

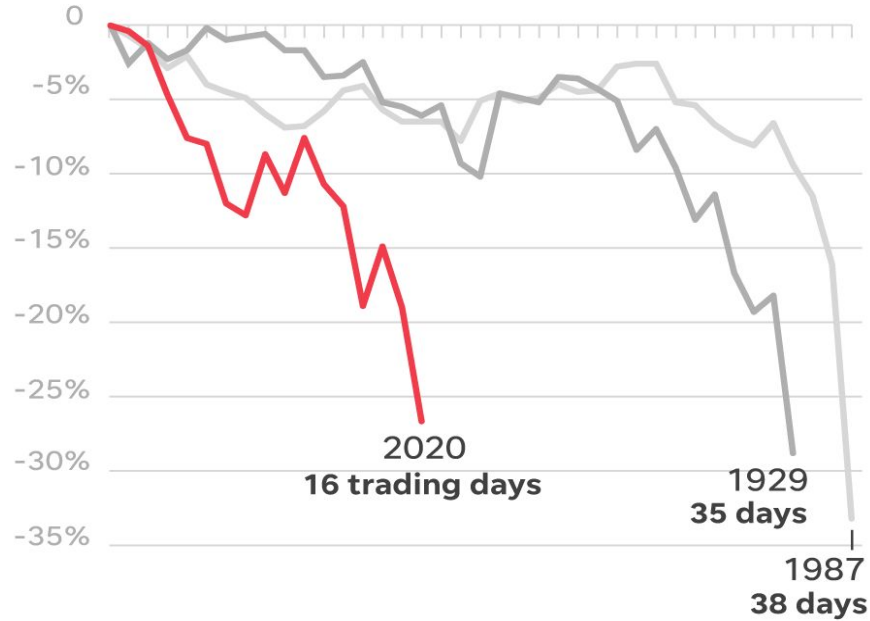
# Pair Trading Strategy

## Algorithmic Statistical Arbitrage

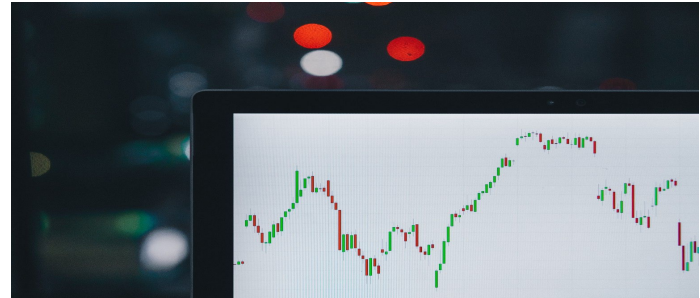
Anisa Tapia, Apoorv Jha, Claire Hutchinson, Eleane Ye, Samhitha Sunkara

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# Introduction



SOURCE Yahoo! Finance



# How to generate profits without exposure to market risk?

Using Data Science and Algorithmic Techniques

# Law of One Price

“The law of one price is an economic concept that states that the price of an identical asset or commodity will have the same price globally, regardless of location, when certain factors are considered.”

Duke

## Anomalies

### The Law of One Price in Financial Markets

Owen A. Lamont and Richard H. Thaler

Economics can be distinguished from other social sciences by the belief that most (all?) behavior can be explained by assuming that rational agents with stable, well-defined preferences interact in markets that (eventually) clear. An empirical result qualifies as an anomaly if it is difficult to rationalize or if implausible assumptions are necessary to explain it within the paradigm. Suggestions for future topics should be sent to Richard Thaler, c/o *Journal of Economic Perspectives*, Graduate School of Business, University of Chicago, Chicago, IL 60637, or (richard.thaler@gsb.uchicago.edu).

