Mathematical Analysis Documentation for Cryptocurrency Metrics

Abstract

This document consolidates the mathematical equations and variables used for fundamental, technical, quantitative, and peer analysis of cryptocurrency metrics within the `/src` folder.

Contents

1 Fundamental Analysis

1.1 NVT Ratio

- **Equation**: $\frac{P \times S}{V \times P}$ (mean over period)
- **Variables**:
  - P: Close Price
  - S: Circulating Supply
  - V: Volume

1.2 Price/Volume Ratio

- **Equation**: $\frac{P_{\text{current}}}{(V \times P)_{\text{mean}}}$
- **Variables**:
  - P_{current}: Current Close Price
  - $(V \times P)_{\text{mean}}$: Average Quote Volume

1.3 Market Cap Growth Rate

- **Equation**: $\left(\frac{P_{\text{end}} \times S}{P_{\text{start}} \times S}\right)^{1/t} - 1$
- **Variables**:
  - P_{end}: End Price
  - P_{start}: Start Price
  - S: Circulating Supply
  - t: Time in Years (1)

1.4 Volume CAGR

- **Equation**: $\left(\frac{V_{\text{end}} \times P_{\text{end}}}{V_{\text{start}} \times P_{\text{start}}}\right)^{1/t} - 1$
- **Variables**:
  - V_{end}: End Volume
  - V_{start}: Start Volume
  - P_{end}: End Price
  - P_{start}: Start Price
  - t: Time in Years (1)

1.5 Liquidity Ratio

- **Equation**: $\frac{(V \times P)_{\text{mean}}}{P_{\text{current}} \times S}$
- **Variables**:
  - $(V \times P)_{\text{mean}}$: Average Quote Volume
  - P_{current}: Current Price
  - S: Circulating Supply

1.6 Mayer Multiple

- **Equation**: $\frac{P_{\text{current}}}{\text{SMA}_{200}}$
- **Variables**:
  - P_{current}: Current Price
  - SMA_{200}: 200-day Simple Moving Average

1.7 Price Momentum

- **Equation**: $\frac{P_{\text{end}} - P_{\text{start}}}{P_{\text{start}}}$
- **Variables**:
  - P_{end}: End Price
  - P_{start}: Start Price

1.8 Volume Momentum

- **Equation**: $\frac{(V \times P)_{\text{late}} - (V \times P)_{\text{early}}}{(V \times P)_{\text{early}}}$
- **Variables**:
  - $(V \times P)_{\text{late}}$: Mean Quote Volume (second half)
  - $(V \times P)_{\text{early}}$: Mean Quote Volume (first half)

1.9 Volatility-Adjusted Market Cap

- **Equation**: $\frac{P_{\text{current}} \times S}{1 + \sigma}$
- **Variables**:
  - P_{current}: Current Price
  - S: Circulating Supply
  - σ: Annualized Volatility ($\text{std}(P_{\text{pct\_change}}) \times \sqrt{365}$)

1.10 Turnover Ratio

- **Equation**: $\frac{\sum(V \times P)}{S}$
- **Variables**:
  - $\sum(V \times P)$: Total Quote Volume
  - S: Circulating Supply

1.11 Price Stability Ratio

- **Equation**: $\frac{P_{\text{mean}}}{\sigma}$
- **Variables**:
  - P_{mean}: Mean Price
  - σ: Annualized Volatility

1.12 Volume-to-Price Ratio

- **Equation**: $\frac{(V \times P)_{\text{mean}}}{P_{\text{current}}}$
- **Variables**:
  - $(V \times P)_{\text{mean}}$: Average Quote Volume
  - P_{current}: Current Price

1.13 Discounted Expected Utility Value (DEUV)

- **Equation**: $\frac{P_{\text{current}} \times S}{\sum_{t=1}^{5} \left[(V \times P)_{\text{current}} \times \frac{(1+g)^t}{(1+r)^t} \right]}$
- **Variables**:
  - P_{current}: Current Price
  - S: Circulating Supply
  - $(V \times P)_{\text{current}}$: Current Average Quote Volume
  - g: Growth Rate (0.08)
  - r: Discount Rate (0.12)

1.14 Price to Volatility Cost

- **Equation**: $\frac{P_{\text{current}}}{P_{\text{current}} \times \sigma}$
- **Variables**:
  - P_{current}: Current Price
  - σ: Annualized Volatility

