Sharpe Ratio

Risk-adjusted performance measurement

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1 Abstract

The Sharpe ratio, developed by William Sharpe in 1966, measures the excess return per unit of risk. It remains the most widely used metric for risk-adjusted performance, allowing investors to compare investments with different volatility levels on a common scale (Sharpe, 1964).

2 Definition

The Sharpe ratio is defined as:

$$SR = \frac{R_p - R_f}{\sigma_p}$$

Where:

- R_p = portfolio return
- R_f = risk-free rate
- σ_p = portfolio standard deviation (volatility)

The numerator $(R_p - R_f)$ is the **excess return** — the return above the risk-free rate. The denominator σ_p is the **risk** measured by volatility.

3 Interpretation

Sharpe Ratio	Interpretation
< 0	Negative excess return
0 - 1	Acceptable, risk may not be adequately compensated
1 - 2	Good risk-adjusted return
2 - 3	Very good
> 3	Excellent (rare, verify data)

4 Annualization

For daily returns, the annualized Sharpe ratio is:

$$SR_{ann} = \sqrt{252} \cdot \frac{\bar{r}_d - r_f/252}{\sigma_d}$$

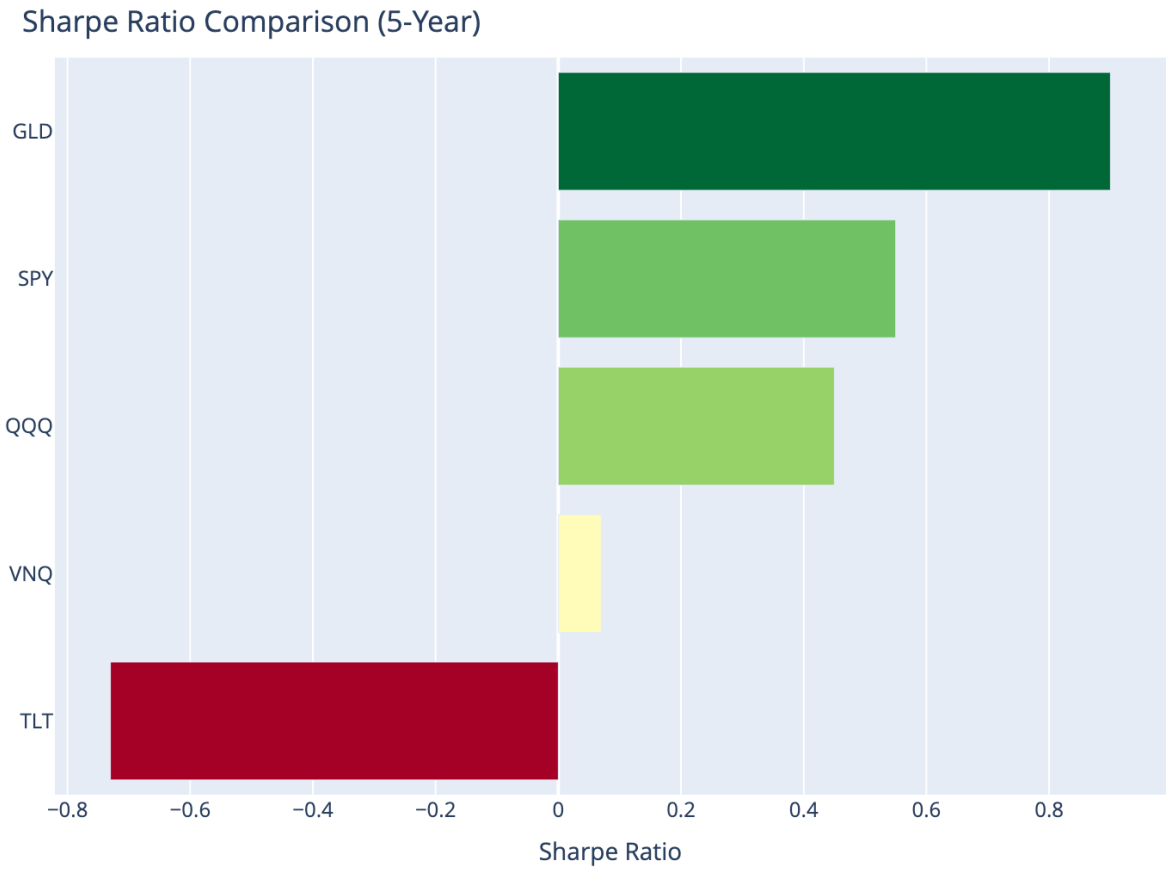
Where $\bar{r}_d$ is the mean daily return and σ_d is the daily standard deviation.

5 Compute (Python)

We calculate the Sharpe ratio for several ETFs representing different asset classes.