#### Introduction

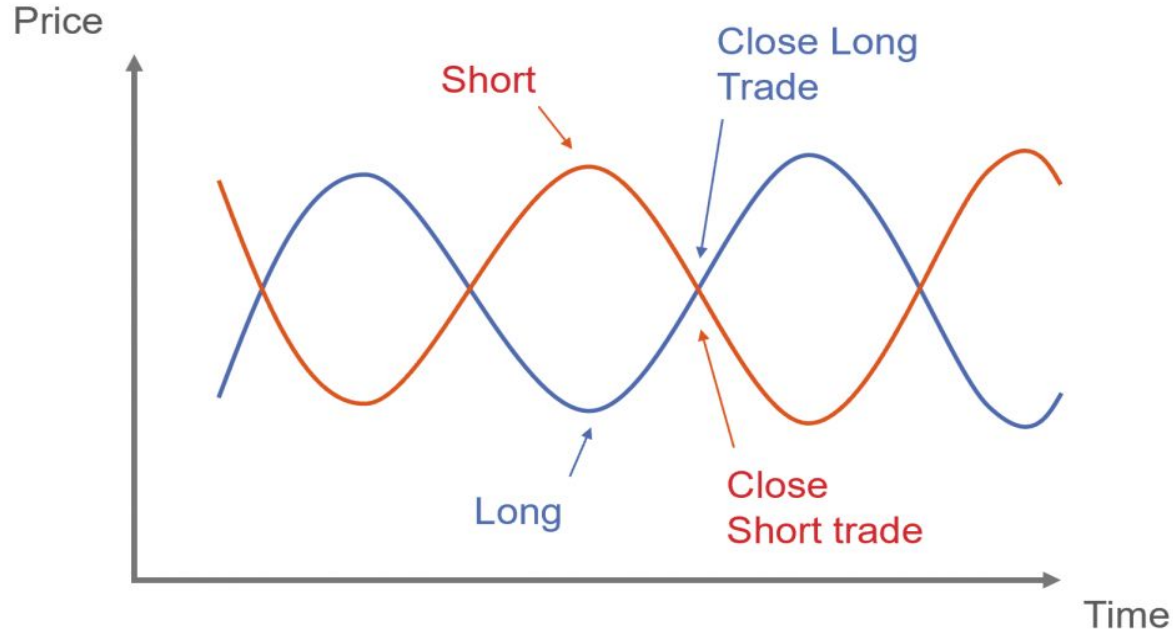
It is good for a scientific enterprise, as well as for a society, to have well-established laws. Physics has excellent laws, such as the law of gravity. What does economics have? The first law of economics is clearly the law of supply and demand, and a fine law it is. We would nominate as the second law “the law of one price,” hereafter simply the Law. The Law states that identical goods must have identical prices. For example, an ounce of gold should have the same price (expressed in U.S. dollars) in London as it does in Zurich, otherwise gold would flow from one city to the other. Economic theory teaches us to expect the Law to hold exactly in competitive markets with no transactions costs and no barriers to trade, but in practice, details about market institutions are important in determining whether violations of the Law can occur.

■ Owen A. Lamont is Visiting Professor of Finance at Yale School of Management, New Haven, Connecticut. Richard H. Thaler is Robert P. Gwinn Professor of Behavioral Science and Economics, Graduate School of Business, University of Chicago, Chicago, Illinois.

# What is Arbitrage?

- Arbitrage is the simultaneous purchase and sale of an asset in different markets to exploit tiny differences in their prices.
- Arbitrage trades are made in stocks, commodities, and currencies.
- Arbitrage takes advantage of the inevitable inefficiencies in markets.

# Pairs Trading Strategy



# Gatev, Goetzmann and Rouwenhorst (2006)

“Finding pairs that are highly correlated over time is the key to the success of the pairs-trading strategy.”

## Pairs Trading: Performance of a Relative-Value Arbitrage Rule

Evan Gatev  
Boston College

William N. Goetzmann  
Yale University

K. Geert Rouwenhorst  
Yale University

We test a Wall Street investment strategy, “pairs trading,” with daily data over 1962–2002. Stocks are matched into pairs with minimum distance between normalized historical prices. A simple trading rule yields average annualized excess returns of up to 11% for self-financing portfolios of pairs. The profits typically exceed conservative transaction-cost estimates. Bootstrap results suggest that the “pairs” effect differs from previously documented reversal profits. Robustness of the excess returns indicates that pairs trading profits from temporary mispricing of close substitutes. We link the profitability to the presence of a common factor in the returns, different from conventional risk measures.

