

Systematic Alpha - Spring '26 Research Showcase

Event-Driven Implied Volatility Mispricing

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Motivation and Research Foundation

Event Driven Volatility

Options markets misprice uncertainty around scheduled events.

Implied volatility (IV) is the market's consensus forecast of future uncertainty, which are embedded in option prices. Around scheduled events like earnings announcements, Fed decisions, and macro data releases, IV follows a predictable lifecycle: it rises in the days before the event as traders buy options for protection, peaks at the announcement, then collapses sharply as uncertainty resolves. This pattern, known as **IV crush**, a concept widely used.

The central question for our research, is whether this lifecycle is **rationally priced**. If IV rises more than it should before an event, a **long straddle** entered early profits purely from **IV appreciation** without the underlying asset needing to move at all. If IV is systematically overpriced heading into certain events, a **short straddle** profits from the crush. Critically, neither trade requires a **directional view** on the underlying. We are not predicting whether Apple beats earnings or whether the Fed hikes. We are betting on the **behavior of uncertainty itself**.

Research Question: How does implied volatility behave around scheduled market events, and can that behavior be systematically exploited through event-driven straddle strategies?

IV Builds Before Events, Then Collapses

Pre-announcement run up creates a systematic entry window before IV crush

T-3: Enter Straddle

T-2: IV Rises

T-1: IV Peaks

T+0: Earnings

T+1: IV Crushes

Motivation and Research Foundation

The Straddle as a Volatility Instrument

An ATM Straddle isolates the volatility bet, removing directional exposure

An **At-The-Money (ATM) straddle** is the simultaneous purchase of a **call and a put** on the same underlying, at the same strike price, with the same expiry. Direction is irrelevant, only **magnitude matters**. In our strategy we exit before expiry: if IV rises between entry and exit even with no stock movement, the straddle appreciates and we profit from the **IV run-up alone**.

Our framework draws directly from **Gao, Xing & Zhang (2018)**, published in the *Journal of Financial and Quantitative Analysis*, which documents a systematic **pre-announcement IV drift** in earnings options.

We replicate their option selection filters and extend the framework across four event types: **earnings announcements** across 541 S&P 500 constituents from 2016-2025, **FOMC rate decisions**, **CPI and unemployment releases**, and **geopolitical shocks**, all tested on 15 liquid sector ETFs.

The Straddle Payoff

Direction is irrelevant, only magnitude matters.

Assume AAPL is trading at \$200 3 days before its earnings date. Buying the \$200 call and put on Apple for \$7.50 total creates a V-shaped payoff. The position loses up to \$7.50 if Apple stays between \$192.50 and \$207.50, but profits in either direction beyond those break-even points, a miss sending the stock to \$180 is just as profitable as a beat sending it to \$220.

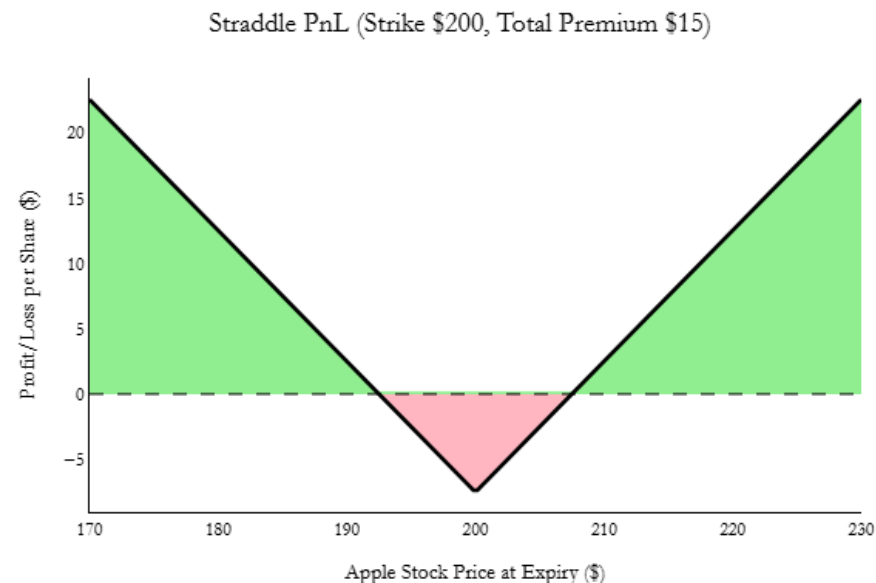


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Analysis Framework and Construction

The Filter Set and Findings from Gao, Zing & Zhang (2018)

5 Option selection filters to ensure straddles are liquid, and ATM contracts

Gao, Xing & Zhang's paper documents that the options market systematically **underprices earnings uncertainty** in the three days before announcements (earnings call).

A long ATM straddle entered at T-3 and exited on announcement day earns **statistically significant positive returns** even after controlling for Fama-French risk factors and transaction costs.

The effect is strongest for stocks with high analyst disagreement and elevated pre-announcement trading activity, and weakens post-2010 as the strategy became more widely known.

Note: We skipped **F3 (Minimum Open Interest Rate)** and **F4 (Maximum bid-ask spread relative to mid price)** as Polygon's historical data does not provide open interest or bid ask spread at daily level for expired contracts. To make up for this we used **VWAP (Volume Weighted Average Price)** as a proxy for liquidity where if both legs had a tradeable VWAP on that day, the contract was liquid enough to have actually traded.

Options Selection Filters Summary

Adopted directly from Gao Zing & Zhang (2018) across all 4 events.

Filter	Rule	Rationale
F1: Minimum Option Price	$\geq \$0.125$	Eliminates illiquid deep OTM contracts at minimum risk
F2: Min Stock Price	$\geq \$5$	Removes penny stocks with unreliable options markets
F5: DTE Window	10-60 Days	Captures IV event window, and avoids instability in gamma near expiry
F6: Delta Filter	$[0.375, 0.675]$ $ \Delta \in [0.375, 0.625]$	Ensures genuinely ATM options (note: requires IV computation first)
F7: Moneyness	0.90-1.10	Secondary ATM check, where the strike is within 10% of spot

Analysis Framework and Construction

Event Universe

5 scheduled event types, 1 systematic framework

Our research extends the Gao et al. framework across four other event types, each with its own pipeline sourced from the **Polygon.io** historical options API with **100% VWAP coverage** across all observations.

Event Types	Universe	Period	Events	Observations
Earnings	541 S&P Stocks (Point-in-time)	2016-2025	1,522	63,021
FOMC	15 ETFs	2016-2025	49 Meetings	4900
CPI & Unemployment	15 ETFs	2016-2025	245	
Geopolitical	15 ETFs	2018-2025	183	15,257
Product Launches	Mag 7	2016-2025	120	499

Entry/Exit Framework

15 valid entry/exit combinations per event, tested across all pipelines

Entry and exit are expressed as offsets relative to the event date. For earnings, FOMC, and macro data releases, **entry spans T-3 to T+0** and **exit spans T+0 to T+3**, producing 15 valid combinations per event.

For geopolitical shocks, entry is strictly post-event at **T+1 to T+3** since events are unknowable in advance, with exit from **T+2 to T+7**.

ETF Universe

Used to assess the straddle's effectiveness on Macro events

ETF Universe: SPY, QQQ, XLK, XLF, XLE, XLI, XLV, XLB, XLP, GLD, TLT, IWM, EEM, XOP, ITA

15 liquid sector ETFs spanning equities, fixed income, commodities, and international markets, capturing how macro uncertainty transmits across asset classes while avoiding the idiosyncratic noise of individual stocks.

