

Pair Trading

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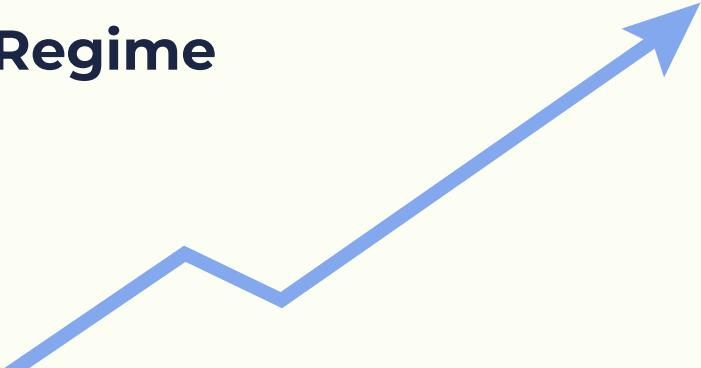
Agenda

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Stock

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04
Market Regime



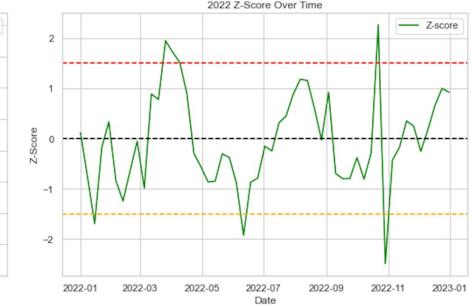
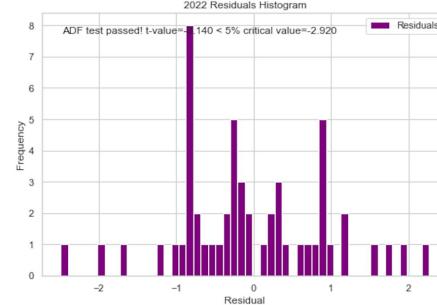
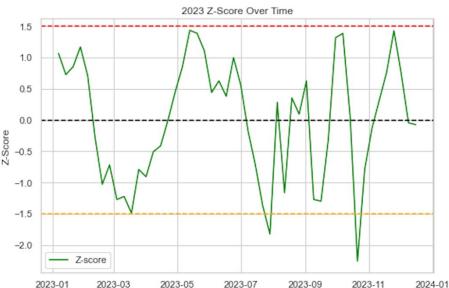
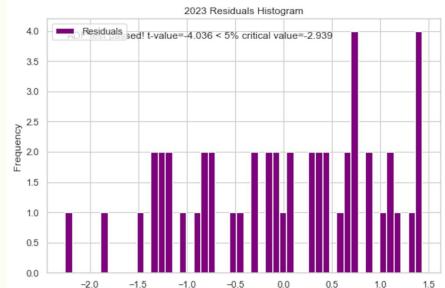
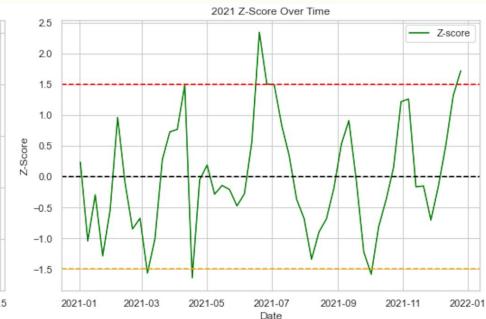
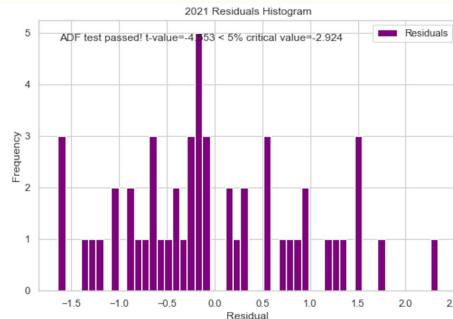
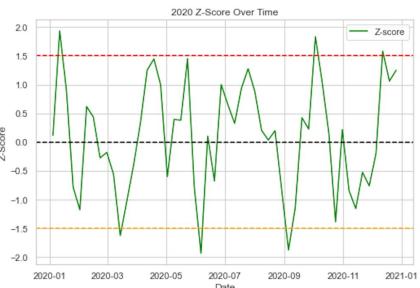
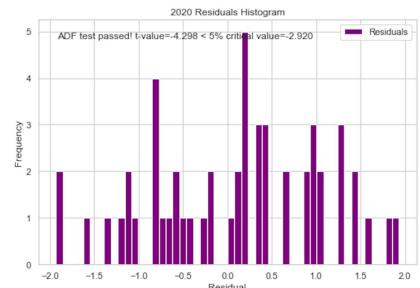


01

Strategy

Cointegration

Akamai - F5 Inc: 2004 - 2023, 3 years failed

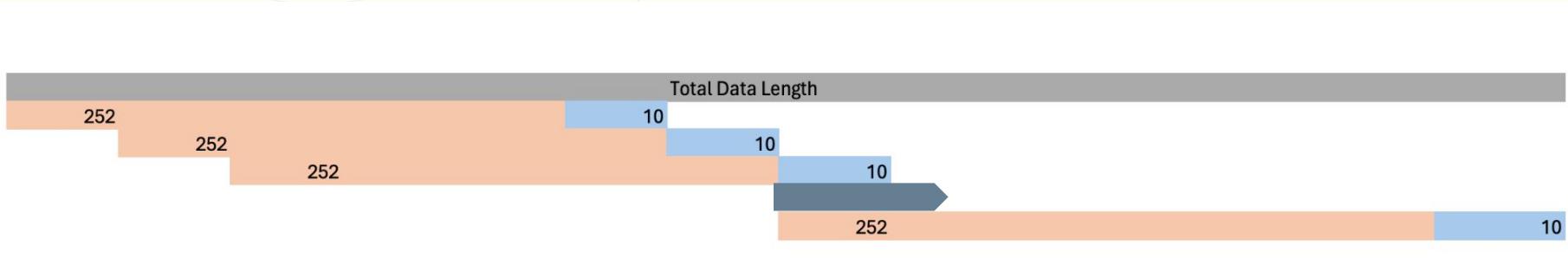


Signal collection

252 days training
Hedge ratio (beta)

Filtering outliers

10 days testing
Residual z score



Backtest



Z score > 1.2

- Actual > predicted
- Short undervalued, or long overvalued
- Maintain hedge ratio

Z score < -1.2

- Actual < predicted
- Short undervalued, or long overvalued
- Maintain hedge ratio

