PCI+ASI Combined Strategy Research Doc

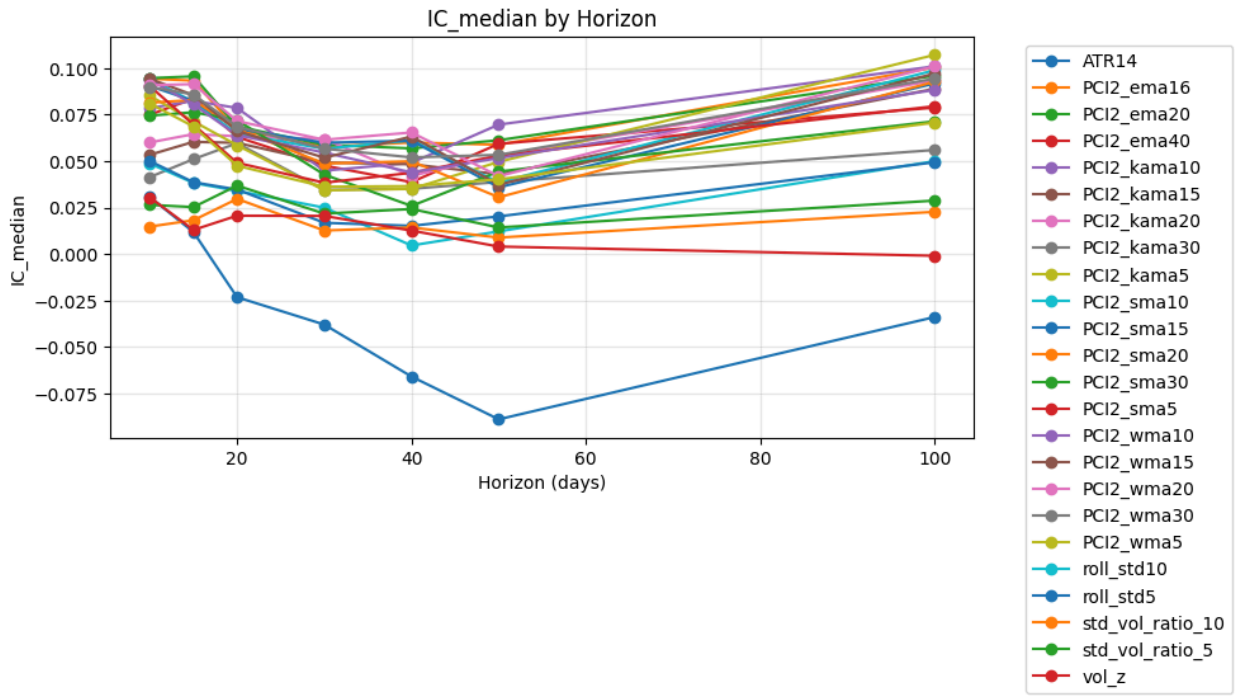
The code attached is a culmination of my efforts to create a successful trading algorithm. My project began with the creation and testing of my novel volatility indicator PCI (Price Confidence Indicator). PCI is calculated by first calculating μ = ((Shares Outstanding + Volume) * Highest Value) then λ = ((Shares Outstanding - Volume_t) * Lowest Value) and Finally PCI = (Highest value - Lowest value) / (μ - λ).
The concept behind this was to imagine Mu and Lambda values as the hypothetical limit the price could have reached that day adjusted for the real price movement and volume with Mu being the Maximum and Lambda the Minimum (hence Mu for Maximum and Lambda for lowest). Then by dividing the highest-lowest value by Mu-Lambda I get a measure of market confidence in a given price, this reveals market confidence as we can consider 4 hypothetical scenarios:

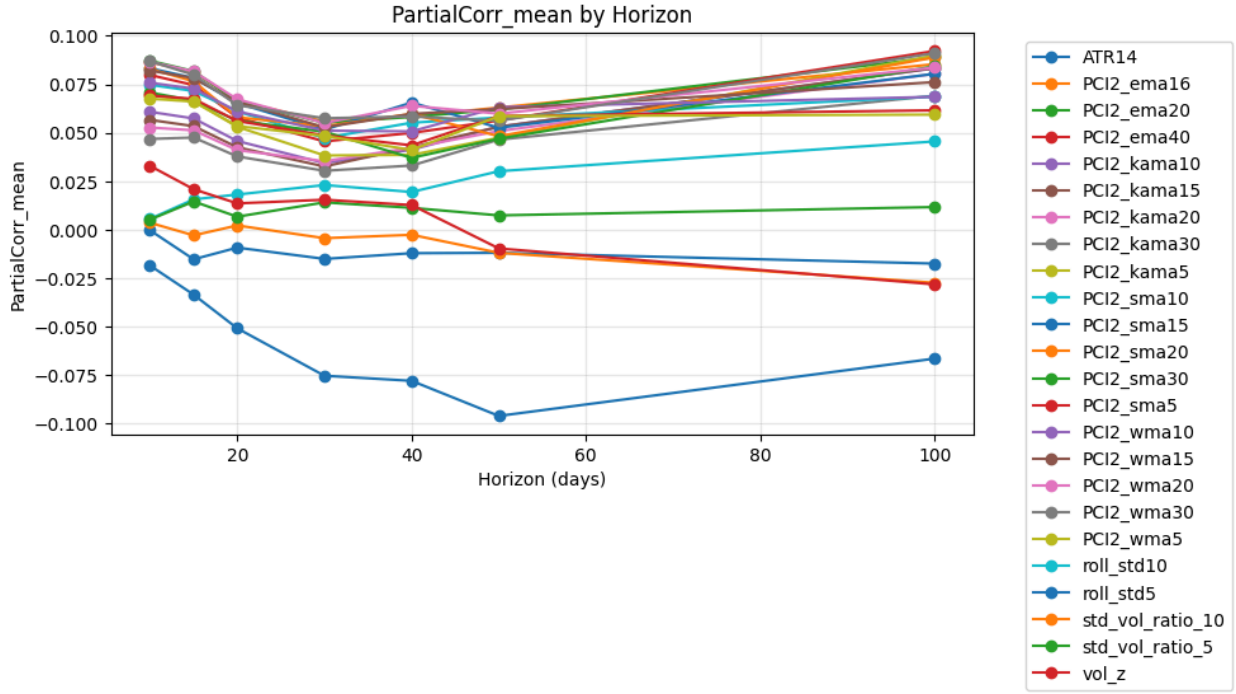
	Low Volume	High Volume
High (High - Low)	In this scenario PCI is high. High future market volatility is expected as the market is shifting rapidly with little volume required to generate a market movement indicating a high selling or buying pressure thus expected future changes.	In this scenario PCI could vary based on exact values but likely isn't low. High future volatility would be expected as the market is uncertain in the initial value of the stock thus causing large volumes and large market movements.
Low (High-Low)	In this scenario PCI will vary based on exact values but is likely high. Low future volatility is expected as the market is confident in the given price meaning there is no need for price changes or much trading volume. This is a weakness of PCI.	In this scenario PCI will be low, Low future volatility is expected as the market is confident in the current pricing since despite high volumes the pricing remains constant.

