Pairs Trading Strategy

Group 3

11-20-2025

Idea

Statistical Arbitrage

1. Short-sell overvalued
2. Long undervalued
3. Unwind position when they are relatively fairly valued

Abnormal return of pairs strategies are a compensation to arbitrageurs for enforcing the “Law of One Price”

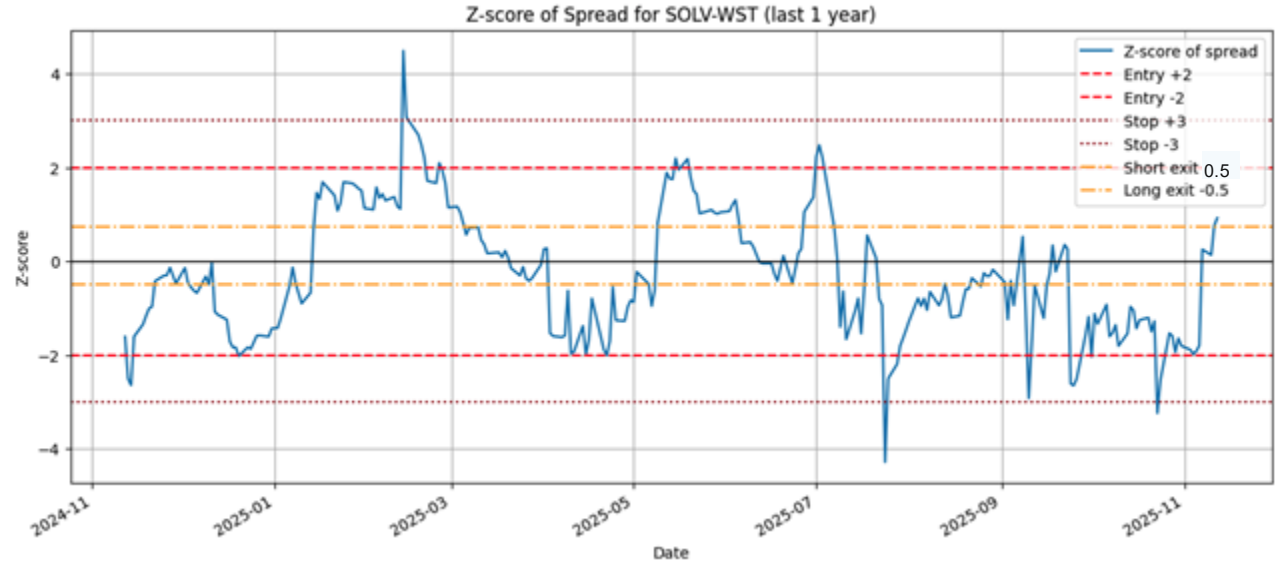
Literature Review

- No clear comparison between methods
- Testing done in non-US market

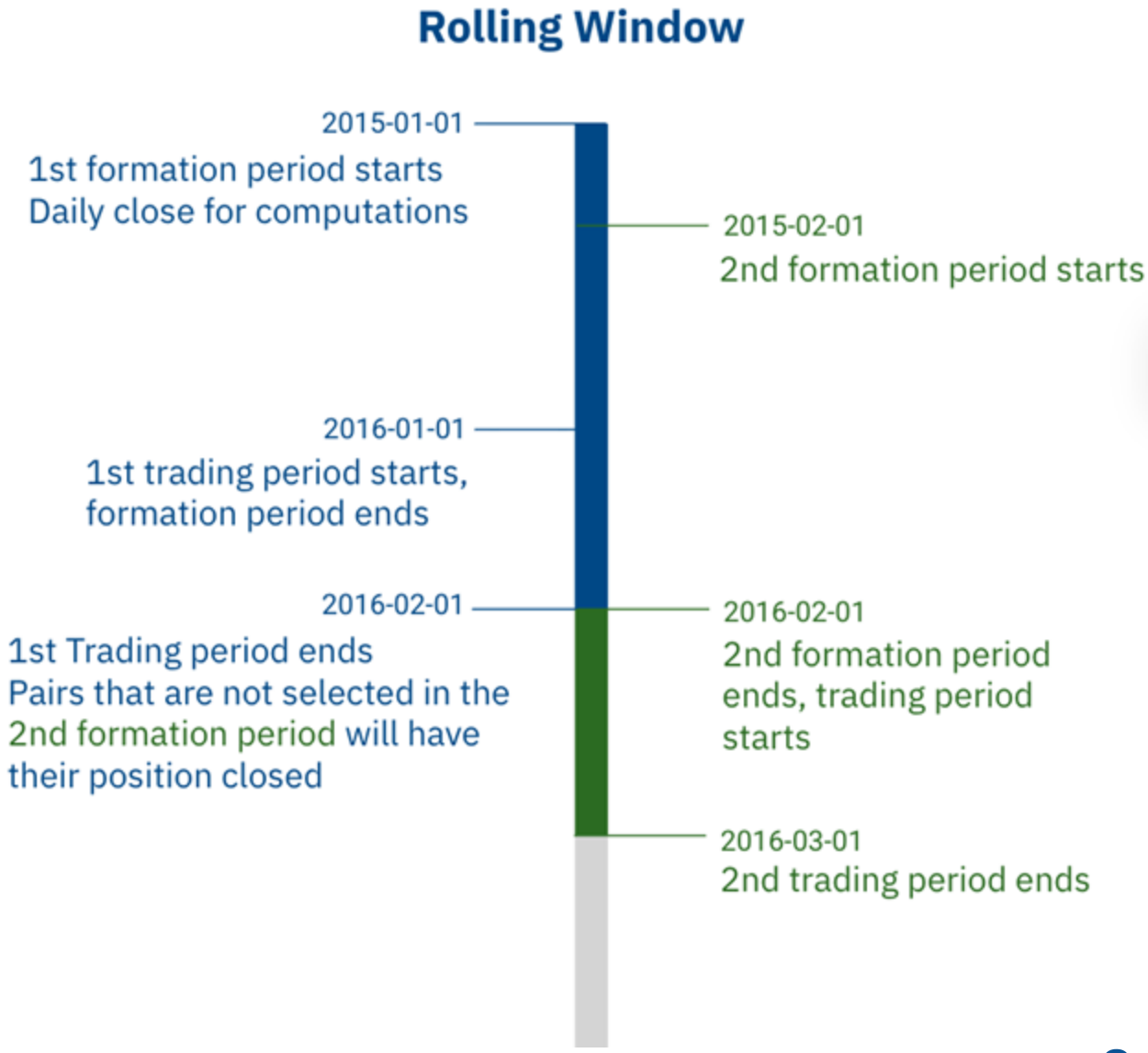
PAIRS TRADING

Trading Strategy

