# Predicting Bitcoin:
## Backtesting Results

### Summary

The following examines the simulated trading performance of BTC/USD and ETH/USD pairs from December 1 and 15, 2017, respectively, to January 1, 2019.

We use the “normal” prediction index, which is a raw prediction normalized to target 1/0 buy and sell thresholds. We partition predictions from different regressions into four sets: short, medium and long term, and the full set of regressions. The time frame refers to the recency of each regression’s training data. We then average the predictions for each partition into a final score which is the basis for simulation.

We show two different metrics, hindsight best path and forward walk results, to demonstrate the value of our predictions. Further, we show two different methods of finding a best path and walking forward, one based on the prediction values themselves and one based on their relative frequency.

Simulations are long only, and levy a 1% fee for every transaction.

For a more detailed explanation of methodology, please refer to “TechnicalPresentation.pdf”. We will focus here mainly on the results.

### BTC/USD

For this period, with a starting wallet of 100, holding Bitcoin would have left you with an ending wallet of 35, as price dropped from ~10,000 to ~3500.

### Frequency Search

Instead of using our Normal prediction values to assign buy and sell thresholds, we transform them into their relative frequencies within the data set. For example, an outlier number like 1.5 might be in the 99.5 percentile of values. Instead of assigning a buy threshold of 1.5, we may assign one of .995.

## Hindsight Best Path

| Stat | Short Term | Medium Term | Long Term | Full Set | Average |
|---|---|---|---|---|---|
| **Wallet** | 116.67 | 163.56 | 148.52 | 167.93 | 149.170 |
| **Relative Performance** | 333 | 467 | 424 | 480 | 426.00 |
| **Threshold (Buy, Sell)** | .995, .25 | .995, .7 | .995, .55 | .995, .75 | .995, .56 |

In hindsight, we can find many paths to profit by buying only at the most extreme positive values (every partition buys only the 99.5 percentile), and selling towards median values or higher, likely because in an extreme bear market like the one Bitcoin went through, values not going up were going down.

## Walk Forward Methodology

The walk forward test is conducted in the following way: we start out with default buy/sell thresholds of 1/0—for frequency, where every value is between 0 and 1, this means we skip the first week. Every week, we search the best path through the relative frequencies of the prior dataset, and adopt those frequencies as the best buy sell thresholds. We then go forward for another week, and buy if the relative frequency of a frame is above our buy threshold, or sell if it's below our sell threshold. Crucially, while iterating through our array of predictions we take only the frequency in relation to all previous elements of the array, or else we would be peeking into the future.

## Walk Forward

| Stat | Short Term | Medium Term | Long Term | Full Set | Average |
|---|---|---|---|---|---|
| **Wallet** | 61.84 | 86.57 | 66.31 | 97.31 | 78.0075 |
| **Relative Performance** | 176 | 247 | 189 | 277 | 222.25 |

With a walk forward, we lose some value for each prediction set, but the Full Set goes down only slightly at 97.3, and our average wallet of 78 is still significantly outperforming the market. This suggests that a frequency search is relatively quick to converge on buying at more extreme values and selling towards the median. It also means that (in a long only simulation) you would have more than doubled the Bitcoin you held walking forward.

## Value Search

The following uses the Normal index prediction values only, as opposed to the frequency of those values, to search for best paths. In theory, the Normal values should have a profitable path when buying at > 1, and selling at < 0. In practice, that may not be the case. Let's look at the best paths in hindsight:

## Hindsight Best Path

| Stat | Short Term | Medium Term | Long Term | Full Set | Average |
|---|---|---|---|---|---|
| **Wallet** | 135.43 | 69.94 | 87.02 | 106.92 | 100.000 |
| **Relative Performance** | 386.14 | 199 | 248 | 305 | 285.00 |
| **Threshold (Buy, Sell)** | 1.15, 0.4 | 1.1, 0.5 | 1.2, 0.45 | 1.2, 0.5 | 1.16, .46 |

Though the best path for each prediction set outperforms the market significantly, only two, the short term and the full set, yield a profit.

However, searching for the best path out of our prediction set reveals something interesting: in a large enough sample, the best path thresholds for each prediction set converge to above the targets of 1/0, to an average of 1.16, .46. This is significant, because although we are underestimating the best thresholds, we are doing so consistently: going forward, we can adjust for it.

