Advanced Algorithmic Trading

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Outline

- How price moves ?
- Building a Trading Strategy
- Backtest
- Trading strategy analysis
- Resources of finding Trading Strategies

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Market Microstructure

Source: ResearchGate

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Ideation

- White paper: Academia, Institutional, Financial Journals.
- Blog/Articles: Research articles, Institutional blogs, Independent Traders blogs
- Economic Theory: Macro/Micro-economics, underlyings fundamentals
- Price patterns: Volatility, Trend, news reactions, price anomalies
- Alternative data: News/Twitter sentiments, Corporate flights, Web-scraping

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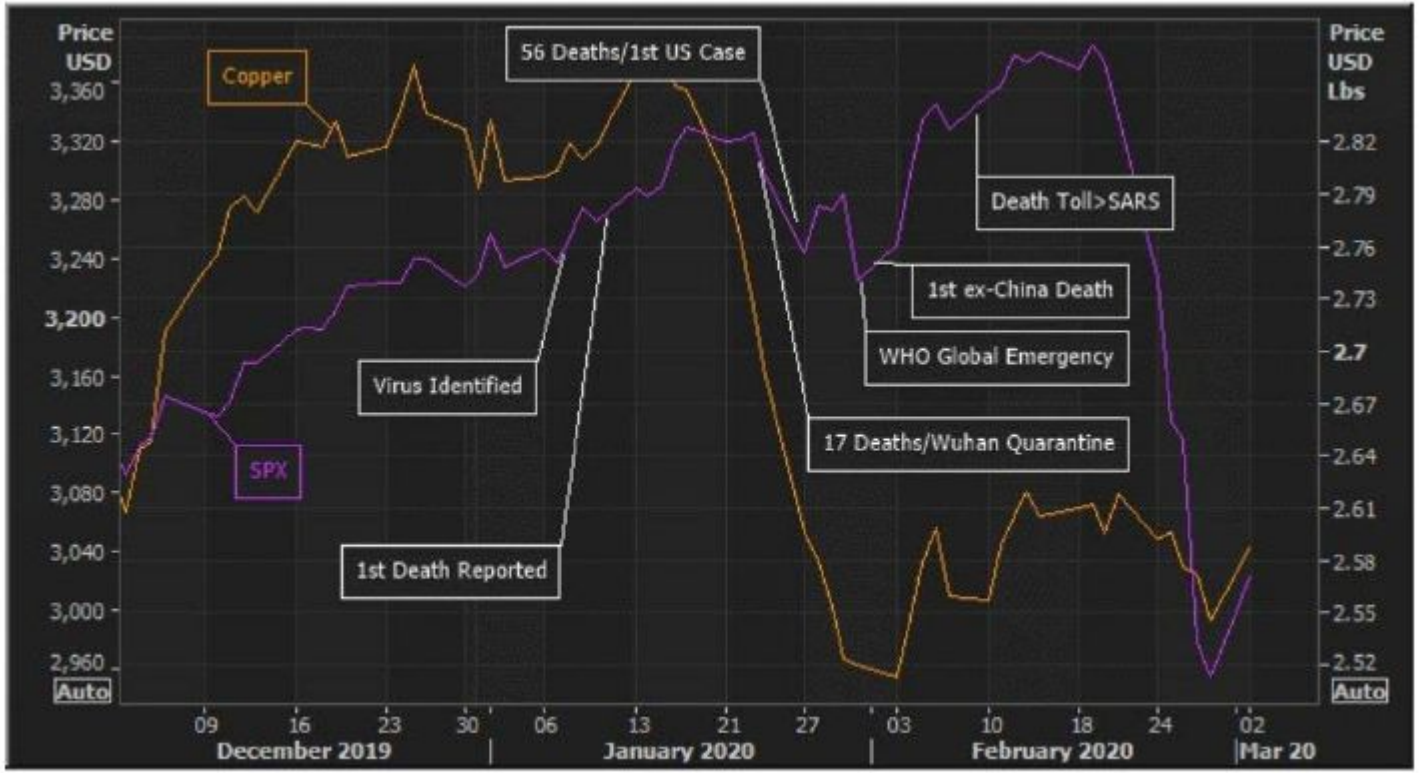
COVID Crash Prediction



Source: Eikon

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Data

- Price : OHLC Bar, Trades, NBBO etc
- Volume: Time Bar and Tick by Tick Size.
- Order Book: Limit order book (LOB)
- Fundamentals: PE ratio, Profit/Loss, Quick ratio, EV/EBITDA etc
- Sentiments: Market sentiments and News sentiments
- Alternative data