	Ticker	Ann. Return (%)	Ann. Volatility (%)	Sharpe Ratio
0	SPY	13.44	17.06	0.55
1	QQQ	14.23	22.60	0.45
2	TLT	-7.71	16.02	-0.73
3	GLD	17.96	15.60	0.90
4	VNQ	5.31	18.83	0.07

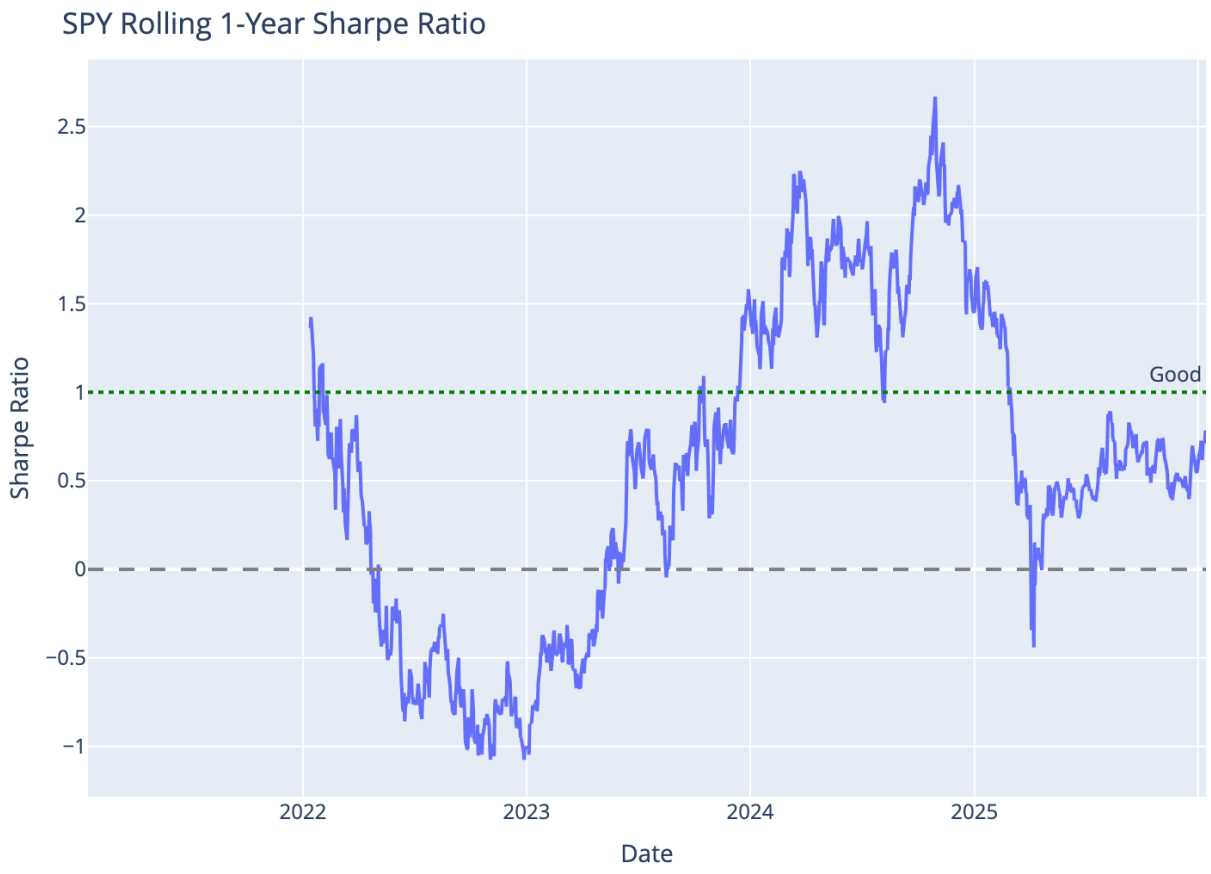
6 Sharpe Ratio Comparison



7 Risk-Return Scatter

8 Rolling Sharpe Ratio

The Sharpe ratio varies over time. A rolling window shows how risk-adjusted performance evolves.



9 Limitations

- **Assumes normal distribution**: Penalizes upside volatility equally to downside
- **Sensitive to time period**: Different periods yield different results
- **Risk-free rate choice**: Results vary with the benchmark rate used
- **Not suitable for**: Strategies with non-normal returns (options, hedge funds)

For strategies with asymmetric returns, consider the **Sortino ratio** (uses downside deviation) or **Calmar ratio** (uses max drawdown).

10 Conclusion

The Sharpe ratio provides a standardized measure of risk-adjusted return, enabling comparison across assets with different volatility profiles. While widely used, it should be considered alongside other metrics, particularly for strategies with non-normal return distributions.

References

Sharpe, W. F. (1964). Capital asset prices: A theory of market equilibrium under conditions of risk. *The Journal of Finance*, *19*(3), 425–442.