Grid Strategy: Portfolio Selection and Configuration

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General Criteria

General Criteria

What measures can show us good pairs for grid trading?

- We want pairs that are quite volatile.
- We want pairs that have more choppy behavior than others. Grid Strategy mainly works in sideway price paths.
- We want coins with high enough liquidity in short-term.

How about risks?

- The lower the holding time, the lower exposure to new events risks.
- The more a pair price moves sideways, the more the probability that the grid strategy works.
- Risk Analysis on coins

General Criteria

In general, we want a coin that is very volatile and choppy in short intervals, however, less volatile in the long intervals.

We can use volatility measures, Choppiness measures and liquidity measures for the short intervals and Risk measures and volatility measures for long intervals.

In another point of view, we want coins that have high $\frac{high}{low}$ ratio and close to one, $\frac{close}{open}$ ratio in time bars than our grid trading operates in.

Volatility Measures

Volatility Measures

Volatility Measures:

- **Close to Close Volatility**
- **Parkinson Volatility**
- **Garman Lass Volatility**
- **Rogers-Satchell Volatility**
- **Yang Zhang Volatility**
- **Sideway Volatility (my solution)**

Volatility Measures

Figure 3. Summary of Advanced Volatility Estimates

Estimate	Prices Taken	Handle Drift?	Handle Overnight Jumps?	Efficiency (max)
Close to close	C	No	No	1
Parkinson	HL	No	No	5.2
Garman-Klass	OHLC	No	No	7.4
Rogers-Satchell	OHLC	Yes	No	8
Garman-Klass Yang-Zhang ext.	OHLC	No	Yes	8
Yang-Zhang	OHLC	Yes	Yes	14

Source: Santander Investment Bolsa.

Efficiency of a volatility is close to close variance divided by alternative measure variance. In the stock market, there are evidences that the close to close volatility underestimates the volatility. Hence, they created the efficiency of volatility measure to compare different volatilities. The more the efficiency, the better the measure calculates the volatility on the paper. However, this may not be the case in perpetual futures in crypto market since the assumption of continuous trading in Parkinson volatility is correct. Hence, the sideway volatility is developed on Parkinson volatility.

Volatility Measures: Parkinson Volatility

$$\sigma_{\text{Parkinson}} = \sqrt{\frac{1}{4T\ln 2}\sum_{t=1}^{T}\left(\ln\left(\frac{h_t}{l_t}\right)\right)^2}$$

Where:

T - Number of days in the sample period

h_t – High price on day t

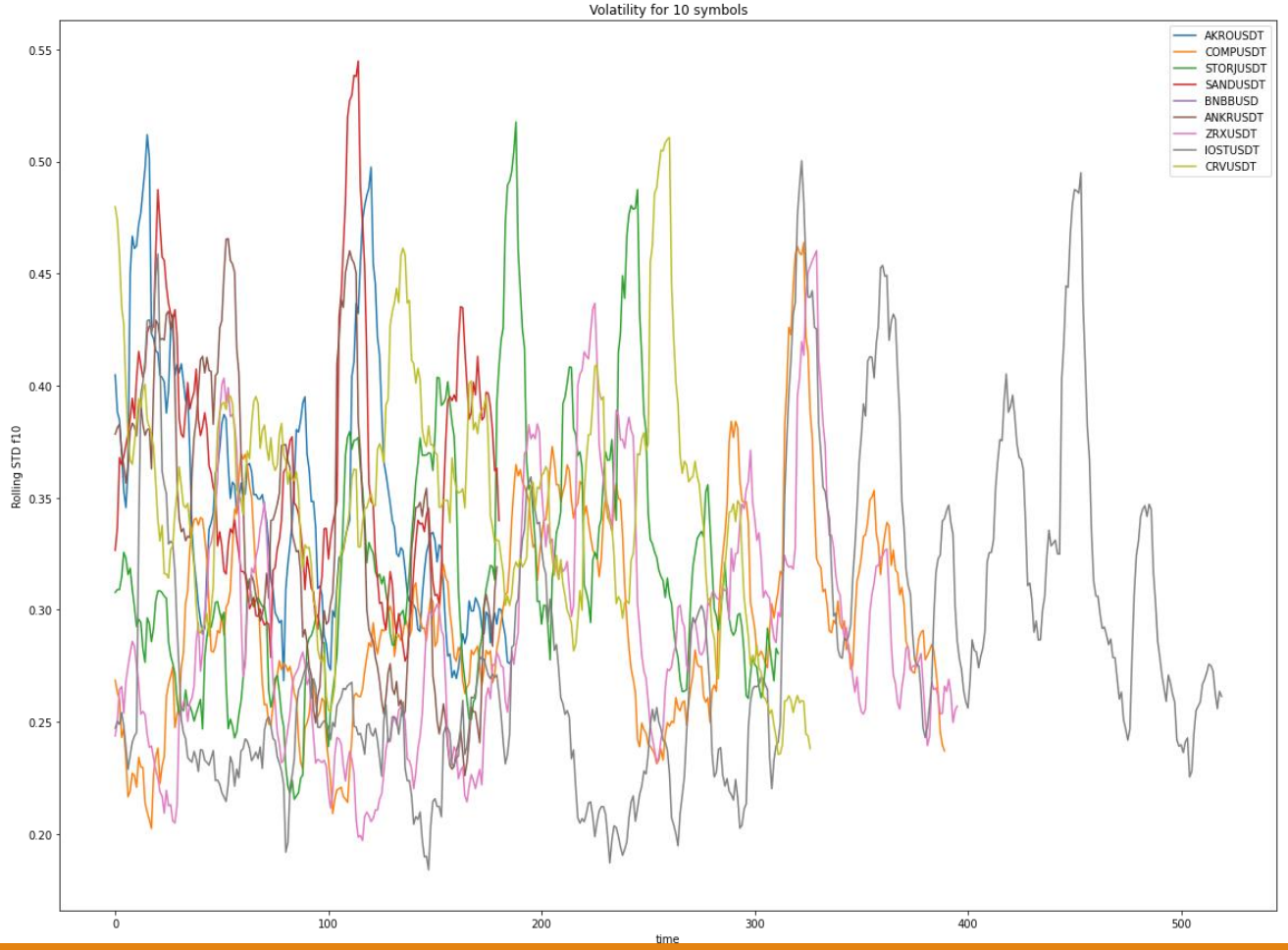
l_t - Low price on day t

Volatility Measures: Parkinson Volatility

The good thing about Parkinson Volatility and it's successors is that it uses high/low ratio. The higher the ratio, the more is the probability that our limited orders get executed. But it does not consider if the time bar represents a sideway pattern.

