

Procter & Gamble Risk Assessment using Value-at- Risk (VaR) (NYSE: PG)

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Executive Summary

Procter & Gamble Co (NYSE: PG)

Risk analysis plays a crucial role in investment decision-making by providing valuable insights into the potential losses and volatility associated with a portfolio. It allows investors to understand and quantify the risks involved, which is essential for managing risk exposure and making informed investment decisions. By evaluating various risk measures such as Value at Risk (VaR), Expected Shortfall (ES), and other metrics, investors can assess the downside potential and plan risk mitigation strategies accordingly.

The findings in this report provide valuable insights into the risk exposure and potential losses associated with the Procter & Gamble Co. (NYSE: PG). It is crucial to note that these predictions and analysis are based on historical data and assumptions, and future market conditions may vary.

To gain a more comprehensive understanding of the risk and return dynamics, it is recommended to consider other risk metrics, diversification strategies, and additional factors such as fundamental analysis and market trends.

Introduction

Procter & Gamble Co (NYSE: PG)

The objective of this analysis is to conduct a comprehensive risk assessment for the Procter & Gamble (PG) stock using data from January 01, 2023, to January 01, 2024, equivalent to 250 trading days.

Key Metrics:

- **VaR:** The VaR estimates the potential loss in the PG portfolio. The VaR parametric are calculated at three confidence levels of 90%, 95% and 99%, and three holding period of 1, 5 and 10 days.
- **Expected Shortfall (CVaR):** The Expected Shortfall (ES) measures the average loss that exceeds the VaR threshold.
- **t-Dist VaR:** The t-Dist VaR considers fat tails and extreme events using a t-distribution assumption, offering an alternative estimate of potential losses.
- **Lognormal VaR for Short Portfolio:** For short portfolios, the lognormal VaR measures potential losses, aiding in assessing downside risk associated with shorting.
- **Monte Carlo VaR & Simulation:** Monte Carlo simulation estimates the VaR of the PG portfolio, considering various uncertainties. Monte Carlo simulation representing potential future scenarios for the adjusted closing price. Each path represents a potential trajectory of the adjusted closing price over time.

PG Adjusted Closing Price (2023-2024)



Methodology

Procter & Gamble Co (NYSE: PG)

Data Sources and Time Period:

The data used for this analysis was sourced from Yahoo Finance API from January 01, 2023, to January 01, 2024.

PnL Vector:

The analysis assumes \$10,000 portfolio (P = \$10,000) with value P is constant.

Analytical Techniques and Calculations:

Arithmetic and Geometric Returns:

- The arithmetic return calculates the average return over a given period.
- The geometric return takes into account the compounding effect of returns.

$$\text{Arithmetic } Ri = \frac{X_i}{X_{i-1}} - 1 \qquad \text{Geometric } Ri = \ln \frac{X_i}{X_{i-1}}$$

Value at Risk (VaR):

$$VaR(h, 1 - \alpha) = -(h\mu - \sqrt{h}\sigma z_{1-\alpha})P_{t-1}$$

where h is the holding period (1, 5 and 10 days), μ is the arithmetic returns, σ is the standard deviation.

Using Kurtosis of the arithmetic returns, degree of Freedom is calculated as:

$$v = \frac{6 + 4K}{K}$$

where v = degrees of freedom and K = Excess Kurtosis. Assume t-distribution for the arithmetic returns with v degrees of freedom from above.

Student t-Dist VaR:

$$VaR(h, 1 - \alpha) = P_{t-1} \left(-h\mu + \sqrt{h} \sqrt{\frac{v-2}{v}} \sigma t_{1-\alpha, v} \right)$$

Expected Shortfall:

$$ES = -P_{t-1} \left(\mu - \frac{\phi(-z_\alpha)}{F(z_\alpha)} \cdot \sigma \right) \qquad \frac{\phi(-z_\alpha)}{F(z_\alpha)} = \frac{\frac{1}{\sqrt{2\pi}} e^{-\frac{z^2}{2}}}{\alpha}$$

Lognormal VaR for short portfolio:

$$VaR(h, 1 - \alpha) = P_{t-1} (1 - \text{Exp}[h\mu_r + \sqrt{h}\sigma_r z_{1-\alpha}])$$

Summary Statistics for PG

Statistics	Arithmetic Return	Geometric Return	PnL
Number of observations	250	250	250
Average (Mean)	0.055	0.047	5.533
Median	0.059	nan	5.916
Standard Deviation	0.95	0.95	94.72
Maximum	4.14	4.14	413.91
Minimum	-3.49	-3.49	-348.55
Range	7.625	7.625	762.45
Skewness	0.31	0.3	0.31
Kurtosis	2.4	2.4	2.4