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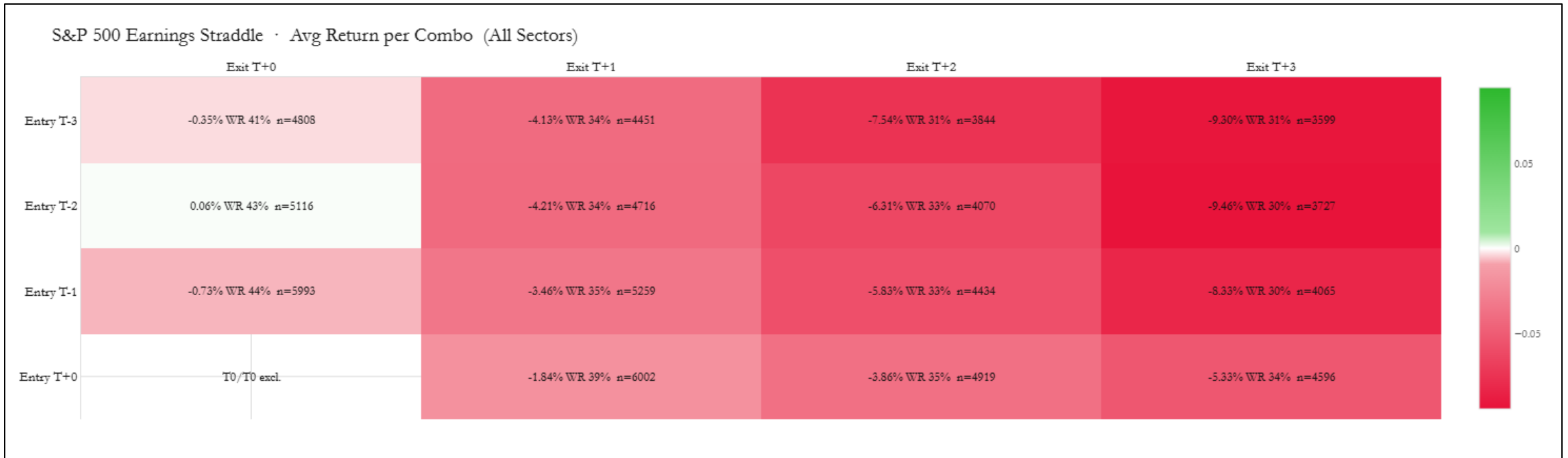
Results and Findings

Part I: Earnings



Results and Findings; Part I. Earnings

The S&P 500 aggregate shows that the straddle - pre-announcement longs have become saturated in the market, as at best they now earn just 0.06% (Entry T-2, Exit T+0) with a 43% win rate. Post-announcement IV crush remains stronger, with returns ranging from -1.84% to -9.30% across later exit windows, but the modest index-level returns raise the question: **does disaggregating by sector reveal pockets where the edge persists more robustly, and can we instead profit by shorting straddles into the post-announcement collapse?**



Results and Findings; Part I. Earnings

Sector Dispersion shows Structural Divergence

Heterogenous performance across sectors

Sector-level disaggregation reveals **meaningful heterogeneity** beneath the compressed index returns. **Real Estate, Utilities, and Communication Services** show the strongest pre-announcement edge, with best combos returning **6.11%, 4.39%, and 1.76%** respectively at win rates above **47%**. These sectors retain **exploitable long opportunities** entering 2-3 days before earnings and exiting at announcement.

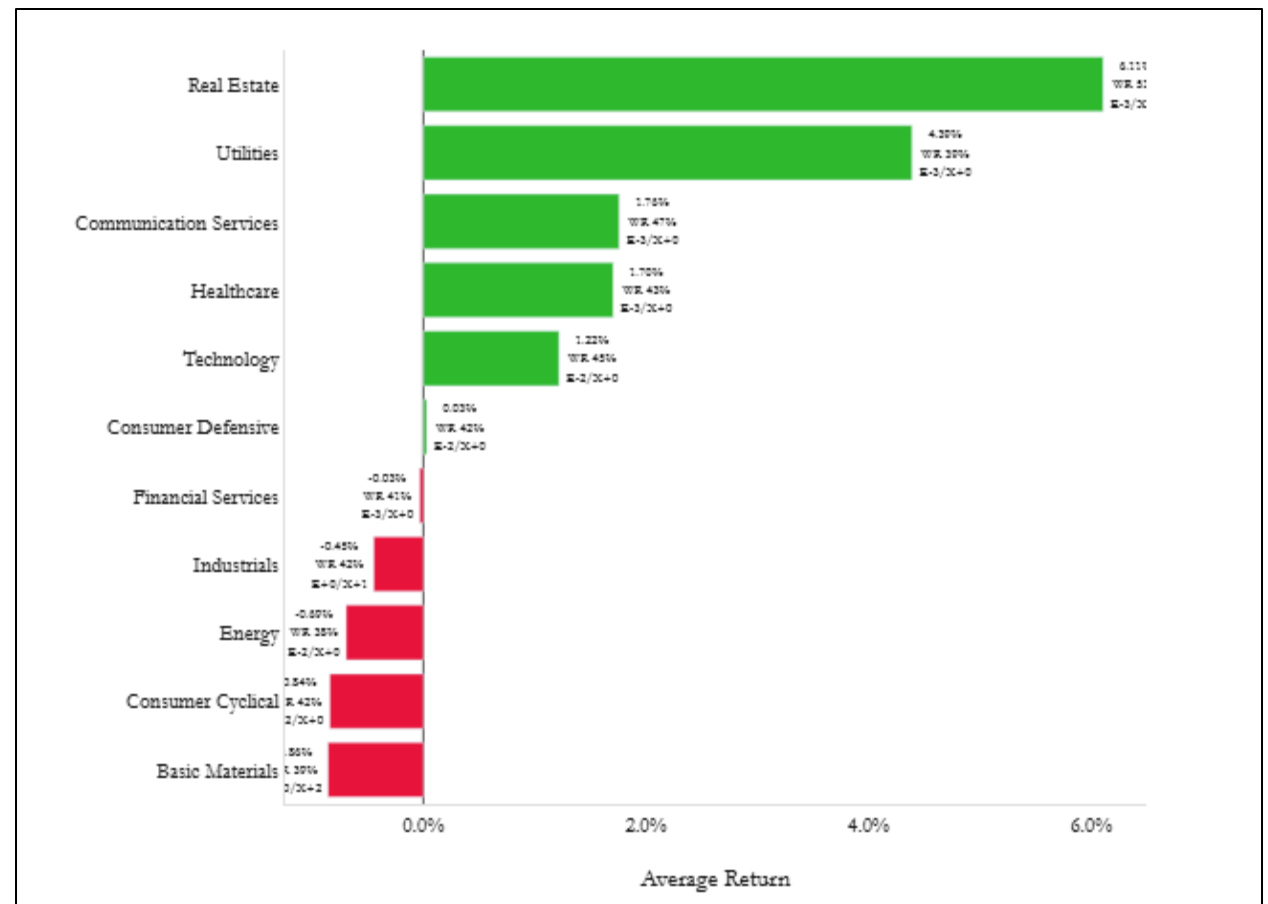
Conversely, **Basic Materials, Consumer Cyclical, Energy, Industrials, and Financial Services** all exhibit **negative best combos** ranging from **-0.03% to -0.86%**, suggesting the pre-announcement edge has **inverted entirely** in these sectors.

Technology and Healthcare sit in the middle at **1.22% and 1.70%**, structurally positive but materially weaker than the top performers.

The cross-sector variation confirms that a **blanket long approach no longer works** - strategy implementation requires **sector-specific entry/exit specifications and directional assignments**.

