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Topic: Risk Management and Backtesting: Estimating VaR for MBB Stock

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1. Introduction

This report focuses on evaluating the Value at Risk (VaR) for the MBB stock using historical data from January 1, 2023, to April 29, 2025. VaR is a widely used risk management tool to quantify the potential loss in the value of an asset or portfolio over a given time horizon at a specified confidence level. In this analysis, we estimate VaR using three different methods: parametric normal distribution, parametric t-distribution, and historical simulation on the return series. The first year of data (2023) is used to calculate VaR, while the remaining data (2024–2025) is reserved for backtesting the models. The objective is to assess the accuracy of these models in predicting market risk, using various backtesting metrics such as violation ratios, RMSE, MAPE, and statistical tests like Kupiec and Conditional Coverage.

2. Data Collection

The dataset was obtained using Excel's STOCKHISTORY function, retrieving the daily closing prices of the stock symbol MBB from January 1, 2023 to April 29, 2025.

- The data from January 1, 2023 to January 1, 2024 was used to estimate VaR models.
- The data from January 2, 2024 to April 29, 2025 was used for VaR backtesting.
- The return series was calculated using log returns, which serves as the input for risk estimation.

3. VaR Calculation Methods

To estimate the 1-day Value at Risk (VaR) at the 99% confidence level, three different approaches were implemented using the log return series of the MBB stock:

- Parametric VaR (Normal Distribution): This method assumes that returns are normally distributed. The VaR is calculated using the mean and standard deviation of returns, along with the inverse of the cumulative distribution function (CDF) of the normal distribution.

- Parametric VaR (Student’s t-Distribution): This method accounts for potential heavy tails in the return distribution by assuming a Student’s t-distribution. The parameters are estimated via maximum likelihood, and the VaR is computed using the inverse CDF of the t-distribution.
- Historical Simulation (Non-Parametric VaR): This method does not rely on any distributional assumptions. It calculates VaR directly from the empirical distribution of historical returns by taking the α-quantile.

Results (VaR estimates at 99% confidence level):

- Normal distribution: −3.55%
- Student’s t-distribution: −4.12%
- Historical simulation: −3.41%

These results represent the estimated potential one-day loss (as a percentage of portfolio value) under each method. The Student’s t-based VaR is the most conservative, capturing more tail risk than the Normal or Historical methods.

4. Backtesting of VaR Models

To evaluate the accuracy of the VaR models, backtesting was conducted using the out-of-sample data (from January 2, 2024 to April 29, 2025). The key metrics used for model evaluation include:

- Violation Ratio (VR): Proportion of days where actual losses exceeded the predicted VaR.
- Root Mean Squared Error (RMSE): Measures the average magnitude of forecast errors.
- Mean Absolute Percentage Error (MAPE): Provides an average percentage error relative to the predicted VaR.
- Kupiec Test (LR Statistic): A likelihood ratio test that assesses whether the observed violation frequency matches the expected frequency under the 99% confidence level.

- Conditional Coverage Test (LR): jointly assesses both the correct frequency and the independence of violations.

Backtesting Results Summary:

	Model	VaR	VR	RMSE	MAPE	LR Kupiec	LR Conditional
0	Parametric Normal	-0.035508	0.018293	0.039919	1.051621	1.829840	0.224312
1	Parametric t	-0.041157	0.015244	0.045161	1.040223	0.785072	0.155286
2	Historical Simulation	-0.034066	0.018293	0.038599	1.055355	1.829840	0.224312

Comments:

- The Parametric t-distribution model demonstrates the best statistical backtesting performance. Its violation ratio (1.52%) is closest to the expected 1%. It achieves the lowest LR values for both the Kupiec and Conditional Coverage tests, indicating accurate coverage and independent breaches. However, it records the highest RMSE, meaning it has larger average errors in magnitude.
- Both the Parametric Normal and Historical Simulation models yield identical VR (1.83%), LR Kupiec, and LR Conditional values, suggesting similar behavior in terms of coverage accuracy and violation independence. Between them, the historical model has the lowest RMSE and MAPE, indicating better predictive precision for loss magnitude. However, both models slightly overestimate VaR breaches, as the violation rate exceeds the 1% threshold.

In summary, while the t-distribution model shows the best statistical consistency with the expected risk level, the historical simulation model offers greater accuracy in magnitude prediction. Depending on the objective—regulatory alignment or forecast precision—either model may be appropriate. The normal model appears less robust in tail-risk estimation.

5. Conclusion

The backtesting results show that the parametric t-distribution model is the most reliable in terms of matching the expected violation rate and statistical accuracy, though it has higher forecast errors in loss magnitude. The historical simulation model offers the best precision in predicting loss sizes, but slightly overestimates the violation rate. The parametric normal model, while simple, underperforms in both capturing extreme risks and violation frequency. For regulatory compliance, the t-distribution model is the best choice, while for more accurate loss forecasting, the historical simulation is recommended. The normal model is less suitable for critical risk management needs.