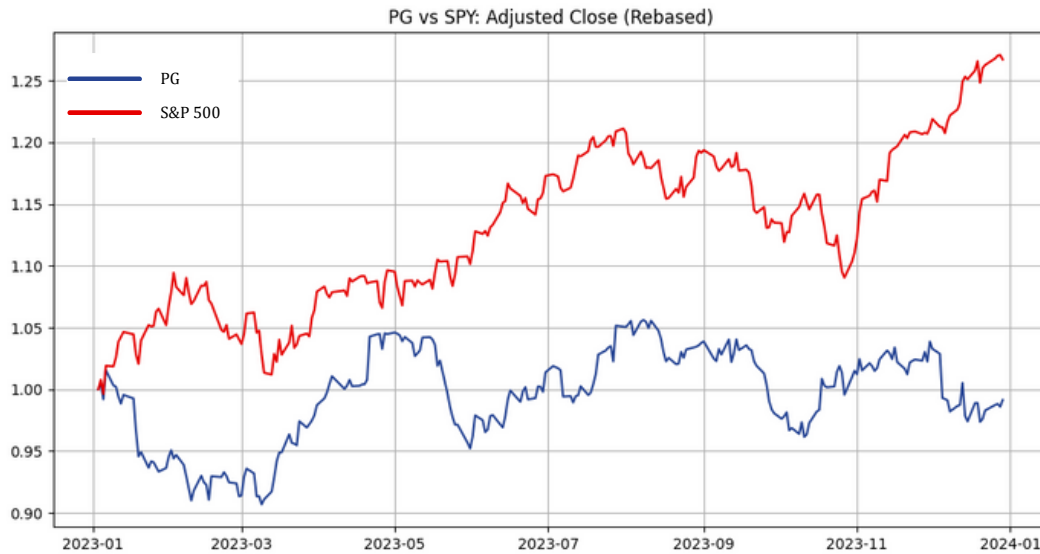
Results and Analysis

Procter & Gamble Co (NYSE: PG)

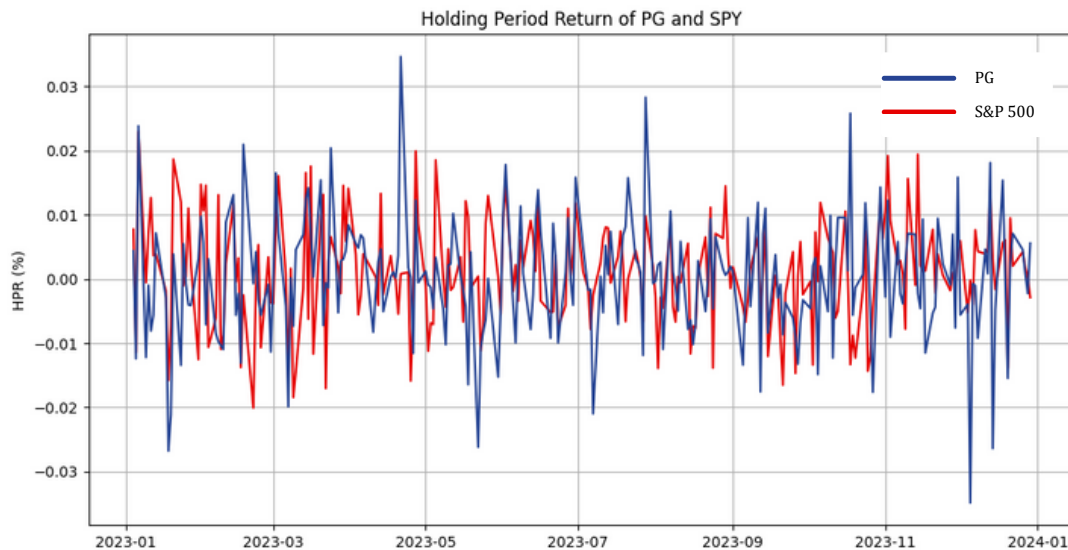
Holding Period Return and Volatility:

- The computed arithmetic return for the PG portfolio over the analysis period is 0.055%. PG stock underperformed comparing to the average return of the market S&P 500 (SPY) of 0.098% over the same period.
- The standard deviation of the S&P 500 (0.825%) is lower than that of the PG portfolio (0.95%), indicating that the S&P 500 had lower volatility compared to the PG portfolio.