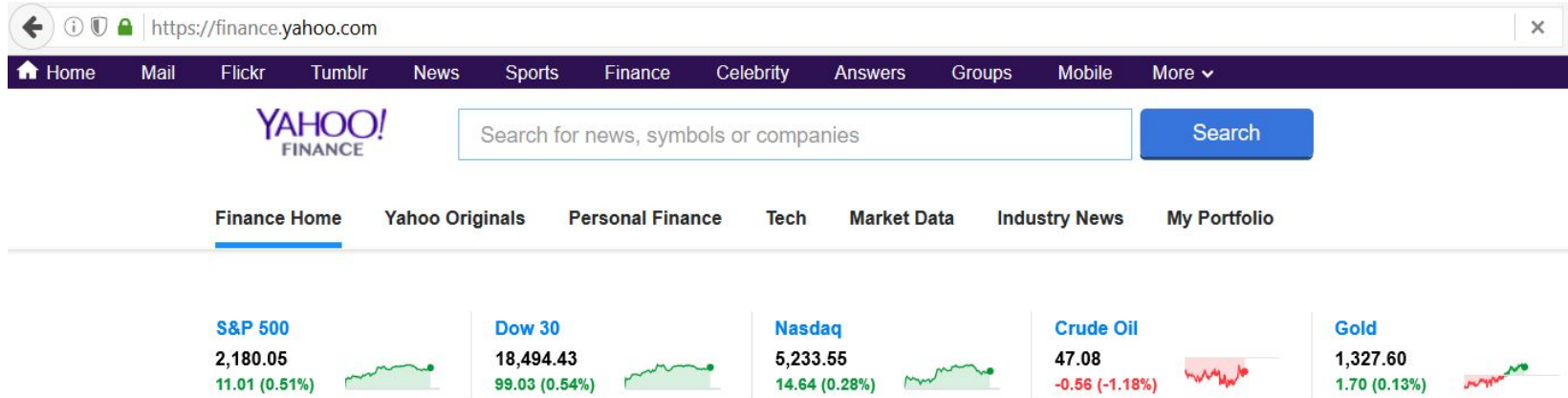
Wall Street has long been interested in quantitative methods of speculation. One popular short-term speculation strategy is known as “pairs trading.” The strategy has at least a 20-year history on Wall Street and is among the proprietary “statistical arbitrage” tools currently used by hedge funds as well as investment banks. The concept of pairs trading is disarmingly simple. Find two stocks whose prices have moved together historically. When the spread between them widens, short the winner and buy the loser. If history repeats itself, prices will converge and the arbitrageur will profit. It is hard to believe that such a simple strategy, based solely on past price dynamics and simple contrarian principles, could possibly make money. If the U.S. equity market were efficient at all times, risk-adjusted returns from pairs trading should not be positive.

In this article, we examine the risk and return characteristics of pairs trading with daily data over the period 1962 through December 2002.

We are grateful to Peter Bossaerts, Michael Cooper, Jon Ingersoll, Ravi Jagannathan, Maureen O'Hara, Carl Schecter, and two anonymous referees for many helpful discussions and suggestions on this topic. We thank the International Center for Finance at the Yale School of Management for research support, and the participants in the EFA'99 Meetings, the AFA'2000 Meetings, the Berkeley Program in Finance, and the Finance and Economics workshops at Vanderbilt and Wesleyan for their comments. Address correspondence to Evan Gatev, Boston College, Carroll School of Management, Fulton Hall, 140 Commonwealth Ave, Chestnut Hill, MA 02467, or email: gatev@bc.edu.

