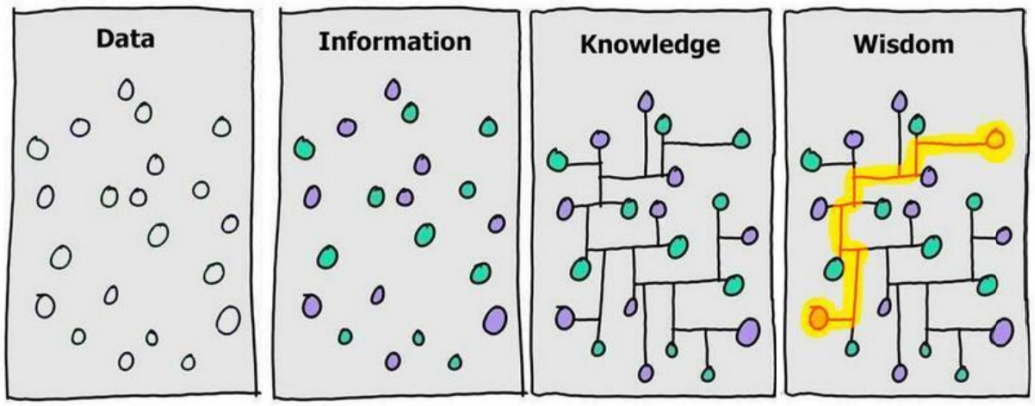
Quant Investing 101

PlanB@100trillionUSD
August 7, 2022



@gapingvoid

"Where is the wisdom we have lost in knowledge?
Where is the knowledge we have lost in information?"
- T. S. Eliot [1]

1. Introduction

I love quant investing and have been doing it since university, about 30 years ago. Quant investing covers several disciplines (investing, trading, statistics, artificial intelligence and programming) and most articles and books about quant investing are theoretical and complex. In this article, I want to demystify quant investing and show you what&how in simple and practical terms.

The hypothesis in this article: is it possible to create and implement a simple working quant investing trading rule that outperforms bitcoin buy&hold investment?

We will see that we can outperform buy&hold, by a wide margin.

Nothing in this article is financial advice. All content is for informational and educational purposes only. No investment is without risk. Make sure you read the risk paragraph in this article.

2. Data, Information, Knowledge, Wisdom

Quant investing uses data, information and models for investment decisions. The concept of DIKW describes the relationships between Data, Information, Knowledge and Wisdom [2][3]. In my opinion, DIKW aligns beautifully with the four process steps in quant investing. All DIKW steps are equally important: if the data is of low quality, information is low signal, or the correlations are spurious, then the trading rules are useless. Quant investing is both art and science.

Data

Data consists of facts and observations, which are unorganized and unprocessed. In quant investing, we mainly use price data. Sometimes other data is available, like volume data, order book data (bid-ask) and sentiment data. With bitcoin, we also have a unique and freely available database that contains all on-chain transactions, the bitcoin blockchain.

An important aspect is the source and quality of the data. Garbage in is garbage out. I know cases where investment funds failed because of data errors. So I like to have at least two sources for the same data.

Data cleaning is another topic. Data can contain errors or missing data. Smoothing is one technique that averages data points to get rid of data errors. Error correction and filtering techniques are interesting areas of research.

Information

Information is processed and structured data. Examples of information are tables and charts.

Processing and transforming data into usable information for analysis is a real art. It requires experience and creativity. If we do data processing correctly, the next step can be straightforward. The data processing step is so critical that it is sometimes called feature engineering.

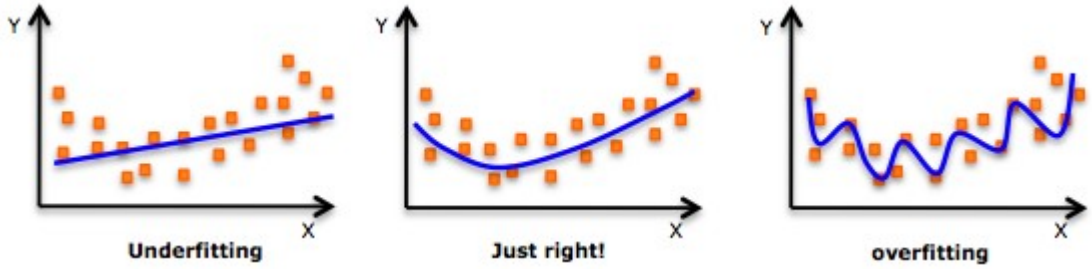
In quant investing, we create all kinds of indicators from raw data: patterns, averages, indexes and indicators. Most indexes and indicators are well known and freely available, but some are the secret sauce of quant funds.