1.15 Regulatory Discount

- **Equation**: $P_{\text{current}} \times (1 - h)$
- **Variables**:
  - P_{current}: Current Price
  - h: Haircut (0.20)

2 Technical Analysis

2.1 SMA 50-day

- **Equation**: $\frac{\sum_{i=1}^{50} P_i}{50}$ (last 50 days)
- **Variables**:
  - P_i: Close Price at day i

2.2 EMA 20-day

- **Equation**: $P_{\text{current}} \times k + \text{EMA}_{\text{prev}} \times (1 - k)$, $k = \frac{2}{20+1}$
- **Variables**:
  - P_{current}: Current Price
  - EMA_{prev}: Previous EMA
  - k: Smoothing Factor

2.3 RSI

- **Equation**: $100 - \frac{100}{1 + \frac{\text{Avg Gain}}{\text{Avg Loss}}}$ (14-day period)
- **Variables**:
  - Avg Gain: Mean of positive price changes
  - Avg Loss: Mean of negative price changes

2.4 MACD Histogram

- **Equation**: $(\text{EMA}_{12} - \text{EMA}_{26}) - \text{Signal}$, $\text{Signal} = \text{EMA}_9$ of $(\text{EMA}_{12} - \text{EMA}_{26})$
- **Variables**:
  - EMA_{12}: 12-day EMA
  - EMA_{26}: 26-day EMA
  - Signal: 9-day EMA

2.5 Bollinger Bands Width

- **Equation**: $\frac{\text{Upper}-\text{Lower}}{\text{SMA}_{20}}$, Upper $= \text{SMA}_{20} + 2 \times \sigma_{20}$, Lower $= \text{SMA}_{20} - 2 \times \sigma_{20}$
- **Variables**:
  - SMA_{20}: 20-day SMA
  - σ_{20}: 20-day Standard Deviation

2.6 ATR

- **Equation**: $\frac{\sum_{i=1}^{14} \text{TR}_i}{14}$ (last 14 days), $\text{TR}_i = \max(H - L, |H - C_{\text{prev}}|, |L - C_{\text{prev}}|)$
- **Variables**:
  - H: High
  - L: Low
  - C_{prev}: Previous Close

2.7 OBV

- **Equation**: $\sum V \times \text{sign}(C - C_{\text{prev}})$
- **Variables**:
  - V: Volume
  - $\text{sign}(C - C_{\text{prev}})$: 1 if $C > C_{\text{prev}}$, -1 if $C < C_{\text{prev}}$, 0 if equal

2.8 VWAP

- **Equation**: $\frac{\sum\left(\frac{H+L+C}{3} \times V\right)}{\sum V}$
- **Variables**:
  - H: High
  - L: Low
  - C: Close
  - V: Volume

2.9 Price ROC

- **Equation**: $\frac{P_{\text{current}} - P_{14}}{P_{14}} \times 100$
- **Variables**:
  - P_{current}: Current Price
  - P_{14}: Price 14 days ago

2.10 Stochastic %K

- **Equation**: $100 \times \frac{C - L_{14}}{H_{14} - L_{14}}$
- **Variables**:
  - C: Current Close
  - L_{14}: Lowest Low (14 days)
  - H_{14}: Highest High (14 days)

2.11 Williams %R

- **Equation**: $-100 \times \frac{H_{14} - C}{H_{14} - L_{14}}$
- **Variables**:
  - H_{14}: Highest High (14 days)
  - L_{14}: Lowest Low (14 days)
  - C: Current Close

2.12 Momentum

- **Equation**: $P_{\text{current}} - P_{10}$
- **Variables**:
  - P_{current}: Current Price
  - P_{10}: Price 10 days ago

2.13 Volume Oscillator

- **Equation**: $\frac{V_{\text{MA}_5} - V_{\text{MA}_{20}}}{V_{\text{MA}_{20}}} \times 100$
- **Variables**:
  - V_{MA_5}: 5-day Volume MA
  - $V_{\text{MA}_{20}}$: 20-day Volume MA

2.14 Chande Momentum Oscillator (CMO)

- **Equation**: $100 \times \frac{\sum \text{Up} - \sum \text{Down}}{\sum \text{Up} + \sum \text{Down}}$ (14-day period)
- **Variables**:
  - $\sum$ Up: Sum of positive price changes
  - $\sum$ Down: Sum of negative price changes