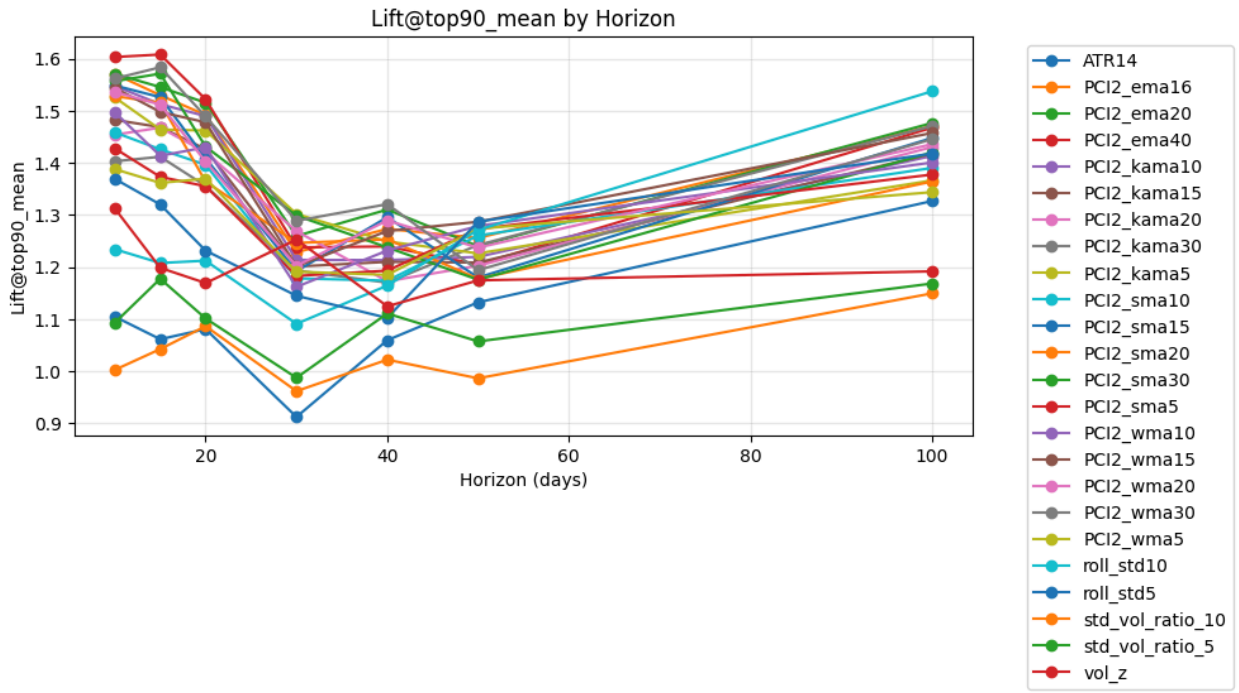
This is the theoretical core of PCI.
The code below calculates PCI and the following outputs. Each code outputs:

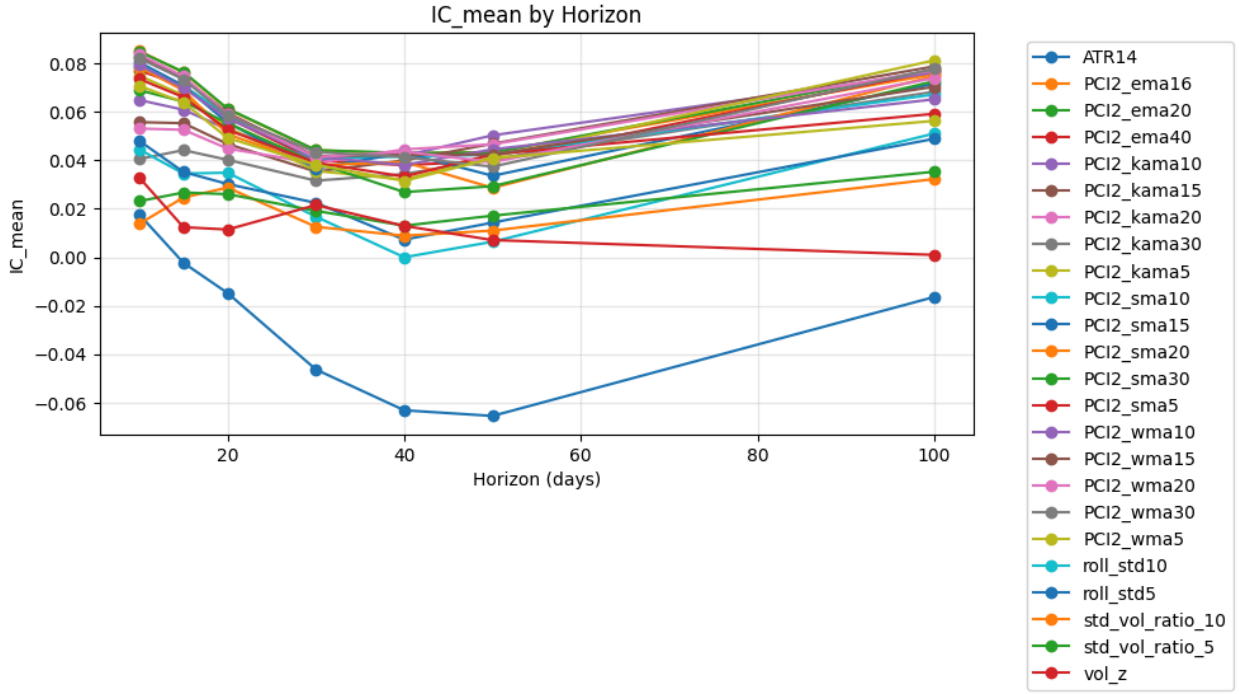
- lift@topK_mean which is a measure of how much stronger PCI is at extremes
- Partial Correlation is a measure of the new information added by PCI onto information like standard deviation and ATR14
- Where IC is the internal correlation it outputs the:
    - IC mean
    - IC median
    - IC at certain percentiles
- CI which is the share of bootstraps where IC is greater than 0