Knowledge

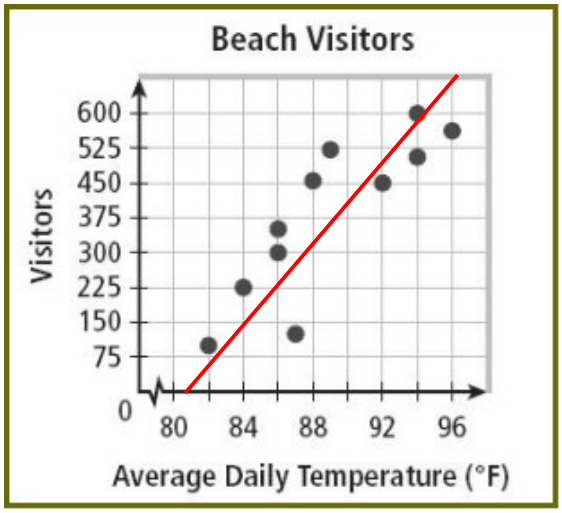
Knowledge is a combination of information with a goal. It is all about analyzing and modeling patterns between the information available and a target. The goal/target in quant investing is usually the price level or return of a financial asset. Three common analysis/modeling approaches in quant investing:

1. Technical Analysis (TA) looks for patterns in historical price charts. TA uses many patterns and indicators that mark momentum, trends and reversals. Examples of TA patterns are flags, triangles, rectangles, wedges, cup&handle, head&shoulders. TA indicator examples are moving averages, relative strength index, Bollinger bands and Ichimoku clouds. Some investors call TA “astrology for men” but most traders use TA in their daily work. A good read on TA is: [4]
2. Statistics goes beyond just looking for patterns. Statistics applies mathematical techniques to distinguish between random, spurious patterns or nonrandom, statistically significant correlations. Examples of statistical tools used in quant investing are correlation, regression, principle component and cluster analysis. Statistics is not about certainty but uncertainty and probability. Statistics on economic data is called econometrics. Many quant investors have studied econometrics. A great intro to econometrics is: [5].

3. Artificial Intelligence (AI) is the statistical analysis of big data sets with fast, dedicated computers. AI uses tools like neural nets, genetic algorithms and machine learning. A good book on AI is: [6]. Although AI is great at finding patterns in big datasets, it also amplifies a well-known statistical problem, overfitting. Overfitting happens when an algorithm memorizes a dataset (including the noise) instead of generalizing the underlying signal. Overfitting gives good model performance when making a model but poor model performance on new out-of-sample data. Preventing overfitting is an art in TA, statistics and AI. My preferred solution is to keep the model as simple as possible (few variables, few parameters) and to fit multiple data sets simultaneously (this does require a specialized fitting tool).



All models (TA, statistical and AI) are simplifications of reality. So all models are wrong because they are not the same as reality. Models try to generalize instead of memorizing reality. Generalization tries to cut through the noise and capture the underlying signal. There is always some variable different or missing. Models try to capture similarities and structures. Take this simple beach visitor model that predicts the number of beach visitors (y-axis) based on temperature (x-axis):



The model shows a positive relationship between temperature and visitors: the higher the temperature, the more visitors. The model is not flawless, it is not always correct and there is uncertainty. Of course, this model does not include all relevant variables like rain, weekends, holidays, etc. For example, the rain could have caused the 87F-130visitors outlier and a holiday weekend could have caused the 89F-525visitors outlier. However, this simple model could be sufficient for beach bar staff planning.

Wisdom

Wisdom is knowledge applied in action. As beach bar owners, we could use the beach visitors model for a staff planning decision rule: IF the temperature is below 88F THEN one person in the bar ELSE two persons in the bar. In quant investing, the decision rule is usually a trading rule (buy&sell) based on a correlation captured by a TA, statistical, or AI model.

A crucial step in making quant investing rules is backtesting. Backtesting is evaluating how a trading rule performs over some historical period in terms of risk and return. However, in the end it is all about out-of-sample performance, performance on future data that the model has not yet seen. The holy grail of quant investing is high return with low risk. Most quant investors use risk-adjusted return as a performance criterion. The Sharpe ratio (return divided by the standard deviation of returns), Sortino ratio (return divided by the standard deviation of negative returns) and Calmar ratio (return divided by drawdown) are examples of risk-adjusted return performance criteria.

3. Quant Investing Example

Enough theory. Let us create and implement a real-life quant investing trading rule!

This trading rule will be simple, only based on monthly bitcoin (BTC) data and the relative strength index (RSI). The goal is to outperform buy&hold BTC.