0.5 z score <-> -0.5 z score

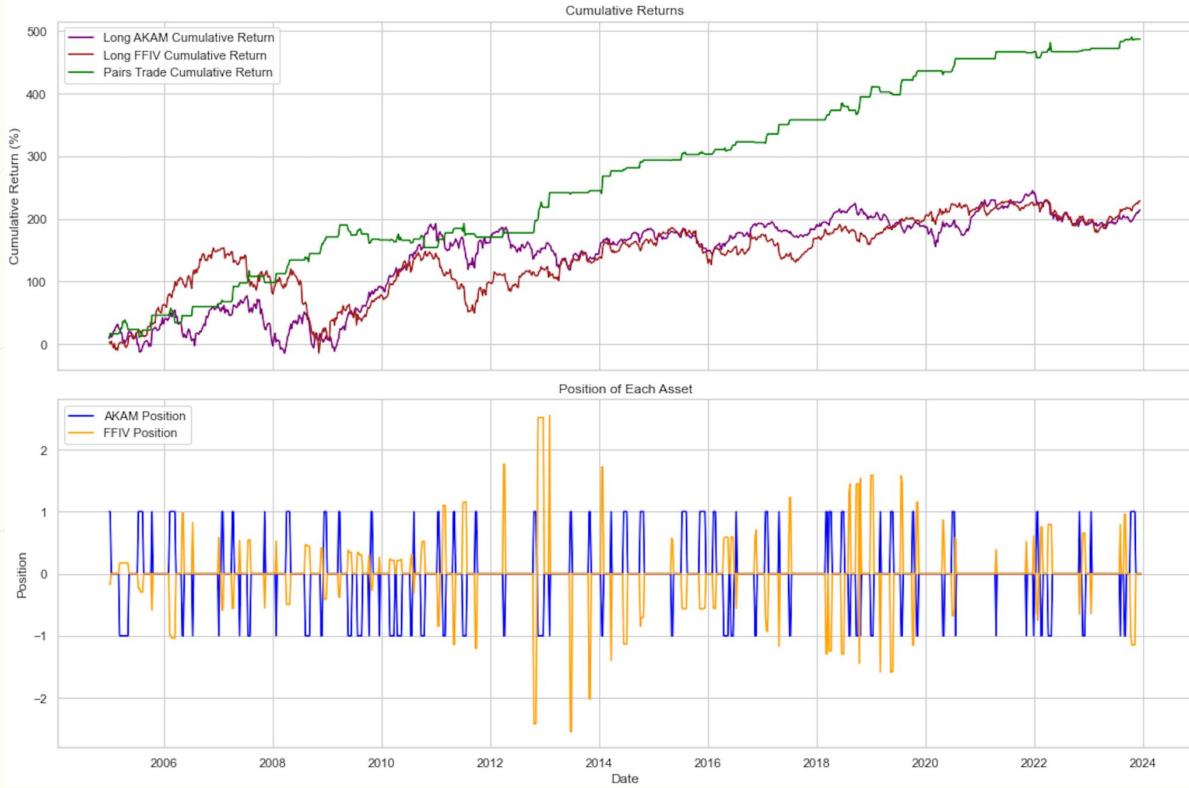
- No trading

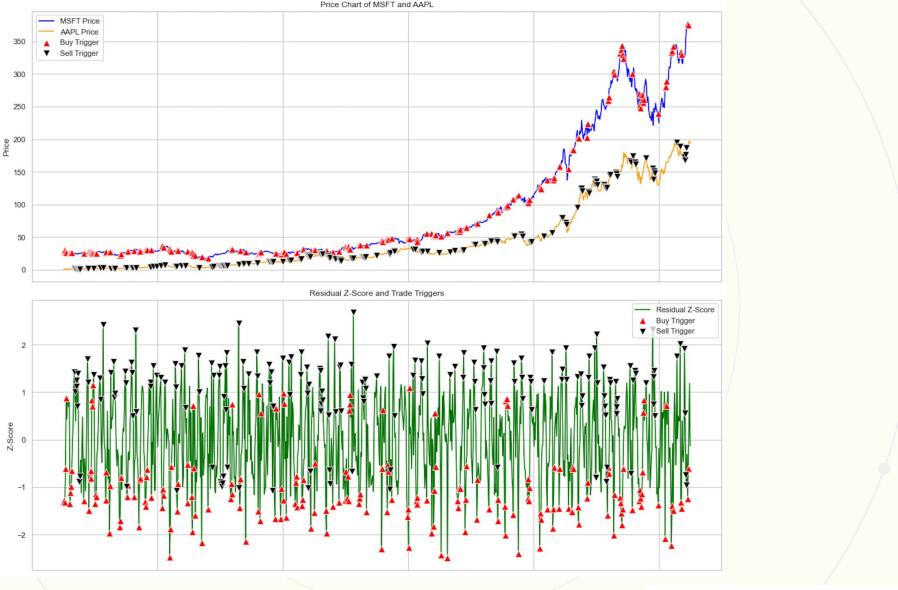


Akamai - F5 Inc

Cloud service industry

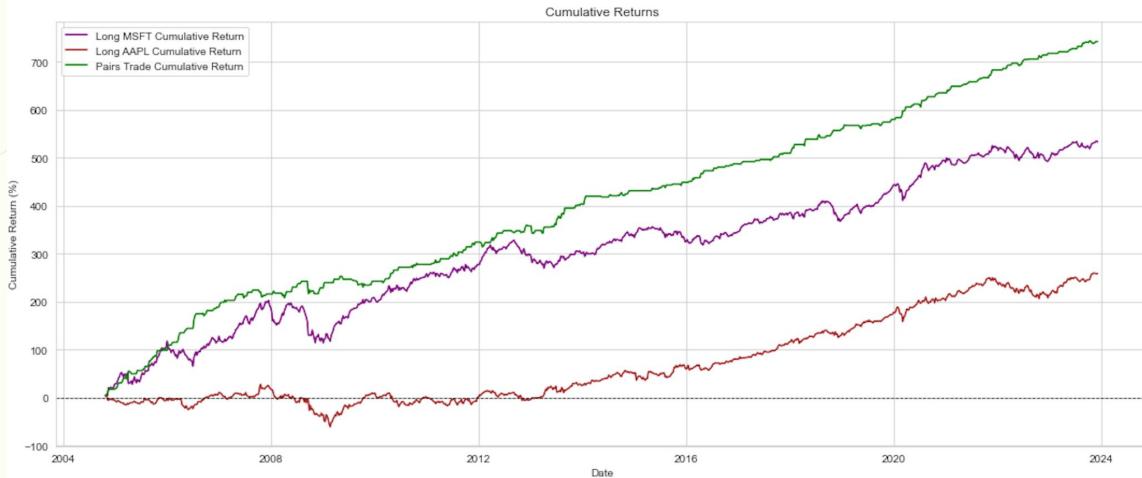
Pass ADF test





AAPL - MSFT

Not pass ADF test



Risk management

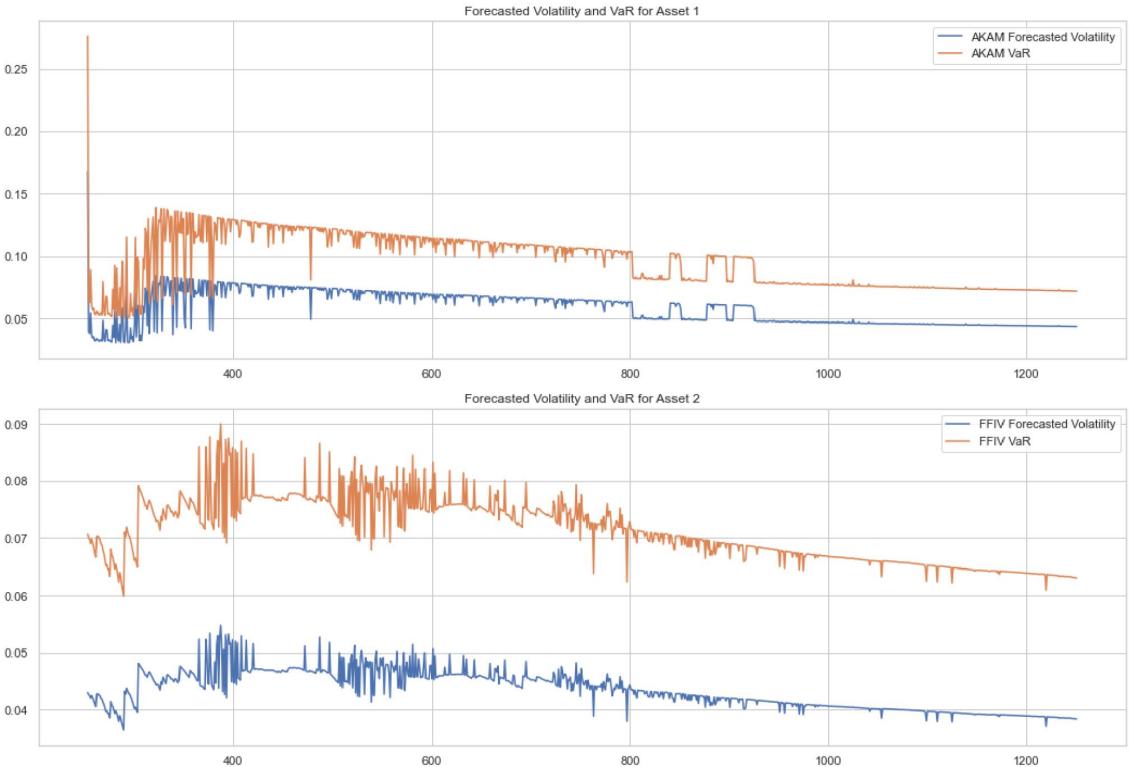
252 days Garch (1.1)