Price Performance (2023-2024) (Rebased)



Holding Period Return PG v SPY (2023-2024)



- The skewness of the S&P500 (-0.27) suggests a slightly left-skewed distribution, compare to the skewness of the PG portfolio (0.31). During the trading period, S&P500 experienced more extreme loss, and PG yield more extreme alpha.
- The kurtosis of the S&P 500 (-1.16) indicates a distribution with more extreme fat tails compared to the PG portfolio (2.4). This implies that the PG portfolio follow the standard normal distribution relatively more than the S&P 500.

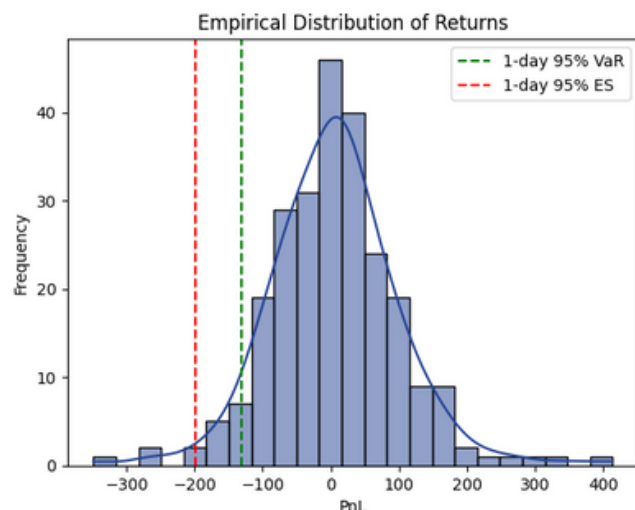
Value-at-Risk:

	Normal	Lognormal Short	t-Dist	Monte Carlo	Expected Shortfall
1-day 90%	\$115.86	\$184.87	\$106.87	\$110.94	\$155.72
1-day 95%	\$150.27	\$236.99	\$145.53	\$126.23	\$199.1
1-day 99%	\$214.82	\$335.48	\$235.91	\$166.22	\$306.19
5-day 95%	\$320.72	\$546.82	\$310.11	\$304	\$995.5
10-day 99%	\$641.49	\$1123.62	\$708.17	\$782	\$3061.89

The normal VaR results for 1-day 95%, 5-day 95% and 10-day 99% can be interpreted as follow:

- At a 95% confidence level, there is a 5% chance of experiencing a loss greater than \$115.86 in a single day based on the normal distribution assumption.
- At a 95% confidence level, there is a 5% chance of experiencing a loss greater than \$320.72 based on the normal distribution assumption.
- At a 99% confidence level and over a 10-day period, there is a 1% chance of experiencing a loss greater than \$641.49 based on the normal distribution assumption.

Expected Shortfall (ES) is designed to complement the limitations of VaR. VaR models typically rely on normal asset returns and are ineffective during periods of extreme price volatility. At the 1-day 95% confidence level, the Expected Shortfall is \$199.1, which means that if losses exceed the VaR level, the average loss is expected to be \$199.1.



As we observe further into 5-day 95% and 10-day 99% confident level, we can see the magnitude of ES loss \$995.5 and \$3061.89 compare to VaR at \$320.72 and \$641.49 respectively.

Conclusion

Procter & Gamble Co (NYSE: PG)

Financial risk encompasses various uncertainties and probabilities surrounding potential outcomes, making it a complex concept to define precisely. This paper aims to provide a valuable snapshot into the risk and performance characteristics of the Procter & Gamble Company stock. The paper uses Value-at Risk (VaR), including Normal VaR, Lognormal Short VaR, Monte Carlo, and Expected Shortfall (ES) in attempt to calculate comprehensive understandings of the potential losses and downside risks associated with the stock.