Section Dispersion in Earnings Straddle Returns

Best performing entry/exit combination per sector (min. 50 observations)



Results and Findings; Part I. Earnings

Technology Sector Long/Short Strategy

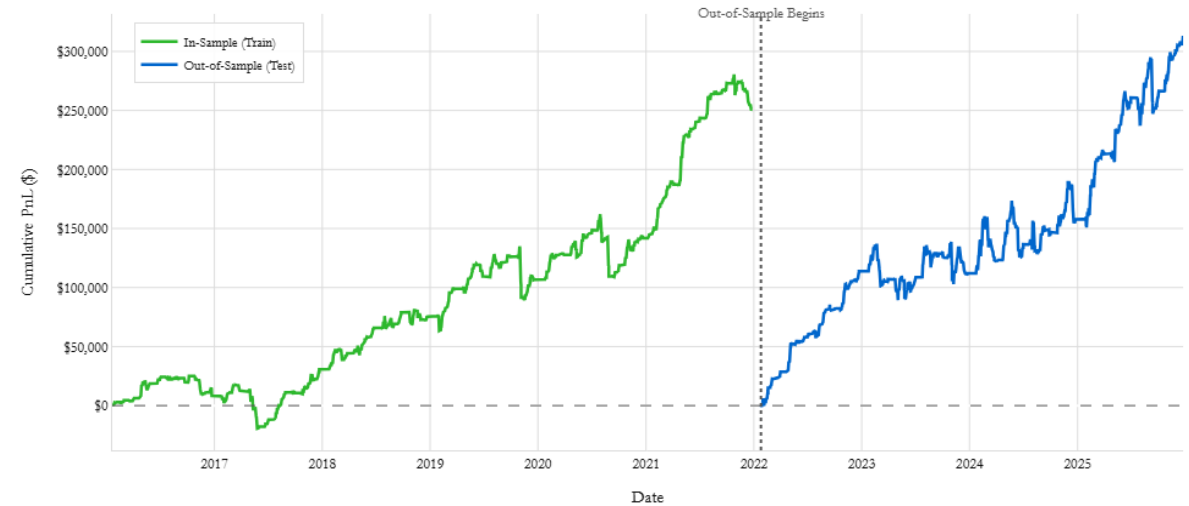
Sector-level signal identification across all Technology constituents

The strategy identifies profitable entry/exit combinations at the **sector level**, not ticker-by-ticker, filtering on **40%+ win rate** thresholds for both long and short signals. Using 2016-2021 as a training period, we aggregate all Technology sector trades by entry/exit offset and flag combinations where average returns are positive (for longs) or negative (for shorts).

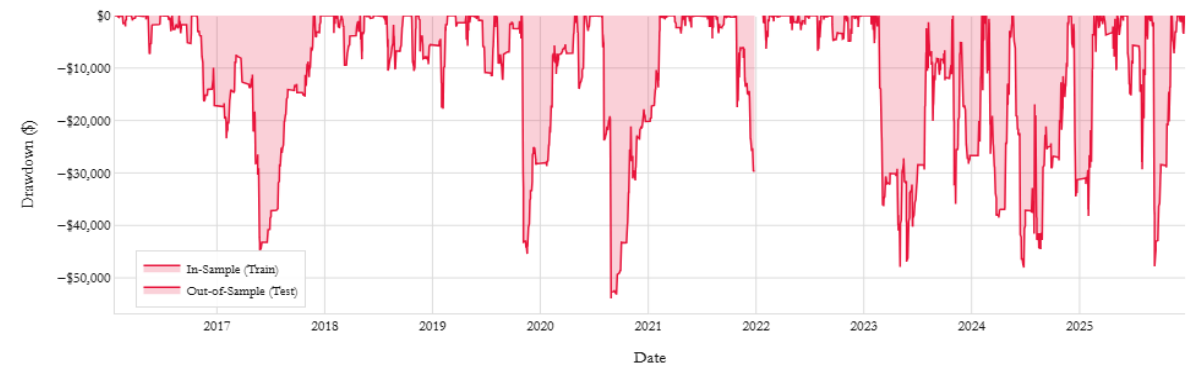
These sector-level signals are then applied to **all tickers** in the Technology sector during the 2022-2025 test period. Long signals capture pre-announcement IV underpricing, while short signals exploit post-announcement IV crush. The approach assumes transaction costs are negligible in the current implementation but can be incorporated by deducting a fixed percentage from returns. All trades are equal-weighted at \$1,000 per straddle, with performance evaluated on a \$10,000 portfolio basis.

	Avg. Return	Sharpe	Win Rate
In Sample	4.45 %	1.46	64.0%
Out of Sample	3.62 %	2.43	63.1%