BTC buy&hold: if you had bought 1 BTC in April 2011 for $3.5 and hodled until July 2022, you would have 1 BTC worth $23,322. That is 119% annualized return. However, you would have to stomach big risks, like -82% drawdown (max cumulative loss) in 2014.

Data

Our BTC price data source is TradingView. They provide free data and charts [7].

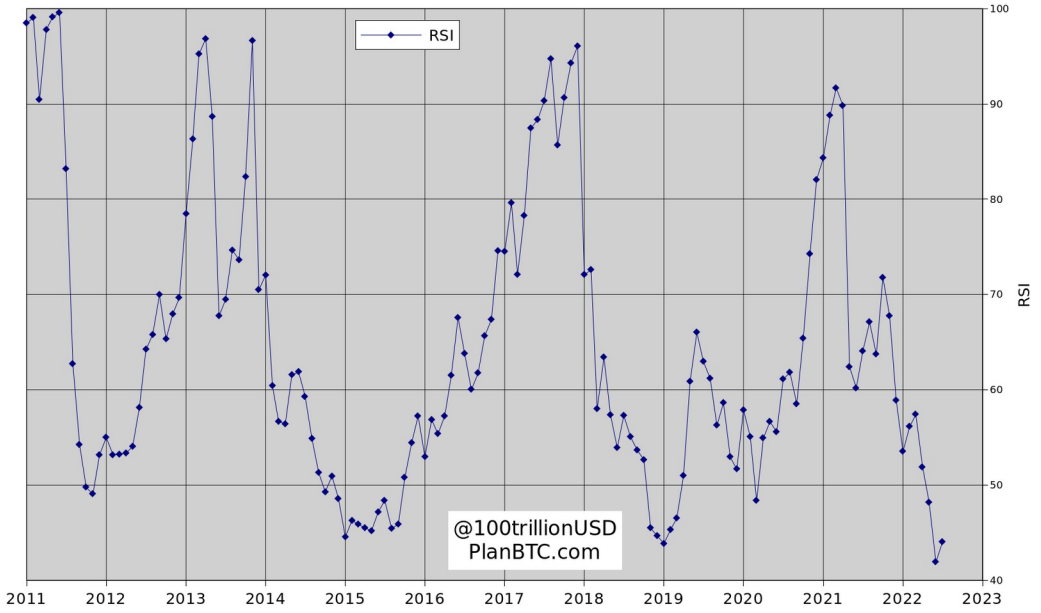
We use January 2011 – July 2022 BTC monthly closing data.

Information

From the BTC monthly closing data, we calculate RSI (14 months). RSI is a well-known TA momentum indicator, calculated as an index with a 0-100 scale [8]. RSI can be used to recognize overbought and oversold conditions.

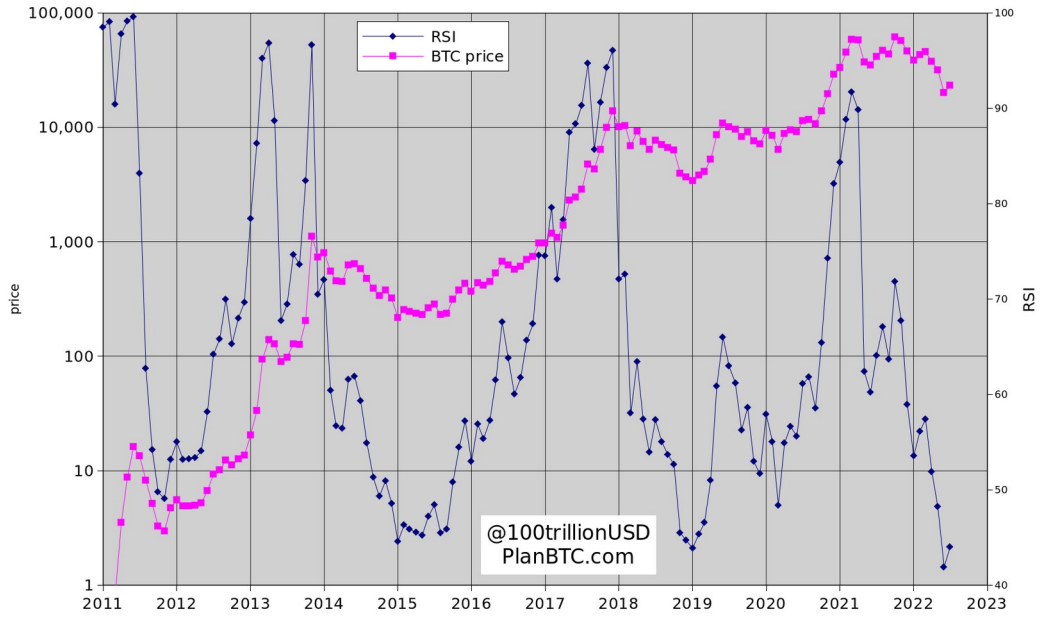
Traditionally, RSI above 70 indicates an overbought situation and RSI below 30 indicates an oversold condition. However, the BTC range is different because BTC RSI can go as high as 90-100 and has never been lower than 40.