Betting Sizing

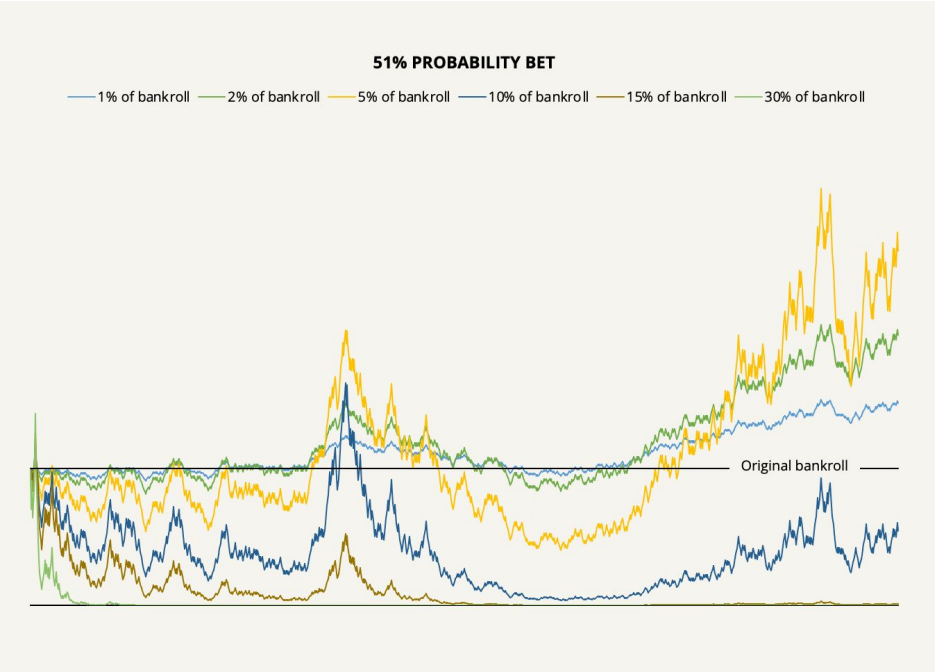
- **Risk Management**: Proper bet sizing helps manage risk by controlling the amount of capital at stake in each trade. Effective risk management is vital to preserving capital and avoiding significant drawdowns.

- **Optimal Returns**: Bet sizing strategies can be designed to optimize returns over the long run. An effective bet sizing strategy contributes to overall profitability and improved risk-adjusted returns.

- **Consistency**: Consistency in bet sizing allows traders to establish a systematic approach to their trading activities. Consistent bet sizing also aids in tracking and evaluating trading performance over time, enabling traders to make data-driven adjustments to their strategies.

(i) Fixed Bet Size

This strategy involves placing a fixed dollar amount or percentage of capital on each trade, regardless of the risk or potential reward. For example, a trader may decide to invest $1,000 or 2% of their portfolio on every trade. This approach provides consistency but does not take into account the specific risk levels of individual trades.



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(ii) Kelly Criterion

The Kelly Criterion is a formula that calculates the optimal position size based on the probability of success and the potential reward-to-risk ratio. It takes into account both the trader's edge and the volatility of the instrument being traded. The formula suggests the percentage of capital to be allocated, which is proportional to the expected return and inversely proportional to the risk.

$$f^* = \frac{bp - q}{b}$$

- f = the fraction of the bankroll to bet
- b = the decimal odds − 1
- p = the probability of winning
- q = the probability of losing, which is 1 − p

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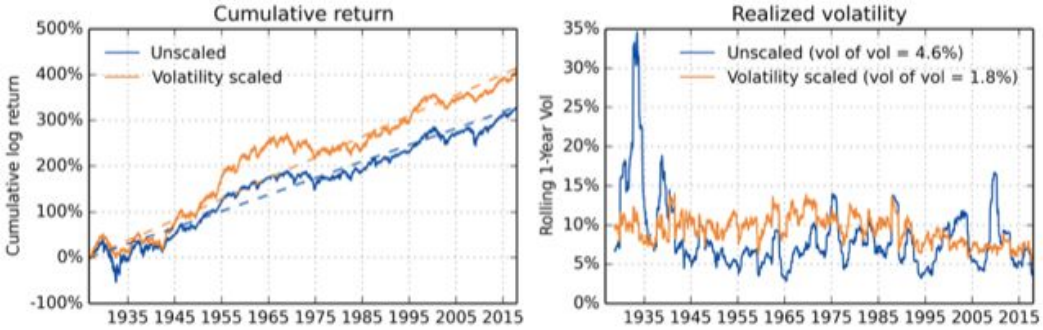
(iii) Volatility Scaling

Volatility scaling, also known as volatility-based position sizing, is a strategy that adjusts the position size of a trade based on the volatility of the underlying asset. The concept behind volatility scaling is to allocate a larger position size when the asset's volatility is lower and a smaller position size when the volatility is higher.