Technology Sector Long/Short Strategy — Cumulative PnL



Drawdown Over Time



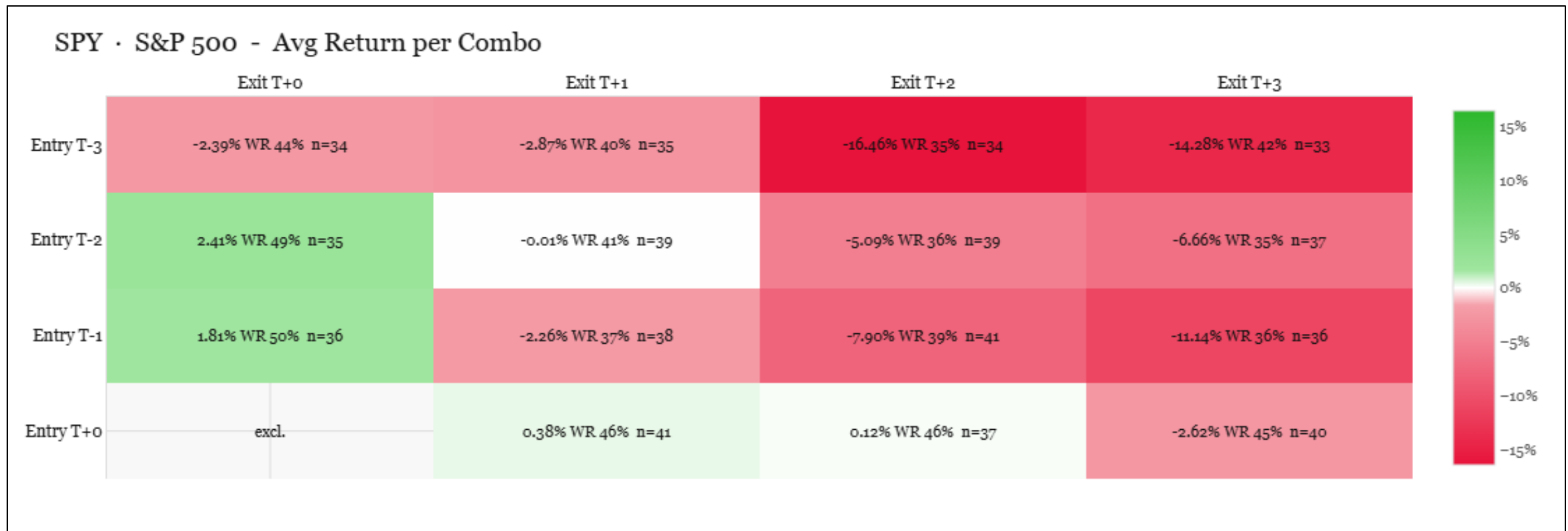
Results and Findings

Part II: Macro Events



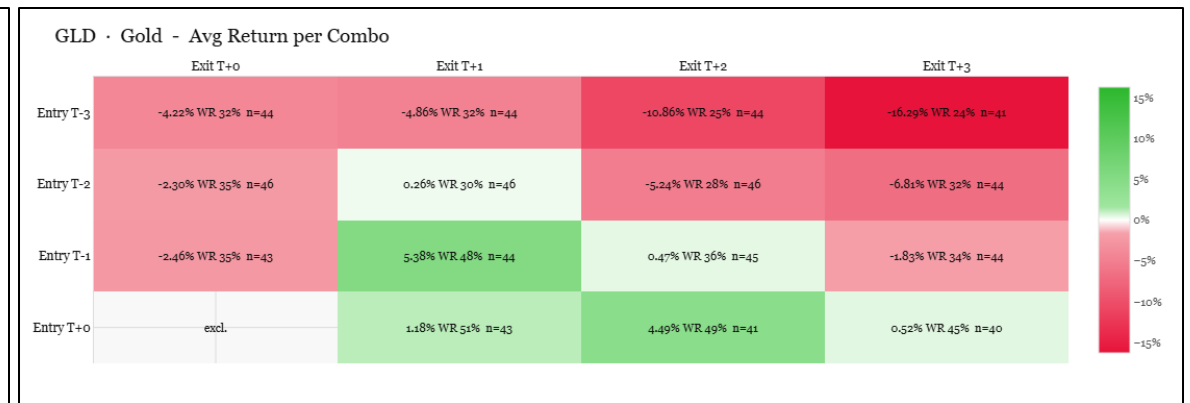
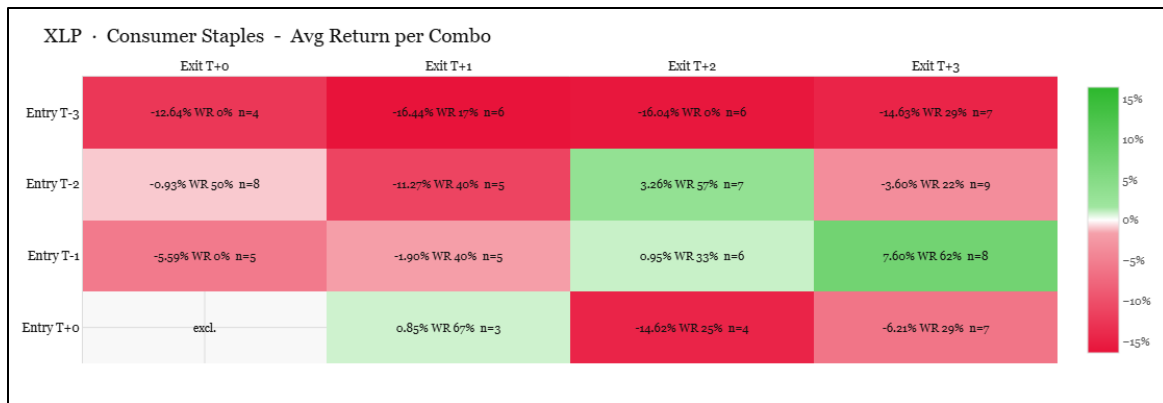
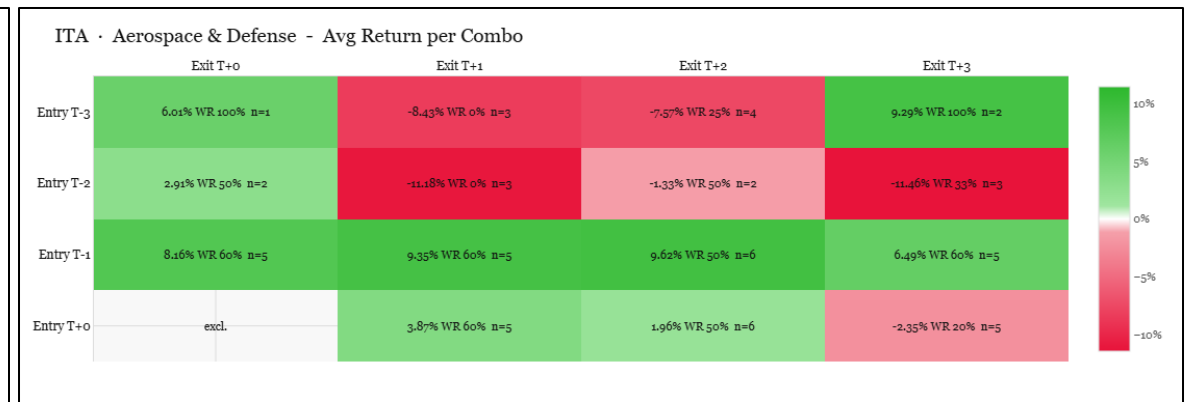
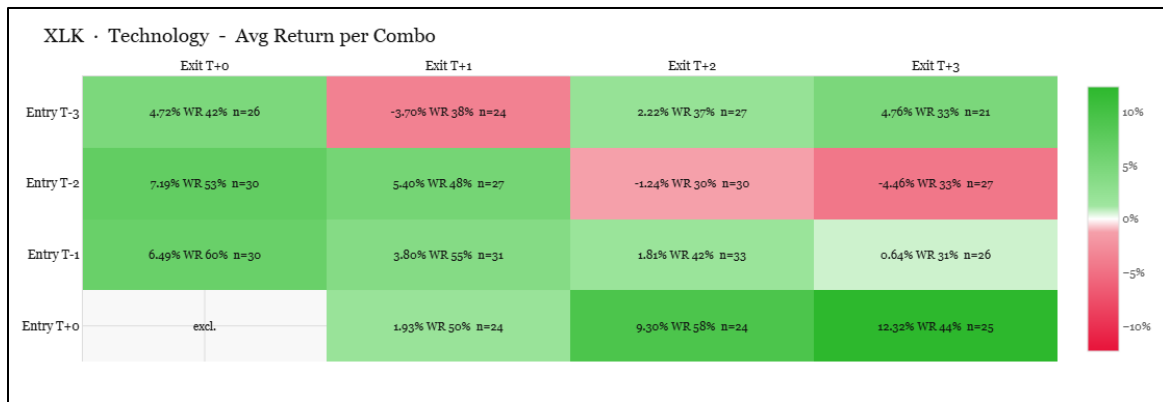
Results and Findings; Part II. Macro Events

The S&P 500 aggregate shows that the implied volatility is **priced efficiently** close to the FOMC date (T-1 to T+1) but experiences a sharp volatility crush 2 days after the FOMC date (FOMC events are on Tuesday/Wednesday). This is due to options traders acting on their options by choosing to sell their positions due to theta decaying exponentially near expiry. This decrease in option value causes other traders to sell/close their positions, creating a **bearish feedback loop**.



Results and Findings; Part II. Macro Events

Sector indices' performance based on FOMC dates reveals a general strategy for going **long volatility on outperforming sectors** while **shorting volatility on underperforming sectors**. Although certain sectors (technology and defense) appeared to have positive returns for certain holding periods, the lack of trades and **skewed returns** resulted in a longer list of long signals than short signals.



Results and Findings; Part II. Macro Events

Training Long and Short Signals

Sector-based signals with varying holding periods

The train split (2020-2024) resulted in **2 long signals** and **33 short signals** with **41 FOMC dates**, **1,179 trades**, a **0.14 Sharpe**, a **60.7%-win rate**, and a **2.01% ROI**.

The difference in the number of long signals and short signals can be explained by 2 factors: a **rise of retail investors** purchasing options and an increase in index **sensitivity from macro events**. These 2 factors **increase option pricing**, further **increasing the implied move** of a sector and yielding an opportunity to **short volatility**.

Gold is the only long sector due to the majority of **"value"** industries (consumer staples/energy) **rotating into "growth"** as companies begin trading at **multiples of their EV** driven by investor expectations. Gold does not experience this rotation and instead has **2 long signals** and **7 short signals** due to how gold's price can be **pushed in opposing directions** regardless of the FOMC decision.

The short signals consisted of **broad-market indices** (SPY, QQQ, IWM) as broad-market indices experienced an increase in sensitivity from macro events **following Covid**.

