MF821 Pairs Trading Report

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1. Summary

This trading strategy I developed is a systematic approach to select and trade ETFs, focusing primarily on the QQQ ETF, which tracks the NASDAQ-100 Index. This index includes major tech companies like Apple, Amazon, and Google's Alphabet, making it a robust choice for exposure to the tech sector. The strategy employs a custom model to identify a highly correlated pair ETF, ensuring efficient trading by focusing on significant assets within the ETF.

The core of the trading strategy relies on MACD and co-integration analysis to determine entry and exit points. By using these technical indicators, the strategy evaluates the momentum and long-term price relationships between QQQ and its paired ETF. Trades are initiated based on MACD discrepancies or if a stable co-integration relationship is detected, ensuring actions are taken based on significant trend shifts or foundational price equilibriums. This methodical approach operates over a one-year period starting March 1, 2023, with a starting capital of $1,000,000, aiming to capitalize on high-tech market movements effectively.

The trading strategy resulted in underperformed, evidenced by a negative Sharpe Ratio of -2.92, signaling a high level of risk relative to the return. A Compound Annual Return of -2.128% and a Net Profit decline of -1.897% suggest a diminishing portfolio value. With a total of 908 trades, a loss rate of 57%, and a win rate of 43%, the strategy maintains a Profit-Loss Ratio of 1.20 but is not enough to offset the overall losses. The Maximum Drawdown of 3.2% and a negative Sortino Ratio of -4.117 further highlight the downside risk and volatility experienced. The strategy concluded with an End Equity of $981,029.46 from a starting $1,000,000, and the low PSR of 5.710% implies a slim chance of meeting the targeted benchmarks, signaling a need for reassessment of the strategy.

2. The Method

a) Stock Selection

I employ a systematic approach to screen the asset universe. Initially, I chose to invest in the QQQ ETF. QQQ is an exchange-traded fund (ETF) officially named Invesco QQQ Trust. It mainly tracks the NASDAQ-100 Index, which is an index that includes the 100 largest and most active non-financial companies listed on the NASDAQ-100 exchange. Therefore, QQQ includes many high-tech companies, such as Apple, Amazon, Google's parent company Alphabet, Facebook's parent company Meta Platforms, and Microsoft. Based on this background, I think it will be easy to find its pair ETF in the technical sector.

Then I developed a method to identify the pair ETF which has a strong correlation. This model inherits from the "ETFConstituentsUniverseSelectionModel" class, highlighting its focus on ETF-based universe selection. Specifically tailored to the QQQ ETF (iShares U.S.

Basic Materials ETF), the model sifts through the ETF's constituents and selects the top security with the highest weight in the index. This systematic methodology aims to mitigate slippage and uphold algorithmic efficiency by concentrating on the most impactful asset within the ETF. It will upgrade the most correlated stock automatically, and also the data in the MACD and Co-Integration Method.

b) Trading Strategy

This trading strategy mainly relies on two core technical indicators: MACD (Moving Average Convergence Divergence) and co-integration analysis. This strategy combines these two techniques to determine when to enter and exit transactions. The trading period spans from March 1, 2023, to March 1, 2024, covering three years, with minute-level data used for analysis. The starting cash is $1000000. The algorithm dynamically selects a pair ETF using the "IYMUniverseSelectionModel" to enhance portfolio diversification and correlation.

When the historical price data is sufficient, perform co integration analysis. Use the coin_Johansen method for statistical testing to examine whether there is a long-term stable relationship between two asset price sequences, i.e. co integration. If a co integration relationship is found, the trading direction is determined based on the co integration factors. Meanwhile, calculate the difference between the current MACD value and the MACD value of the paired ETF. If the difference is greater than the set threshold (± 0.2), adjust the position according to the direction of the difference.

The trading happened based on these two condition:

1. MACD differences

MACD is a commonly used trend-tracking momentum indicator, typically consisting of two lines - the MACD line and the signal line. In this strategy, I compared the difference between the MACD values of the main asset (IYM) and the MACD values of paired ETFs.

Transaction triggering conditions:

When the absolute value of macd_difference is greater than 0.2, it is considered that there is a significant difference in the trend of the two assets, thus triggering a transaction.

i. If macd_difference>0.5, it indicates that the main asset shows a stronger upward trend compared to the paired ETF, and the strategy will increase its holdings in the main asset (buy IYM) and reduce its holdings in the paired ETF (sell pairETF).

ii. If macd_difference<-0.5, it indicates that the paired ETF shows a stronger upward trend relative to the main asset, and the strategy will reduce its holdings in the main asset (sell IYM) and increase its holdings in the paired ETF (buy pairETF).

2. Co-integration analysis

Co-integration analysis is a statistical method used to examine whether there is a long-term stable relationship between two or more non-stationary time series. Co integration analysis relies on a large number of data points to ensure the accuracy of statistical testing. I use 2000 time spot to do the analysis. This strategy uses the coin_Johansen method to determine whether the price sequences of the main assets and paired ETFs are co-integrated, and check the co-integration exists at the 1% level.

Transaction triggering conditions:

If the results of the cointegration test show a cointegration relationship between two price sequences (i.e. the value of the statistical test exceeds a certain threshold), the trading direction will be determined based on the value of the cointegration factor.The calculation of ci_factor may be based on the vectors returned by the coin_Johansen method, which typically involves analysis of long-term equilibrium relationships.

i. If ci_factor<-1.5, it indicates the need to adjust positions to restore long-term equilibrium. The strategy will sell major assets (IYM) and buy paired ETFs (pairETFs).
ii. If ci_factor>1.5, the strategy will buy the main asset (IYM) and sell the paired ETF (pairETF) in an attempt to benefit from price regression.