In grid trading, we try to exploit the sideway pattern and avoid trending markets. Hence, we want to see which timeframe has a higher ranging behavior frequency and also how volatile the ranging pattern is.

Volatility Measures: Parkinson Volatility



The only reason that we are measuring different volatilities is to find the most volatile coins for grid trading. Here we measured 10 day rolling volatility hopping that the volatility remains persistent for at least a short period of time. As you can see, some coins have more data points than others and some have fewer. There are two issues regarding the Parkinson volatility and others volatilities. First, these volatilities are quite volatile themselves. Second, some of them do not represent volatility between high and low. In other words, high/low dispersion is what makes profits in grid trading and not the dispersion between closes or solely close/open. In this sense, Parkinson volatility seems better than RS or Yang-Zhang.

Volatility Measures: German Lass Volatility

$$\sigma_{GK} = \sqrt{\frac{1}{2T}\sum_{t=1}^{T}\left(\ln\left(\frac{h_t}{l_t}\right)\right)^2 - \frac{2\ln 2-1}{T}\left(\ln\left(\frac{c_t}{o_t}\right)\right)^2}$$

Where:

T - Number of days in the sample period

O_t - Open price on day t

h_t - High price on day t

l_t – Low price on day t

c_t – Close price on day t

Volatility Measures: Rogers-Satchell Volatility

$$\sigma_{RS} = \sqrt{\frac{1}{T}\sum_{t=1}^{T}\left(\ln\left(\frac{h_t}{c_t}\right)\ln\left(\frac{h_t}{o_t}\right) + \ln\left(\frac{l_t}{c_t}\right)\ln\left(\frac{l_t}{o_t}\right)\right)}$$

Where:

T - Number of days in the sample period

O_t - Open price on day t

h_t - High price on day t

l_t – Low price on day t

c_t - Close price on day t

Volatility Measures: Yang Zhang Volatility

$$\sigma_{\text{Yang-Zhang}} = \sqrt{\sigma_o^2 + k\sigma_c^2 + (1-k)\sigma_{rs}^2}$$

Where:

$k = \frac{\alpha - 1}{\alpha + \frac{T+1}{T-1}}$

$\sigma_o^2 = \frac{1}{T-1}\sum_{t=1}^{T}\left(\ln\left(\frac{o_t}{c_{t-1}}\right) - \text{Avg}\ln\left(\frac{o_t}{c_{t-1}}\right)\right)^2$ – Overnight volatility

$\sigma_c^2 = \frac{1}{T-1}\sum_{t=1}^{T}\left(\ln\left(\frac{c_t}{o_t}\right) - \text{Avg}\ln\left(\frac{c_t}{o_t}\right)\right)^2$ – Open-to-Close volatility

σ_{rs} - Rogers-Satchell volatility

T – Number of days in the sample period

o_t – Open price on day t h_t – High price on day t l_t - Low price on day t

c_t - Close price on day t

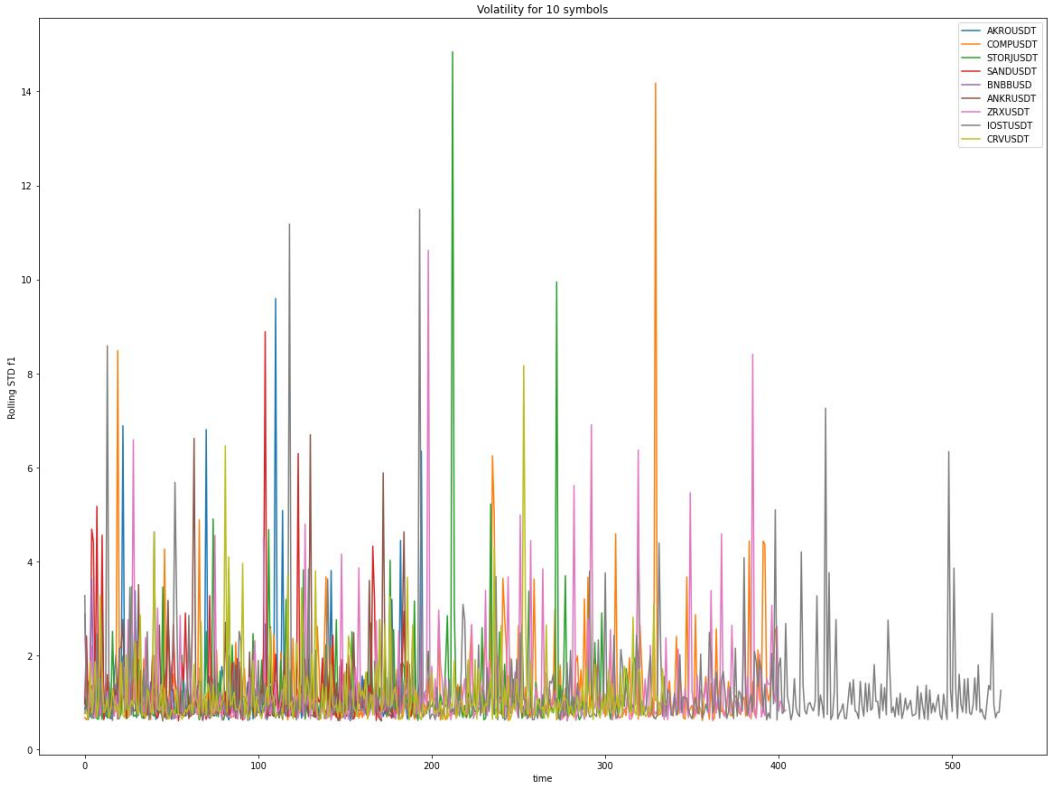
Volatility Measures: Sideway Volatility

This volatility is a small diversion from Parkinson Volatility, as defined:

$$\sigma_{sideway} = \begin{cases} \text{if } O_0 \geq L_T: \sqrt{\frac{1}{4Tln2} * \sum_{t=0}^{T} \left(\frac{\frac{h_t}{l_t}}{\frac{O_0}{L_T}} \right)} \\ \text{if } L_T \geq O_0 : \sqrt{\frac{1}{4Tln2} * \sum_{t=0}^{T} \left(\frac{\frac{h_t}{l_t}}{\frac{L_T}{O_0}} \right)} \end{cases}$$