Training Period (2020–2024) · Avg Strategy Return per Signal



Results and Findings; Part II. Macro Events

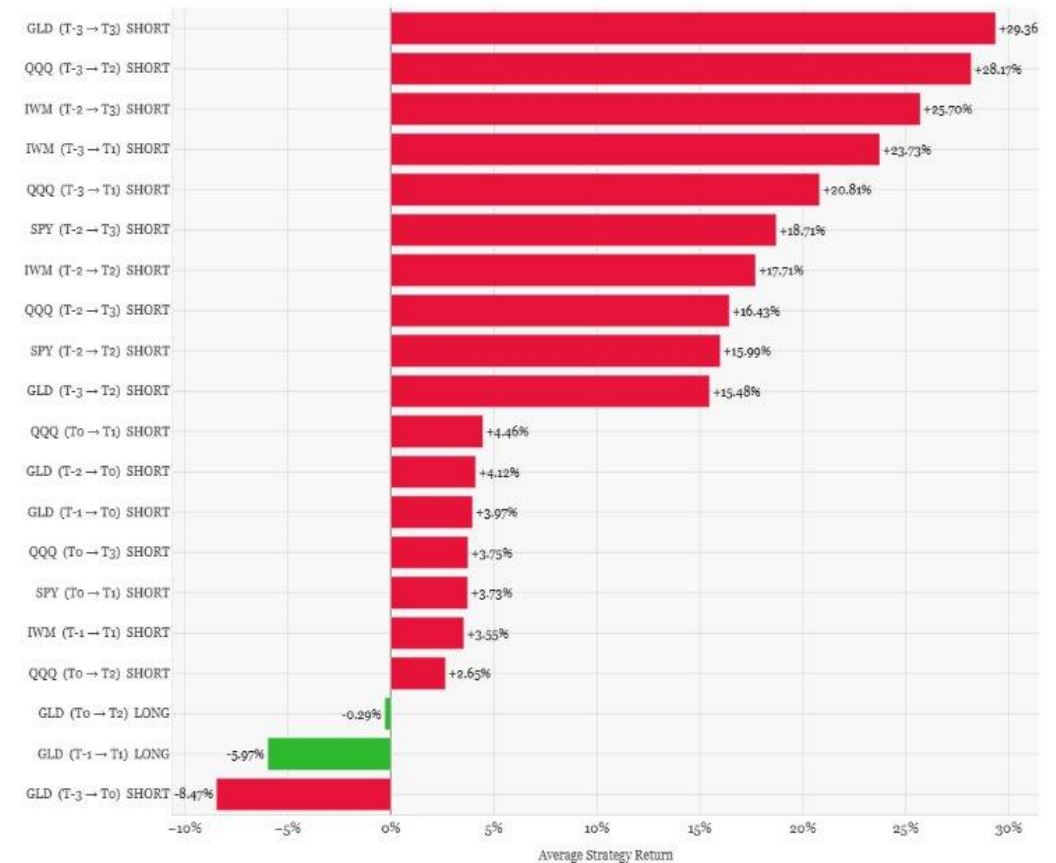
Testing Long and Short Signals

Sector-based signals with varying holding periods

The test split (2025) resulted in **8 FOMC dates**, **263 trades**, a **3.21 Sharpe ratio**, a **74.1%-win rate**, and a **10.81% ROI**.

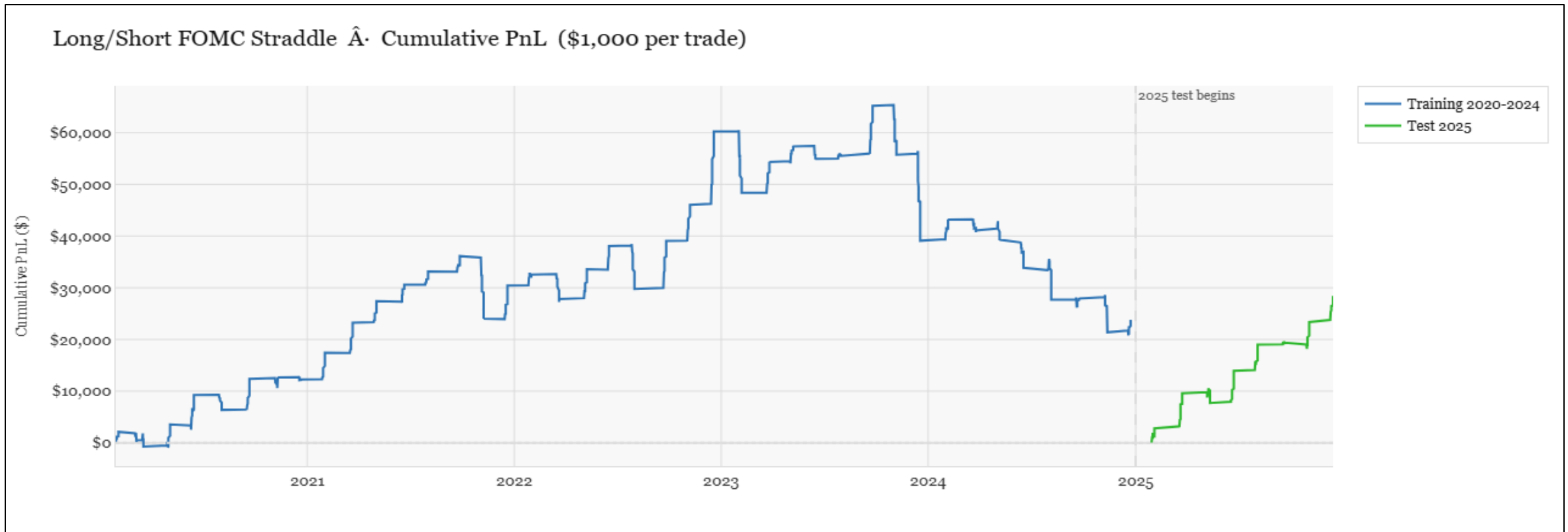
The short positions **outperformed** due to an **increase in implied volatility** for 2025 stemming from tariffs, foreign policy, and advancements in AI. The **long positions underperformed** as options were priced **higher than their efficient level**.