Each code compares different smoothing techniques and horizons which after testing and comparing outputs was discovered to be weighted moving average of strength 15 over a 10 day horizon. Here are the results for the Absolute Return correlation code:


IC_median by Horizon
IC_median
Horizon (days)
0.100
0.075
0.050
0.025
0.000
−0.025
−0.050
−0.075
20
40
60
80
100
ATR14
PCI2_ema16
PCI2_ema20
PCI2_ema40
PCI2_kama10
PCI2_kama15
PCI2_kama20
PCI2_kama30
PCI2_kama5
PCI2_sma10
PCI2_sma15
PCI2_sma20
PCI2_sma30
PCI2_sma5
PCI2_wma10
PCI2_wma15
PCI2_wma20
PCI2_wma30
PCI2_wma5
roll_std10
roll_std5
std_vol_ratio_10
std_vol_ratio_5
vol_z


PartialCorr_mean by Horizon
PartialCorr_mean
Horizon (days)
0.100
0.075
0.050
0.025
0.000
−0.025
−0.050
−0.075
−0.100
20
40
60
80
100
ATR14
PCI2_ema16
PCI2_ema20
PCI2_ema40
PCI2_kama10
PCI2_kama15
PCI2_kama20
PCI2_kama30
PCI2_kama5
PCI2_sma10
PCI2_sma15
PCI2_sma20
PCI2_sma30
PCI2_sma5
PCI2_wma10
PCI2_wma15
PCI2_wma20
PCI2_wma30
PCI2_wma5
roll_std10
roll_std5
std_vol_ratio_10
std_vol_ratio_5
vol_z





The output data was then used to find the best PCI combination. To do this I estimated the area under the graph of a graph with the Y axis being IC and the X axis being the bootstraps ordered in sequential success. I then summed these graph estimates across the PCI correlation with absolute returns, standard deviation and limited standard deviation. This shows the top 10 results.

	Limits			Limits			Returns		Graph Estimate
Horizon	Type	Graph Estimate	Horizon	Type	Graph Estimate	Horizon	Type	Graph Estimate	
10	PCI2_wma15	0.04485653618	10	PCI2_wma15	0.1656088551	10	PCI2_wma15	0.071743796 04	0.2822091873
10	PCI2_ema20	0.04002593374	10	PCI2_ema20	0.1624536466	15	PCI2_ema20	0.077965663 16	0.2804452435
10	PCI2_sma20	0.03789740689	10	PCI2_sma20	0.149880417	10	PCI2_sma20	0.071505099 28	0.2592829232
10	PCI2_ema16	0.0441084677	10	PCI2_ema16	0.1653031431	10	PCI2_ema16	0.049112149 41	0.2585237602
10	PCI2_sma10	0.04409688175	10	PCI2_sma10	0.1602143664	10	PCI2_sma10	0.051694034 76	0.2560052829
10	PCI2_wma20	0.04460963191	10	PCI2_wma20	0.165256441	10	PCI2_wma20	0.038247533 04	0.248113606
15	PCI2_ema16	0.02445820979	15	PCI2_ema16	0.1667464919	15	PCI2_ema16	0.053186366 72	0.2443910684
10	PCI2_ema40	0.02992931399	10	PCI2_ema40	0.1352693522	10	PCI2_ema40	0.078619994 66	0.2438186609
15	PCI2_sma5	0.04963483176	15	PCI2_sma5	0.151890817	15	PCI2_sma5	0.035751959 59	0.2372776084
15	PCI2_wma5	0.05297767219	15	PCI2_wma5	0.1461173689	15	PCI2_wma5	0.037310569 22	0.2364056103