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# Data

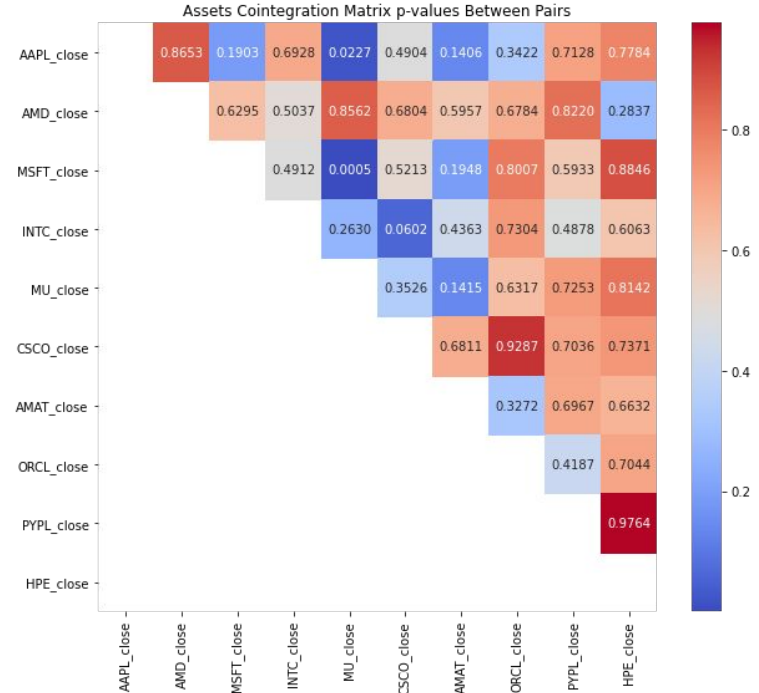
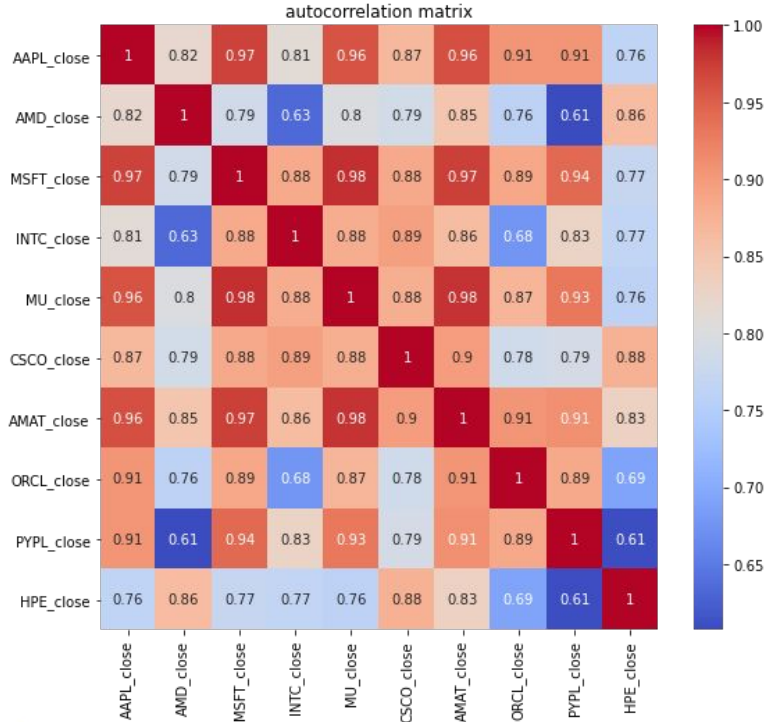