Testing Period (2025) · Avg Strategy Return per Signal



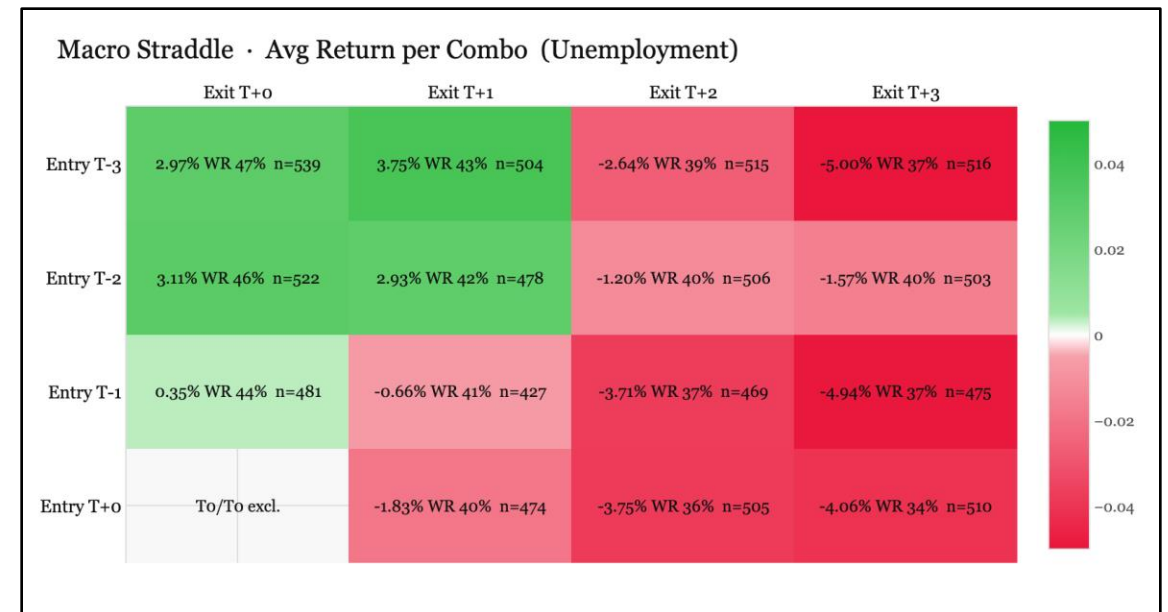
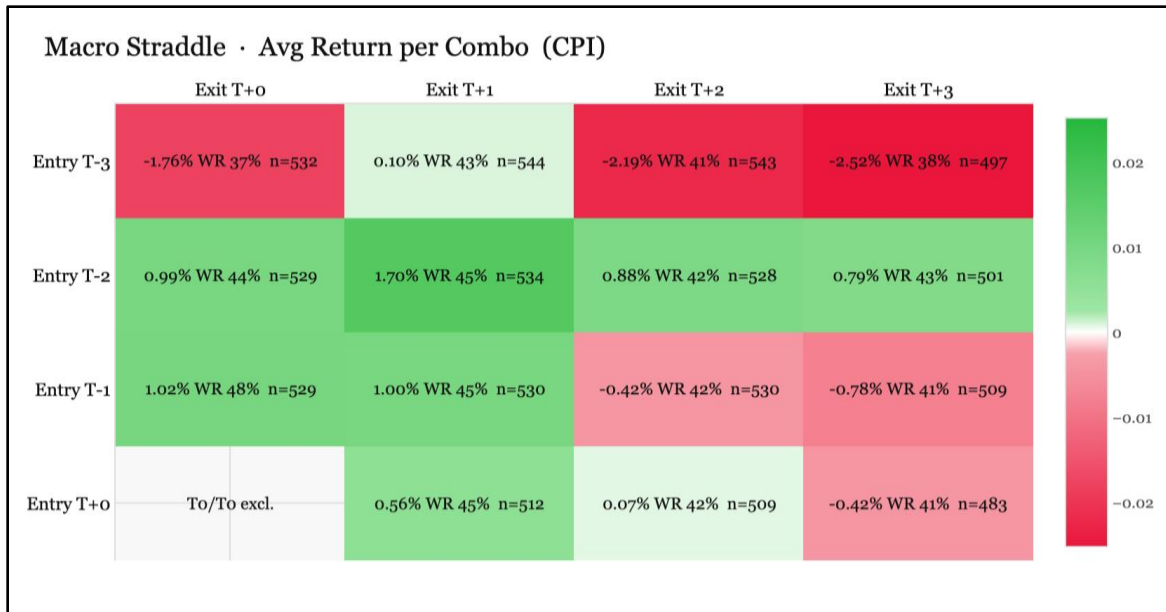
Results and Findings; Part II. Macro Events

The results are biased due to the short testing period, as the data provider, at the time, did not have access to data prior to 2020. This limitation resulted in either a **shorter testing period** or a **shorter training period**. Nevertheless, the strategy provides an explanation for **price efficiency in large market indices** but at times **may overprice volatility**; this overpricing can be attributed to **loss aversion**; investors are **hedging against volatility by buying straddles**.



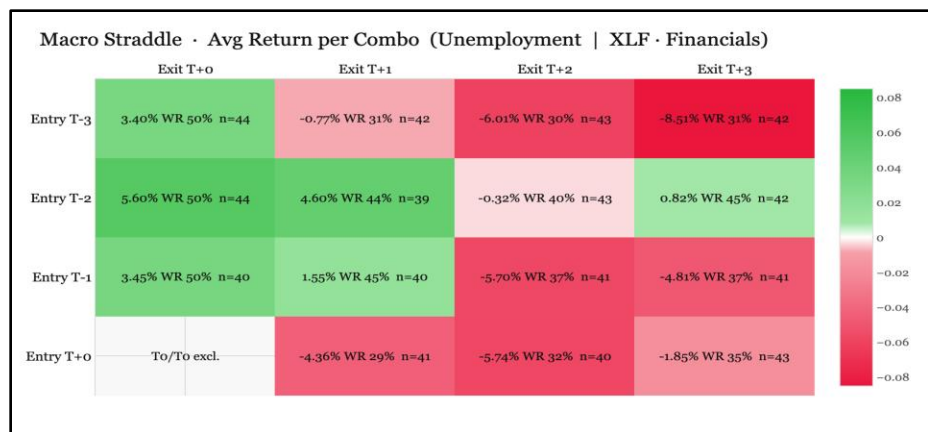
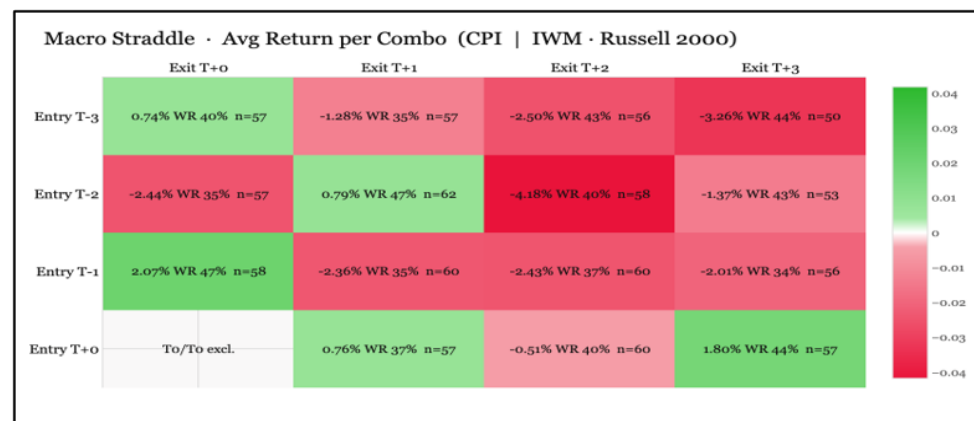
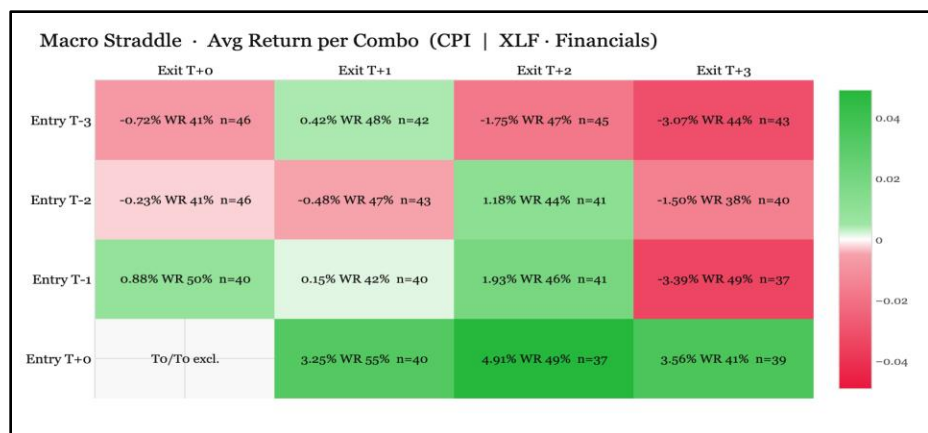
Results and Findings; Part II. Macro Events (CPI & Unemployment)

Across all 15 ETFs, CPI straddles offer no consistent edge. T-3 entries are almost always negative, and while T-2 and T-1 entries with earlier exits show slight improvement, win rates stay below 50% across every configuration. No entry and exit combination reliably pays off. Unemployment shows a cleaner, more predictable pattern: early entry and early exit is clearly most profitable, with returns turning strongly negative the longer positions are held.