You can see 2011-2022 RSI going from below 50 to over 90 and back to below 50 again.



Knowledge

So how does RSI correlate with our target BTC?



We can see that 2011, 2013, 2017 and 2021 BTC tops correlate with high RSI. Similarly, 2011, 2015, 2018/19 and 2022 BTC bottoms correlate with low RSI. Bull markets seem to run out of steam when RSI>90. Bear markets seem to fizzle out when RSI<50.

We can use this pattern for a trading rule that avoids bear markets and outperforms buy&hold BTC.

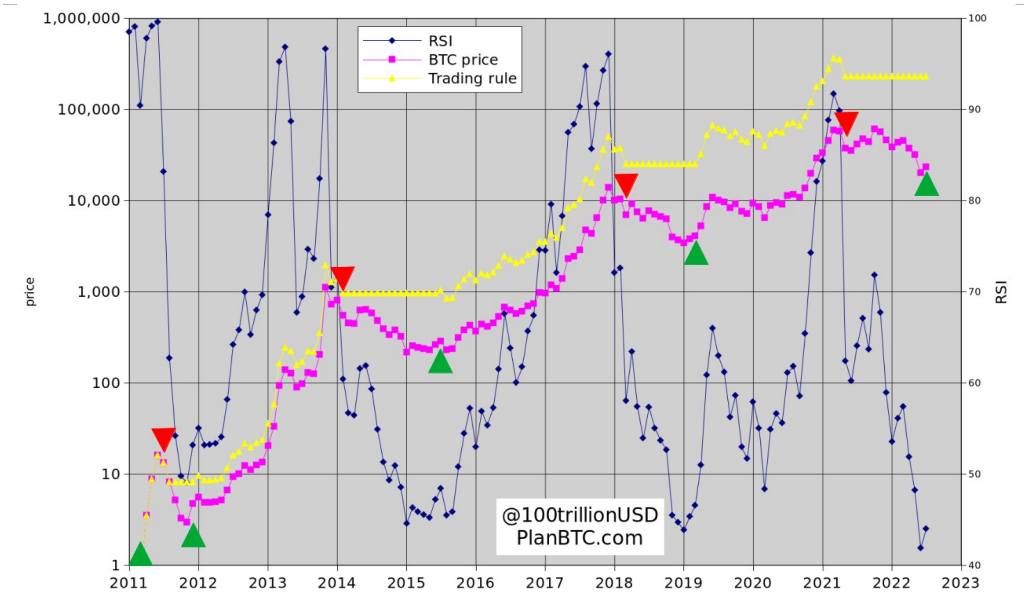
Wisdom

Optimization over multiple periods on the Calmar ratio results in the following trading rule:

IF (RSI was above 90% last six months AND drops below 65%) THEN sell,

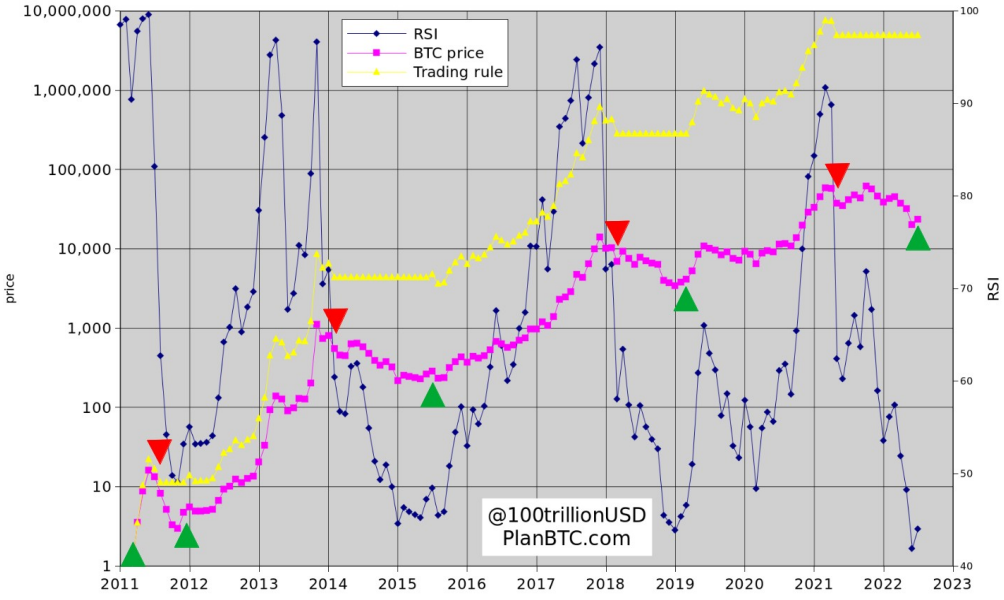
IF (RSI was below 50% last six months AND jumps +2% from the low) THEN buy, ELSE hold.