As to why this is the case, when we examine a histogram of our values, we see that they are skewed right; hence, the best thresholds are too.

## Walk Forward Results

| Stat | Short Term | Medium Term | Long Term | Full Set | Average |
|---|---|---|---|---|---|
| **Wallet** | 36.50 | 31.70 | 50.50 | 52.50 | 42.800 |
| **Relative Performance** | 104 | 91 | 144 | 150 | 122.10 |

We see with a walk forward that our best path expectations were somewhat inflated, and that these results are significantly worse than a walk forward using relative frequency. Although the average performance is 22% higher than the market performance, it is still in raw terms a dismal 42: a 58% loss. This reflects the difficulty of finding the best path in advance with a data set of only weeks; most of the losses came in the volatile period of December-January.

## ETH/USD

For this period, holding ETH with a starting wallet of 100 would have left you with an end value of 20, as the price went from ~700 to ~140.

### Frequency Search

### Hindsight Best Path

| Stat | Short Term | Medium Term | Long Term | Full Set | Average |
|---|---|---|---|---|---|
| **Wallet** | 98.96 | 135.40 | 124.36 | 156.55 | 128.800 |
| **Relative Performance** | 495 | 677 | 622 | 783 | 645.00 |
| **Threshold (Buy, Sell)** | .995, .45 | .985, .75 | .995, .65 | .99, .65 | .991, .63 |

The results here end up very similarly to Bitcoin's: buy at a percentile over the 99th, sell when it approaches above the median. The average hindsight wallet is lower, but the the relative performance to market is significantly higher (and large on its own) given ETH's steeper decline in value.

### Walk Forward

| Stat | Short Term | Medium Term | Long Term | Full Set | Average |
|---|---|---|---|---|---|
| **Wallet** | 25.94 | 61.95 | 34.48 | 111.52 | 58.4725 |
| **Relative Performance** | 129 | 309 | 172 | 556 | 291.5 |

The walk forward, again similarly to Bitcoin, shows the relative value of the different time frames in our prediction set. The average lost significant value, but the full set actually made an 11.5% profit!

### Value Search

### Hindsight Best Path

| Stat | Short Term | Medium Term | Long Term | Full Set | Average |
|---|---|---|---|---|---|
| **Wallet** | 85.50 | 60.40 | 74.75 | 100.80 | 80.000 |
| **Relative Performance** | 426.4 | 301 | 373 | 502 | 401.00 |
| **Threshold (Buy, Sell)** | 1.15, 0.45 | 1.2, 0.5 | 1.2, 0.45 | 1.2, 0.5 | 1.19, .48 |

Only the full set makes a profit in hindsight; the other sets struggle. This reflects the difficulty of profitable trading when the underlying loses 80% of its value. Relative performances are still quite high, again because of ETH's poor performance.

Best thresholds are extremely similar to Bitcoin's, which highlights even further the consistency of performance. For example, finding the best thresholds on either trading pair, and then testing the other pair (an out of sample test) would have yielded approximately the best path results.

## Walk Forward Results

| Stat | Short Term | Medium Term | Long Term | Full Set | Average |
|---|---|---|---|---|---|
| **Wallet** | 34.84 | 59.22 | 51.23 | 66.61 | 52.97 |
| **Relative Performance** | 174 | 295 | 256 | 332 | 264.25 |

A similar pattern to others unfolds: the full set is the highest performing, but as with Bitcoin, losses are still high; on the other hand, relative performance is even higher, because of ETH's worse performance.

## Conclusion

It's clear from our various back and forward tests that our predictions have value and accuracy in direction. The best strategies, in hindsight, were consistent in either targeting the high end of the frequency distribution for buying and the middle for selling; in value terms, they performed similarly, and the consistency of those thresholds mean that moving forward, we can adjust our buy and sells accordingly.

The forward walks give us a clear indication that the higher the number of regressions in a prediction set, the more value: the Full Set is the highest performer in all walks for both ETH and BTC. Further, a frequency search forward walk would have yielded a small 3% loss (compared to -65% for the market) for BTC and an 11% gain (compared to -80% for the market) for ETH. This conforms with our expectation that Full Set would outperform, and shows that even in an extreme bear market, TradeBot's predictions are powerful.