2.15 Price Channel Breakout

- **Equation**: 1 if $P_{\text{current}} > H_{20}$, -1 if $P_{\text{current}} < L_{20}$, else 0
- **Variables**:
  - P_{current}: Current Price
  - H_{20}: 20-day High
  - L_{20}: 20-day Low

3 Quantitative Analysis

3.1 NVT Ratio

- **Equation**: $\frac{P \times S}{V \times P}$ (mean)
- **Variables**:
  - P: Close Price
  - S: Circulating Supply
  - V: Volume

3.2 Price/Volume Ratio

- **Equation**: $\frac{P_{\text{current}}}{(V \times P)_{\text{mean}}}$
- **Variables**:
  - P_{current}: Current Price
  - $(V \times P)_{\text{mean}}$: Average Quote Volume

3.3 Sharpe Ratio

- **Equation**: $\frac{R_{\text{mean}} + \text{APY}_d - \text{Rf}_d}{\sigma \times \sqrt{365}}$
- **Variables**:
  - R_{mean}: Mean Daily Return
  - APY_d: Staking Yield / 365 (0.06 / 365)
  - Rf_d: Risk-Free Rate / 365 (0.025 / 365)
  - σ: Daily Return Std

3.4 Current Utility Value (CUV)

- **Equation**: $\frac{P_{\text{current}} \times S}{(V \times P)_{\text{mean}}}$
- **Variables**:
  - P_{current}: Current Price
  - S: Circulating Supply
  - $(V \times P)_{\text{mean}}$: Average Quote Volume

3.5 Discounted Expected Utility Value (DEUV)

- **Equation**: $\frac{P_{\text{current}} \times S}{\sum_{t=1}^{5} \left[(V \times P)_{\text{current}} \times \frac{(1+g)^t}{(1+r)^t} \right]}$
- **Variables**:
  - P_{current}: Current Price
  - S: Circulating Supply
  - $(V \times P)_{\text{current}}$: Current Average Quote Volume
  - g: Growth Rate (0.08)
  - r: Discount Rate (0.12)

3.6 Volume CAGR

- **Equation**: $\left(\frac{V_{\text{end}} \times P_{\text{end}}}{V_{\text{start}} \times P_{\text{start}}} \right)^{1/t} - 1$
- **Variables**:
  - V_{end}: End Volume
  - V_{start}: Start Volume
  - P_{end}: End Price
  - P_{start}: Start Price
  - t: Time in Years (1)

3.7 Volume Composition (Buy)

- **Equation**: $\frac{V_{\text{buy}}}{(V \times P)_{\text{total}}}$
- **Variables**:
  - V_{buy}: Taker Buy Quote Volume
  - $(V \times P)_{\text{total}}$: Total Quote Volume

3.8 Volume Composition (Sell)

- **Equation**: $\frac{V_{\text{sell}}}{(V \times P)_{\text{total}}}$
- **Variables**:
  - V_{sell}: Total Quote Volume - V_{buy}
  - $(V \times P)_{\text{total}}$: Total Quote Volume

3.9 Volatility Reduction

- **Equation**: $\frac{\sigma_{\text{early}} - \sigma_{\text{late}}}{\sigma_{\text{early}}}$ (if > 0, else 0)
- **Variables**:
  - σ_{early}: Std of Returns (first half) $\times\sqrt{365}$
  - σ_{late}: Std of Returns (second half) $\times\sqrt{365}$

3.10 Price Momentum

- **Equation**: $\frac{P_{\text{end}} - P_{\text{start}}}{P_{\text{start}}}$
- **Variables**:
  - P_{end}: End Price
  - P_{start}: Start Price

3.11 Risk-Adjusted Volume Discount

- **Equation**: $\frac{(V \times P)_{\text{mean}}}{1 + (\text{Rf} + \beta \times \text{MRP}) \times \sigma} / (V \times P)_{\text{mean}}$
- **Variables**:
  - $(V \times P)_{\text{mean}}$: Average Quote Volume
  - Rf: Risk-Free Rate (0.025)
  - β: Beta (1.4)
  - MRP: Market Risk Premium (0.06)
  - σ: Annualized Volatility

3.12 Trading Volume

- **Equation**: $(V \times P)_{\text{mean}}$
- **Variables**:
  - $(V \times P)_{\text{mean}}$: Average Quote Volume