3. Result

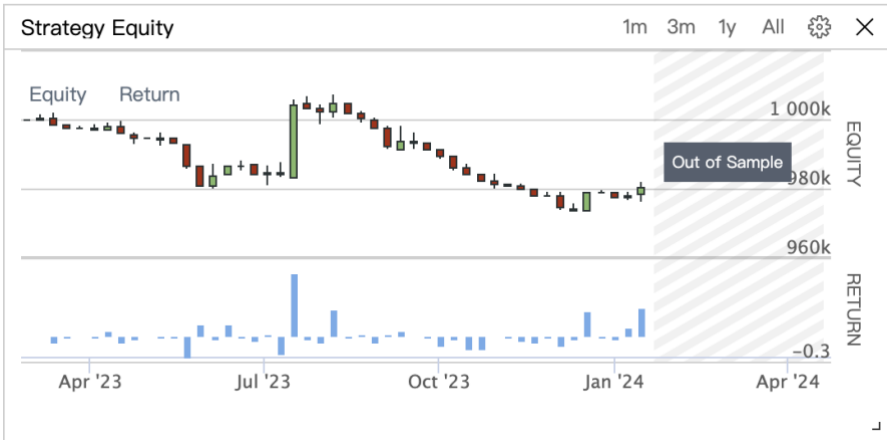
a) Return

The portfolio concluded with a negative return of 1.90%, equating to a net loss of $18970.54. The remaining equity stands at $981029.46, and trading fees amounted to $7279.80. With a negative Sharpe Ratio of -2.92, the strategy significantly underperformed the risk-free rate, implying excessive volatility or risk relative to the returns. The Compound Annual Return was also negative at -2.128%, suggesting a downward trend in portfolio value over the period.

The strategy executed a total of 908 orders, with an average win of 0.11% and a slightly higher average loss of -0.09%. This resulted in a Profit-Loss Ratio of 1.20, which typically would indicate a favorable outcome, but the high loss rate of 57% alongside a win rate of 43% reflects the overall negative performance. The PSR at 5.710% is relatively low, highlighting the low probability of the strategy achieving its target benchmark.

The portfolio turnover is 119.16%, indicates that during the inspection period, the trading volume of securities in the investment portfolio exceeded the average value of the investment portfolio by more than twice. The investment strategy is relatively active, adopting active trading methods, frequently adjusting positions to respond to market changes, and is more suitable for pursuing short-term profits.

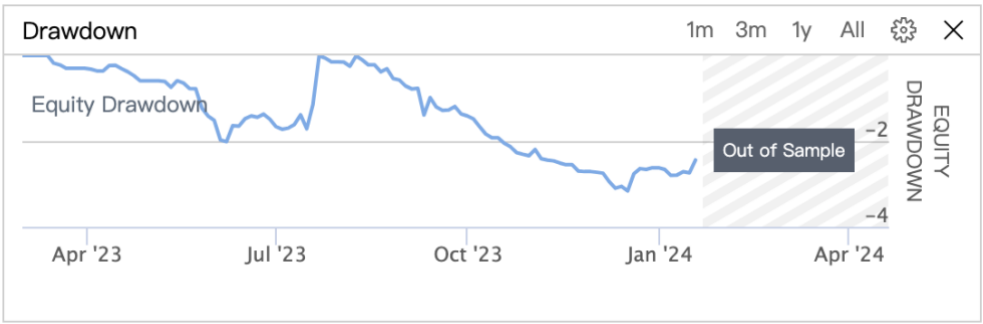
The return suddenly improved in July 2023, then kept dropping with a rare positive return. Although the overall return was negative, there's an observable shift towards profitability starting in 2024, suggesting some potential for recovery.



b) Drawdown

Initially, there curve is smooth, and the drawdown remains smaller than 1%, indicating a tiny loss in equity. A steep drop occurred happened from May to June, peaking at around 2%. Following this, the line flattens out somewhat and tends to recover, the drawdown sits between 1% and 2%, suggesting a period of less severe losses, which also result in some return.

On July 17, there was a huge upward and indicated a return of 2.1701%, which might be due to the pair ETF change from AAPL to MSFT, then the drawdown of the equity showed a downward again. This period reflects a less volatile phase with intermittent recoveries, although the strategy still doesn't return to the baseline of zero drawdown. It might be helpful to reevaluate the trading strategy and implement measures to avoid such significant declines in the future, possibly by reducing position sizes, employing stop-loss strategies, or diversifying the trading approach further.



c) Profit Margin

The portfolio margin chart shows fluctuating margin use from March 2023 to March 2024, with no clear long-term trend but notable variability, suggesting an active

management of leverage. The recent rise in margin usage points to increased borrowing for trading, which may correlate with either strategic positioning for growth or a response to market conditions. This pattern highlights the need for careful risk management, especially considering the potential for margin calls if the market moves unfavorably against the portfolio's positions.

4. Improvement

This strategy combines trend tracking (through MACD) and market balance (through co-integration analysis) as a diversification strategy. It attempts to use short-term trends and long-term equilibrium relationships in the market to make trading decisions. This combination can help the strategy maintain stability and adaptability under different market conditions, but it also requires careful parameter adjustment and sufficient back testing to ensure its effectiveness and profitability.