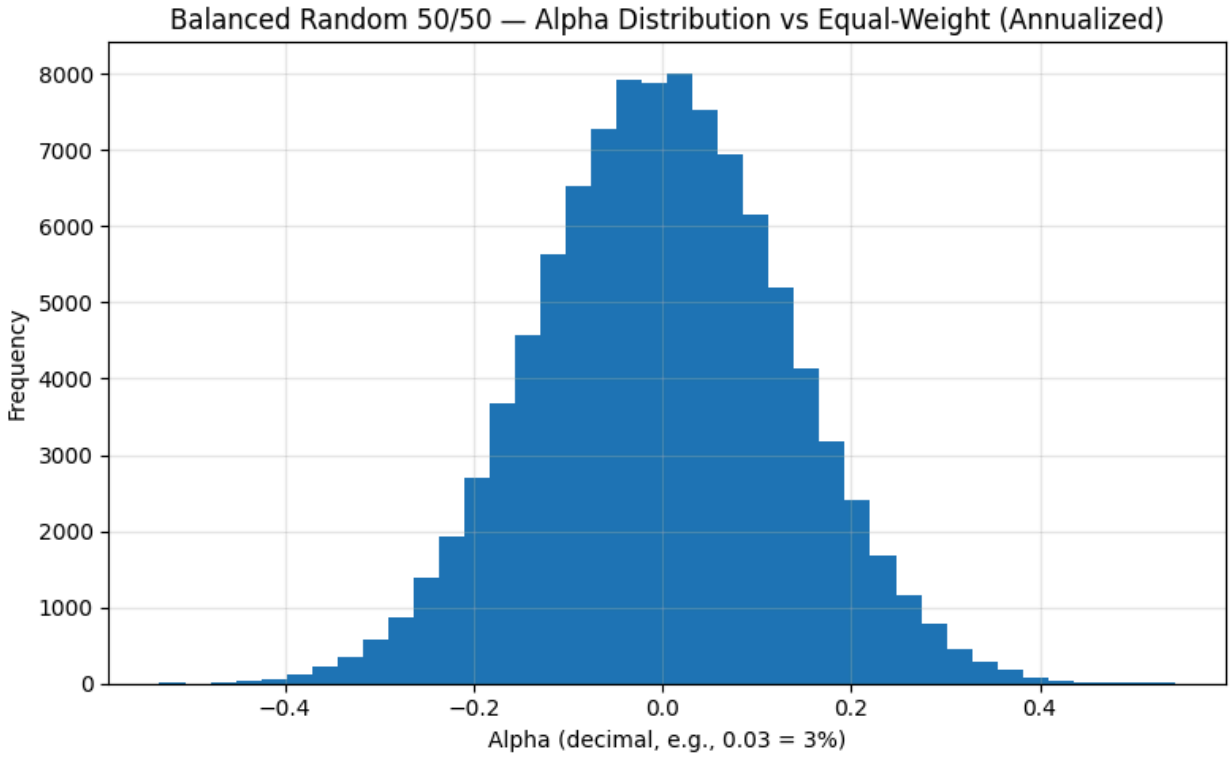
Each code also has certain control variables such as bootstrapping, and including a random PCI as a baseline.

- The file named PCI_ABSReturns_Research finds the correlation of PCI and future absolute returns
- The file named PCI_STDev_Research calculates the correlation of PCI and standard deviation
    - std_limits can be adjusted such that if std_limits = 0.9 only the 90th percentile of movements are used as data points to calculate standard deviation.

This concluded my PCI research however for future experimentation I intend to test PCI over larger time periods then a day to see if that can predict longer trends and I also want to test correlation with absolute returns and standard deviation such that high PCI and high volume is required to remedy the contradiction that occurs with low volume and low (high-low).

