of exceptions falls within the expected range.

- $$\text{Kupiec Test Statistic} = -2 \cdot \left(\ln(1-p) + n_e \cdot \ln\left(\frac{1-\alpha}{p}\right) \right)$$

- The Standard Coverage Test assesses the consistency between the actual and expected number of exceptions using a chi-squared statistic.

- $$\chi^2 = \frac{(n_e - n \cdot p)^2}{n \cdot p \cdot (1-p)}$$