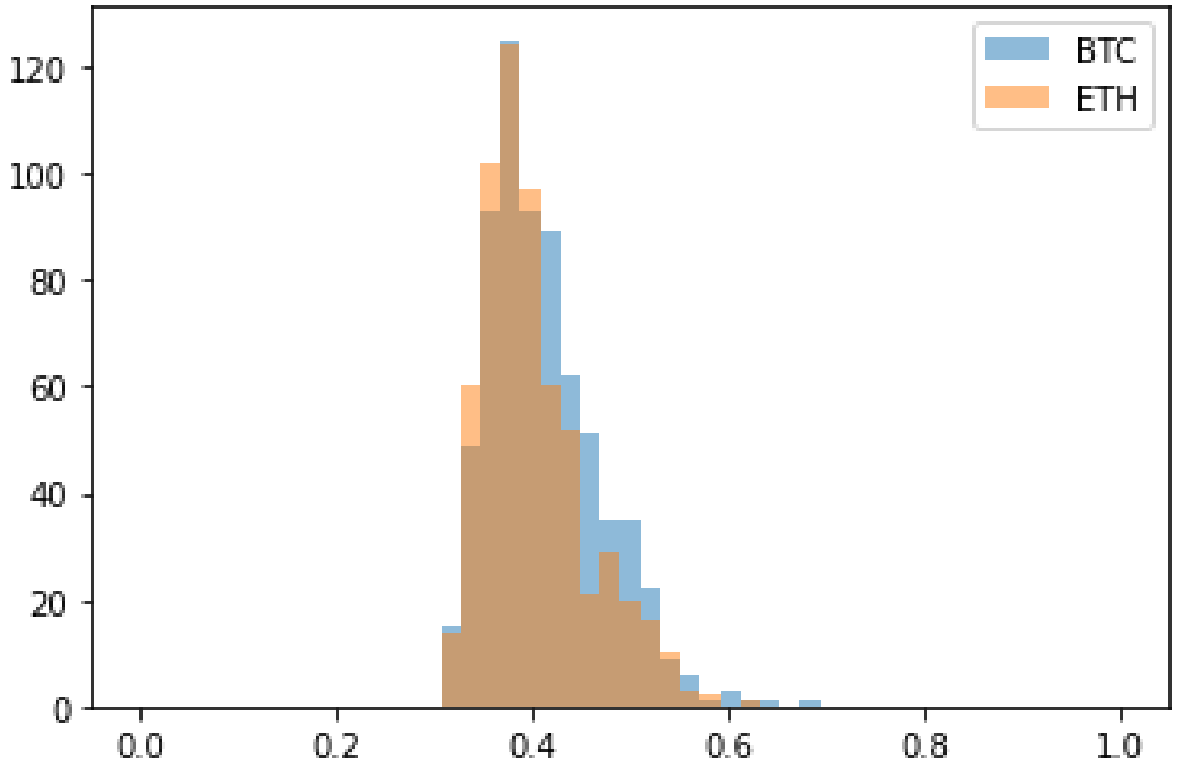
Volatility Measures: Sideways Volatility

In each 1 day bar, how many times we reached high vol.



Sideway volatility uses high to low ratio as the important factor to measure the volatility and uses the close to open (or open to close ratio to keep the ratio above 1) to penalize the dispersion between high and low. This way the volatility represents the dispersion between high and low in sideway market and disregards any dispersion when the market is highly trending. Thus, It's a two birds one stone situations. Now, we have to see in which time period, we can measure and predict

Volatility Measures: Sideways Volatility - Compare BTC and ETH

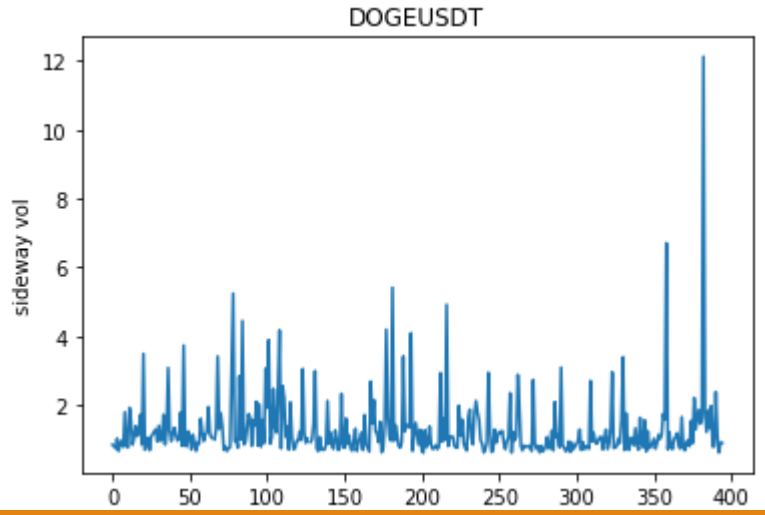


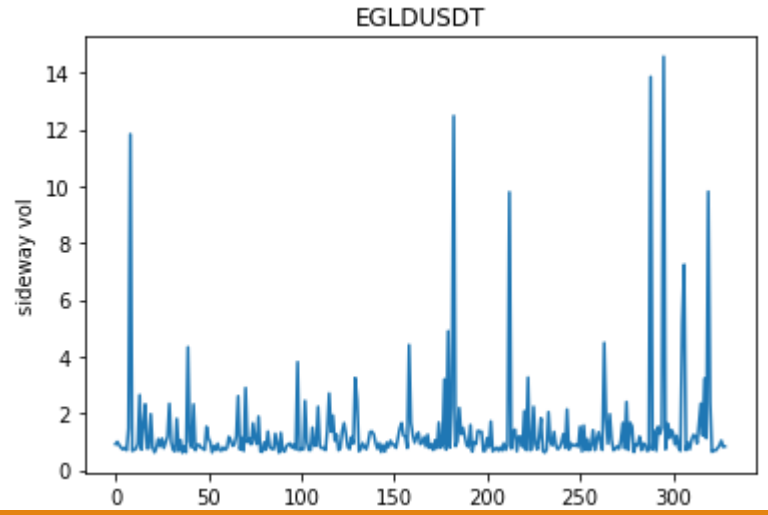
Comparing the distributions of sideway volatility can help us understand the frequency and the intensity of the opportunities leading to a successful grid trading. The median can represent a naïve measure for the frequency of the opportunity and skewness can represent the intense opportunities. In other words, the higher the skewness, the more extreme opportunities happen, giving us the chance to have less dense grid numbers with wider grid range (Upper and Lower grid levels). On the other hand, higher median is a naïve way to rank the coins that had more frequent opportunities in the past.

