# **Monte Carlo Value at Risk (VaR) Simulation**

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**Model Title:** Monte Carlo Method for Portfolio VaR  
**Tool Used:** Microsoft Excel (Standard Deviation, Covariance, Data Table, Histogram)  
**File Attached:** Monte Carlo Method Value at Risk (VaR).xlsx  
**Portfolio Composition:** SPY (S&P 500 ETF) & BND (Vanguard Total Bond ETF)

Objective

The purpose of this model is to estimate **Value at Risk (VaR)** for a two-asset portfolio (equities and bonds) using the **Monte Carlo Simulation method** in Excel. This approach generates thousands of potential market scenarios and quantifies the worst-expected portfolio loss within a chosen confidence interval.

This probabilistic framework is highly applicable to firms like **Fasanara Capital**, where understanding tail risk and scenario distribution is critical for structured credit and digital lending risk management.

Portfolio Setup & Assumptions

| **Parameter** | **Value** |
| --- | --- |
| Portfolio Value | $100,000 |
| Asset 1 | SPY (S&P 500 ETF) – 60% weight |
| Asset 2 | BND (Bond ETF) – 40% weight |
| SPY Expected Return | 7% annually |
| BND Expected Return | 2% annually |
| SPY Volatility | Annualized from daily returns |
| BND Volatility | Annualized from daily returns |
| Covariance | Annualized from daily returns |
| VaR Time Horizon | 10 trading days |
| Confidence Levels | 90%, 95%, 99% |

Methodology

Daily Return Data

Daily closing prices for SPY and BND were imported and converted to daily returns:

Return = (Next days price - Previous days price) / Previous days price

Annualized Risk Measures for 252 trading days

* Expected Return:

An accurate measurement of the annual expected return

* **Standard Deviation:**  
  Calculated using =STDEV.S(range) and then annualized via multiplying 252^.5
* Covariance: of both the S&P 500 INDEX AND TOTAL BOND MARKET:  
  Calculated using =COVARIANCE.S(range1, range2) both arrays of data and multiplied by 252

Portfolio Variance & Standard Deviation

Portfolio Value: $100,000

Portfolio variance was computed using the formula:

σ²\_p = w₁²σ₁² + w₂²σ₂² + 2w₁w₂Cov₁₂

=60%^2 \* SPY.ST.Dev.^2 + 40%^2 \* BND.ST.Dev.^2 + 2\*60%\*40%\*Covariance

Then, portfolio volatility was extracted by taking the square root:

Portfolio Std Dev = (Portfolio Variance)^0.5

**Expected Return Over 10 Days**

Weighted average return scaled to 10 days:

Expected Return = (w₁r₁ + w₂r₂) × (10 / 252)

=(10/252) \* 100,000 \* ((7%\*60%)+(2%\*40%))

Monte Carlo Simulation (10,000 Scenarios)

* For each iteration:
  + 20 day trading period
  + A **Z-score** (random) is drawn from a standard normal distribution:  
    =NORM.S.INV(RAND())    ==NORM.S.INV(confidence interval
  + Scenario VaR is calculated:
  + Scenario VaR = Expected Return - (Portfolio Value \* total porfolio st.dev. \* Z-Score \* (20/252)^.5
* Excel’s Data Table function generates **10,000 scenario-based VaR results**:

**Implementation in Excel**: After generating the Z-scores and scenario VaRs in a column, select the full range using **Ctrl + Shift + Down** > Go to **Data → What-If Analysis → Data Table** > For the **Column Input Cell**, select any **blank cell** to trigger the simulation (this tricks Excel into recalculating the random values). > Excel then performs **10,000 simulations**, recalculating each time with a new Z-score. > The result: **10,000 unique scenario-based VaR values** based on the Monte Carlo approach.

Monte Carlo VaR Extraction

Using:

=PERCENTILE.INC(range, 1 - confidence\_level)

Example outputs:

| **Confidence Level** | **Monte Carlo VaR (20 Days)** |
| --- | --- |
| 95% | $(3,910.64) |
| 90% | $(2,955.43) |
| 99% | $(5,617.63) |

IF you ReRun this by pressing fn + F9 or just F9 you will see that this monte carlo VaR keeps on updating but its always around a similar value

Visual Output: VaR Distribution Histogram

A histogram of the 10,000 simulations shows a normal bell-shaped curve centered around the expected return, with the **left tail** representing losses (VaR region).

Observations:

* **Fifth percentile** aligns closely with calculated 95% VaR
* Model dynamically shifts based on confidence level
* Users can update confidence inputs and re-run simulations using F9

Historical Method: Value at Risk (VaR)

Overview

This method calculates VaR based directly on past market performance—no assumptions about normal distribution or volatility modeling required. It answers the question: *"What’s the worst expected loss (with X% confidence) based on actual history?"*

Step-by-Step Process

Import Historical Prices

* **SPY (Equity)** and **BND (Bond)** represent the equity and fixed income components.
* One year of daily closing price data is used for both.

Calculate Daily Returns

* Daily returns are calculated as:  
  Daily Return = (Price\_today - Price\_yesterday) / Price\_yesterday

Use Ctrl + Shift + Down Arrow, Ctrl + V to paste in these long colums

* Applied to both SPY and BND columns to generate historical return series.

Define Portfolio Assumptions

| **Parameter** | **Value** |
| --- | --- |
| Portfolio Value | $100,000 |
| SPY Weight | 60% |
| BND Weight | 40% |
| Confidence Interval | 99% |

Compute Daily Profit/Loss

* Assume the portfolio is rebalanced daily.
* Formula:  
  P/L = Portfolio Value × ((Weight\_SPY × SPY Return) +(Weight\_BND × BND Return))
* Every cell in column L should be Absolute / locked: =$L$6\*(($L$7\*D7)+($L$8\*G7))
* This generates a time series of daily profits and losses.

Calculate Historical VaR

* Excel Function:  
  =PERCENTILE.INC(Range\_of\_PnL, 1 - Confidence Level)

=PERCENTILE.INC(I7:I257,1-L9)

* For 99% CI, this calculates the 1st percentile (worst 1%) of daily losses.
* **Example (from sheet):**  
  **VaR = $(1,429.96)**

Visualize the Distribution

* Inserted a histogram of daily P/L values.
* Visually identifies where the VaR lies in the return distribution.
* As the confidence level increases (e.g., from 90% to 99%), the VaR shifts further into the tail.

Key Benefits

* Simple and intuitive.
* No model risk, relies solely on historical data.
* Assumes returns from the past are representative of potential future losses.

Interpretation & Insights

* **Monte Carlo VaR** provides a flexible, scenario-based measure of downside risk
* The simulated distribution offers richer insight than single-scenario (parametric) models
* The model can be adapted to portfolios with more assets or to include **non-normal distributions**

Deliverables

* **Model**: Monte Carlo Method Value at Risk (VaR).xlsx:

Includes all formulas, simulations, percentile outputs, and histogram

* Confidence-level toggles for flexible stress testing
* Expandable for multi-asset or historical methods

Final Notes

This VaR simulator offers a **highly adaptable framework** for risk analysis. It helps quantify worst-case scenarios and build a robust understanding of tail risk, a critical requirement in today's volatile macro environment.

For firms managing credit exposure or perhaps algorithmic volatility strategies, this Monte Carlo-based VaR engine is a core risk control tool.