Financial Metrics: Formulas, Explanations, and Interpretations

Basic Return Calculations

1. **Simple Return**
   - Formula: $$R = \frac{P_t}{P_{t-1}} - 1$$
   - Where P_t is the price at time t, and P_{t-1} is the price at time $t-1$
   - Explanation: Measures the percentage change in price over a single period.

2. **Log Return**
   - Formula: $$r = \ln(\frac{P_t}{P_{t-1}})$$
   - Explanation: Measures the continuously compounded return, useful for multi-period analyses.

Performance and Risk Metrics

1. **Annualized Return - Measures the average yearly return of a strategy, accounting for compounding.**
   - Formula: $$Annualized; Return = (1 + \text{Total Return})^{(1/n)} - 1$$
   - Where n is the number of years

2. **Maximum Drawdown**
   - Formula: $$Max ; Drawdown = \frac{\text{Trough Value} - \text{Peak Value}}{\text{Peak Value}}$$
   - Explanation: Shows the largest percentage drop from a peak to a trough in a portfolio's value.
     - Lower is better.
     - Values below 20-30% are often considered acceptable, but this can vary by strategy and risk tolerance.

3. **Calmar Ratio - Compares the annualized return to the maximum drawdown, indicating return per unit of downside risk.**
   - Formula: $$Calmar; Ratio = \frac{\text{Annualized Return}}{\text{Maximum Drawdown}}$$
   - Interpretation
     - Higher is better.
     - A ratio above 1 is generally considered good, with top performers often achieving ratios of 3 or higher.

4. **Sharpe Ratio - Evaluates risk-adjusted performance by relating excess return to volatility.**
   - Formula: $$ Sharpe; Ratio = \frac{R_p - R_f}{\sigma_p}$$
   - Where R_p is portfolio return, R_f is risk-free rate, σ_p is portfolio standard deviation
   - Interpretation

        - Higher is better.
        - A ratio above 1 is considered acceptable, above 2 is very good, and above 3 is excellent.

5. **Sortino Ratio - Evaluates risk-adjusted performance by relating excess return to downside volatility.**
    - Formula: $$Sortino; Ratio = \frac{R_p - R_f}{\sigma_d}$$
    - Where σ_d is downside deviation
    - Interpretation
        - Higher is better.
        - Values tend to be higher due to considering only downside risk.

6. **Treynor Ratio - Assesses risk-adjusted returns relative to systematic risk (beta).**
    - Formula: $$Treynor; Ratio = \frac{R_p - R_f}{\beta}$$
    - Where β is portfolio beta
    - Interpretation
        - Higher is better. Should be compared to the market's Treynor ratio for context.

7. **Information Ratio - Evaluates risk-adjusted return of a portfolio against a benchmark.** Formula: $$\text{IR} = \frac{R_p - R_b}{\text{Tracking Error (TE)}}, \text{TE} = \sqrt{\frac{\sum_{i=1}^n (R_{p,i} - R_{b,i})^2}{n-1}}$$
    - Where R_p is portfolio return and R_b is benchmark return
    - Where $R_{p,i}$ is the portfolio return in period i, $R_{b,i}$ is the benchmark return in period i, and n is the number of periods
    - The tracking error represents the standard deviation of the difference between portfolio and benchmark returns.
    - Interpretation
        - Higher is better.
        - Values above 0.5 are good, above 0.75 are very good, and above 1 are excellent.

8. **Beta(β) - Measures the portfolio's sensitivity to benchmark movements.**
    - Formula: $$\beta = \frac{\text{Cov}(R_p, R_b)}{\text{Var}(R_b)}$$
    - Where R_b is benchmark return
    - Interpretation:
        - 1 indicates benchmark-like volatility,
        - <1 indicates lower volatility, and
        - >1 indicates higher volatility than the market.

9. **Alpha(α) - Represents excess return after adjusting for market-related risk.**
    - Formula: $$ \alpha = R_p - [R_f + \beta(R_m - R_f)]$$
    - Intepretation
        - Positive alpha is desirable, indicating outperformance relative to the risk taken.

10. **R-Squared(R^2)- Indicates how closely portfolio performance matches benchmark performance.**
    - Formula: $$R^2 = (\text{Correlation coefficient between portfolio and benchmark})^2$$

- Interpretation:
  - Ranges from 0 to 1.
  - Higher values indicate closer correlation with the benchmark.