# Investopedia

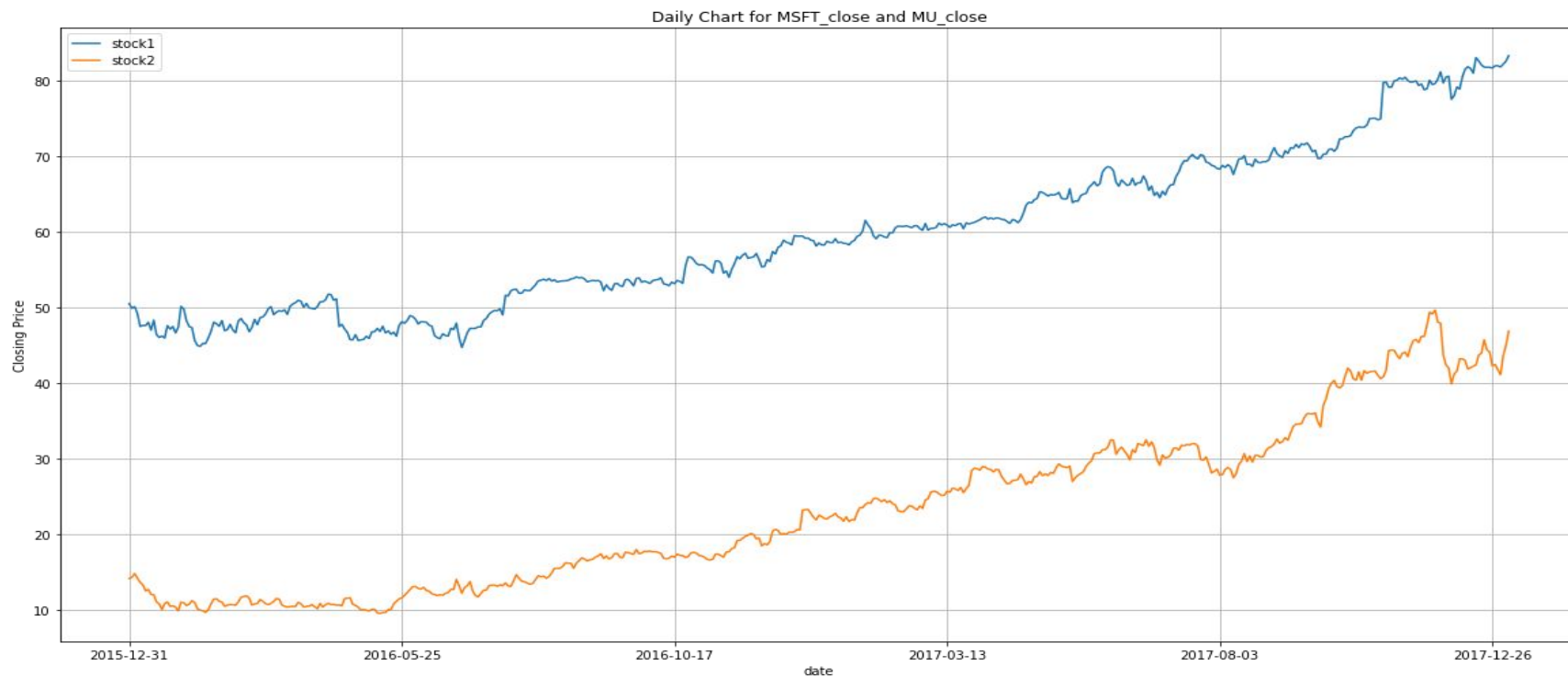
Duke



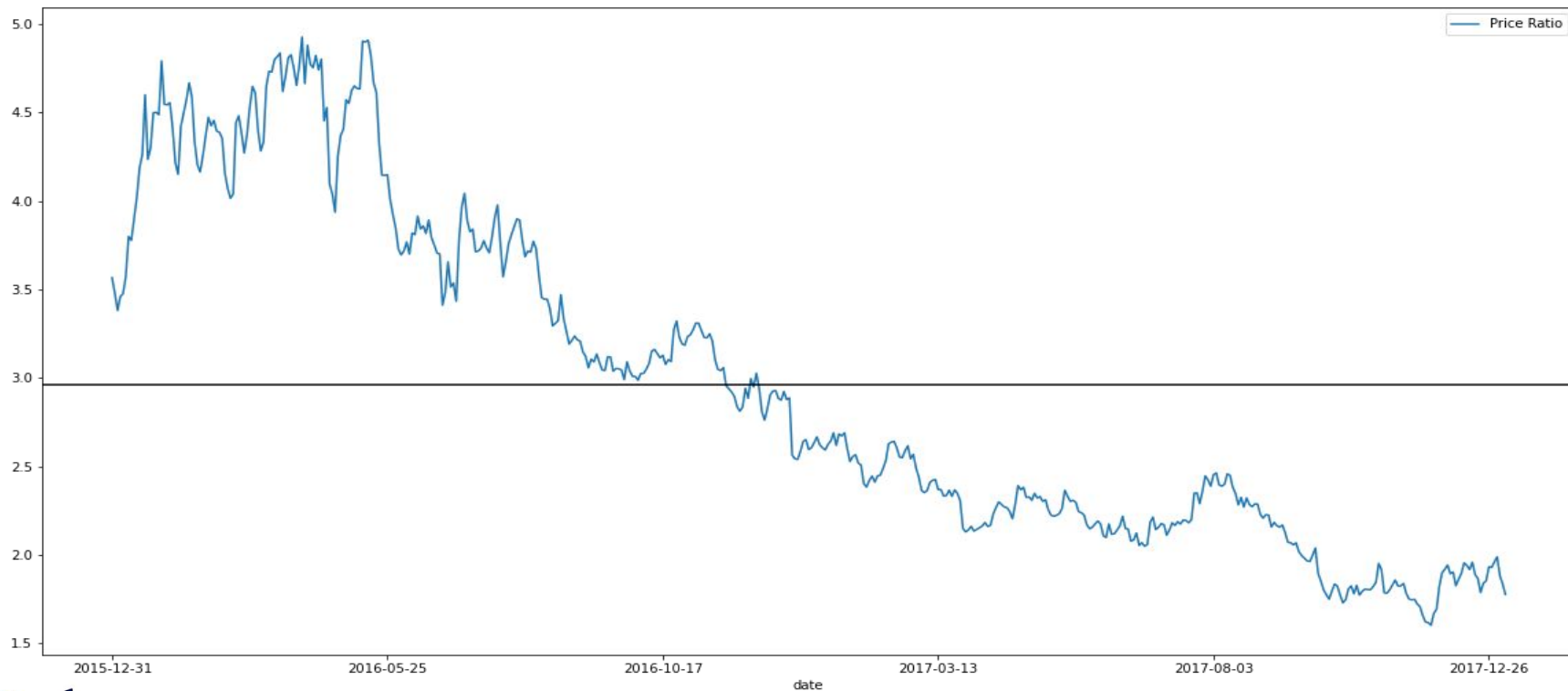
