Title : **A Pair Trading Strategy for Cryptocurrencies** OS20901

Field : STEM and Innovation

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Abstract :

Nowadays, money is a medium for exchanging goods all around the world and well-known as one of the assets. As the world is turning into the digital era, cryptocurrency turns out to be increasingly crucial in our society. This is because cryptocurrency can decentralize a financial system and has no intermediary, so its transactions are more convenient. The value of cryptocurrency is determined by supply and demand. Furthermore, it has become a new asset class with high volatility. Consequently, trading cryptocurrencies are popular among the speculators. In recent years, there were new trading strategies that can be used in cryptocurrency, but in this project, the purpose of this study will focus on pair trading strategy only. Primitively, pair trading is used in stock market. This project investigates the applications of the strategy in cryptocurrency. The cointegration of each pair of top-50 currencies in market capitalization are determined. Then, the cointegrated pairs are adopted for strategy testing using data from the testing set. Finally, the results are evaluated for the strategy's profitability, and evaluate the result to continue using the strategy in the future.

Keywords : Cryptocurrency, Pair trading, Cointegration

Introduction

At the present, money is a medium for exchanging goods all around the world. The development of the medium is always changing so this is the main point that people create money and make their own currency.

Cryptocurrency or digital assets that are secured with passwording, will always have equivalent price. The factor that made cryptocurrency popular is it has no monetary authority, and its prices are demanding on demand and supply. This makes cryptocurrency fluctuate and the profits are made here, however, the risk of sell and buy in cryptocurrency are also at a high level. For these reasons, the usage of strategy in cryptocurrency is significant. The study of all strategies in assets and cryptocurrency show that pair trading is one of the most efficient strategies, but there is low usage in cryptocurrency. So, this project will be focused on pair trading only. Because pair trading can make reasonable profit when compared to its risk, it also makes profit in any situation: high demand and low demand.

Methodology

The studies were divided into 3 parts as follow, Part 1: Preprocessing

The 50 cryptocurrencies with the highest market capitalization were selected to perform the strategy evaluation, referencing from CoinGecko. Sentiment platform is used to collect 1-year historical daily price data, which is available for 33 currencies. There are three sets of data, consisting of training set, validation set, and testing set, that is split in the proportion of 56.25%, 18.75 %, and 25%, respectively.

Part 2: Pair selection

By performing a cointegration test on a training set of data to reject the null hypothesis of no cointegration as well as selecting pairs with a p-value less than the level of significance of 0.05, the cryptocurrency pairs to be traded were chosen. Moving standard score ($\tilde{z}$), which was used in trading simulation to identify trading signals, is defined as:

$$\tilde{z} = \frac{\tilde{x}(t_{short}) - \tilde{\mu}(t_{long})}{\tilde{\sigma}(t_{long})}$$

where $\tilde{x}$ is short-term and $\tilde{\mu}$ is long- term moving average of normalized ratio between two currencies, respectively, and $\tilde{\sigma}$ is standard deviation of long- term moving average. The opening position was determined by the high moving standard score ($\tilde{z}_{high}$), and the closing position by the low moving standard score ($\tilde{z}_{low}$). All pairs were given identical initial conditions to simulate, and 20 cointegrated pairs with the highest Sharpe ratios from trading simulation of training set were chosen to continue the analysis. Sharpe ratios is a measure of risk-adjusted return and can be calculated as

$$\text{Sharpe ratios} = \frac{R_p - R_f}{\sigma_p}$$

where R_p represents a portfolio's return, R_f represents risk-free rate, and σ_p represents the standard deviation of portfolio's return.

Part 3: Performance evaluation

Strategy performance was evaluated through cumulative return and Sharpe ratio (SR). To optimize the strategy, four variables combined as a condition were varied in simulation to maximize trading performance of each pair as follow:

1. $\tilde{z}_{high}$ was varied with values of 1, 1.25, 1.5, and 1.75.
2. $\tilde{z}_{low}$ was varied with values of 0.25, 0.5, and 0.75.
3. t_{long} was varied with values of 15, 30, 45, and 60.
4. t_{short} was varied with values of 2, 3, 4, and 5.

Using the training set of data, 20 selected pairings were used to simulate all possible conditions before choosing the five conditions from each pair that resulted in the highest Sharpe ratio. The top five conditions for each pair were performed in a trading simulation, and the finalized trading conditions for each pair were selected using a validation set of data. To evaluate the performance of the strategy, the finalized condition and testing set of data were simulated.

Result

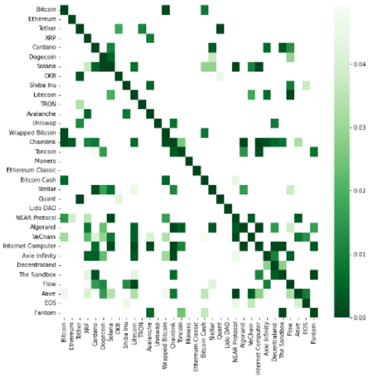

Figure 1: Graph of p-value receiving from cointegration testing using training set of data.

Regarding 1,056 possible pairs, it was found that there were 160 cointegrated pairs, which is calculated as 15.15%. From the figure, the dark green color represents less p-value and greater statistical significance of cointegration testing.

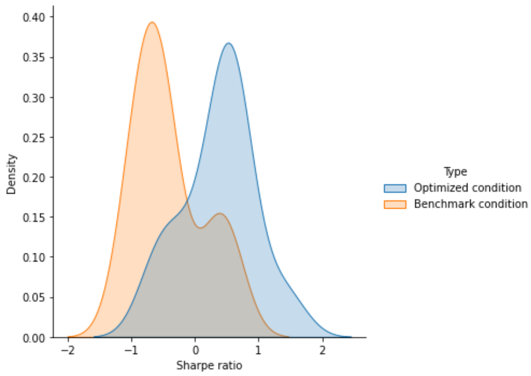

Figure 2: Distribution graph of Sharpe ratio value from the simulation using optimized condition and benchmark condition in testing set of data.

The graph shows that optimizing the strategy condition using training set and validation set of data is beneficial to the profitability. The mean value and standard deviation of Sharpe ratio resulting in simulation with optimized condition is 0.3675 and 0.5670, which cause more return. Meanwhile the mean value and standard deviation of benchmark condition is -0.417 and 0.5379.

Conclusion

The cointegration approach of a pair trading strategy for cryptocurrencies can be used with cointegrated pairs, which is 15.15% of all possible pairs combining from 33 available cryptocurrencies with highest market capitalization. The 20 cointegrated pairs with greatest Sharpe ratio were performed strategy evaluation. Consequently, the optimized condition used in trading strategy resulted in profitability with average Sharpe ratio of 0.3675, which is 188.129% increased from non-optimized condition, and standard deviation of 0.5670

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