11. **Skewness - Measures asymmetry of return distribution.**
    - Formula: $$E[(\frac{X - \mu}{\sigma})^3]$$
    - Where X is the return, μ is mean, σ is standard deviation
    - Interpretation:
      - Positive skew is generally preferable, indicating more extreme positive returns than negative.
12. **Kurtosis - Indicates "tailedness" of return distribution and potential for extreme outcomes.**
    - Formula: $$E[(\frac{X - \mu}{\sigma})^4]$$
    - Interpretation:
      - Higher kurtosis indicates more frequent extreme outcomes.
      - Normal distribution has a kurtosis of 3.
13. **Omega Ratio - Compares likelihood of returns above a threshold to likelihood of returns below it.**
    - Formula: $$Omega; Ratio, \Omega = \frac{E[\max(R - \tau, 0)]}{E[\max(\tau - R, 0)]}$$
    - Where τ is threshold return
    - $(R - τ)$ represents the excess return above the threshold
    - $(τ - R)$ represents the shortfall below the threshold
    - Interpretation
      - Higher is better.
      - A ratio above 1 indicates more potential for gains than losses relative to the threshold.
14. **Downside Deviation - Measures volatility of negative returns, used in Sortino Ratio calculation.**
    - Formula: $$Downside ; Deviation = \sqrt{\frac{\sum(\min(R - \tau, 0))^2}{n}}$$
    - $\min(R - τ, 0)$ captures only the returns that fall below the threshold
    - Interpretation:
      - Lower values indicate less downside risk.
15. **Value at Risk (VaR) - Predicts the maximum loss likely to occur over a specified time period at a given confidence interval.**
    - Formula: $$\text{VaR} = \mu - (z \cdot \sigma \cdot \sqrt{t})$$
    - Where μ is expected return, z is z-score for confidence level, σ is standard deviation, t is time horizon
    - Interpretation:
      - Lower absolute values are better, indicating less potential for extreme losses.
16. **Conditional Value at Risk (CVaR) or Expected Shortfall - Gives the expected loss given that a loss is beyond the VaR threshold.**
    - Formula: $$\text{CVaR} = E[X | X > \text{VaR}]$$
    - Where X represents the loss

- Interpretation:
  - Lower values are better, indicating smaller expected losses in worst-case scenarios.

17. **Profit Factor - The ratio of gross profit to gross loss, indicating overall profitability of a trading strategy.**
    - Formula: $$Profit ; Factor=\frac{\text{Gross Profit}}{\text{Gross Loss}}$$
    - Good values:
      - Above 1 is profitable, with higher values being better.
      - A value of 2 means twice as much profit as loss.
18. **Recovery Factor - Compares the net profit to the maximum drawdown, showing how well the strategy recovers from losses.**
    - Formula: $$Recovery;Factor = \frac{\text{Net Profit}}{\text{Maximum Drawdown}}$$
    - Interpretation
      - Higher is better. A value above 1 indicates that profits exceed the worst drawdown.
19. **Ulcer Index - Measures the depth and duration of drawdowns in price.**
    - Formula: $$Ulcer ; Index = \sqrt{\frac{\sum D_i^2}{n}}$$
    - Where D_i is the drawdown from previous peak, n is number of periods
    - Interpretation:
      - Lower values are better, indicating less severe and prolonged drawdowns.

Trade Metrics

1. **Win Rate - The percentage of trades that are profitable.**
2. **Reward-to-Risk Ratio - Compares the average winning trade to the average losing trade.**
    - Formula: $$Risk-to-Reward;Ratio = \frac{\text{Average Winning Trade}}{\text{Average Losing Trade}}$$
    - Interpretation
      - Higher is better. A ratio above 1 indicates larger average wins than losses.
3. **Expectancy - Gives the average amount you can expect to win (or lose) per trade.**
    - Formula: $$Expectancy = (\text{Win Rate} \cdot \text{Average Win}) - (\text{Loss Rate} \cdot \text{Average Loss})$$
    - Interpretation
      - Positive values indicate a profitable system, with higher values being better.
4. **Trade Duration - Average time a position is held.**
5. **Number of Trades - Indicates how frequently the strategy trades.**
6. **Turnover Rate - Measures how frequently assets within a portfolio are bought and sold.**
    - Formula: $$ Turnover; Rate = \frac{\min(\text{Asset Sales}, \text{Asset Purchases})}{\text{Average Portfolio Value}}$$
    - Interpretation:

- Lower values indicate a more passive strategy, while
- Higher values indicate more active trading.

Financial Ratios: Interpretation Guide

Higher Values Are Better	Lower Values Are Better
Annualized Return	Maximum Drawdown
Calmar Ratio	Downside Deviation
Sharpe Ratio	Value at Risk (VaR)
Sortino Ratio	Conditional Value at Risk (CVaR)
Treynor Ratio	Ulcer Index
Information Ratio	
Alpha	
Omega Ratio	
Profit Factor	
Recovery Factor	
Win Rate	
Reward-to-Risk Ratio	
Expectancy	

Notes:

1. **R-Squared**: Higher or lower isn't necessarily better. It depends on the investment strategy. A higher R-squared indicates closer correlation with the benchmark.

2. **Beta**: Neither higher nor lower is inherently better. It depends on the investor's risk tolerance and market expectations.

    - Beta > 1: More volatile than the market
    - Beta < 1: Less volatile than the market
    - Beta = 1: Same volatility as the market

3. **Skewness**: Positive skew is generally preferred, indicating more extreme positive returns than negative.

4. **Kurtosis**: Neither higher nor lower is inherently better. Higher kurtosis indicates more frequent extreme outcomes, which could be positive or negative.

5. **Trade Duration**: Optimal duration depends on the specific trading strategy. Consistency is often more important than absolute value.

6. **Number of Trades**: Optimal number depends on the strategy. More trades provide more data points but may incur higher transaction costs.

7. **Turnover Rate**: Optimal level depends on the strategy and associated costs. Lower values indicate a more passive strategy, while higher values indicate more active trading.