Volatility



Value at risk

VaR > 50% -> close position



Risk management

Capital: 100000

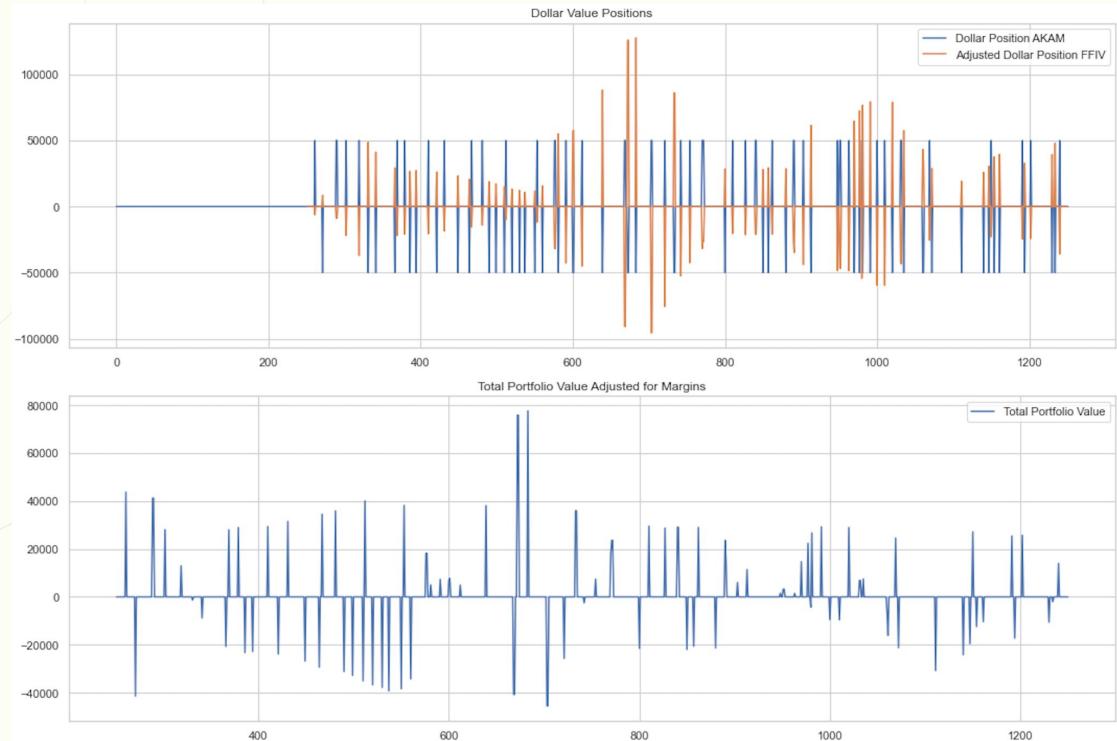
Dollar Value positions:

-\$100,000 - +\$100,000

Margin adjusted value:

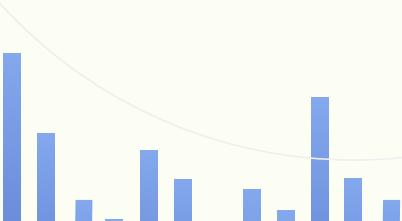
Lowest: -40000

Additional: 60000





02 Stock



Stock

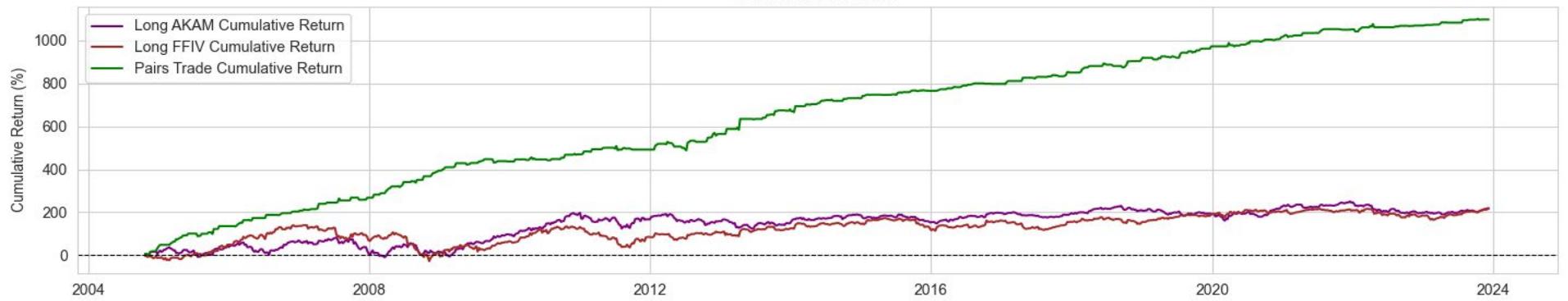
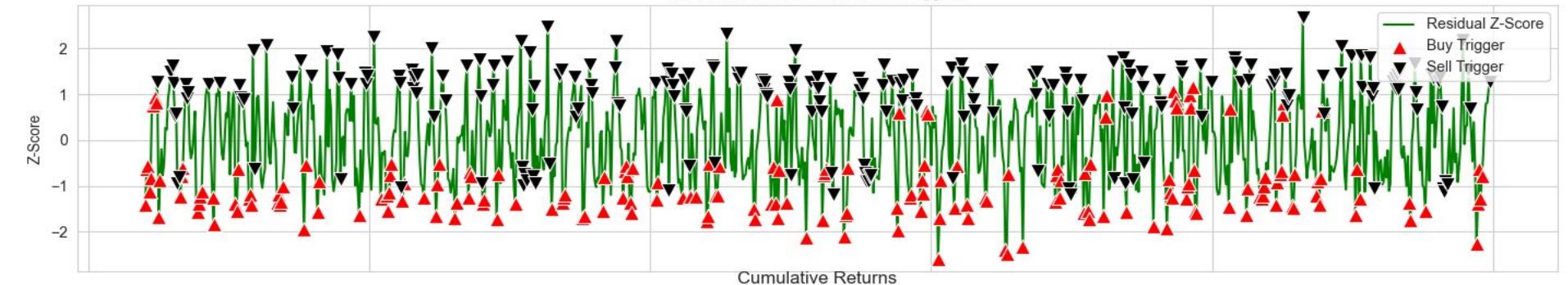
Last time

Euclidean
distance

Co-integration

	Euclidean distance	CADF p-value
INCY-VRSN	1.917523	0.000002
AKAM-FFIV	1.933973	0.0
MSI-XRX	2.052561	0.010177
ADI-INTC	2.087769	0.000502
AMT-CCI	2.346958	0.076286
DISH-KLAC	2.40962	0.619337
FFIV-VRSN	2.457549	0.000128
GPS-QCOM	2.47492	0.044311
CSCO-CCI	2.525632	0.213647
ADI-TXN	2.610967	0.150849





AKAM-FFIV



AKAM

Business: primarily operates as a provider of cloud services and content delivery networks (CDNs).