<u>Developing PCI into a tradeable algorithm:</u>

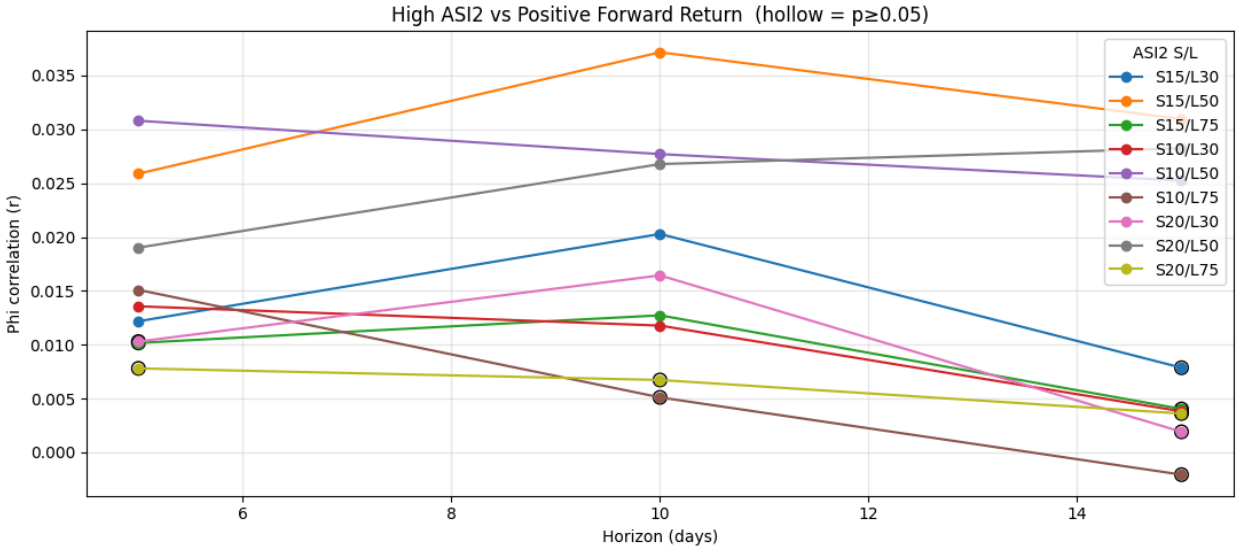
- First I tested if PCI had any directional qualities using a Montecarlo simulation which it did not as shown:



- Given this to create a tradeable strategy I introduced a directional indicator named ASI
- ASI is calculated by doing the following:
    - Define a time period e.g. one day
    - ASI is calculated using daily data as one day is the time period

- First find the number of days with positive returns and the number of days in total for a given horizon up to N days
- Then find the number of 2 day periods with positive returns and the number of two day periods in total
- continue this all the way to N day periods
- Take the number of periods with positive returns and divide with total number of periods to get ASI
- For example take a 5 day period where returns are as follows [+5, -5, -5, +3, +3]
- There are 3 successful one day periods and 5 total periods
- there is 1 successful period out of 4 total possible 2 day periods
- There is 1 successful period out of 3 possible 3 day periods
- There no successful periods out of 2 possible 4 day periods
- There is 1 successful period out of 1 possible 5 day periods
- Thus ASI is (3+1+1+1)/(5+4+3+2+1) =0.4

- The ASI I use for the strategy can be dubbed ASI2 or RASI which is from calculating a 15 day rolling ASI and dividing it by a 50 day rolling ASI.
    - I deduced this to be the best combination through testing ASI correlation with future returns in a similar fashion to PCI



- The graph shows pearson correlation, points on the graph with markers around it have p value greater than 0.05 and those without have a p value less than 0.05

