Quantitative Finance Club Financial Modeling Case Competition Report

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1 Mathematical Model

1.1 Relative Strength Index (RSI)

1.1.1 Calculate the price change (Δ_t)

$$\Delta_t = \text{prices}_t - \text{prices}_{t-1}$$

1.1.2 Compute weighted gains and losses (G_t, L_t)

$$G_t = \begin{cases} w \cdot \Delta_t, & \text{if } \Delta_t > 0 \\ 0, & \text{otherwise} \end{cases}$$

$$L_t = \begin{cases} (1-w) \cdot (-\Delta_t), & \text{if } \Delta_t < 0 \\ 0, & \text{otherwise} \end{cases}$$

1.1.3 Calculate the moving averages of gains and losses ($\textbf{avg\_gain}_t$, $\textbf{avg\_loss}_t$

$$\text{avg\_gain}_t = \frac{1}{N} \sum_{i=t-N+1}^{t} G_i$$

$$\text{avg\_loss}_t = \frac{1}{N} \sum_{i=t-N+1}^{t} L_i$$

1.1.4 Compute the relative strength (RS)

$$RS_t = \frac{\text{avg\_gain}_t}{\text{avg\_loss}_t + \epsilon}$$

1.1.5 Calculate the RSI

$$RSI_t = 100 - \frac{100}{1 + RS_t}$$

1.2 Exponential Moving Average (EMA)

$$\text{EMA}_t = \alpha x_t + (1 - \alpha)\text{EMA}_{t-1}$$
$$\alpha = \frac{2}{N + 1}$$

where N is the period

1.3 Moving Volatility (20 day)

$$\text{Volatility}_t = \sqrt{\frac{1}{N} \sum_{i=t-N+1}^{t} (r_i - \bar{r})^2}$$

where N is 20 days by default

2 Trading Strategy

2.1 High Volatility Event

We define a high volatility event as when the most recent volatility value is greater than the 90th percentile of past 20 days of volatility.

2.2 Negative Returns

We define a negative return as when the 3 day (short) Exponential Moving Average is less than 0.

2.3 General Trading Strategy

We consider both the 1st and 2nd derivatives of price, which are returns and RSI, respectively. This comes from the mathematical intuition that if we know both those values, we are able to determine the concavity of price.

On day 1, we always start by buying HydroCorp. Alternatively, if the short term EMA of HydroCorp is positive and there is enough money in the portfolio, buy HydroCorp.

If the most recent volatility of HydroCorp is higher than its 95th percentile historical maximum and there are negative returns, sell HydroCorp stock to hold cash instead.

If we see high momentum, volatility and positive returns in BrightFuture Renewables, we will sell all HydroCorp holdings and switch to BrightFuture Renewables. As soon as BrightFuture Renewables shows negative returns, we sell holdings.

3 Hedging Strategy

3.1 Cash Consideration

The original task was to decide between entering and existing the two stocks or hold cash. We determined that the only situation in which to hold cash is during a negative shock of the two stocks. However, due to the inherent opportunity cost of cash, when either BF or HC presented an opportunity, we invested all capital.

Ultimately, we decided holding HydroCorp long-term and investing in Brightfutures as their stock showed promise is the optimal strategy. HydroCorp is notoriously stable so there is less risk associated in their position while BrightFutures is a start-up and much more volatile. BF's volatility offers an opportunity for fantastic returns, however, so switch our position into BF at the right time is pivotal to the strategy.