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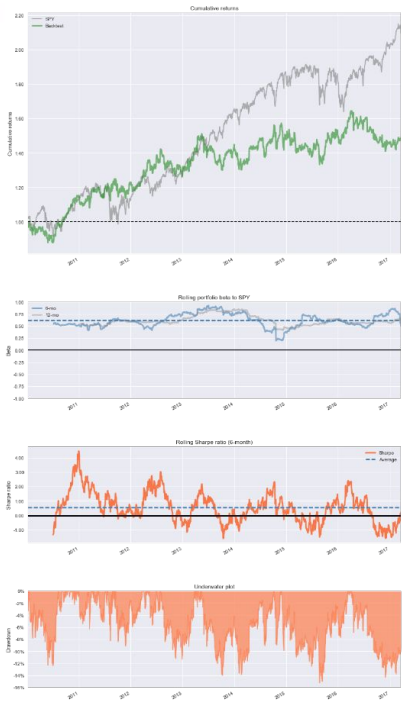
Motivation behind Backtesting

- Does the trading strategy you have hypothesised even perform ?
- Backtest is a process of testing the historical performance of a trading strategy. It is used as to check the if a strategy works on past and what performance we can expect in future.
- A backtest is a simulation which can be used for sanity check on the hypothesis behind the strategy and various factors under a given scenario of the market.
- Backtest is not an experiment and shouldn't aimed to prove profitability of a strategy as it is only historical performance.

```
Entire data start date: 2010-01-04
Entire data end date: 2017-03-21
Backtest months: 86
```

	Backtest
Annual return	5.7%
Cumulative returns	49.1%
Annual volatility	15.0%
Sharpe ratio	0.44
Calmar ratio	0.37
Stability	0.79
Max drawdown	-15.3%
Omega ratio	1.08
Sortino ratio	0.63
Skew	-0.28
Kurtosis	3.15
Tail ratio	1.03
Common sense ratio	1.09
Daily value at risk	-1.9%
Gross leverage	2.00
Daily turnover	16.2%
Alpha	-0.00
Beta	0.59



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Seven Sins of Quantitative Investing*

1. *Survivorship bias*: Ignoring the stocks that have gone bust or delisted in past and only considering the existing stocks in the sample. This can lead to overestimation of historical performance. E.g.- Only considering the current composition of SP500.

2. *Look-ahead bias*: Using information that is not available at the current moment.

3. *Storytelling*: Making up a story ex-post to justify some random pattern in the result.

4. *Data snooping*: Using the test sample for tuning the strategy and improving the backtest.

5. *Transaction cost*: Ignoring the transaction cost results inaccurate backtest results. While including transaction cost some strategies that were profitable earlier may fail.

6. *Outliers*: A backtest is severely skewed if it performance (profit or loss) is heavily dependent on few extreme outcomes that is observed in past. E.g.: Financial crash, Tech Boom.

7. *Shorting*: Shorting involves finding lender who can lend securities, which is dependent on inventory, relative demand and markets.

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Types of Backtest algorithms

Vectorized

- Vectorized the backtesting loop using Numpy/Pandas
- Fastest
- Not a reliable backtest. Is used as a sanity check.
- Easy to implement.

For Loop

- The backtest is executed using a for loop.
- Slower than vectorized.
- Not a reliable backtest. Is used as a sanity check.
- Easy to implement.

Event Driven

- Uses market simulation and runs the backtest as events takes place.
- Slowest
- The most reliable backtest.
- Difficult to implement.