Trading Signal	Long if $z_t < -2$, Close long position if $z_t > -0.5$ Short if $z_t > 2$, Close short position if $z_t < 0.5$
Portfolio	Equal weighted on each pair Close positions at the end of trading period



Backtesting



Correlation - Fixed-window pairing and static hedge results

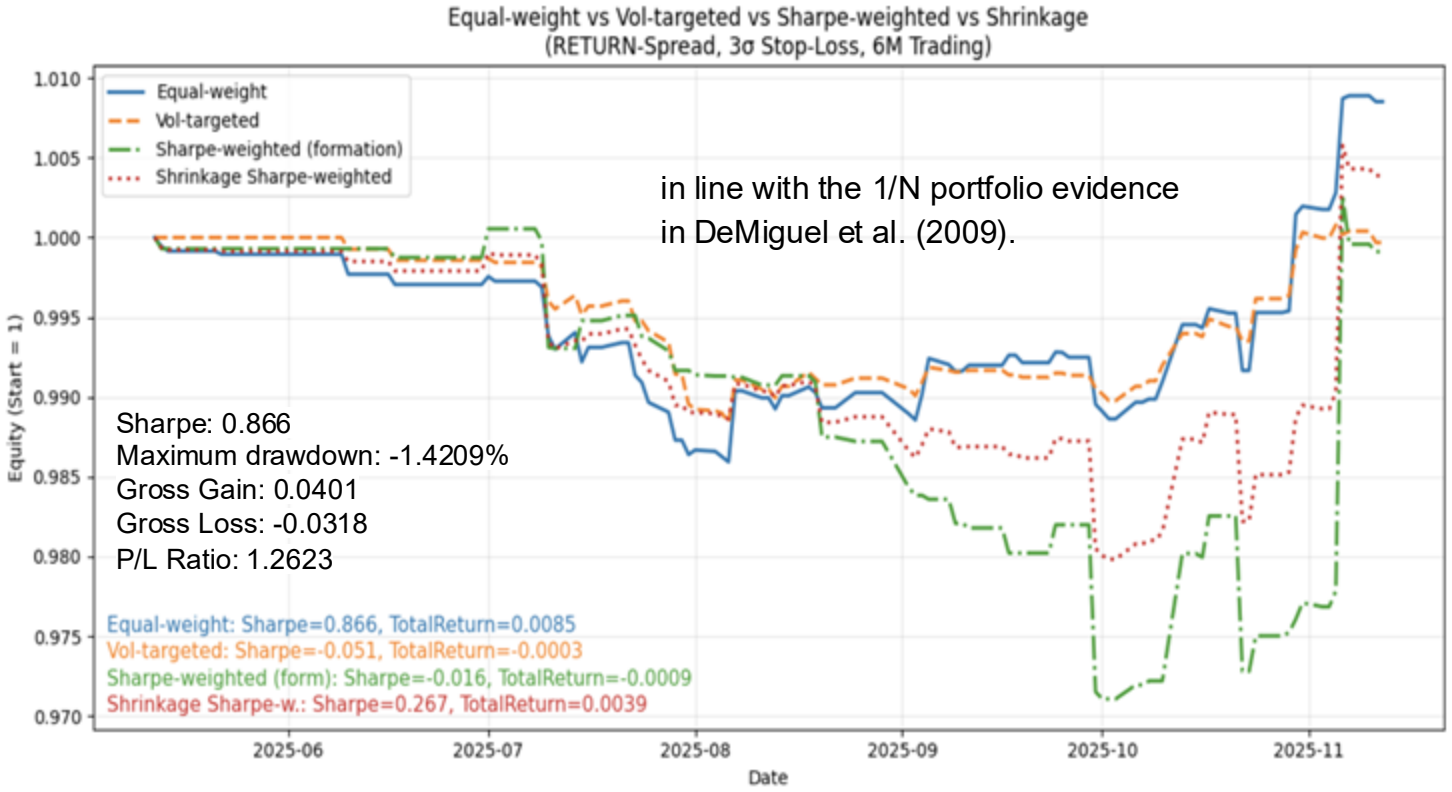
Pearson correlation. Align the two daily return series over the formation window and compute the sample:

$$\bar{x} = \frac{1}{n}\sum_{t=1}^{n} x_t, \qquad \bar{y} = \frac{1}{n}\sum_{t=1}^{n} y_t$$