Components:

Security	46.31%
Delivery	40.46%
Compute	13.23%

Avg. revenue growth over the past four years: 5.87%



FFIV

Business: primarily specializes in multi-cloud application services and security solutions.

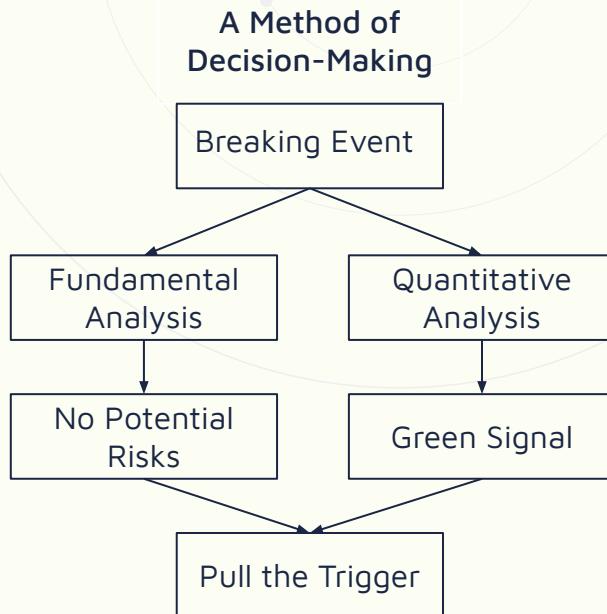
Components:

Services	52.56%
Systems	23.84%
Software	23.6%

Avg. revenue growth over the past four years: 7.16%

Dual Insurance Trading Mechanism

Let's say: How much weight do you want the results of data analysis to carry in your real decisions?



NEWS

Critical F-
F5 BIG-IP Has Huge, Enormous, Bad, Scary Security Holes
(Patch NOW)

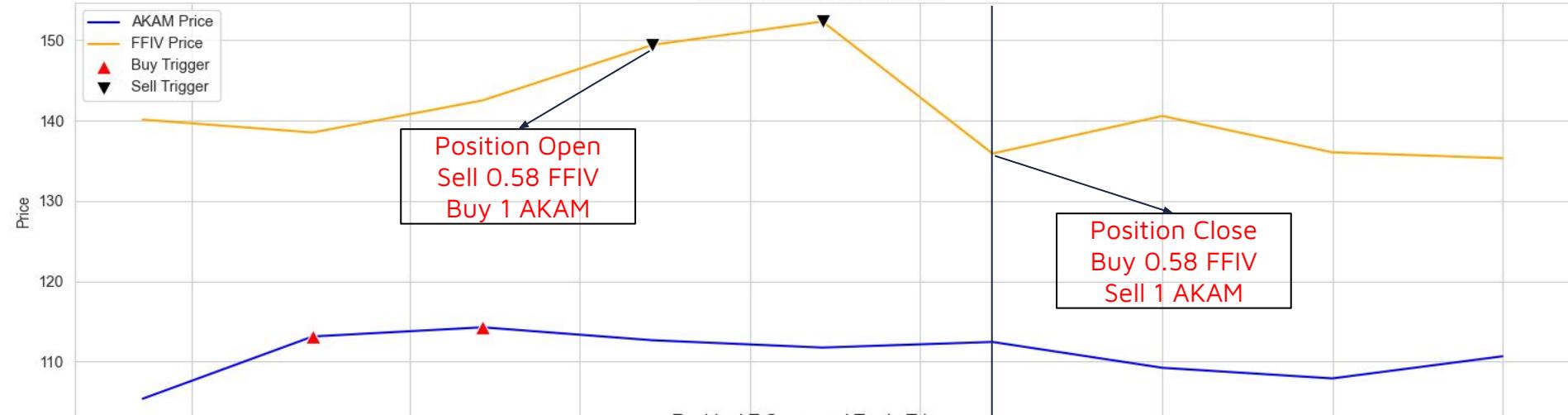


by Richi Jennings on July 7, 2020

Drop everything: A CVSS score of 10 is as bad as it gets. Trivial to exploit, this F5 BIG-IP vulnerability lets criminals pwn your entire network, and redirect your customers elsewhere.

F5's enterprise LTM-cum-GTM boxes also harbor another bug. But this one "only" scores 7.5. Even if your kit is protected via VLAN or firewall, say, get that patch installed—*pronto*. In today's SB Blogwatch, we scurry to fix.

Price Chart of AKAM and FFIV



Residual Z-Score and Trade Triggers





03 Commodity

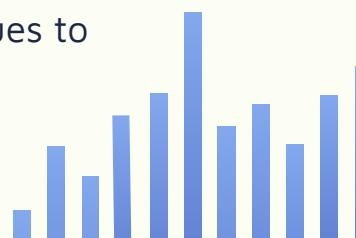


Pricing Difference



1. Oil Quality and Types:

- **WTI** has a lower sulfur content: simplifies the refining process & lower refining costs.
 - better for producing gasoline.
- **Brent** has a higher sulfur content: requires more complex refining techniques to remove sulfur & higher refining costs.
 - better for producing diesel fuel