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Risk and Performance Metrics (1)

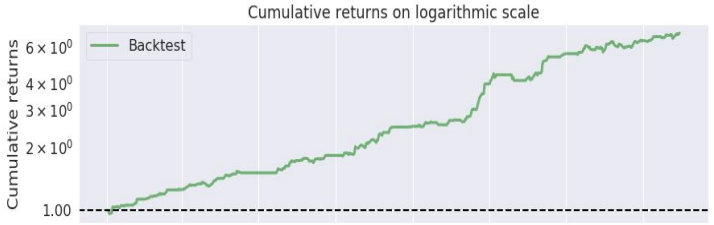
- **Cumulative Returns**

$$R_c = \prod_{t=0}^{n}(1 + r_t)$$

where

r_t = return at t

n = number of observations



- **Annualized Return**

$$R_A = R_c^{\frac{m}{n}} - 1$$

where

R_c = Cumulative returns

m = periods per year

n = number of observations

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Risk and Performance Metrics (2)

- **Annualized Volatility**

$$\sigma_A = \sigma_r \sqrt{m}$$

where

σ_r = std. dev. of returns

m = periods per year

- **Annualized Sharpe Ratio**

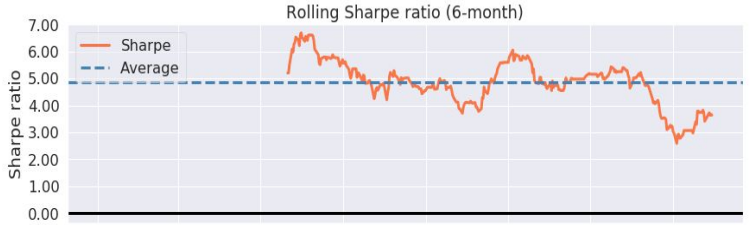
$$SR = \frac{R_A - R_f}{\sigma_A}$$

where

R_A = Annualized return

R_f = risk-free rate

σ_A = Annualized volatility



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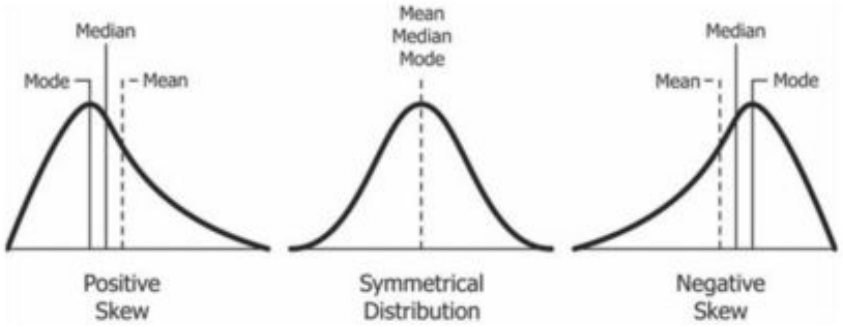
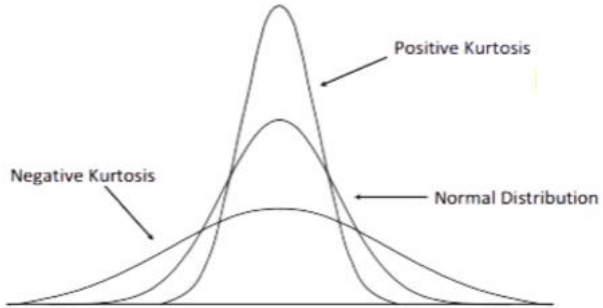
Risk and Performance Metrics (3)

- **Skewness**



Source: wikipedia

- **Kurtosis**



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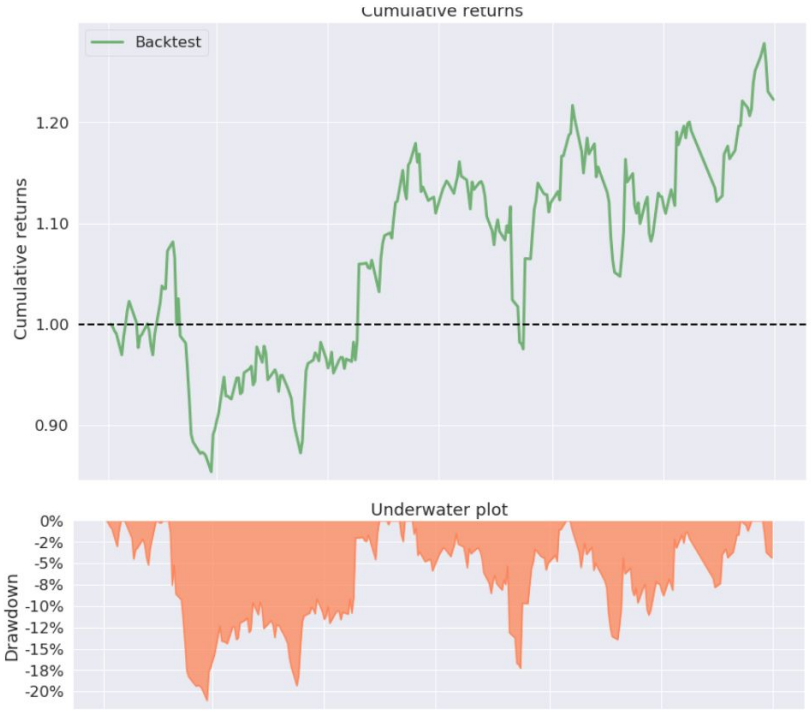
Risk and Performance Metrics (4)