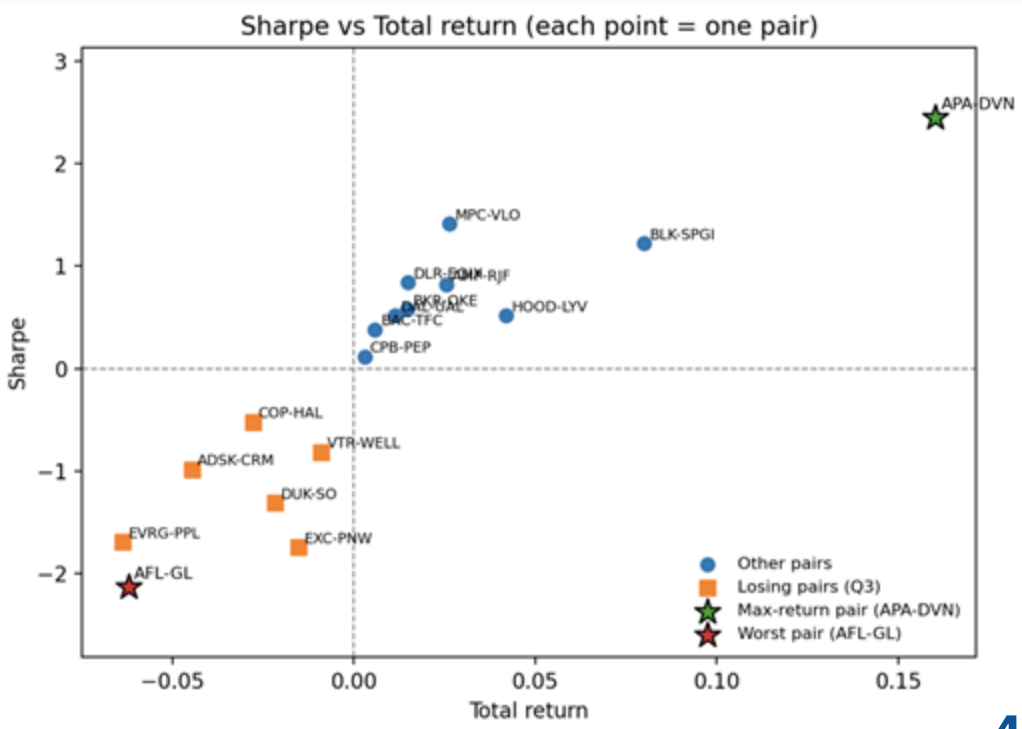
$$r_{xy} = \frac{\sum_{t=1}^{n}(x_t - \bar{x})(y_t - \bar{y})}{\sqrt{\sum_{t=1}^{n}(x_t - \bar{x})^2}\sqrt{\sum_{t=1}^{n}(y_t - \bar{y})^2}}$$

Spearman rank correlation. Rank each series over time to obtain R_t:=rank(X_t) and S_t=rank(Y_t), then compute Pearson on the ranks

$$\rho_s = \mathrm{corr}(R_t, S_t) = \frac{\sum_{t=1}^{n}(R_t - \bar{R})(S_t - \bar{S})}{\sqrt{\sum_{t=1}^{n}(R_t - \bar{R})^2}\sqrt{\sum_{t=1}^{n}(S_t - \bar{S})^2}}$$



in line with the 1/N portfolio evidence in DeMiguel et al. (2009).



Correlation(Rolling)