The trading rule does 8 transactions and turns $3.5 start capital in April 2011 into $229K (10 BTC) in July 2022. 10x buy&hold outperformance, 168% annualized return, and less risk (-57% drawdown).



It is exciting that the trading rule gave a BUY signal based on July 2022 BTC closing price!

We can make a second/improved implementation by adding a little leverage. Leverage is usually done with futures, but I chose in-the-money (ITM) call options. The benefit of buying options is that no stop-loss is needed and positions can not be liquidated. ITM call options have a strike (X) below spot price (S). ITM call option position is determined by aiming for ~4x leverage. The position size is set at 33%.



The implementation with options/leverage turns $3.5 start capital in April 2011 into $5M (214 BTC) in July 2022. 214x buy&hold outperformance, 252% annualized return, and less risk (-58% drawdown).

In this example, I use call options with 4x leverage and a position size of only 33%. This means 67% of the portfolio is in cash, with little risk. Even if there is a month with a very negative BTC return and the call option expires worthless, our maximum loss would still be only -33% per month.

4. DIY

Since it is all about out-of-sample performance, I will implement the trading rule and track out-of-sample performance of the trading rule.

5. Risks, Disclosures & Disclaimers

No investment is without risk. Risks in this quant investing example are (but not limited to):

- Data: the data could contain errors.
- Information: the calculation of RSI could be wrong.
- Knowledge: the correlation between RSI and BTC could be spurious.
- Wisdom: overfitting of the trading rule, the backtest could be wrong, there could be black swans and past performance is no guarantee of future results.
- Trading: there is credit risk on exchanges ("not your keys not your coins").
- Do not invest or trade more than you are willing and able to lose.
- I do not promise or guarantee anything.

Disclosures and disclaimers:

- My BTC portfolio is 90% buy&hold and only 10% trading (mainly because of credit risk).
- I partner with Bybit exchange.
- Nothing in this article is financial advice.
- All content is for informational and educational purposes only.
- Past performance is no guarantee of future results.

6. Conclusion

The hypothesis in this article is: is it possible to create and implement a simple working quant investing trading rule that outperforms a bitcoin buy&hold investment?

Following a four-step DIKW (Data, Information, Knowledge, Wisdom) process, we are able to construct a simple trading rule based on RSI that outperforms buy&hold BTC. We also backtest an implementation with call options (4x leverage and 33% position size) that performs even better.

- BTC buy&hold: if you had bought 1 BTC in April 2011 for $3.5 and hodled until July 2022, you would have 1 BTC worth $23,322 (119% annualized return, with -82% max drawdown.
- The trading rule does 8 transactions and turns $3.5 start capital in April 2011 into $229K (10 BTC) in July 2022 (10x buy&hold outperformance, 168% annualized return, -57% drawdown).
- The implementation with options/leverage turns $3.5 capital in April 2011 into $5M (214 BTC) in July 2022 (214x buy&hold outperformance, 252% annualized return, -58% drawdown).

Since it is all about out-of-sample performance, I will implement the trading rule and track out-of-sample performance of the trading rule. It is exciting that the trading rule gave a BUY signal based on BTC July 2022 closing price!

Nothing in this article is financial advice. All content is for informational and educational purposes only. No investment is without risk. Make sure you read the risk paragraph in this article.

7. References

[1] Eliot, T. S. (1934) "Choruses from The Rock".

[2] Boulding, Kenneth (1955). "Notes on the Information Concept". Exploration.

[3] Henry, Nicholas L. (1974). "Knowledge Management: A New Concern for Public Administration".

[4] Faith, Curtis (2007). “Way of the Turtle”.

[5] Verbeek, M. (2004). “A Guide to Modern Econometrics”.

[6] Vinod Chandra & Anand Hareendran (2014). “Artificial Intelligence and Machine Learning”.

[7] https://www.tradingview.com

[8] J. Welles Wilder Jr. (1978). “New Concepts in Technical Trading Systems”. Trend Research.