Configuration

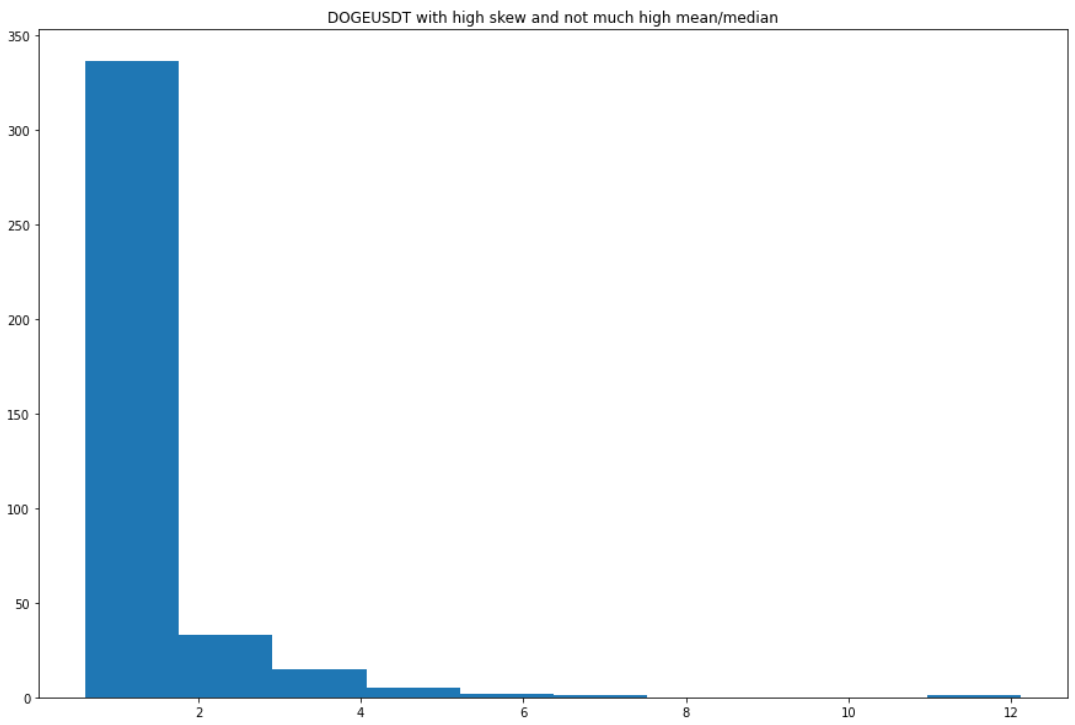
Pair Selection: Sideways Volatility - Median vs Mean Ranking

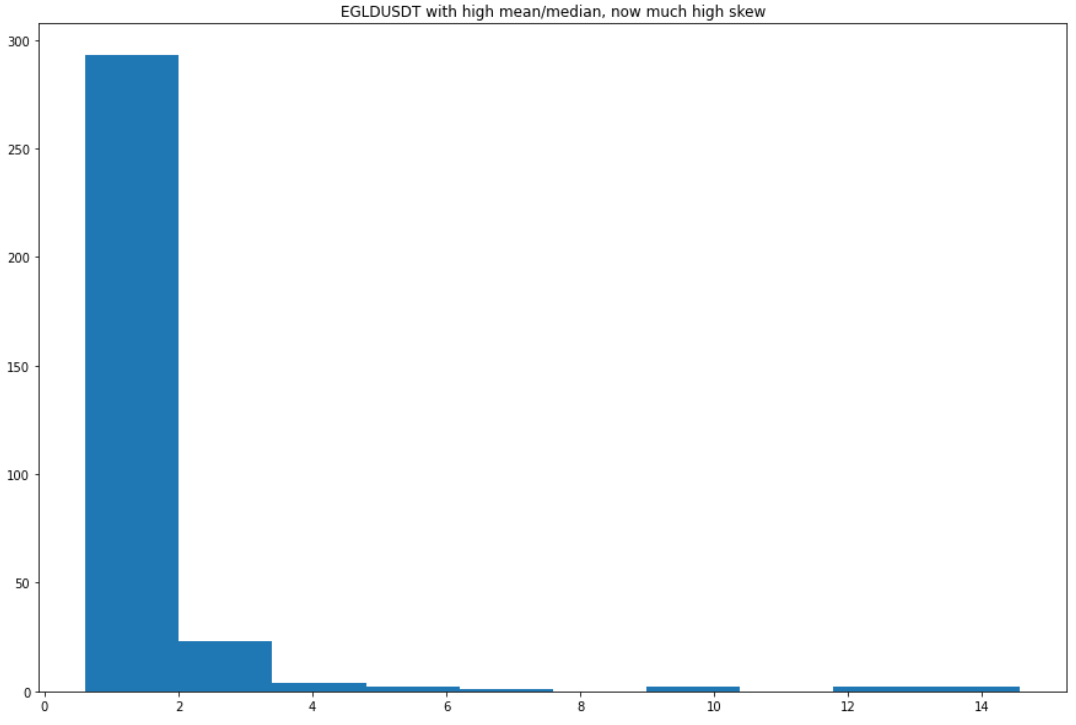
Now we can compare median of the sideway volatility measure to rank the coins. The higher the median, the higher the past high volatile sideway-trend opportunities happened. Let's look at 1 day sideway volatility of two pairs. EGLDUSDT is in top 10 highest mean volatility across 90, 30, and 14 past days. DOGEUSDT is in top 10 highest median volatility across 90, 30, 14 past days. We used arbitrary last days to show that some coins show persistency in being rich with opportunities.