COVID-19 Shock (2020): Sharp equity jump

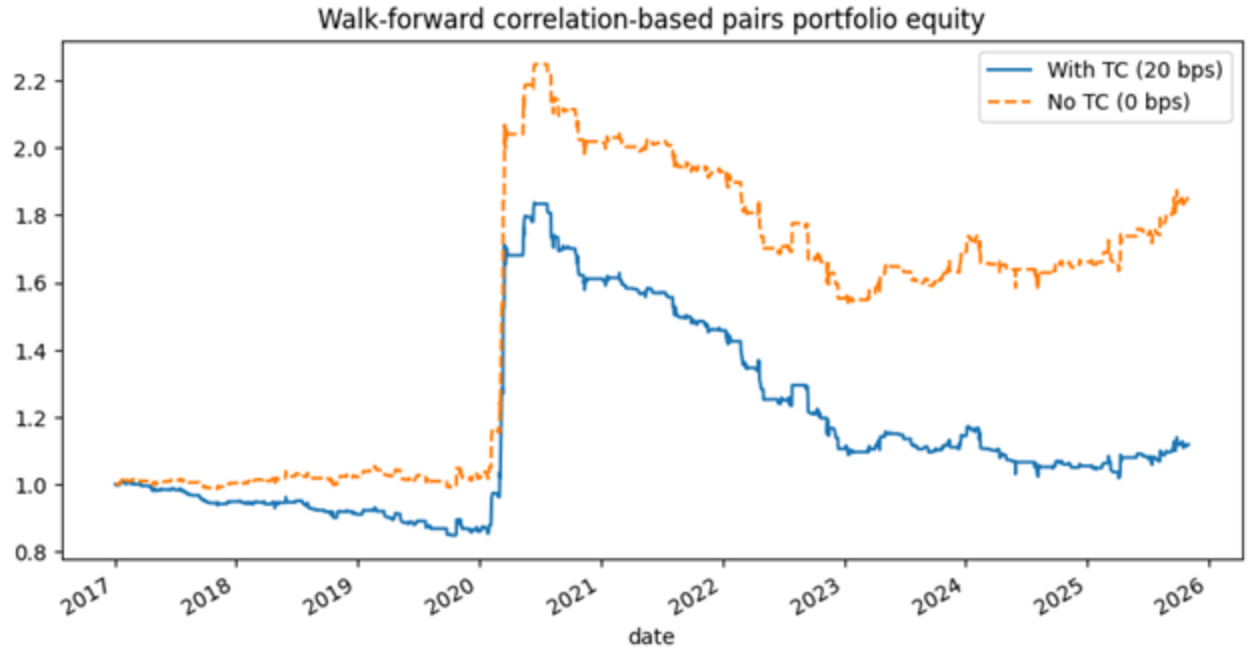
- Crisis-driven divergence + rapid rebound created outsized short-term mean-reversion opportunities.
- Rolling correlation quickly adapted to new synchronous patterns → captured strong snap-back trades.

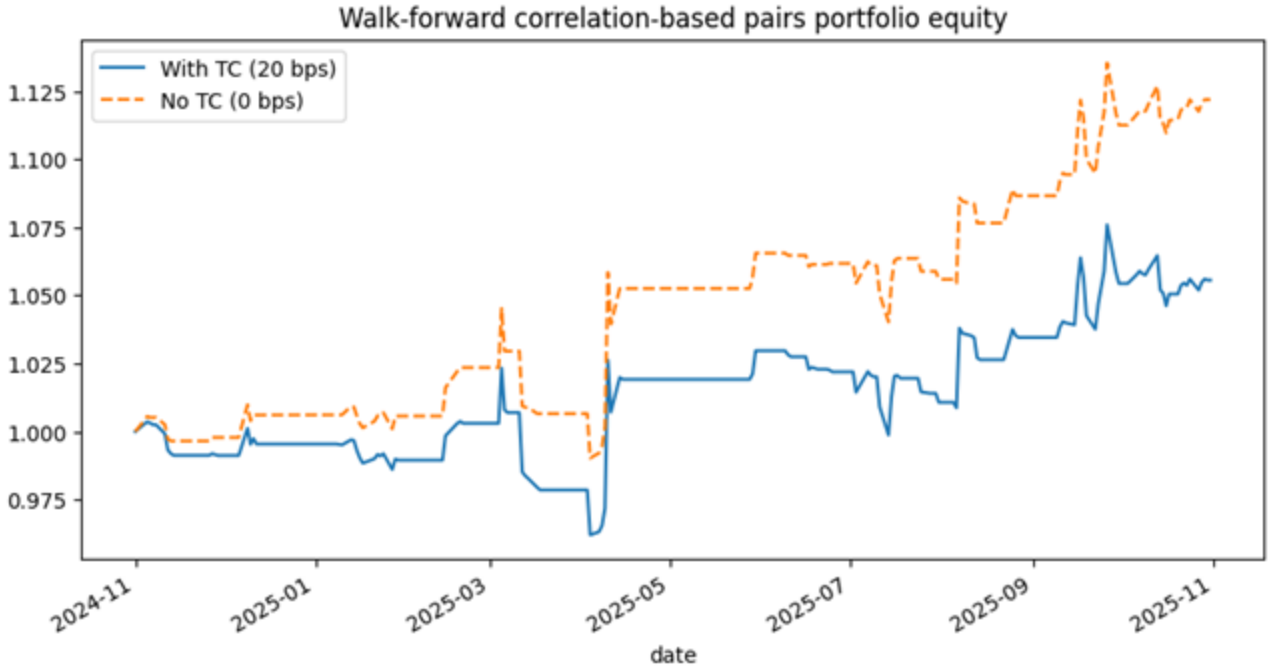
2021–2023: Decline in performance

- Post-crisis co-movement became noisy and short-lived.
- Rolling re-selection adapted frequently—but often to noise rather than persistent relationships.
- Cross-sectional correlation weakened → fewer viable pairs + slower spread reversion → portfolio decay

2024–2025: Partial recovery but volatile

- Some improvement as correlation structure stabilizes again.