3.13 Volume Volatility

- **Equation**: $\frac{\sigma_v}{(V \times P)_{\text{mean}}}$
- **Variables**:
  - σ_v: Std of Quote Volume
  - $(V \times P)_{\text{mean}}$: Average Quote Volume

3.14 Volume-to-Price Ratio

- **Equation**: $\frac{(V \times P)_{\text{mean}}}{P_{\text{current}}}$
- **Variables**:
  - $(V \times P)_{\text{mean}}$: Average Quote Volume
  - P_{current}: Current Price

3.15 Price Correlation

- **Equation**: $\text{corr}(P_{\text{pct\_change}}, P_{\text{pct\_change}})$ (self-correlation = 1)
- **Variables**:
  - $P_{\text{pct\_change}}$: Daily Price Returns

3.16 Mayer Multiple

- **Equation**: $\frac{P_{\text{current}}}{\text{SMA}_{200}}$
- **Variables**:
  - P_{current}: Current Price
  - SMA_{200}: 200-day SMA

3.17 Price DCF Intrinsic Value

- **Equation**: $\sum_{t=1}^{5} \left[P_{\text{current}} \times \frac{(1+g)^t}{(1+r)^t} \right]$
- **Variables**:
  - P_{current}: Current Price
  - g: Growth Rate (0.10)
  - r: Discount Rate (0.15)

3.18 Price DCF Valuation Ratio

- **Equation**: $\frac{\text{DCF}_{\text{Intrinsic}}}{P_{\text{current}}}$
- **Variables**:
  - $\text{DCF}_{\text{Intrinsic}}$: Price DCF Intrinsic Value
  - P_{current}: Current Price

3.19 Price to Volatility Cost

- **Equation**: $\frac{P_{\text{current}}}{P_{\text{current}} \times \sigma}$
- **Variables**:
  - P_{current}: Current Price
  - σ: Annualized Volatility

3.20 Regulatory Discount

- **Equation**: $P_{\text{current}} \times (1 - h)$
- **Variables**:
  - P_{current}: Current Price
  - h: Haircut (0.20)

3.21 Price/Volume Ratio (Alt)

- **Equation**: $\frac{P_{\text{current}}}{(V \times P)_{\text{30day\_mean}}}$
- **Variables**:
  - P_{current}: Current Price
  - $(V \times P)_{\text{30day\_mean}}$: 30-day Average Quote Volume

4 Peer Analysis

4.1 NVT Ratio

- **Equation**: $\frac{P \times S}{V \times P}$ (mean)
- **Variables**:
  - P: Close Price
  - S: Circulating Supply
  - V: Volume

4.2 Sharpe Ratio

- **Equation**: $\frac{R_{\text{mean}} + \text{APY}_d - \text{Rf}_d}{\sigma \times \sqrt{365}}$
- **Variables**:
  - R_{mean}: Mean Daily Return
  - APY_d: Staking Yield / 365 (0.05 / 365)
  - Rf_d: Risk-Free Rate / 365 (0.025 / 365)
  - σ: Daily Return Std

4.3 Price/Volume Ratio

- **Equation**: $\frac{P_{\text{current}}}{(V \times P)_{\text{mean}}}$
- **Variables**:
  - P_{current}: Current Price
  - $(V \times P)_{\text{mean}}$: Average Quote Volume

4.4 Mayer Multiple

- **Equation**: $\frac{P_{\text{current}}}{\text{SMA}_{200}}$
- **Variables**:
  - P_{current}: Current Price
  - SMA_{200}: 200-day SMA

4.5 Speculative Signal

- **Equation**: 1 if NVT > 50 or Mayer > 2.4, else 0
- **Variables**:
  - NVT: NVT Ratio
  - Mayer: Mayer Multiple

4.6 RSI

- **Equation**: $100 - \frac{100}{1 + \frac{\text{Avg Gain}}{\text{Avg Loss}}}$ (14-day period)
- **Variables**:
  - Avg Gain: Mean of positive price changes
  - Avg Loss: Mean of negative price changes

4.7 MACD Histogram

- **Equation**: $(\text{EMA}_{12} - \text{EMA}_{26}) - \text{Signal}$, $\text{Signal} = \text{EMA}_9$ of $(\text{EMA}_{12} - \text{EMA}_{26})$
- **Variables**:
  - EMA_{12}: 12-day EMA
  - EMA_{26}: 26-day EMA
  - Signal: 9-day EMA