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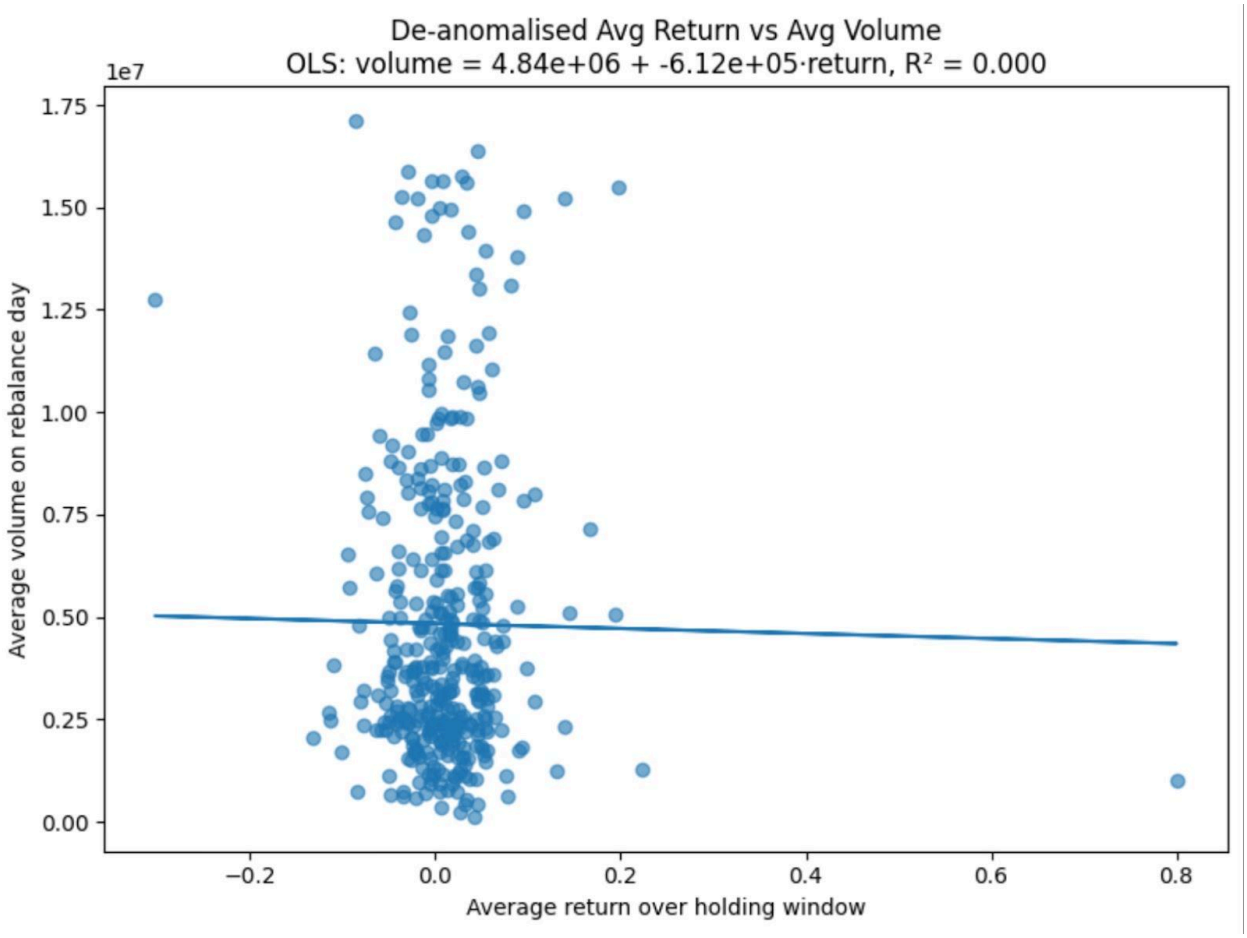
Top lift@90 by horizon (higher = better):
  H=  5d  best=S15/L30   lift@90=-0.047
  H= 10d  best=S15/L50   lift@90=-0.071
  H= 15d  best=S15/L50   lift@90=-0.090
```

- This shows the lift@90 output

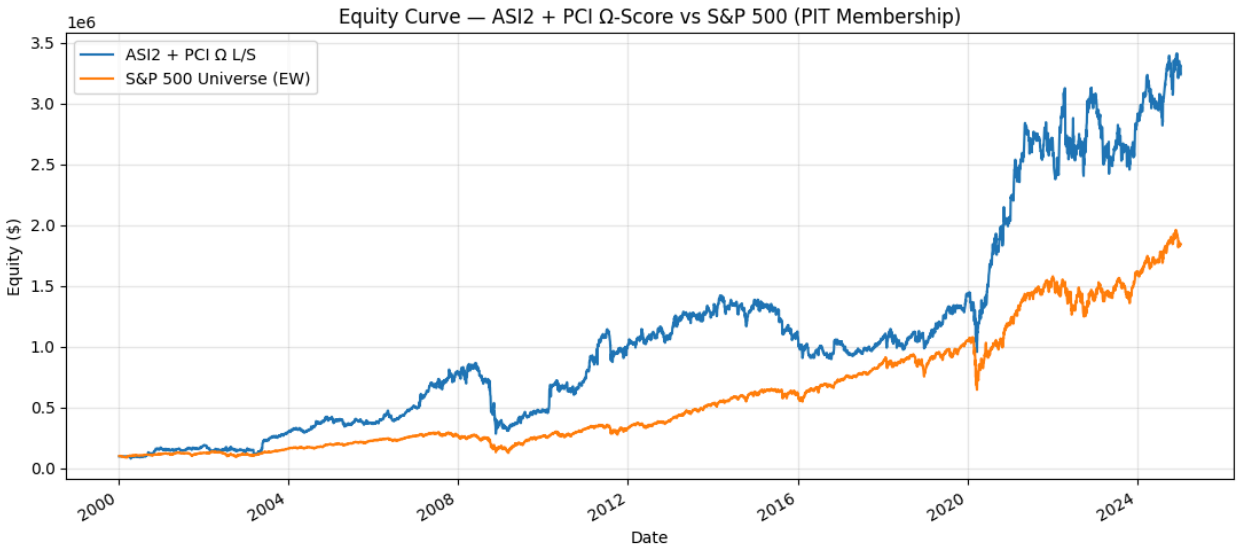
- To combine the two indicators I did the following calculations
    - For a given ticker ASIΩ = (ASI^ASI indice) / Σ(ASIΩ)
    - For a given ticker PCIΩ = (PCI^PCI indice) / Σ(PCIΩ)
    - For a given ticker Ω = ASIΩ + PCIΩ
    - For a given ticker weighting = Ω/ΣΩ where ΣΩ can be narrowed down to only the top K percentile ASI basket

- For this I used the S&P 500 as a universe initially and then to avoid survivorship bias I used a contemporary list
- I then began to notice that the code was significantly more successful when rebalancing on Fridays than any other day with cumulative returns being 1.5X the second highest day and 6.5X the lowest day indicating something must be causing this and it is not simply a case of overfitting.
    - To investigate I found that Fridays generally have higher trading volumes. If trading volume is on average higher I theorised that PCI would have more information to outline sentiment and trends.
        - I then plotted every rebalance dates trading volume against the resultant return to see if higher volume indicated higher returns however volume had a negligible effect as shown



- My other theory is that since option expiration tends to be on Friday the code may be picking up on maximum pain theory to some extent.