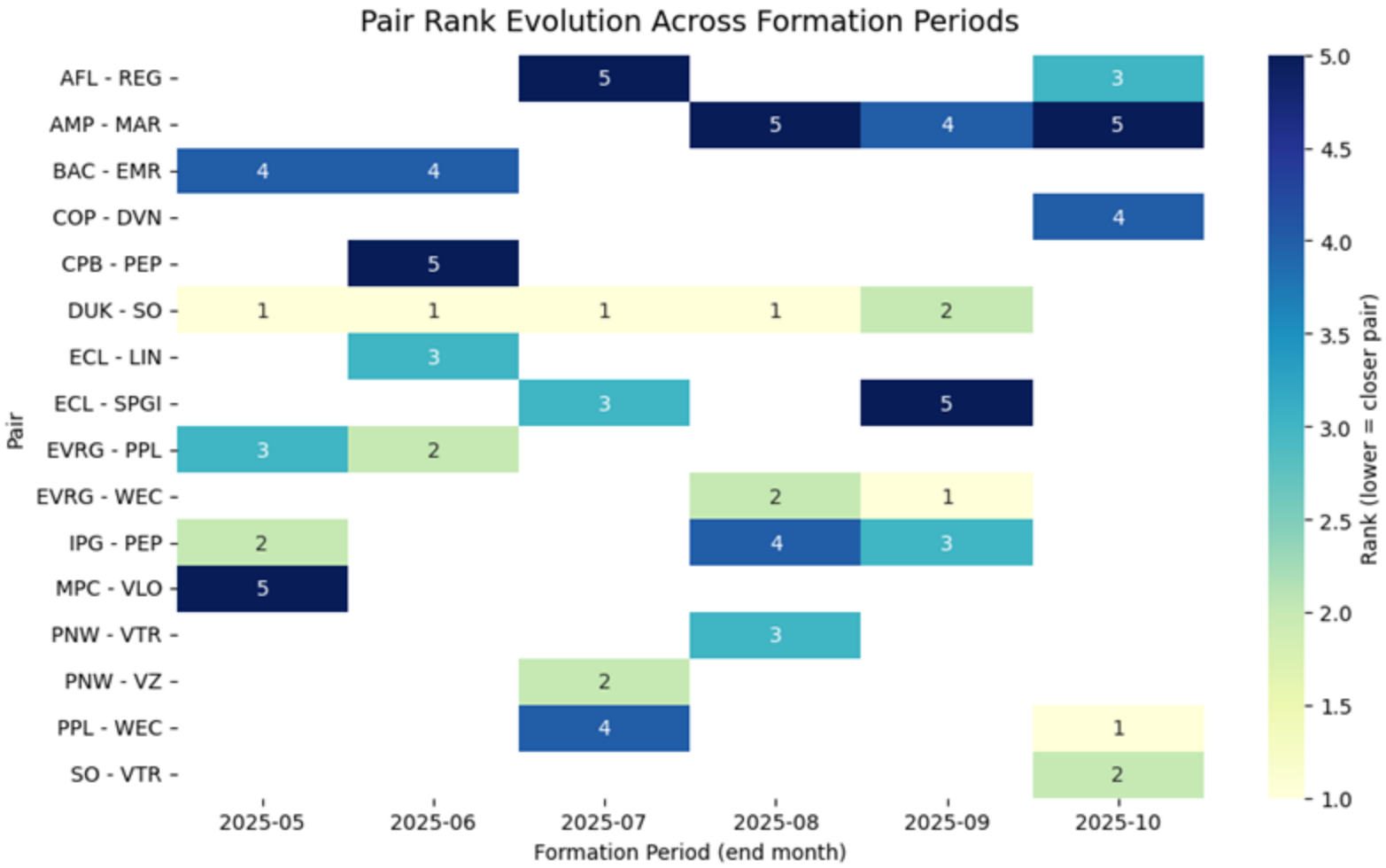




Distance Method

$$\mathrm{ESD}(A,B) = \sum_{t} \left(S_A(t) - S_B(t)\right)^2$$

- $S_A(t)$: the cumulative return of stock A at time t
- $S_B(t)$: the cumulative return of stock B at time t