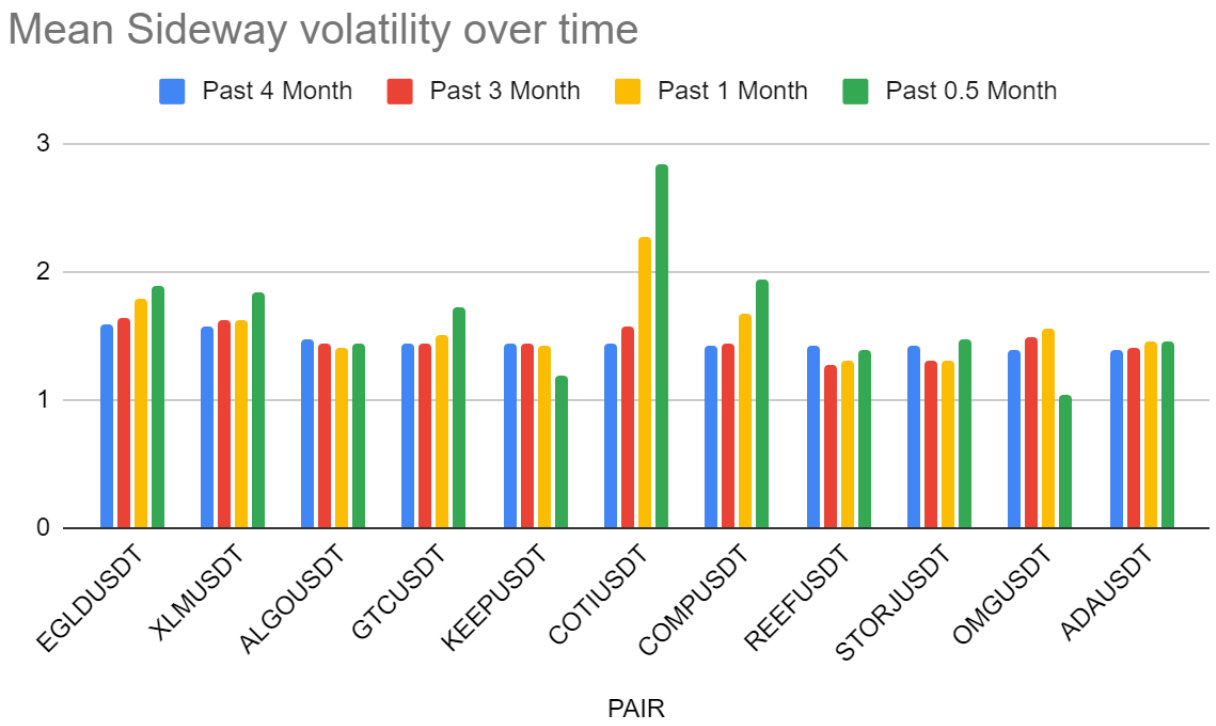


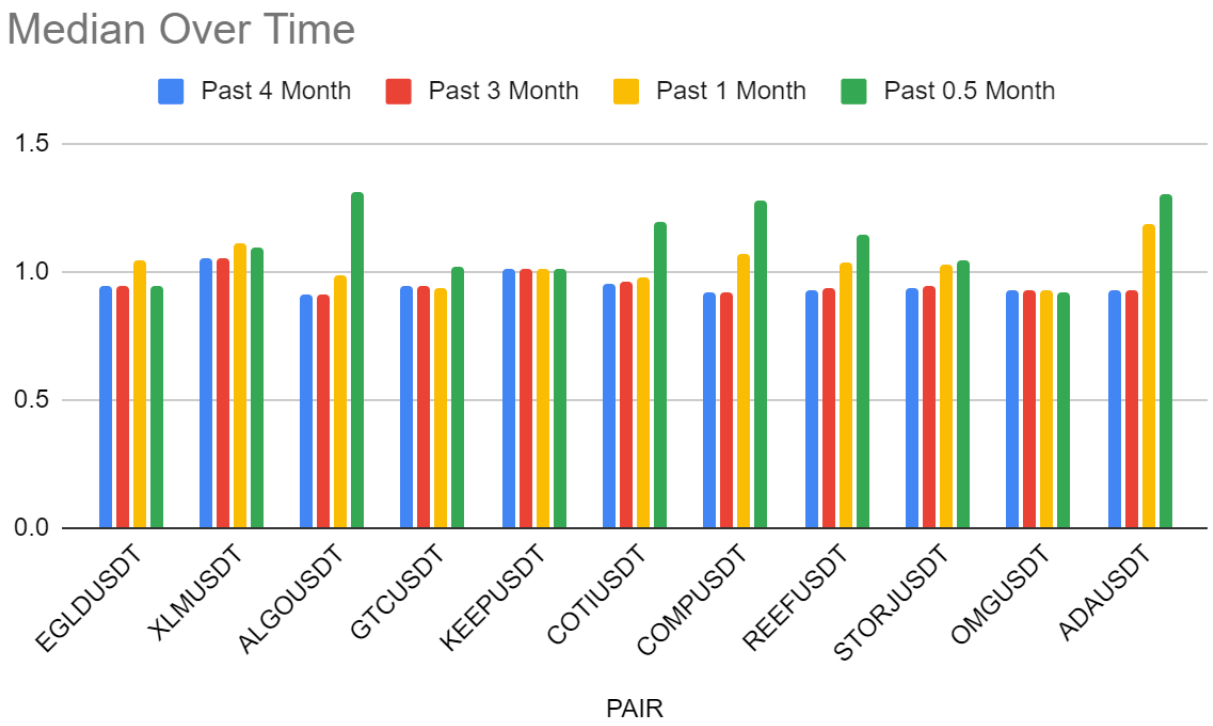
Pair Selection: Sideways Volatility - Median vs Mean Ranking





Pair Selection: Sideways Volatility: Daily data, top median





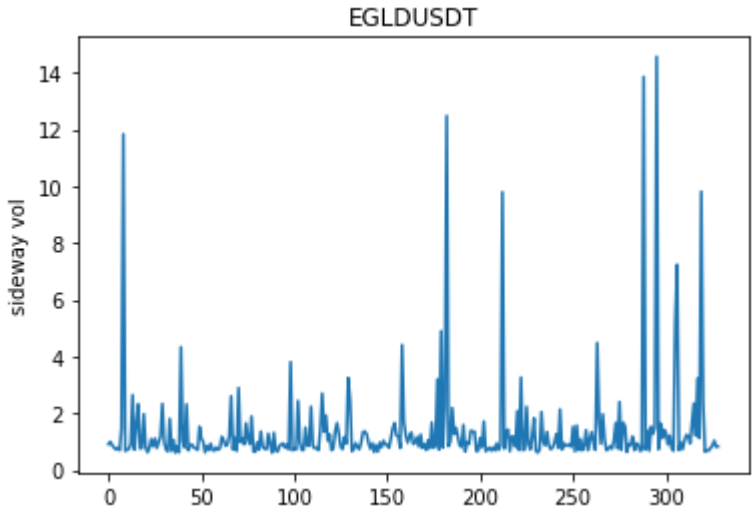
Although it seems persistent, the volatility plots in long intervals like 1 day, show no autocorrelation. It is the delusion of aggregation that make us believe we can decide when to start trading and what Configurations to use.