Pricing Difference

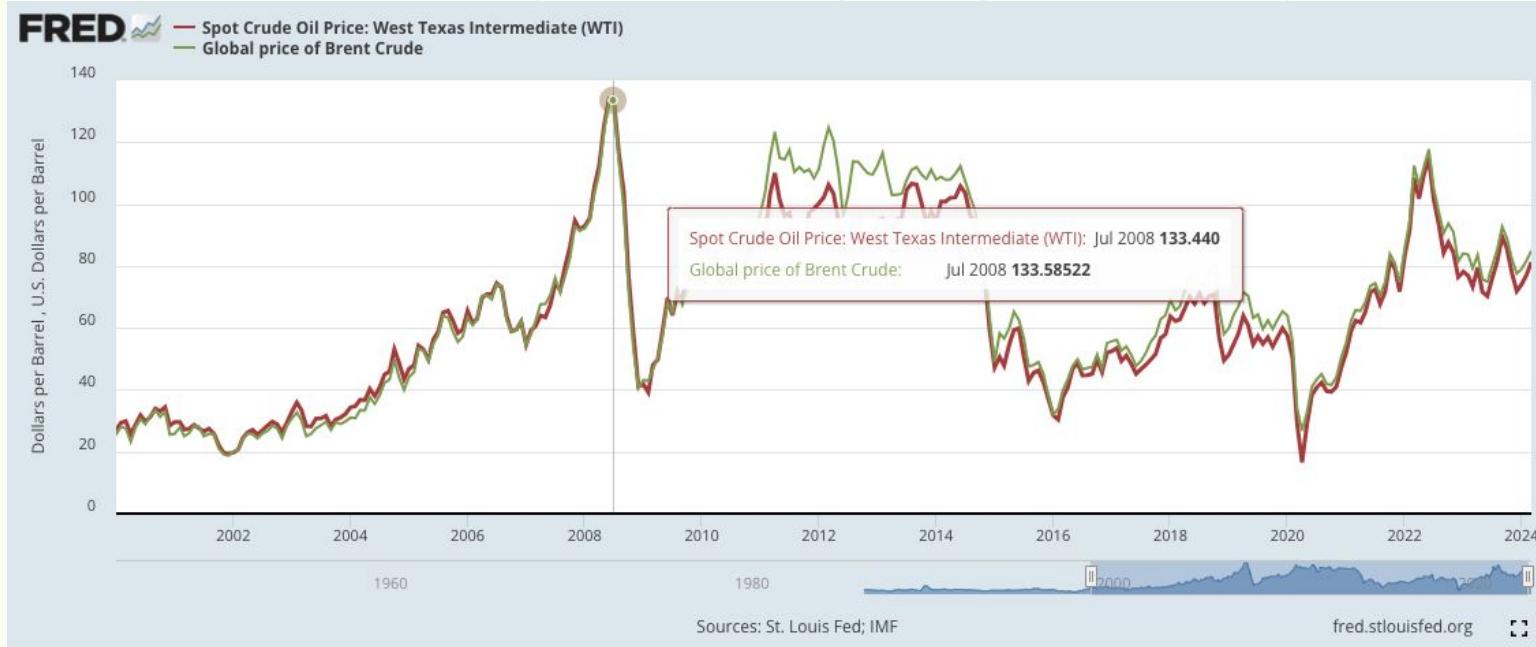


2. Transportation and Storage Costs:

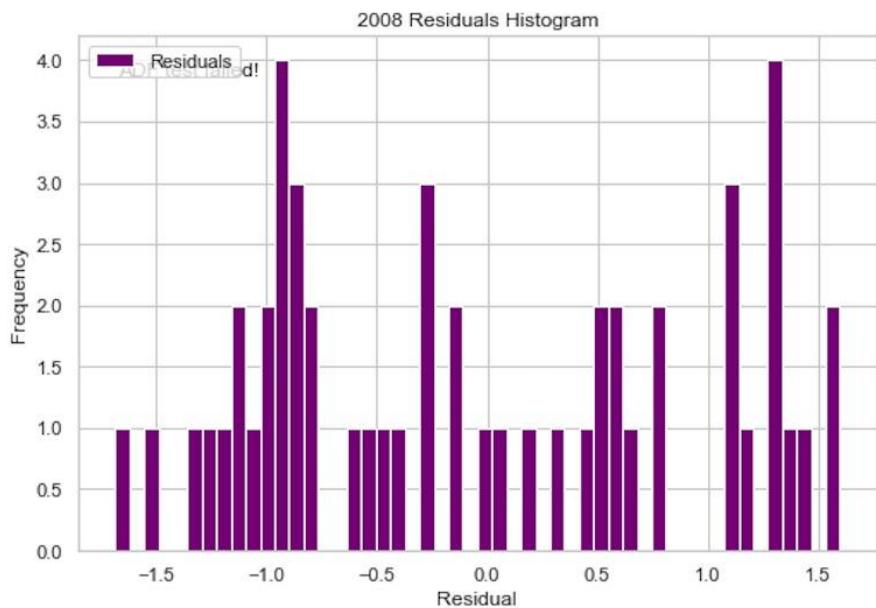
- **WTI** is primarily produced in the central United States and close to major consumer markets
 - lower transportation and storage costs.
- **Brent** is primarily extracted in the North Sea and requires higher transportation costs to ship the oil to refineries in other regions
 - approximately two-thirds of the world's oil production is priced according to Brent price

Global Economy: Demand

- Strong global economic growth drives up oil demand, increasing prices, vice versa.
- The **financial crisis in 2008**, crude oil prices sharply fell from nearly \$140 to \$40.

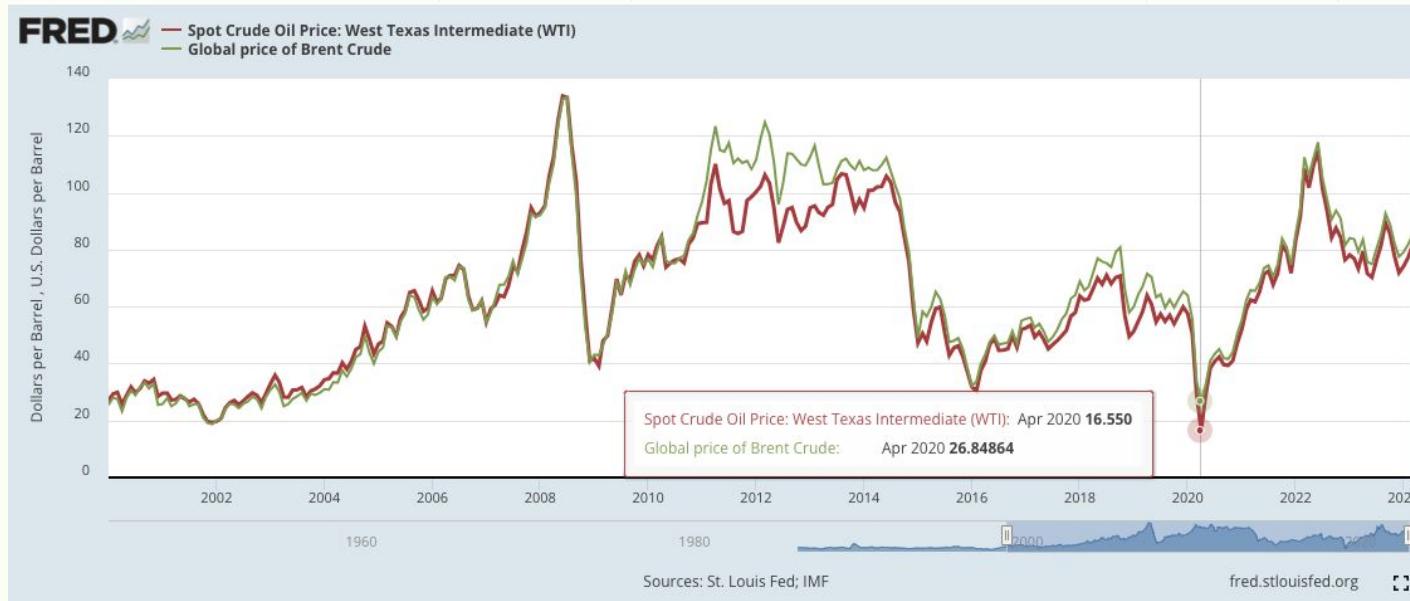


Cointegration Breakdown in 2008



Global Economy: Supply

- The COVID-19 pandemic at **2020** led to a global economic halt, causing a sharp decline and reaching a 24-year low.
- Disagreements between OPEC and Russia on production cuts, leading to an **oversupply**.
- In April 2020, **WTI crude oil futures prices fell into negative** for the first time in history, meaning that sellers had to pay buyers to take the oil off their hands.



Other Factors

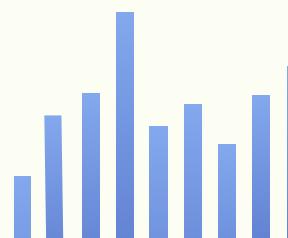
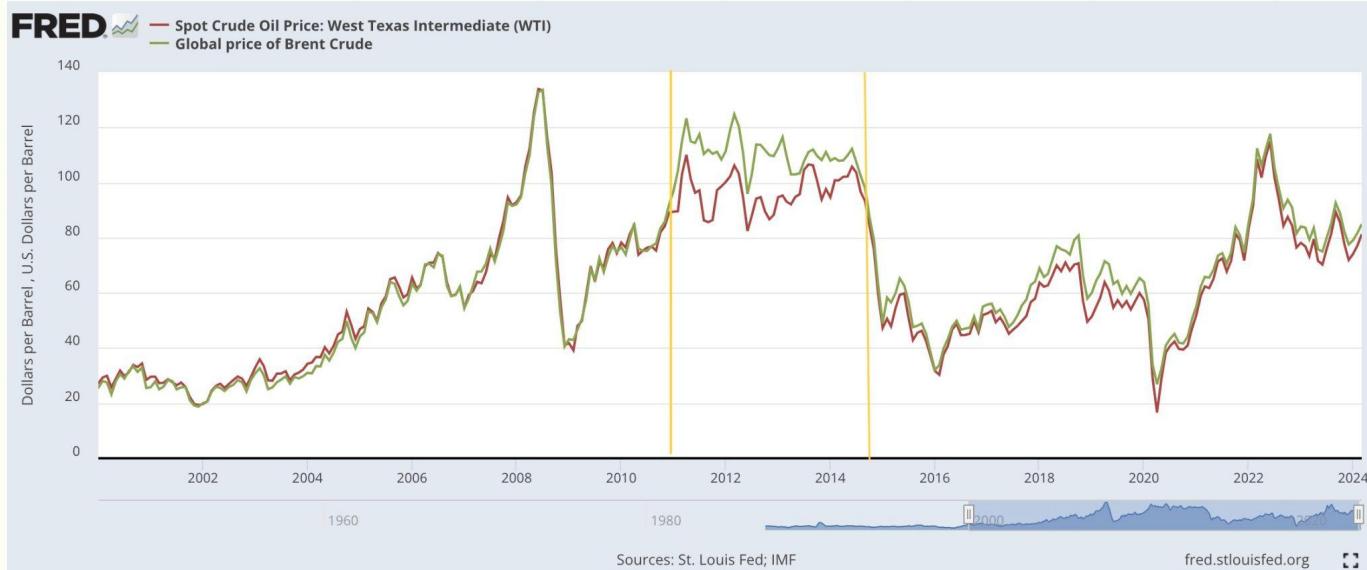