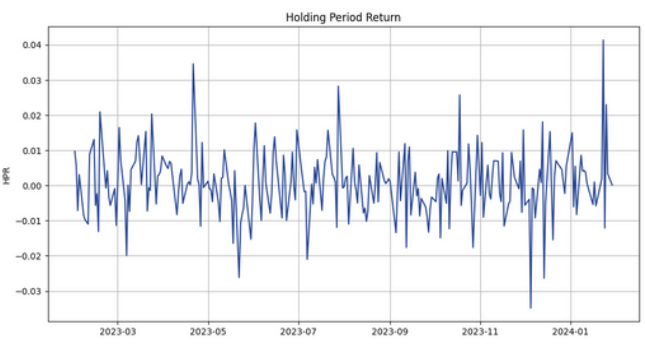
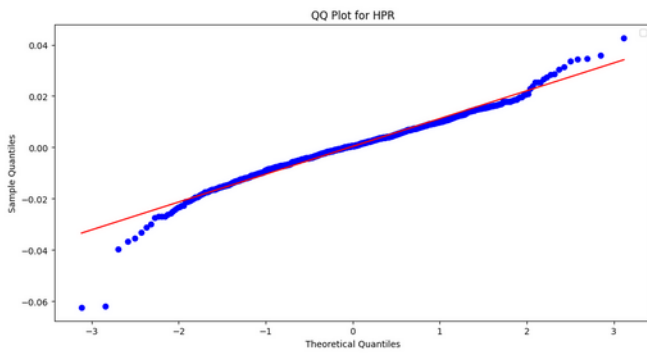
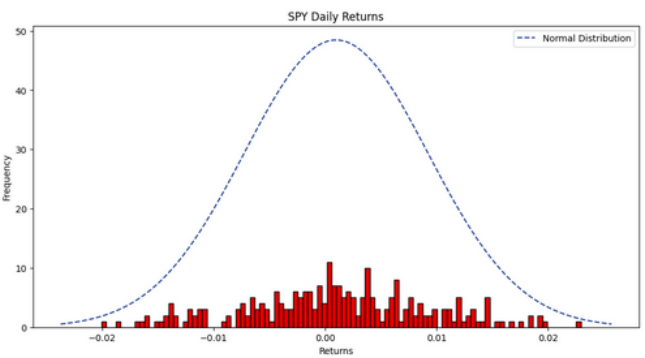
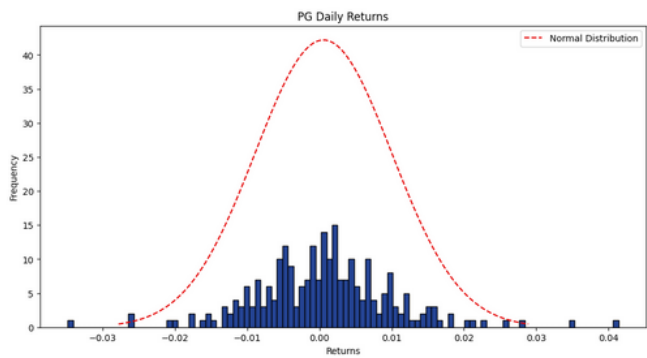
VaR serves as a valuable tool for risk managers, offering probabilistic insights into the likelihoods of specific loss amounts. However, it's crucial to recognize that VaR is just one piece of the puzzle. The benefit of Expected Shortfall lies in its ability to provide a further by estimating the average magnitude of losses beyond the VaR threshold. However, both VaR and ES still rely on assumptions and historical data, which may not accurately reflect future market conditions.

It's essential to note that VaR and ES are only part of a broader risk management framework and should be used in conjunction with other risk measures and tools. They should be interpreted alongside qualitative assessments and stress testing to provide a more robust understanding of overall risk exposure.

Appendices

Summary Statistics for SPY

Statistics	Arithmetic Return	Geometric Return	PnL
Number of observations	250	250	250
Average (Mean)	0.098	0.092	9.85
Median	0.073	nan	7.32
Standard Deviation	0.825	0.826	82.47
Skewness	-0.027	-0.041	-0.027
Kurtosis	-0.16	-0.158	-0.16



References

- Allen, L., Boudoukh, J., & Saunders, A. (2008). *Understanding market, credit and operational risk: The value at risk approach*. Blackwell.
- Chen, J. (2023, May 1). Skewness: Positively and negatively skewed defined with formula. Investopedia. <https://www.investopedia.com/terms/s/skewness.asp>
- Dowd, K. (2008). *Measuring market risk*. Wiley.
- McNeil, A. J., Frey, R. and Embrechts, P. (2015). *Quantitative Risk Management: Concepts, Techniques and Tools*. Revised Edition. Princeton University Press.
- Stammers, R. (2022, July 13). How to use Monte Carlo Analysis to estimate risk. Investopedia. <https://www.investopedia.com/articles/financial-theory/08/monte-carlo-multivariate-model.asp>
- Yahoo Finance. (2023). Procter & Gamble Co. (PG) Historical Data. Yahoo Finance. Retrieved from <https://finance.yahoo.com/quote/PG/history?period1=1590883200&period2=1685491200&interval=1d&filter=history&frequency=1d&includeAdjustedClose=true>
- Yamai, Y., & Yoshida, T. (2002). *Comparative analyses of expected shortfall and value-at- ...* <https://www.bis.org/cgfs/conf/mar02p.pdf>

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