# Correlation and Cointegration



# Prices (Training Data)



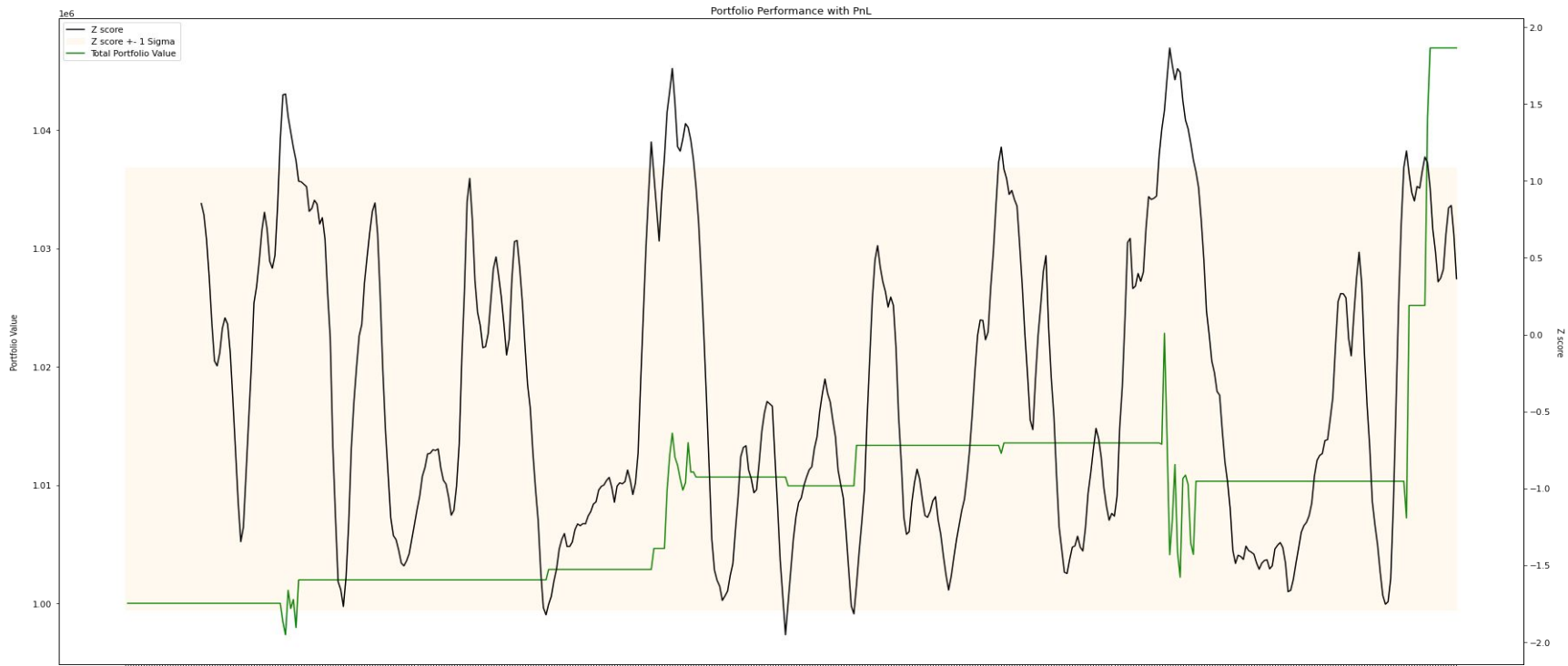
# Price Ratio (Training data)



