

Alpha Decay & the Limits of Discovery

Research Question

Do simple technical signals lose effectiveness after they become widely known?

What This Project Tests

This is **not** about finding alpha. It's about **measuring how alpha dies**.

We are studying:

- The limits of empirical discovery
- The economics of attention
- Researcher selection bias
- How humans mistake noise for opportunity

Level-7 quant work is about understanding why you *cannot win*, not how to win.

Imports and Setup

Available signals:

- : momentum_12_1: 12-month return lagged 1 month (Jegadeesh-Titman style)
- : mean_reversion: Deviation from short-term moving average
- : volatility_breakout: Price breakout beyond volatility-adjusted bands
- : ma_crossover: Short-term MA crossing long-term MA
- : value: Book-to-market ratio (requires fundamental data)

Available discovery proxies:

- : academic: First major academic publication date
- : book: First appearance in widely-read practitioner books
- : blog: Widespread mentions in popular finance/quant blogs
- : conservative: Earliest date among all proxies - most conservative
- : aggressive: Latest date among all proxies - assumes decay starts later

Step 1: Choose Simple Signals

We select 3-5 well-known signals. No fancy ML. If it feels "too basic," we're doing it right.

Selected signals for analysis:

12-1 Momentum

Description: 12-month return lagged 1 month (Jegadeesh-Titman style)
Default params: {'lookback_months': 12, 'skip_months': 1}

Short-Term Mean Reversion

Description: Deviation from short-term moving average
Default params: {'short_window': 5, 'long_window': 20}

Volatility Breakout

Description: Price breakout beyond volatility-adjusted bands
Default params: {'ma_window': 20, 'volatility_window': 20, 'std_multiplier': 2.0}

MA Crossover

Description: Short-term MA crossing long-term MA
Default params: {'short_window': 50, 'long_window': 200}

Step 2: Define Discovery Proxies

This is the hardest and most interesting part. We are not claiming *the exact* discovery moment — only a **reasonable proxy**.

We'll use the conservative proxy (earliest date) for our main analysis.

Using discovery proxy: Conservative (Earliest)
Description: Earliest date among all proxies - most conservative

12-1 Momentum: 1993-06-01
Short-Term Mean Reversion: 1990-01-01
Volatility Breakout: 1980-01-01
MA Crossover: 1970-01-01

Step 3: Load Data

For this demonstration, we'll use a broad market index (SPY) as our test case. In a full analysis, you'd run this across multiple assets or a portfolio.

```
Loading data for ^GSPC from 1970-01-01 to 2025-12-26...
Loaded 14118 price observations
Date range: 1970-01-02 to 2025-12-26
```



Step 4: Compute Signals and Returns

Computing momentum_12_1...

Computed 13824 strategy returns

Date range: 1971-03-01 to 2025-12-24

Computing mean_reversion...

Computed 14098 strategy returns

Date range: 1970-01-29 to 2025-12-24

Computing volatility_breakout...

Computed 14117 strategy returns

Date range: 1970-01-02 to 2025-12-24

Computing ma_crossover...

Computed 13918 strategy returns

Date range: 1970-10-14 to 2025-12-24

Step 5: Measure Performance Pre- vs Post-Discovery

For each signal:

- Measure performance **before** discovery proxy
- Measure performance **after** discovery

Metrics: Sharpe, hit rate, drawdown, stability

=====

Signal: 12-1 Momentum

=====

Pre-Discovery Period (1971-03-01 to 1993-05-28):

Sharpe Ratio: -0.053

Hit Rate: 50.8%

Max Drawdown: -60.8%

Mean Return: -0.0000

Observations: 5624

Post-Discovery Period (1993-06-01 to 2025-12-24):

Sharpe Ratio: 0.116

Hit Rate: 50.9%

Max Drawdown: -61.2%

Mean Return: 0.0001

Observations: 8200

Decay Statistics:

Sharpe Decay: 0.169 (319.1% change)

Hit Rate Decay: 0.1% (0.2% change)

Return Decay: 0.0001 (366.5% change)

Statistical Significance:

Test: Mann-Whitney U (one-sided)

P-value: 0.6161

Significant at 5%: False

=====

Signal: Short-Term Mean Reversion

=====

Pre-Discovery Period (1970-01-29 to 1989-12-29):

Sharpe Ratio: -1.214

Hit Rate: 46.6%

Max Drawdown: -98.9%

Mean Return: -0.0007

Observations: 5035

Post-Discovery Period (1990-01-02 to 2025-12-24):

Sharpe Ratio: 0.343

Hit Rate: 51.3%

Max Drawdown: -70.9%

Mean Return: 0.0002

Observations: 9063

Decay Statistics:

Sharpe Decay: 1.557 (128.2% change)

Hit Rate Decay: 4.7% (10.1% change)

Return Decay: 0.0010 (133.0% change)

Statistical Significance:

Test: Mann-Whitney U (one-sided)

P-value: 1.0000

Significant at 5%: False

```
=====
Signal: Volatility Breakout
=====
```

Pre-Discovery Period (1970-01-02 to 1979-12-31):

Sharpe Ratio: 0.026
 Hit Rate: 49.9%
 Max Drawdown: -46.7%
 Mean Return: 0.0000
 Observations: 2526

Post-Discovery Period (1980-01-02 to 2025-12-24):

Sharpe Ratio: -0.521
 Hit Rate: 46.7%
 Max Drawdown: -99.4%
 Mean Return: -0.0004
 Observations: 11591

Decay Statistics:

Sharpe Decay: -0.547 (-2079.1% change)
 Hit Rate Decay: -3.2% (-6.4% change)
 Return Decay: -0.0004 (-2695.3% change)

Statistical Significance:

Test: Mann-Whitney U (one-sided)
 P-value: 0.0004
 Significant at 5%: True

```
=====
Signal: MA Crossover
=====
```

Insufficient data: 0 pre, 13918 post

```
=====
SUMMARY TABLE
=====
```

	signal	discovery_date	pre_sharpe	post_sharpe	sharpe_decay	pre_hit_rate	post_hit_rate	hit_rate_decay	pre_return	post_return	return_decay	pvalue	significant
0.508659	12-1 Momentum	1993-06-01	-0.052839	0.115764	0.168603	0.507824	0.000835	-0.000032	0.000085	0.000117	0.616106	False	
0.512634	Short-Term Mean Reversion	1990-01-01	-1.214398	0.342731	1.557129	0.465740	0.046894	-0.000745	0.000246	0.000990	1.000000	False	
0.467432	Volatility Breakout	1980-01-01	0.026307	-0.520643	-0.546950	0.499208	-0.031777	0.000014	-0.000369	-0.000383	0.000409	True	

Step 6: Visualize Decay

Step 7: Control for Alternative Explanations

Test whether decay correlates with:

- Market efficiency (liquidity, volume)
- Volatility regime
- Transaction costs
- Crowding proxies

We're not just saying "it died" — we're asking **why**.

Analyzing 12-1 Momentum with control variables...

=====

Decay by Volatility Regime:

REGIME_1:

```
Pre mean return: 0.0002
Post mean return: 0.0002
Decay: -0.0001 (-29.0% change)
```

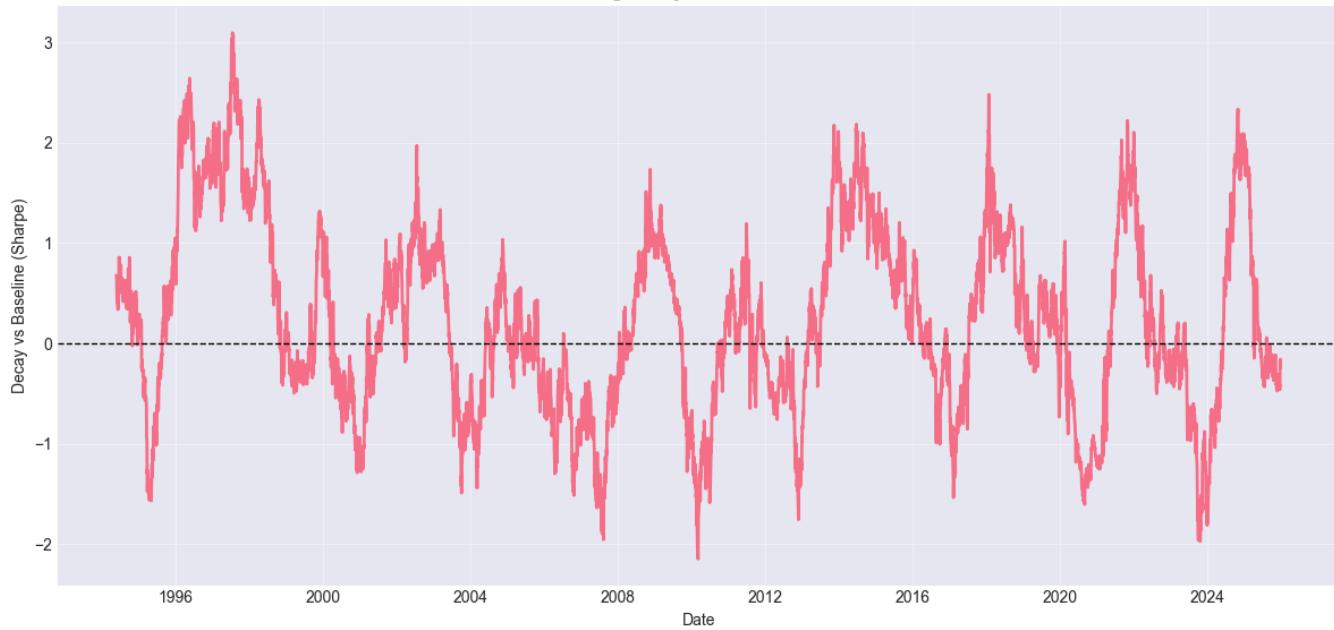
REGIME_2:

```
Pre mean return: -0.0005
Post mean return: 0.0001
Decay: 0.0006 (121.0% change)
```

=====

Computing time-varying decay (rolling window analysis)...

Rolling Decay: 12-1 Momentum



Step 8: Conclusions and Interpretation

What the Results Mean

This project tests **the research process itself**, not just market efficiency.

Key questions to address:

1. Do signals show measurable decay after discovery?
2. Is decay consistent across different signals?
3. Can decay be explained by structural factors (volatility, liquidity, costs)?
4. What does this tell us about the limits of empirical discovery?

Expected Conclusion

"Our results suggest that the discovery of simple signals is constrained not by creativity but by structural limits imposed by competition, liquidity, and cost. The apparent abundance of alpha in retrospective studies likely reflects selection bias rather than persistent inefficiency."

What Makes This Level-7

- We explicitly acknowledge data-snooping, survivorship bias, and hindsight bias
- We are not claiming tradability
- We study the research process itself
- Negative or boring conclusions are **the correct outcome**
- This is about understanding why you *cannot* win, not how to win

FINAL SUMMARY

Average Sharpe Ratio Decay: 0.393

Average Hit Rate Decay: 0.5%

Signals with statistically significant decay: 1 / 3

Interpretation:

△ Signals do not show clear decay pattern.

✓ 1 signal(s) show statistically significant decay.

This analysis tests the limits of empirical discovery and highlights potential selection bias in retrospective studies.