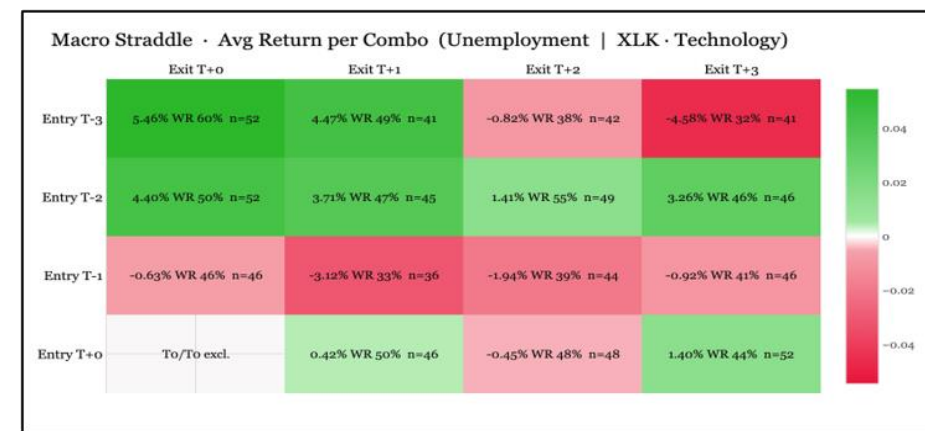
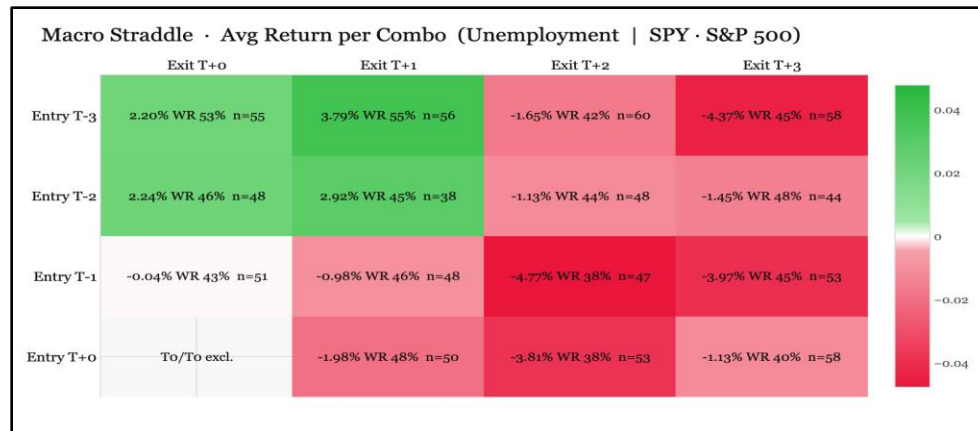
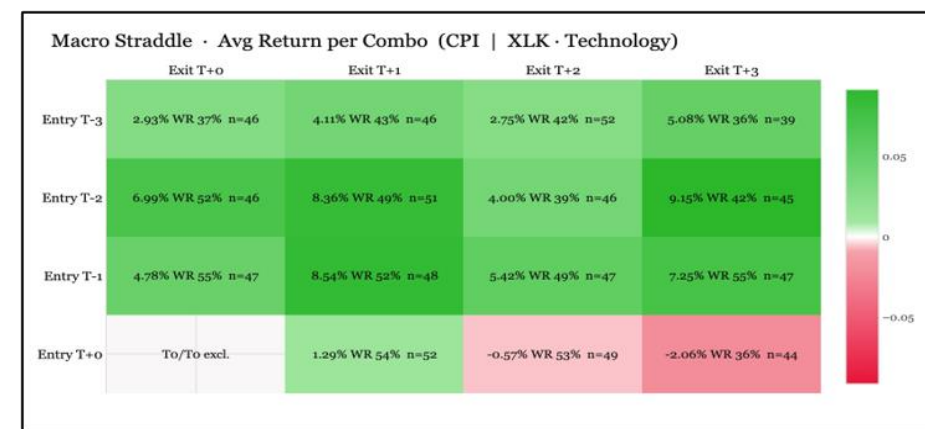
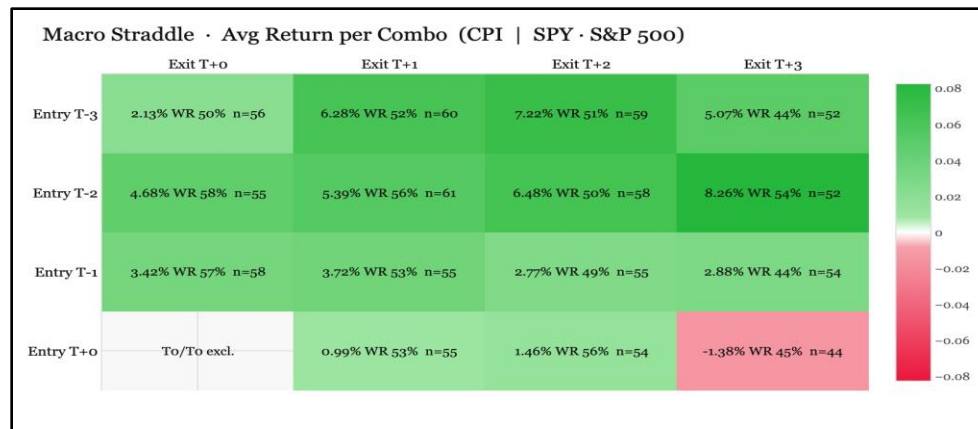
Results and Findings; Part II. Macro Events (CPI & Unemployment)

For Financials, CPI creates persistent volatility that keeps building after the release. Entering on announcement day and holding is strongly profitable. Straddles are overpriced at T-3 but underpriced by T+0. For Unemployment, straddles are profitable when entered early and exited around the announcement, but the window closes by T+1 for most entries and anything beyond that turns negative. CPI · Russell 2000 has no consistent pattern. Unemployment · Russell 2000 straddles are significantly underpriced 2 days before but must be exited by T+1. Entering late and holding long produces the worst outcomes.



Results and Findings; Part II. Macro Events (CPI & Unemployment)

CPI · S&P 500 SPY straddles are broadly and persistently underpriced before CPI releases. The market systematically underestimates how much the S&P 500 moves on inflation data. Unemployment · S&P 500 Straddles are underpriced 2 to 3 days before but volatility collapses fast. Exit timing is critical, holding too long makes straddles sharply overpriced. For Technology, CPI straddles are underpriced almost everywhere. Unemployment is noisier: straddles are underpriced at T-2 and T-3 but the mispricing corrects by T-1, with volatility decaying more slowly than other sectors after the release.