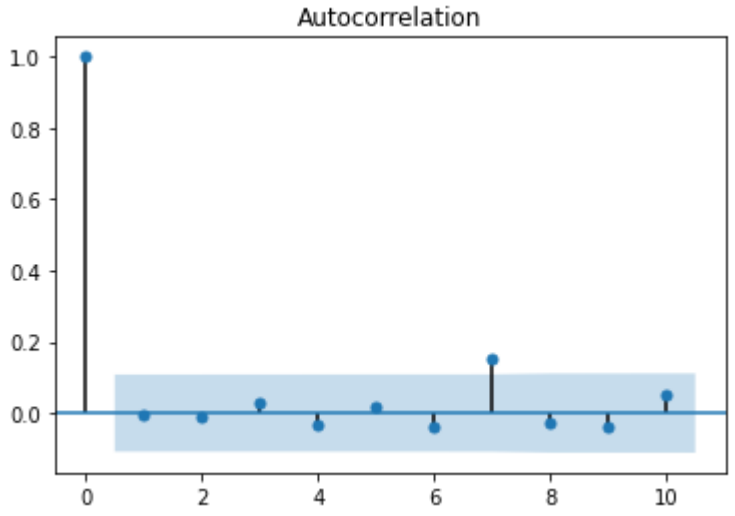
Pair Selection: Sideways Volatility - Median vs Mean Ranking

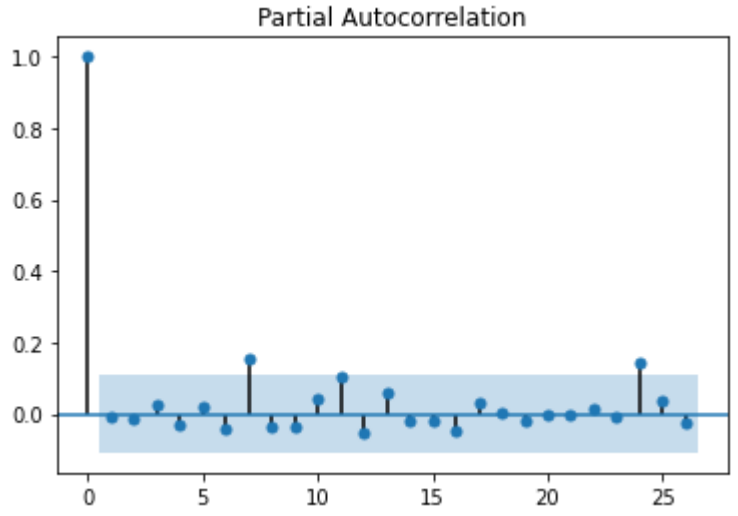
The only problem is that in in longer timeframes, the volatility is not persistent. But in shorter timeframes, volatility shows persistency. However, if we calculate the mean and median of the volatility, we see that it remains persistent even up to four month, showing that the ranking would not change dramatically. On the other hand, if we want to use mean and median, we cannot identify the periods with hyped volatility. To use the volatility itself, we need a timeframe that volatility prediction is easy and feasible.

Pair Selection: Criteria

We guess that sideway volatility is going to help us choose the best pairs at each time period for grid trading. The main problem is under which time interval, sideway volatility remains at previous levels with more certainty. The graphs below show the lack of autocorrelation in 1 day bars.







Pair Selection: Sideways Volatility - obstacle

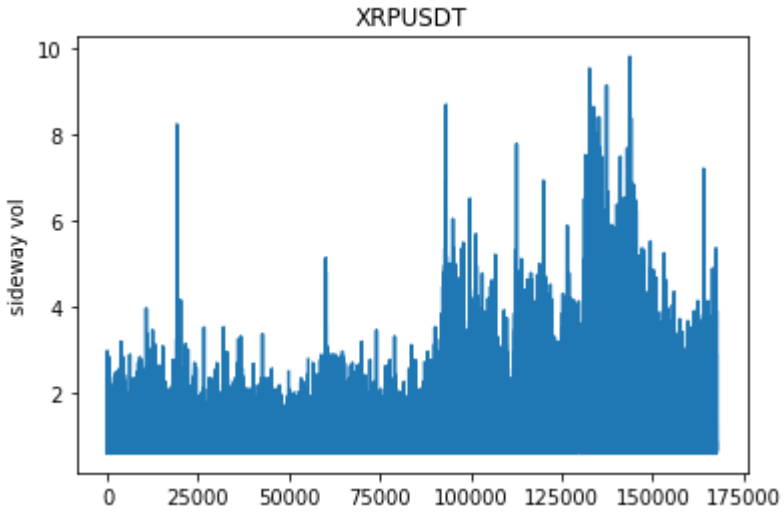
As it is shown in the previous page, the main problem is that most of the bars does not show a sideway and volatile behavior. We need excess measures to show us these events.

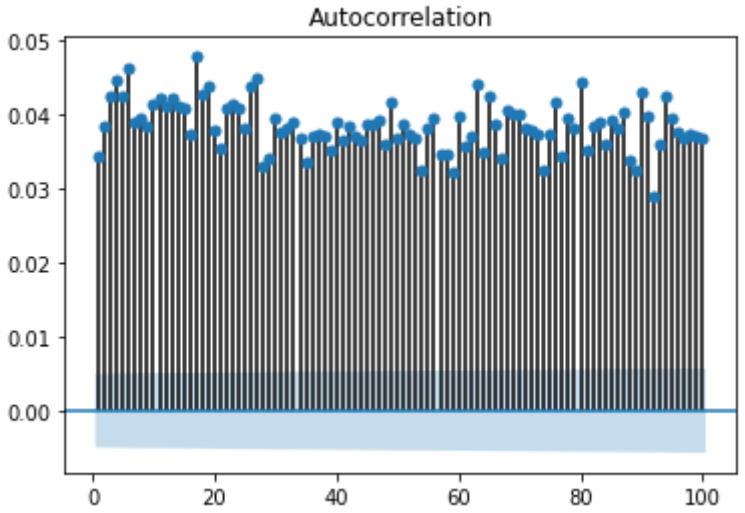
We can use Hurst Value, to see in which interval, and coin, the price historical realization was more persistent. A better way is to use ACF to see if there is a persistent autocorrelation that we can rely on.

When we use ACF, we see stronger autocorrelation in small timeframes. However, the price change in short intervals are small.