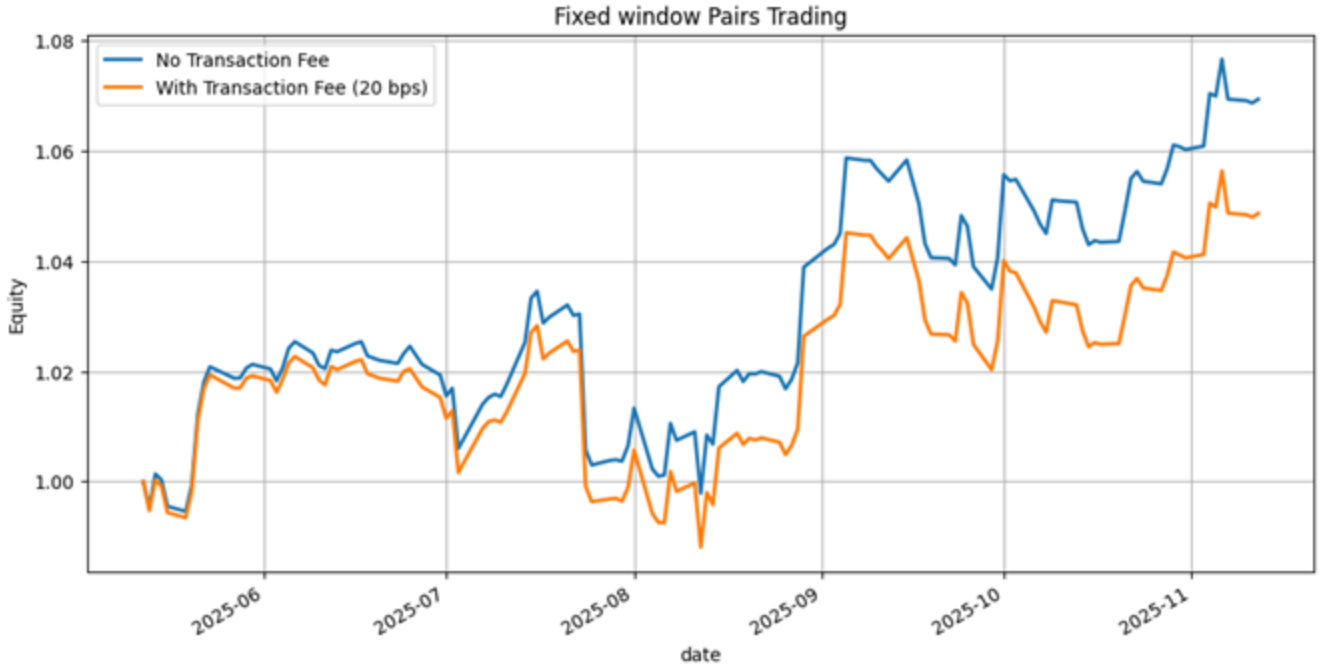


Distance Method

- Fixed Pairs Trading Metric (With transaction fee)
  - ➢ Sharpe: 1.2004
  - ➢ Maximum drawdown: -3.91%
  - ➢ Gross Gain: 0.2364
  - ➢ Gross Loss: -0.1873
  - ➢ P/L Ratio: 1.2624

- Fixed window performs consistently in the 6-month period due to stable long-term parameters.

- Rolling window delivers strong long-term gains, but exhibits frequent drawdowns and is sensitive to rapid market changes.



Cointegration

Engle-Granger 2-step approach

Non-stationary prices ➡ **OLS** ➡ **ADF**

Check log-price drift over time (I(1)) over time, i.e. has unit root

Estimate spread through OLS for each pair(stocks A,B)

$$p_A(t) = \alpha + \beta\, p_B(t) + u_t$$

$$\hat{u}_t = p_A(t) - \hat{\alpha} - \hat{\beta}\, p_B(t)$$

Augmented Dicky Fuller(ADF) test on the spread to check on stationarity

- Transform AR(p) model into ADF regression model

$$y_t = \phi_1 y_{t-1} + \phi_2 y_{t-2} + \cdots + \phi_p y_{t-p} + \varepsilon_t$$

$$\Delta y_t = (\phi_1 y_{t-1} - y_{t-1}) + \phi_2 y_{t-2} + \cdots + \phi_p y_{t-p} + \varepsilon_t$$

Identity steps (Index shifting)

Final ADF regression model

$$\Delta y_t = \gamma y_{t-1} + \psi_1 \Delta y_{t-1} + \psi_2 \Delta y_{t-2} + \epsilon_t$$

Run regression on gamma $\gamma = \phi_1 + \phi_2 + \phi_3 - 1$

Cointegration - Evaluation

Fixed Window

Sharpe (annualized) : 0.059576
Geometric return (ann.): 0.200449
Arithmetic return (ann.): 0.184985
Maximum drawdown (net): -0.053241

10Y

1Y

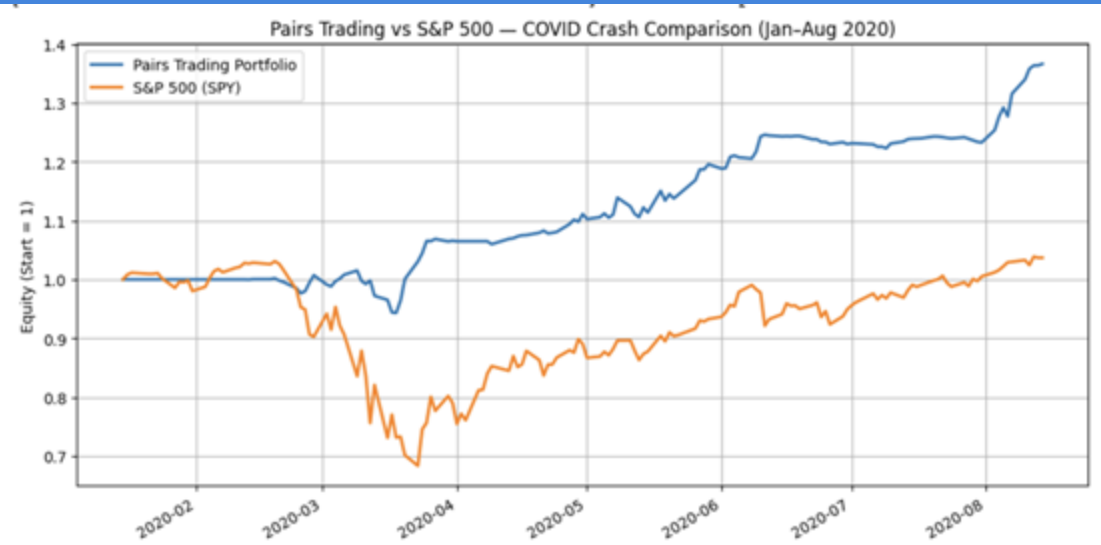
Rolling Window

Sharpe (annualized) : **2.05**
Geometric return (ann.): 0.0959
Arithmetic return (ann.): 0.0995
Maximum drawdown (net): -0.0163

10Y

1Y

Co-integration during Covid-Period Period



Final Values:

	Pairs Portfolio	S&P 500 (SPY)
2020-08-14	1.366458	1.036935

pair	Sharpe	TotalReturn	LastEquity
META-NWSA	2.847167	1.950554	2.950554
EA-SPGI	2.353580	0.517457	1.517457
MOS-PSKY	2.291602	0.570911	1.570911
CDNS-COR	2.005707	0.330276	1.330276
META-RJF	1.919367	0.889749	1.889749
CRM-RJF	1.632646	0.464322	1.464322
COR-META	1.615302	0.278548	1.278548
CRM-MAR	1.568215	0.505006	1.505006
AFL-WELL	1.129404	0.174863	1.174863
EXR-IFF	0.990195	0.118702	1.118702

1.META - NWSA
total return >190%
Sharp ratio: 2.35

Meta: dropped hard in March but recovered sharply with online activity surge.
NWSA: news-media.

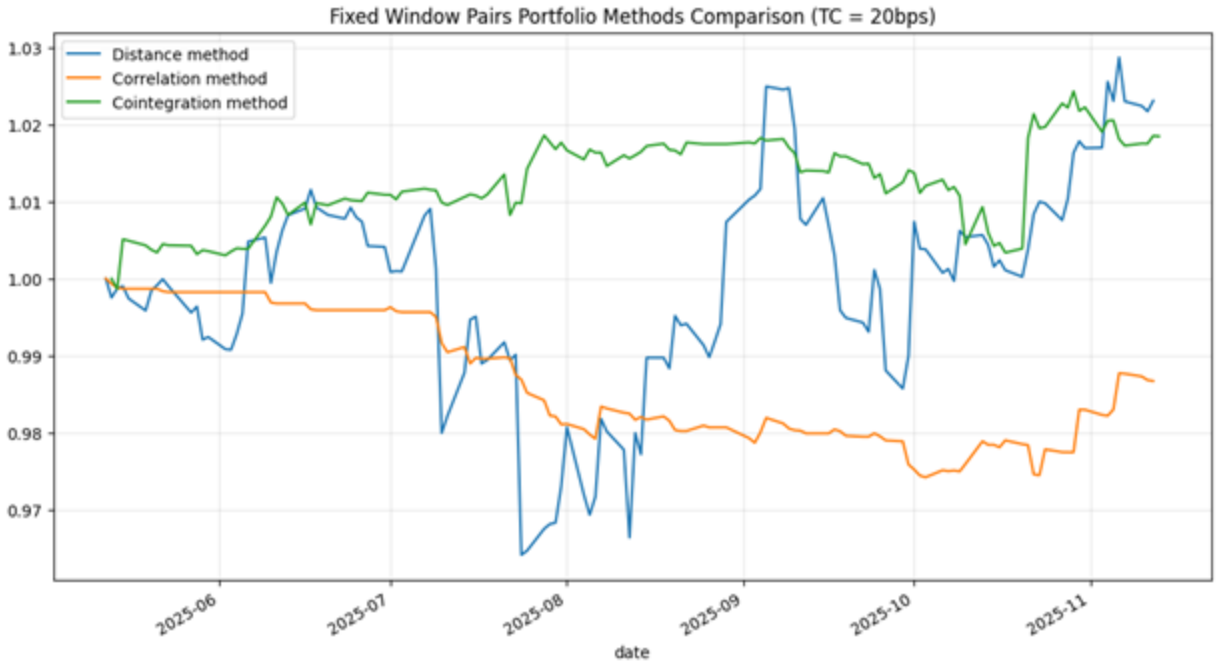
the digital advertising cycle broke, causing short-term dislocations between online ad giants and traditional media companies while facebook recovered sharply to create entry/exit opportunities to trade.

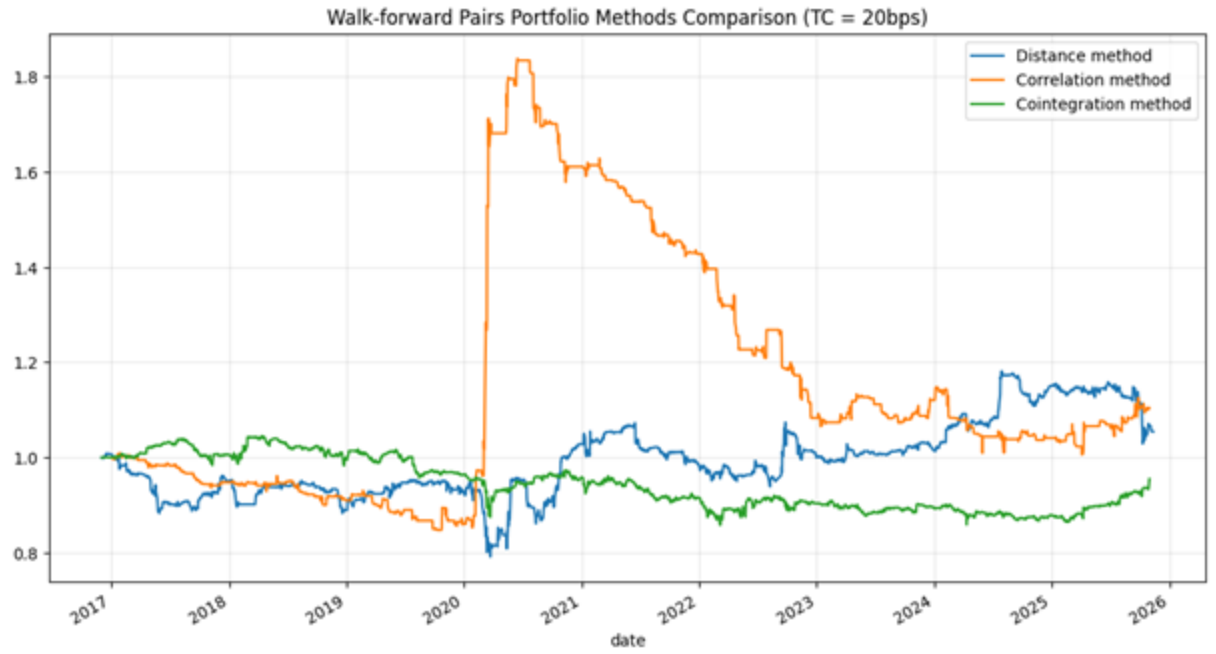
2. MOS - PSKY
Sharpe: 2.29
Return: 57%
Mosaic - commodity fertilizer
PSKY - high growth tech