- **Maximum Drawdown**

$$MDD = \frac{\text{Trough Value} - \text{Peak Value}}{\text{Peak Value}}$$



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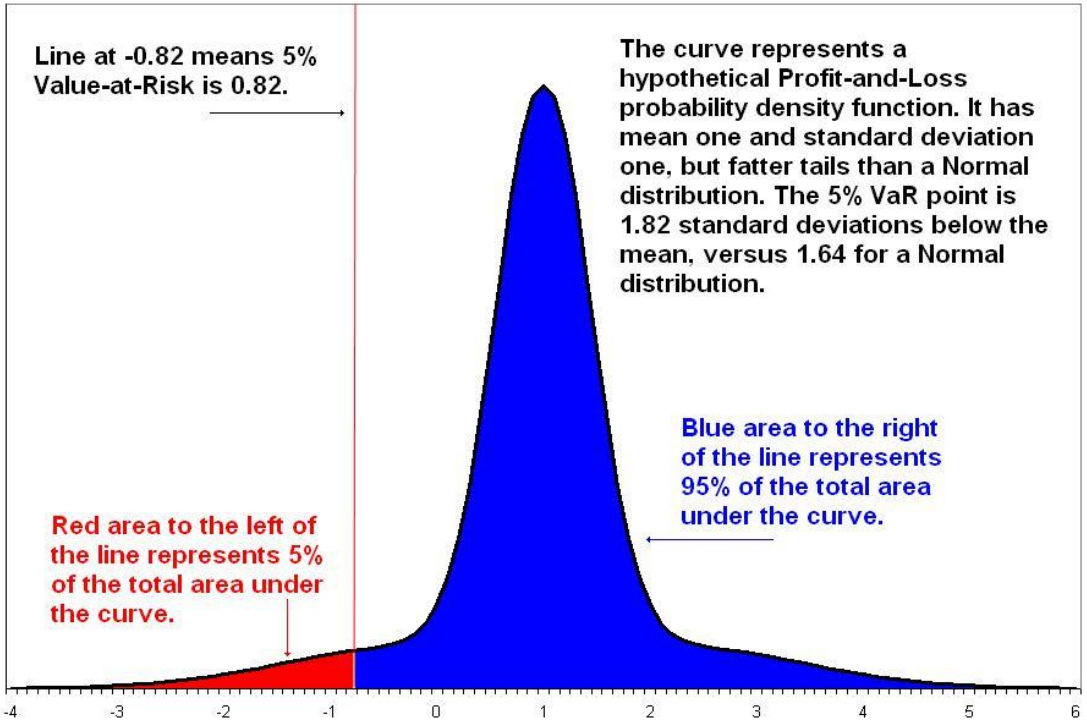
Risk and Performance Metrics (5)

- **VaR (Value at Risk)**



Source: wikipedia

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(i) QuantPedia : https://quantpedia.com/

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The Encyclopedia of Algorithmic and Quantitative Trading Strategies

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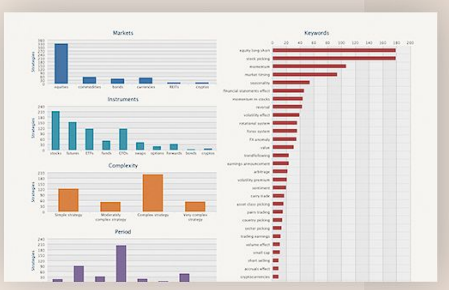
- **Asset allocation** and **stock picking**
- **Equities**, **bonds**, **commodities** or **FX**



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(ii) Research Papers

- SSRN: https://www.ssrn.com/

- arXiv: https://arxiv.org/

- RePEc: http://repec.org/

(iii) Blogs/Articles

- Medium : https://medium.com/
- Quantocracy: https://quantocracy.com/
- ML Quant: https://www.ml-quant.com/

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