Time interval: Sideways Volatility - 5m

In short intervals, some pairs show predictability evidences. Initially, We used ACF and the results for the promising pairs like like this:





Time interval: Sideways Volatility - Prediction

We can use autoregressive models or any other model to predict the sideway volatility and choose the pairs with highest volatility.

The only problem here is that we cannot be sure that the volatility is enough to cover the transaction cost, considering the short time interval we are choosing.

Transaction Cost

We invented another measure to give us the idea about the transaction cost and high/low dispersion in short time intervals, as follow:

$$TransactionCost_t = \frac{l_t*(1+Fee_{taker}) - l_t + h_t - h_t*(1-Fee_{taker})}{h_t - l_t} = \frac{l_t*Fee_{taker} + h_t*Fee_{taker}}{h_t - l_t}$$

This ratio shows, in percentage, how much of the high and low difference goes for transaction cost. Since the trade class (taker or maker) is not known prior to trade or backtest, we used taker fee as a situation worst than worst case scenario.

Bounds

Upper and Lower Bound

- The idea is to have bounds that represent high and low in the coming time bar.
- Predicting the optimum bound is impossible, however, we can choose a factor of Yang Zhang standard deviation to put the bounds.
- YZ Volatility is drift-less volatility. By choosing a factor of YZ standard deviation, we can have floating bounds.
- The std multiplier can be determined with back-test and validated by high-dimensional smoothness.
- Notice that the standard deviation should be in a grid timeframe. If we want to execute grid trading in each 5 min interval, the volatility should be measured in 5 min. Closed time frame in grid trading refers to a configuration of Grid trading that we put a time trigger to offset all positions with market price to eliminate any further holding risk.
- For smaller grid intervals, we should have smaller multiplier. However, higher volatility in some pairs indicate that we can choose higher multiplier.
- Further improvement: We can invest volatilities based on high/open and see if we can predict a better estimation of upper bound and open/low to see if we can estimate a better lower bound dynamically.

Number of grids

Dense grid will have frequent transaction behaviors, thus profits generated from every transaction might be inadequate to cover the transaction fee, causing a loss. Whereas a wide grid will execute fewer transactions, making a relatively low profit.

When the transaction cost measure is low, we can have dense grids and when the transaction cost is high, we can have low number of grids. In a similar perspective, we can have dense grids when sideway volatility is low and light grids when sideway volatility if high. In other words, when the volatility (or the predicted volatility is low) the range that price will visit is short, so the dense orders have a better chance of being executed. However, low sideway volatility should be considered with other indicators that show no trends since the sideway volatility itself can be low just because there is a trend. On the other hand, when the sideway volatility is high, it means that the market is more sideway with higher diffused high/low. Now, we can have less dense orders that pick on high fluctuations and big returns paying less fee compared to high dense orders. Still, the key is to predict the volatility with good enough accuracy.

Position Control

- One strategy could be redefining grid levels to lower the trend risk. For example in a downside trend, If a lower grid level buy order get's executed, the higher grid level can be defined as a level for selling. In this configuration of grid trading, the redefined grid level should be higher than $trade_{t-1} * (1 + Fee_{maker})$. In summary, when the volatility drops, we should bring the orders close to first order to make sure the opening orders will be cleared. Of course, this needs a large amount of order cancellation and revision, which is not automated in the Binance grid trading but can be handles by Selenium package and a program that gives the signal (Volatility drop signal).

Starting Time

When we should start to act?

- When the predicted sideway volatility is high. Predicting the sideway volatility with good accuracy is the key.
- For Short term prediction we can begin with AR models for prediction.

Grid Margin Mode

Isolated mode reduce the risk of parameter estimation. If we choose Cross mode, only one wrong parameter estimation for a coin can destroy the whole portfolio. However, cross mode helps with financing more trades.

Grid Mode

The only way that we can implement any mode other than neutral is to have a feature predicting the direction with a good accuracy. This means that if we want to choose long grid mode, which indicates that the first position is a long, we must be confident the price is more probable to go upward. In other words, the initial price is in the downside of the volatility range. In neutral mode, we are confident the initial price is in the middle of our volatility range.

Leverage and Initial Margin

We should not implement any leverage or initial margin when we do not have any performance analysis of the trading strategy.

In the future, we can have higher leverages for pairs with lower volatility and vice-versa.

Stop trigger

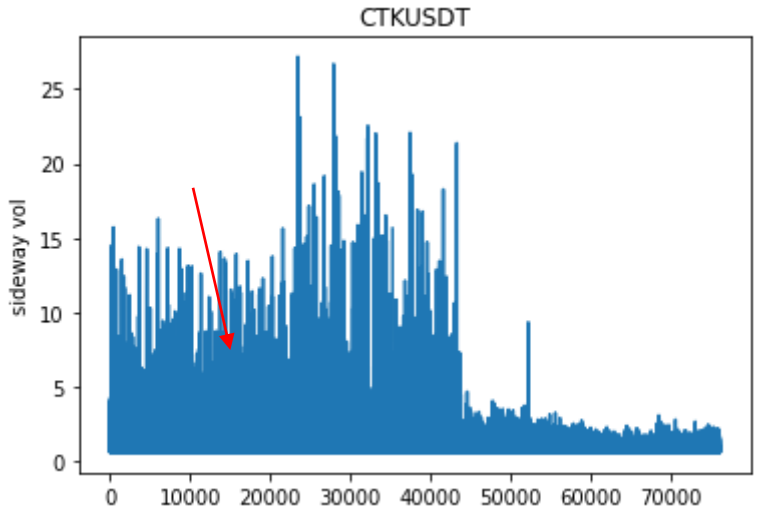
Different modes can be considered for backtest:

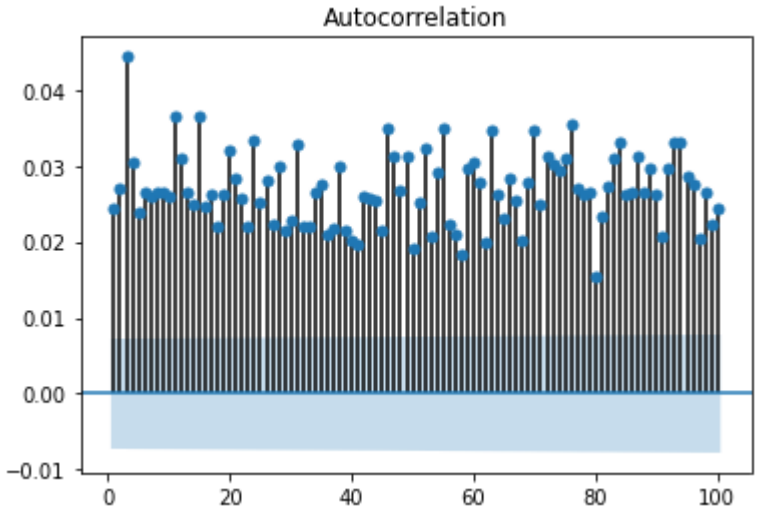
- Account Stoploss: Based on investor's preferences and successful backtest returns drawdowns.
- Time interval Stoploss: choosing the time interval (e.g. 5 min) and clearing all the orders at closing time at market price.
- Position sizing:
  - Safe Mode (Take Profit): By default, we are doing a greedy strategy that finds volatile situations and exploit them, however, in times that our indicators suggest that the market is not volatile enough or trending, we can define a function that calculates a predefined small profit and changes the other side orders close to the first positions to clear them out as soon as possible with the predefines small profit. Alternatively, we can stop trading the put orders at the market price and clear all positions. However, safe mode is for the times that volatility drops but not that much. This means that we have to define a threshold for when the volatility drop is too big that asks for stop trading, or moderate that asks for safe mode trading.
  - Safe Mode can be triggered as a stop loss in anticipated trending market.
  - Safe mode is very fruitful when the sideway volatility drops to lower levels.
  - The threshold can be determined in backtests.

Stop trigger

When should we terminate the strategy?

- **Account stoploss at investors preferences.**
- **When the sideways volatility prediction to realization varies a lot. In other words, we are using some live indicators to set our parameters, so if those indicators start to show diminishing performance, we have to execute the stop trigger and shut down trading.**

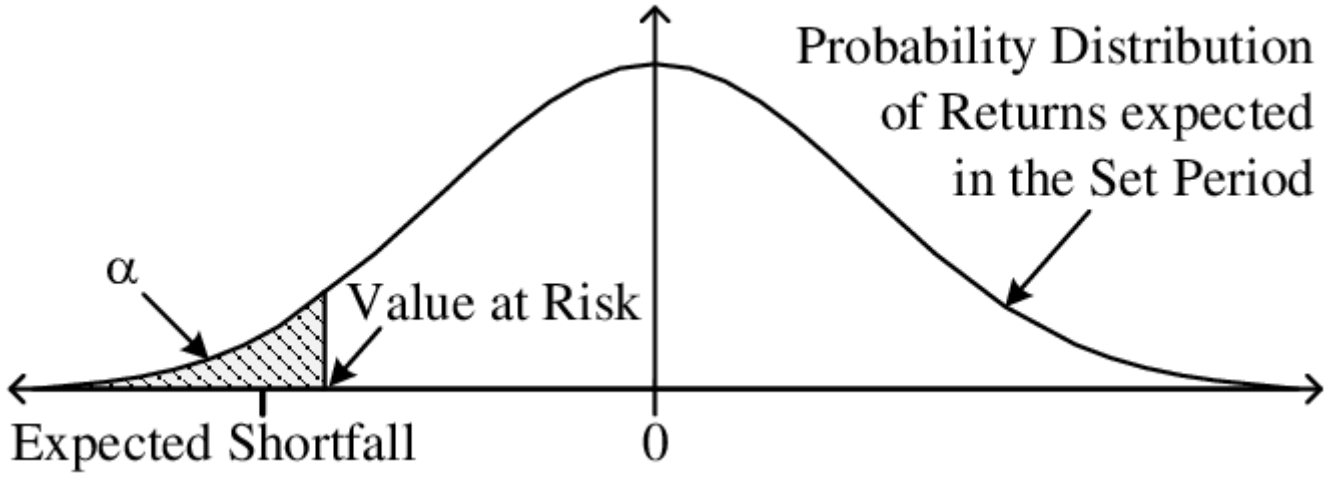




Initial Margin

Determined by the leverage, and grid range and number of grids.

In general, initial margin should always cover the ES of the backtest returns at 95 or 99%. In other words, the winning backtest configuration, has a return distribution. The Expected shortfall or an even more extreme measure can be used as the lower bound of initial margin.



Hurst Exponent indicator

Hurst Value is more than 0.5

If the Hurst value is more than 0.5 then it would indicate a persistent time series (roughly translates to a trending market).

Hurst Value is less than 0.5

If the Hurst Value is less than 0.5 then it can be considered as an anti-persistent time series (roughly translates to sideways market).

Hurst Value is 0.5

If the Hurst value is 0.5 then it would indicate a random walk or a market where prediction of future based on past data is not possible.

Coding Part

- Downloading Data: For faster operations
- Volatility Measures + an experiment with hp-filter cycles at the end
- Trend Measure (Direction Feature): For further studies
- Volatility and ACF
- Hurst Ranking

Performance

- **Compound Annual Return (CAR)**. What percentage does the system make on average per year historically.
- **Risk Adjusted Return.** The percentage returned per year allowing for the risk taken in the market.
- **Exposure.** The percentage of time spent in the market (and therefore that the capital was exposed to market risk).
- **Expectancy.** The average gain (or loss!) per trade. This must always be a positive value.
- **Number of trades per year.** Average frequency of trades. This should be a number you are comfortable with and have the lifestyle to accommodate.
- **Average holding period.** How long on average each trade lasts.
- **Sharpe Ratio.** A measure of the daily returns divided by the standard deviation of returns. In other words the smoothness and steepness of the equity curve. It should be above one ideally (risk is no bigger than returns).
- **Win/Loss ratio.** Different systems will have different win rate profiles. Shorter term swing systems can have high win rates but low expectancy. Longer term momentum systems can have lower win rates but higher per trade expectancy.
- **Maximum Historical Drawdown.** This is what your float would have drawn down by had you started trading the system just prior to the max drawdown. Make sure it's within your personal limits. Plus, you should always bank on a number twice this amount being in the future for a given system.
- **Return (CAR) to Maximum Historical Drawdown ratio.** Compares the average annual historic return to the worst drawdown experienced in the trade history. You're generally looking for a ratio at least above 1 (ie the compound annual return is bigger than the max historical drawdown).

Resources

https://portfolioslab.com/tools

Advances in Financial Machine Learning {BOOK}

https://www.tradingview.com/support/solutions/43000501980-choppiness-index-chop/

https://www.bexplus.com/blog/what-is-grid-trading-and-how-to-use-it/