- **Political Uncertainty**

- **The Arab Spring:** Starting at the end of **2010**, this series of revolutions and protest movements swept across several countries in the Middle East and North Africa, causing uncertainty over the global supply of crude oil.

- **U.S. Dollar Exchange Rate:**

- U.S. dollar exchange rate can also directly affect their prices since both types of crude oil are priced in U.S. dollars.





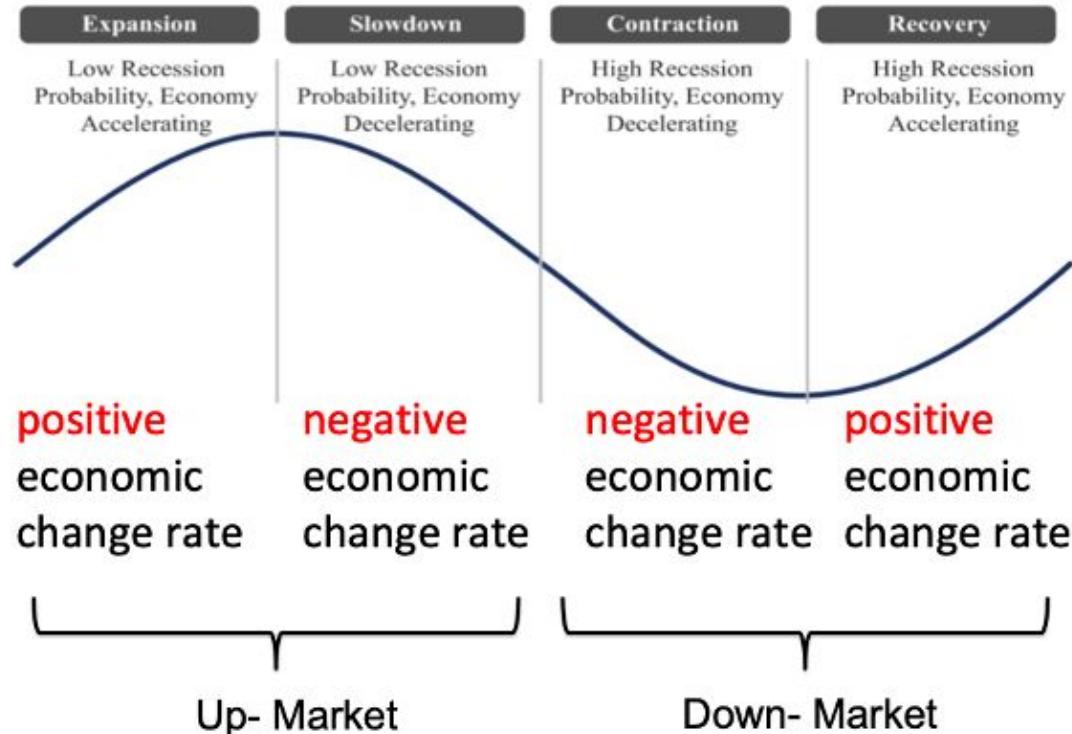
04 Market Regime



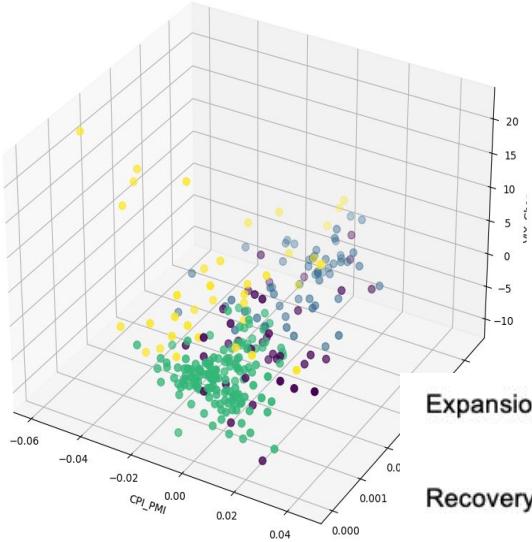
Market Regime Identification



Stylized Economic Regimes



Cluster Market Regime



Expansion



Recovery



Contraction



Slowdown



Map 9 features as Scatters in the Space
Divide Scatters into 4 Clusters
Assign Regime Based on the Cluster
reflect the different market regimes on the S&P500 price





Market Regime

1. Finally choose 2 market regime:

(1) 1252 weekly data, reserving 20% for testing

(2) 2 market regime used:

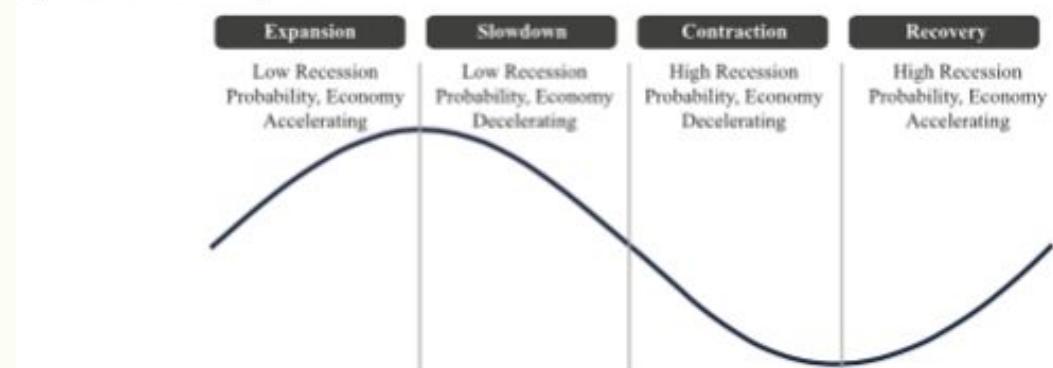
Down Market: Contraction + Slowdown

(around 400 data)

Up Market: Expansion + Recovery

(around 800 data)

