

## INTRODUCTION

The cryptocurrency markets involving the likes of Bitcoin and Ethereum have gained widespread interest among speculators and investors looking to turn a profit. The decentralized networks are prone to abnormally high volatility making stock analysis ever more important. Traditional methods for evaluating the price of cryptocurrencies have proven very difficult as key instruments such as quarterly returns or centralized management are not present. Those looking to evaluate cryptocurrency prices may be forced incorporate other methods.

## TECHNICAL ANALYSIS AND THE EXPONENTIAL AVERAGE CROSSOVER STRATEGY

Technical analysis has become increasingly important in cryptocurrency trading due to speculators clouding prices and the lack of key information for traditional price evaluation. Technical analysis draws conclusion on the future price movement based on historic price data. The form of analysis can yield signals to either buy or sell a security in question. The Moving Average strategy is one of many indicators used in Technical Analysis. The strategy requires one to know the current price as well as a short term and a long term price average. If the historical price is available in equally spaced intervals of time, one can calculate the simple moving average (SMA) for a specific point by averaging a chosen number of past prices to get a single average price for a specific point in time. One can then calculate the exponential moving average (EMA) by averaging out the past average while providing the most current price with a larger weighting in the average.

$$\begin{aligned} & \textit{Exponential Average} : E(p_i) \\ & \textit{Current Price} : p_i \\ & \textit{Multiplier} : m \\ & E(p_i) = E(p_{i-1}) * (1 - m) + p_i * m \end{aligned}$$

The short and long term moving averages differ in that the short term average is more sensitive to current rapid changes in price than the long term average. A crossover between short and long term averages generally indicates a change in momentum of price and thus a buy or sell signal. Should the short term average change from underneath to above the long term

average, it can be inferred that the current price is rapidly increasing and one can expect the price to continue its upward trend. This indicates a buy signal. The short term price changing from above to below the long term indicates a sell signal.

### **OBJECTIVE**

To understand the effects of varying the parameters in an EMA crossover strategy on the interest earned and the frequency of buy and sell matches as one aims to maximize profits while minimizing transaction fees.

### **VARIABLES**

The Moving Average strategy requires the user to specify specific parameters including the multiplier used when calculating the long and short term exponential averages as well as the interval of time between price data. The naming of multipliers is counter intuitive as the short multiplier is always greater than the long multiplier. When backtesting the strategy, one must also choose the range of time over which to run and hence, the market conditions. A realistic simulation will also consider the fees required to list buy and sell orders. The price data used in the simulation is obtained from the Poloniex Exchange which charges low volume customers a fee of fifteenth ten-thousandths on the amount of United States Dollars to be bought or sold. The parameters discussed are the system's dependant variables. For the purposes of simplifying our analysis, we have chosen to hold the interval of time between price data and the time range constant. Closing prices appear in thirty minute intervals. We have chosen a time range of great volatility spanning from 2017-05-20 00:00:00 UTC to 2017-07-22 00:00:00 UTC. The time series data for the given range of time is shown in figure five. For our intents and purposes we will be using the currency cross between the United States Dollar and Bitcoin.

### **HYPOTHESIS**

If an exponential moving average crossover strategy is employed with large long and short multipliers, then the frequency of transactions will increase resulting in a lower profit due to the heightened sensitivity to short term price fluctuations and greater transaction fees.

## **METHOD OF ACQUIRING RESEARCH STATISTICS**

Research statistics acquisition can be divided into three areas: raw data acquisition, data processing and data visualization. Raw price data containing opening, closing, volume bought and sold in United States Dollars amongst others statistics was obtained using the Poloniex Exchange Application Program Interface.

Once the raw price data was obtained, another script was used to calculate the long and short exponential averages. The first exponential average was equal to the closing price because the standard exponential average formula cannot be applied; the formula requires the previous calculated average and the current closing price. The following entries used the standard exponential average formula. The lists containing the long and short term average were compared to yield a list of buy and sell signals.

A later section of the script used a hypothetical account, initially containing one-hundred United States Dollars and zero Bitcoins. When an element of the signal list yielded a buy signal, the script would use the corresponding bitcoin price to transfer all of the United States Dollars into Bitcoins. If an element of the signal list instead yielded a sell signal, the script would use the inverse price to transfer all of the Bitcoins into United States Dollars.

The script was run for each long and short term multiplier combination where the long term multiplier is less than the short term multiplier. Using Matlab, the data was visualized graphically using the three axis plots. Matlab was further used to determine the Pearson's Correlation between the yield rates and buy and sell counts.

The scripts described above were developed using the Python language and were specifically designed for the purpose of researching the relationship between moving average strategy yield rates and transaction frequencies.

## ANALYSIS

Figures 1.1 and 1.2 display the yield rate with respect to the long and short multipliers without fees considered. From this graph it seems many combinations yield profitable results with about a quarter yielding 60-85%. These profitable ranges involve a short multiplier anywhere from 5-100 with a long multiplier of 4-40. This translates to a short EMA of 1-39 with a long EMA of 4-49. The most profitable point occurs with a 3.25 and 21.22 ema yielding 85%. The least profitable ranges involve larger multipliers, meaning moving averages that are more sensitive to recent fluctuations. From this data, it can be inferred that the more sensitive the EMA combinations, the smaller the yield.

Figures 2.1 and 2.2 employ the same conditions as figures 1.1 and 1.2 but now involve the Poloniex transaction fee of 0.15%. It can be observed from this graph that generally the larger the long and short multipliers, the higher the sensitivity to short term price fluctuations triggering buy and sell signals causing more transactions to occur and lowering profits. Short multipliers ranging from 5-80 with a long multiplier of 4-15 provide the highest yields. This translates to short EMAS of 1.5-39 with a long EMA of 12.3-49. The most profitable point occurred with a 24 and 39 ema yielding a 60% return. This is a very desirable yield considering that buying and holding the bitcoin with no transactions for the tested period of time would've resulted in a 35% return. Any dark red point in figure 2.1 marks an EMA strategy that effectively beats the market in terms of profits.

Figures 3.1 and 3.2 employ the same long and short multiplier conditions as before while calculating the number of transactions on the Z axis. It can be observed that as short and long multipliers increase, the number of transactions increase. This can be confirmed as a Pearson's Correlation Coefficient calculation between the short(i) + long(i) multiplier with the transaction count(i) for all points (i) results in 0.96, a strong positive statistically significant relationship. The higher the multipliers, the larger the transactions.

Figure 4 is a scatter graph of yield rates involving transaction fees against the number of transactions for all short vs long EMA combinations calculated previously. A very clear trend can be observed between the two variables. As the number of transactions increase (from increasing short and long multipliers), the yields decrease. As the number of transactions decrease, the yields increase. The relationship between transactions and yield rates show a strong negative correlation at -0.94.

The data collected can point to several key points. A larger multiplier indicates a moving average that is more sensitive to short term fluctuations in data. When dealing with a moving average crossover strategy, using larger multipliers generally results in more transactions occurring. The transactions that occur, the more fees subtracted from profits. The positive relationship between the size of multipliers and transaction count is statistically significant. The relationship between the number of transactions and yields is also a very strong negative one.

#### **FUTURE IMPROVEMENTS**

We hope to conduct more research concerning the effects of micro, macro market trends and the effect of market volatility on the exponential moving average strategy's yield rates and optimal long and short trend multipliers combinations. We want to conduct an analysis on the effects of decreasing the interval of time between closing prices. We intend to understand why low long and short multipliers result in low yield rates. Future iterations of the analysis script will have a graphic user interface and graphing capabilities.