    - Unfortunately I had insufficient access to data to graph a rebalance days resultant return against the value of option contracts expiring on that rebalance day (or the next)

- The file named Main_ASI+PCI_Backtest contains the strategy's performance using the contemporary S&P 500 universe and in the optimal set up that I have discovered and here is the strategy over the past 25 years:

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=== Backtest Summary (ASI2 + PCI via Ω-score; PIT S&P 500) ===
                    Total Return %:    3137.98
                     Ann. Return %:      14.95
                       Ann. Sharpe:     0.5433
                     Max Drawdown %:     -66.98
                   Alpha (annual %):       6.13
                   Beta vs Universe:     0.8001
                              Start: 2000-01-07
                                End: 2025-01-08
                   Rebalance (days): 14
                  Rebalance Weekday: Friday
                        Long Alloc: 1
                       Short Alloc: 0
                         Long Pair: S15/L50
                        Short Pair: S15/L50
                         Top% Long:     0.0100
                        Bot% Short:     0.0100
                       ASI Ω Power:     2.0000
                       PCI Ω Power:     2.0000
                  ASI Ω Denominator:     1.0000
                  PCI Ω Denominator:     3.0000
                      ASI Narrowing: True
                     PCI WMA Window: 15
```

- My future research plans are:
    - Testing my option expiration theory
    - Exploring the strategy's performance in larger universes and in different geographies

- Testing higher frequency ASI calculations e.g. hourly candles to get more incremental ASI