Stylized Economic Regimes



Stock Pair Trading & Market Regime

- For the stock pair

- X = INCY

- Y = VRSN

- **Incyte Corporation (INCY)**

- **Sector:** Healthcare

- **Industry:** Biopharmaceuticals

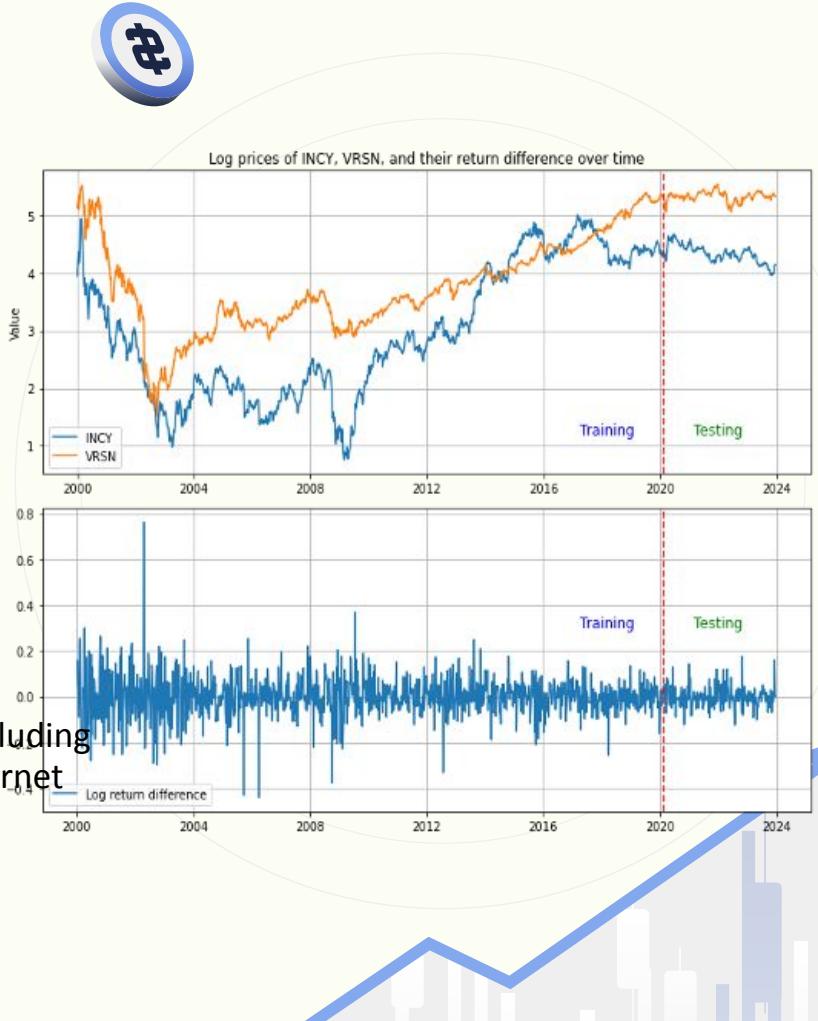
- **Overview:** Incyte focuses on the development of novel therapeutics, particularly in oncology and inflammation. Its flagship product is Jakafi.

- **VeriSign, Inc. (VRSN)**

- **Sector:** Technology

- **Industry:** Internet Information Providers

- **Overview:** VeriSign manages internet domain registries including .com and .net, ensuring the security and stability of key internet infrastructure.



Stock Pair Trading & Market Regime

- We assume the return difference

$$d_{(xy)} = r_x - r_y \sim N(\mu, \sigma^2)$$

- Let

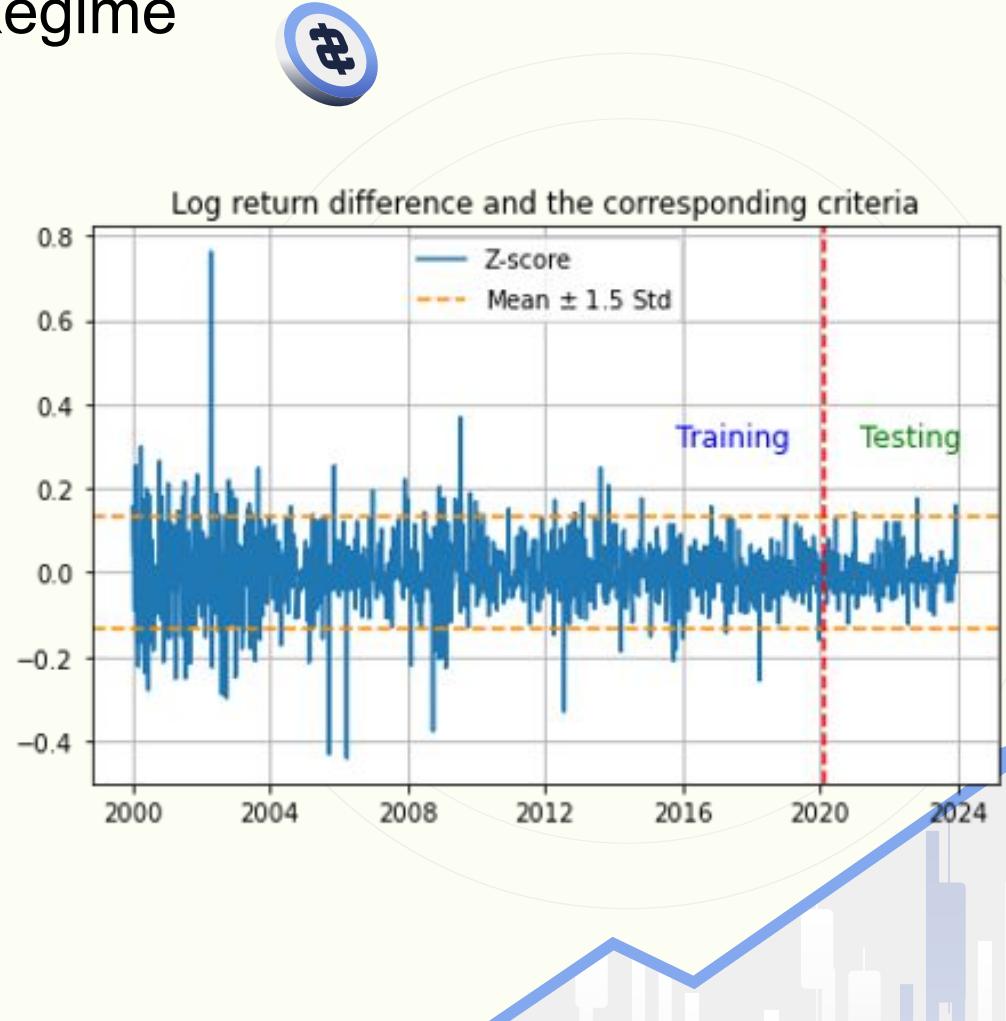
- $\hat{\mu} = \bar{r}_x - \bar{r}_y$ over the training period
- $\widehat{\sigma^2} = SE(r_x - r_y)^2$ over the training period

- Construct the Z-score

$$Z = \frac{r_x - r_y - \hat{\mu}}{\hat{\sigma}}$$

- Criteria: we choose criterion ± 1.5

- if $Z > 1.5$, short X long Y, each of amount \$100
- if $Z < -1.5$, short Y long X, each of amount \$100