# Backtesting (Generating Signals)



# Arbitrary Parameters



# Parameter Tuning

## Maximizing CAGR

short window: 3 days

long window: 38 days

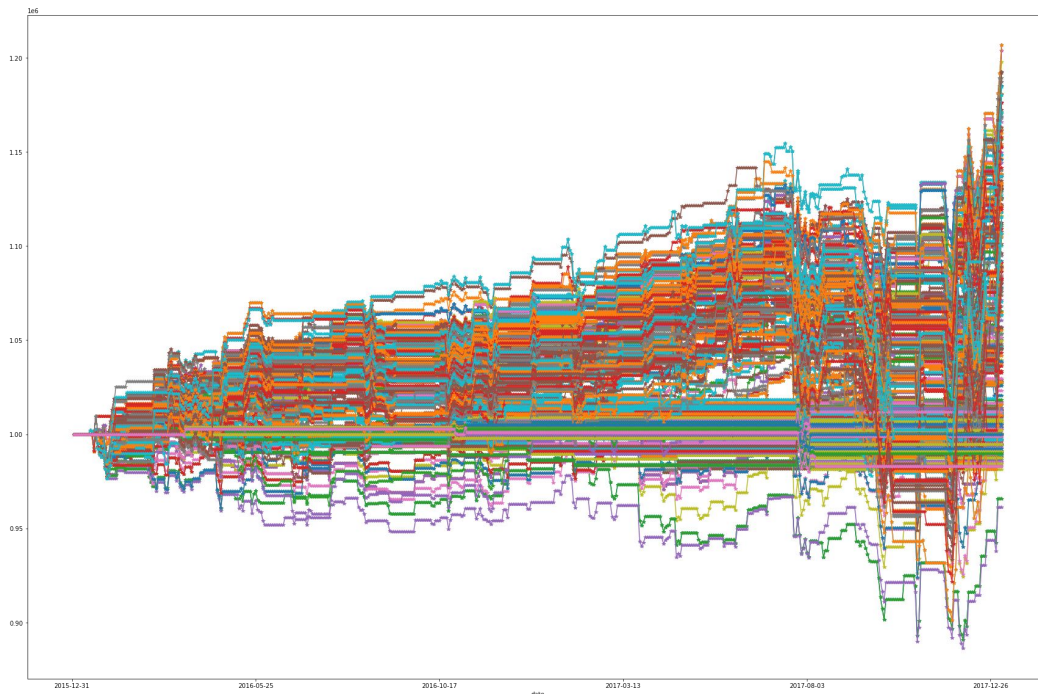
standard deviation: 1.0

CAGR (tuned):

54.893%

CAGR (Arbitrary):