commodities collapsed and rebounded while tech soared dramatically creating mean reversion opportunities indicating market neutrality.

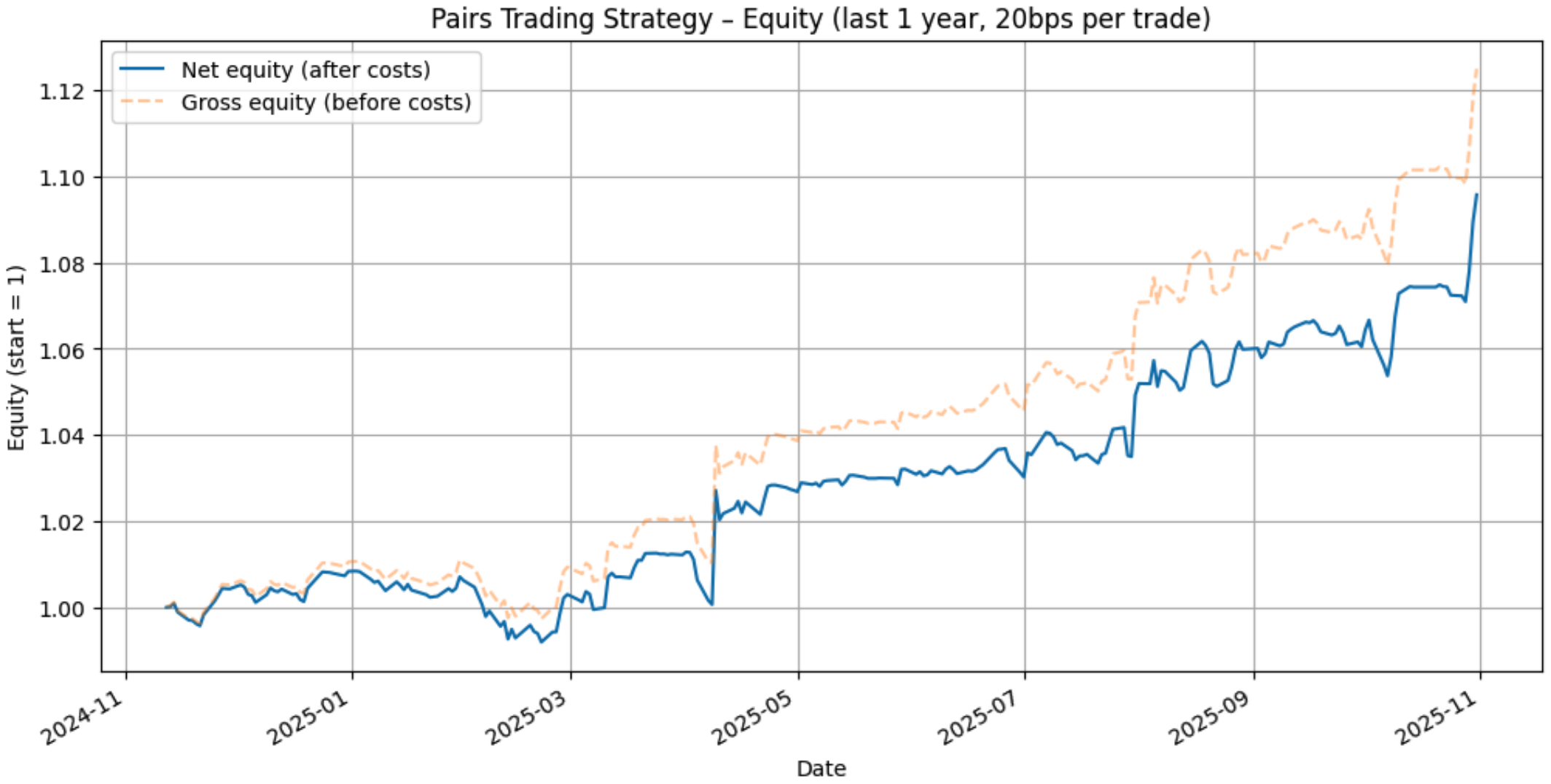
Insight

- Correlation method is unstable and highly sensitive to market shocks.
- Distance method is simple but struggles under structural regime shifts.
- Cointegration method is the most stable and captures true mean reversion





Cointegration (Rolling)



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