Stock Pair Trading & Market Regime



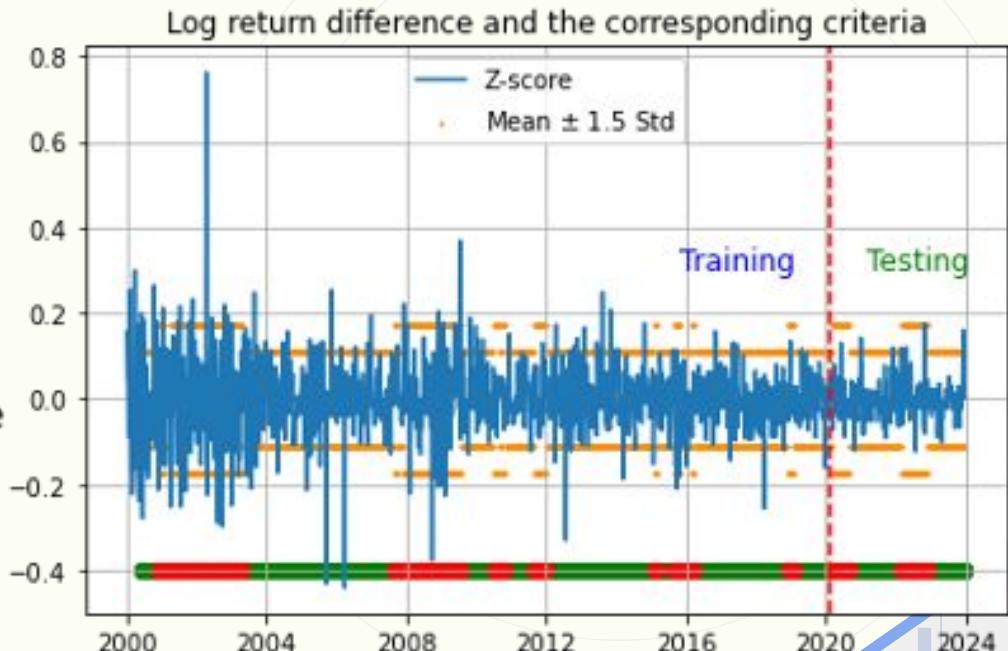
- Different Market Regime
- Up Market: Contraction, Slowdown
- Down Market: Recovery, Growth
- Mean and Variance are different for different market regimes
- Let
 - $\widehat{\mu_{up}} = \bar{r}_x - \bar{r}_y$ over the up training period
 - $\widehat{\sigma_{up}^2} = SE(r_x - r_y)^2$ over the up training period
- $\widehat{\mu_{down}} = \bar{r}_x - \bar{r}_y$ over the down training period
- $\widehat{\sigma_{down}^2} = SE(r_x - r_y)^2$ over the down training period



Stock Pair Trading & Market Regime



- Construct correspondingly
 - Z-score up
 - Z-score down
- Down market volatility is larger than the up market, leading to a wider threshold for the return difference

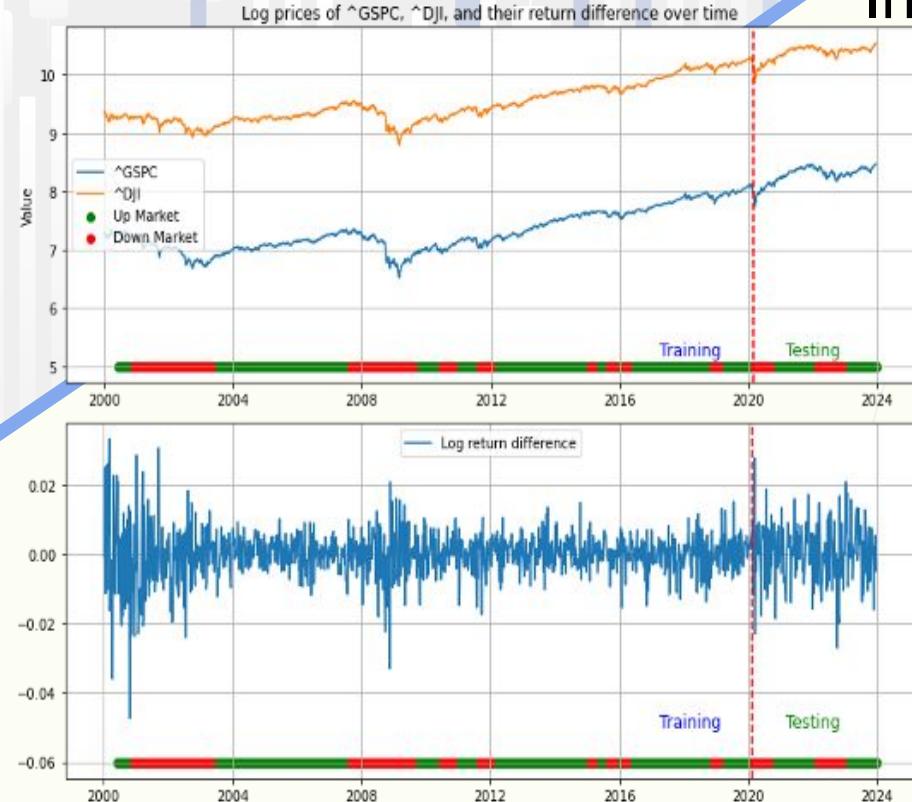


Stock Pair Trading & Market Regime

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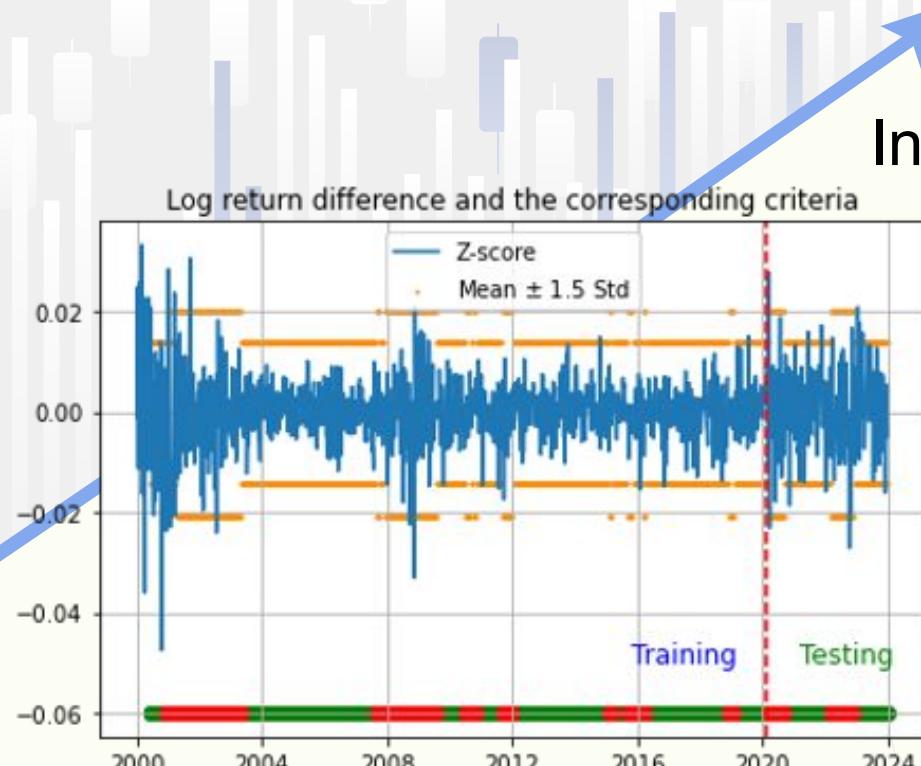
Index Pair Trading & Market Regime



- **$^{\text{GSPC}}$ (S&P 500 Index)**
- **Description:** The S&P 500 is a market-capitalization-weighted index of 500 of the largest publicly traded companies in the U.S.
- **Importance:** Reflects the U.S. market's large-cap sector and is used as a benchmark for the overall stock market's health.

- **$^{\text{DJI}}$ (Dow Jones Industrial Average)**
- **Description:** The Dow Jones Industrial Average is a price-weighted index of 30 significant stocks traded on the New York Stock Exchange (NYSE) and the NASDAQ.
- **Importance:** Often used to represent the overall health of the industrial sector and the economy.

Index Pair Trading & Market Regime



- Construct correspondingly
 - Z-score up
 - Z-score down
- Down market volatility is larger than the up market, leading to a wider threshold for the return difference
- Threshold are narrower than that of stocks
- For conservative investor, suggest using index pair trading rather than stocks pair trading

\wedge GSPC, \wedge DJI Pair Trading PnL - Training



Index Pair Trading & Market Regime

- Market Regime Adjusted Strategy can set threshold more suitable for different regimes
- Capture more profitable opportunities and avoid fake signals during the down market
- The total return for both training and testing periods are higher than the corresponding unconditional case

\wedge GSPC, \wedge DJI Pair Trading PnL - Testing





Thank You for Listening!