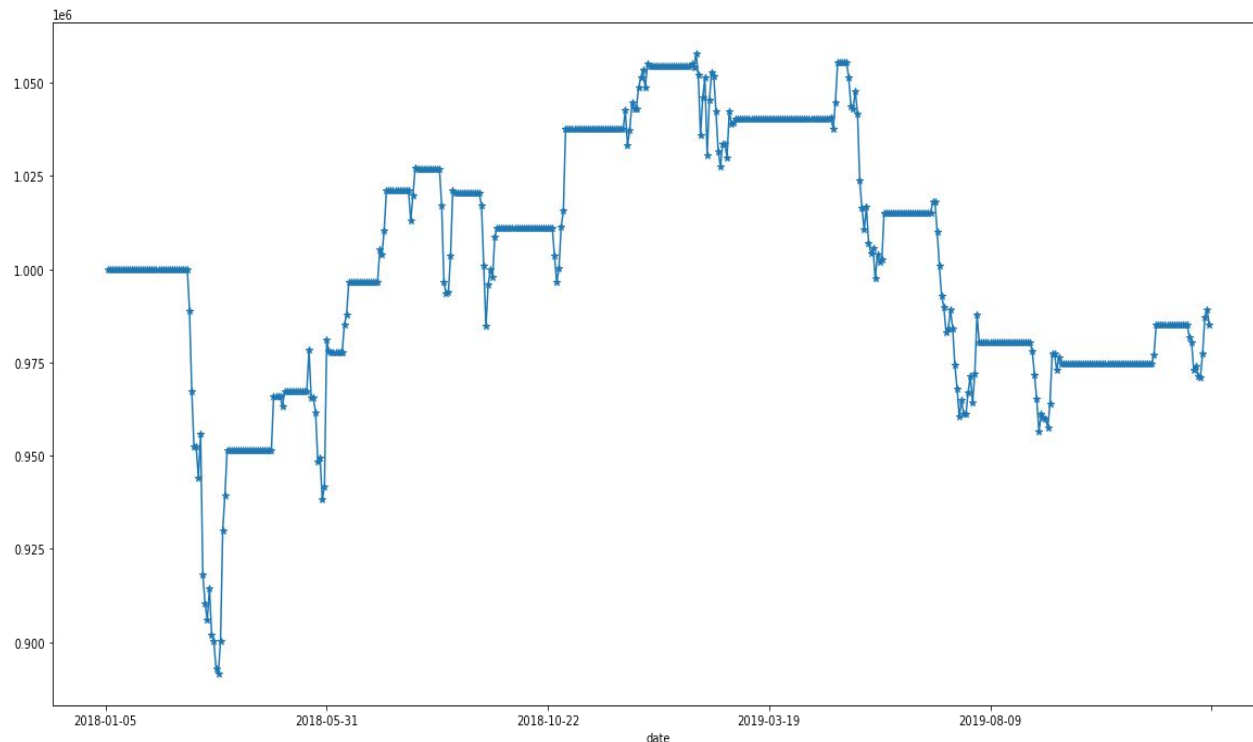
44.339%



# Testing Strategy on out-of-sample data

Using  
parameters  
optimized to  
training data

CAGR:  
40.69%

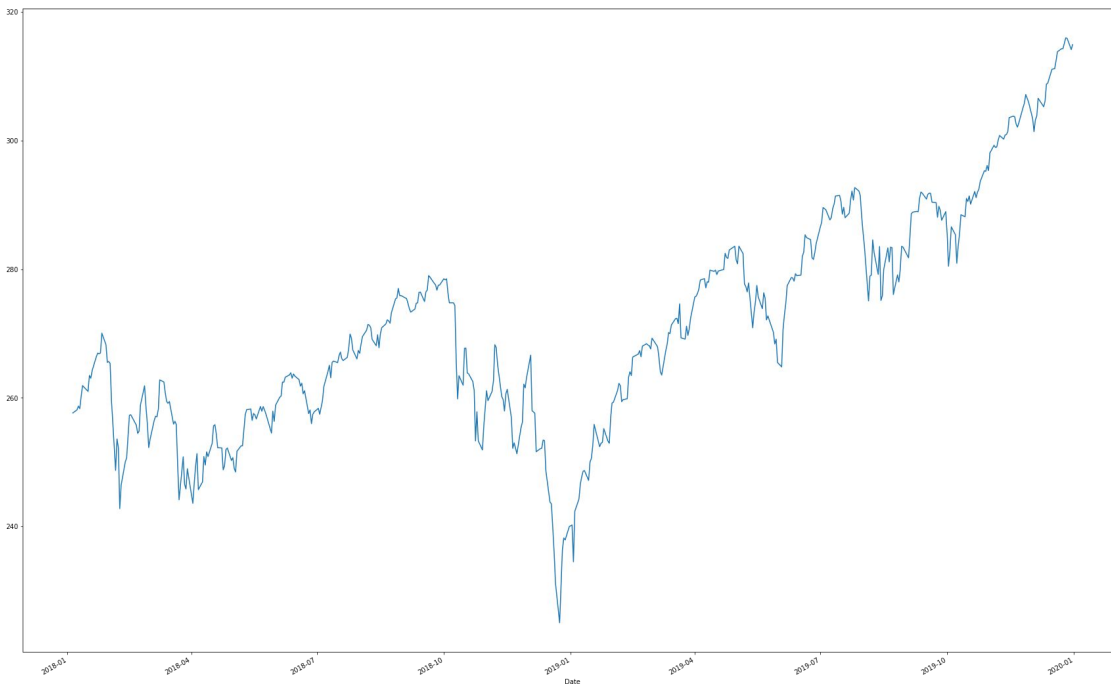


# Market Performance during Testing Period

SPY (S&P 500 Index  
tracker price for the  
testing period)

CAGR of holding through  
test period:

10.617%





# Limitations & Future Work:

- Incorporate risk management techniques
- Slippage, Transaction Costs
- Use much more data
- Rigorous Backtesting
- Markovitz Portfolio Theory: Mean Variance Optimization
- Portfolio Allocation

Thank you!

Questions?

[All Data + Code + Visualizations + Strategy Math](#)