Results and Findings

Part III: Geopolitical



Results and Findings; Part III. Geopolitical

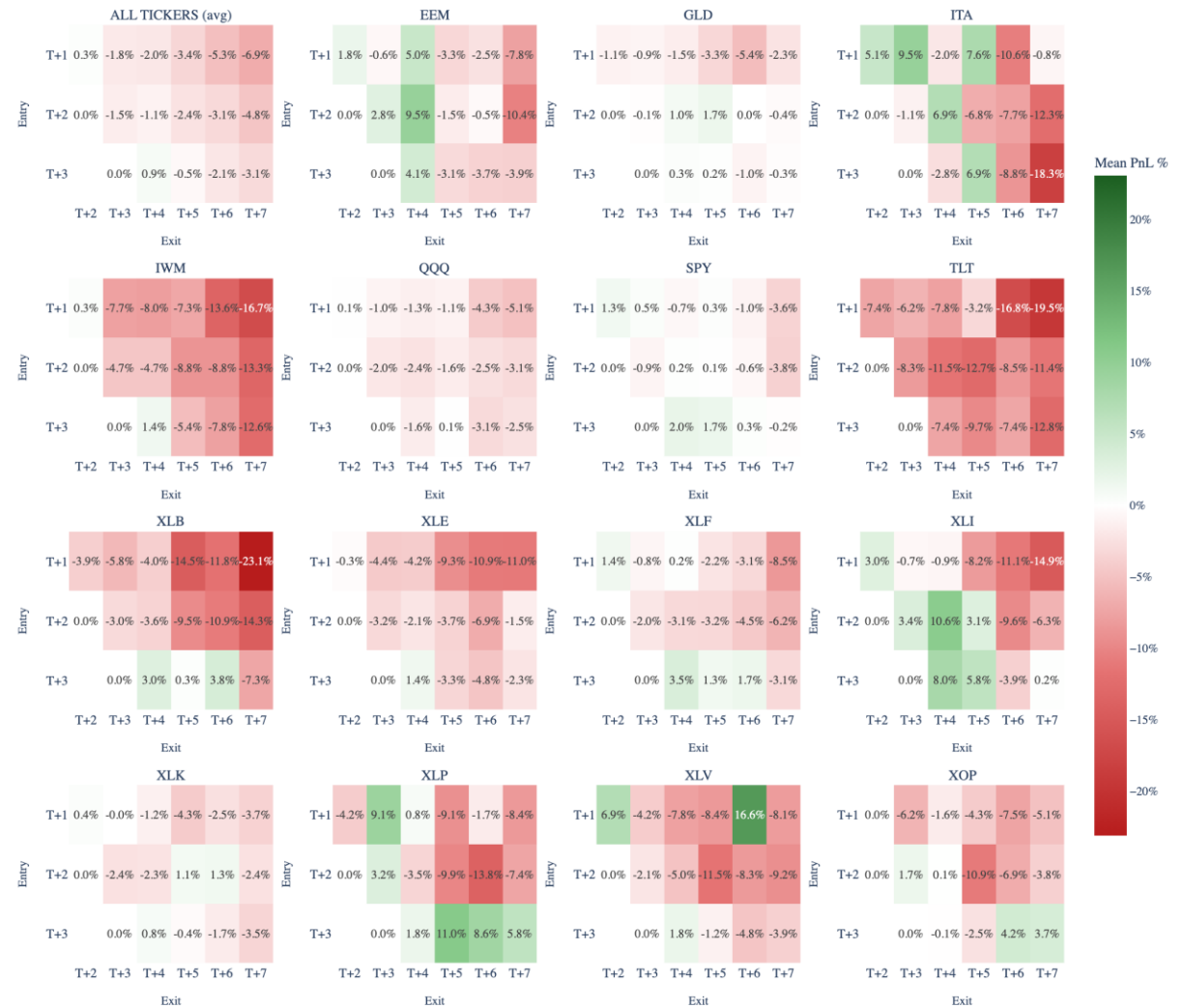
Testing Long Vol Around Geopolitical Catalysts

Sector-based ETFs with varying holding periods post event

Going long volatility after geopolitical events is generally a losing trade. The ALL TICKERS heatmap makes this clear: the longer you hold a straddle, the more negative your return, as theta decay and vol crush dominate.

The exception is the T+3 entry / T+4 exit window, which shows a consistent positive return. The hypothesis: major geopolitical events tend to cluster (escalations, retaliatory actions, policy responses) and the market underestimates the probability of these aftershocks. By T+3, implied volatility has repriced downward too aggressively, so realized vol exceeds implied, generating excess returns on a short-duration long vol position.

Mean Straddle PnL% by Entry / Exit Offset — Post-Event Geopolitical

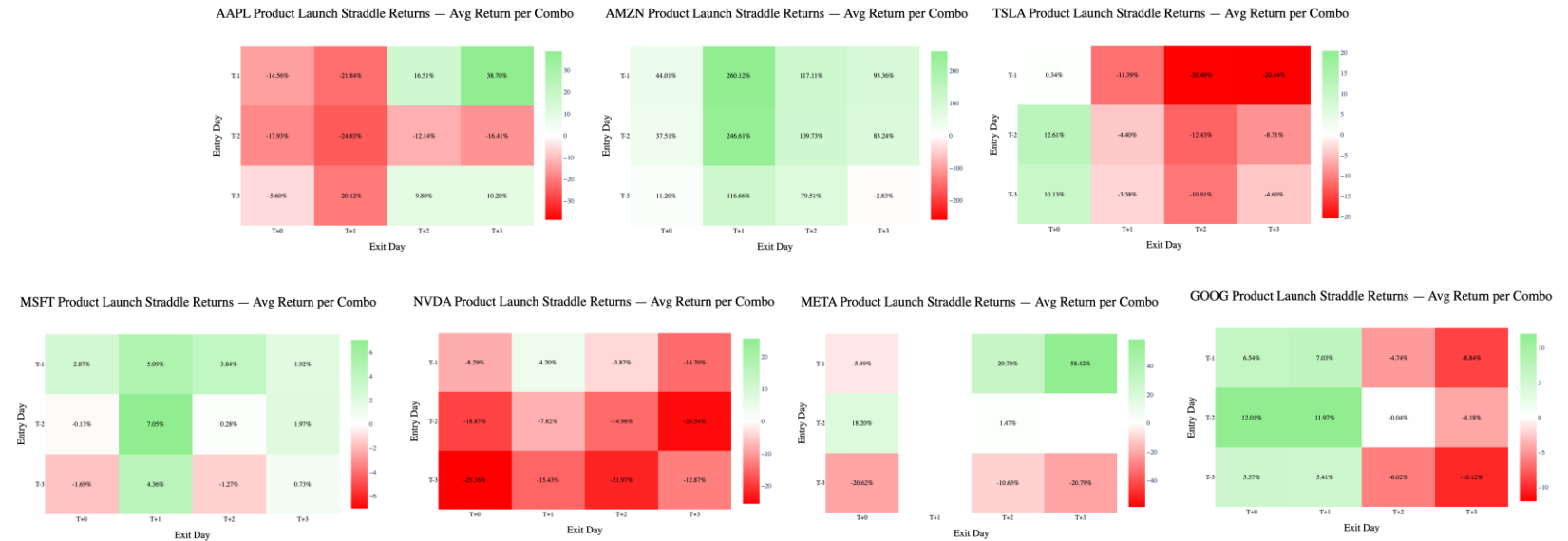
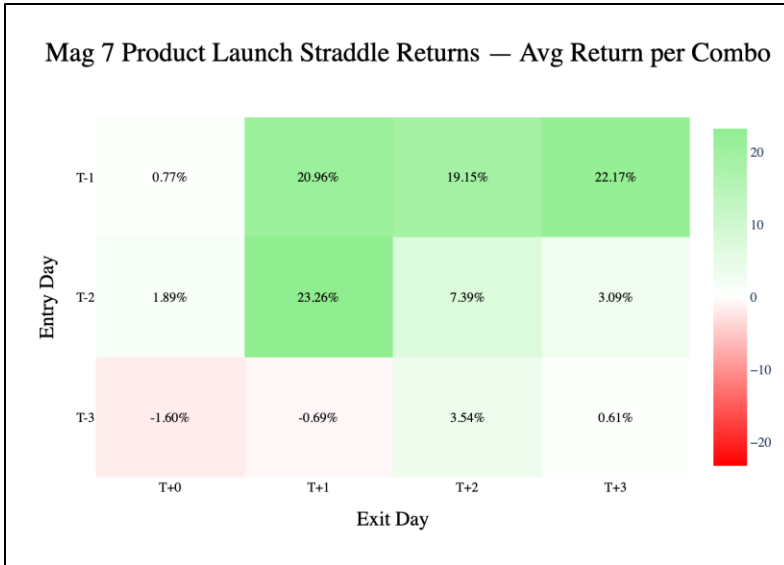


Results and Findings

Part IV: Product Launches



Results and Findings; Part IV. Product Launches



Product launch events show strongest returns when holding straddles through and after the event, indicating that post-event price movement dominates volatility compression.

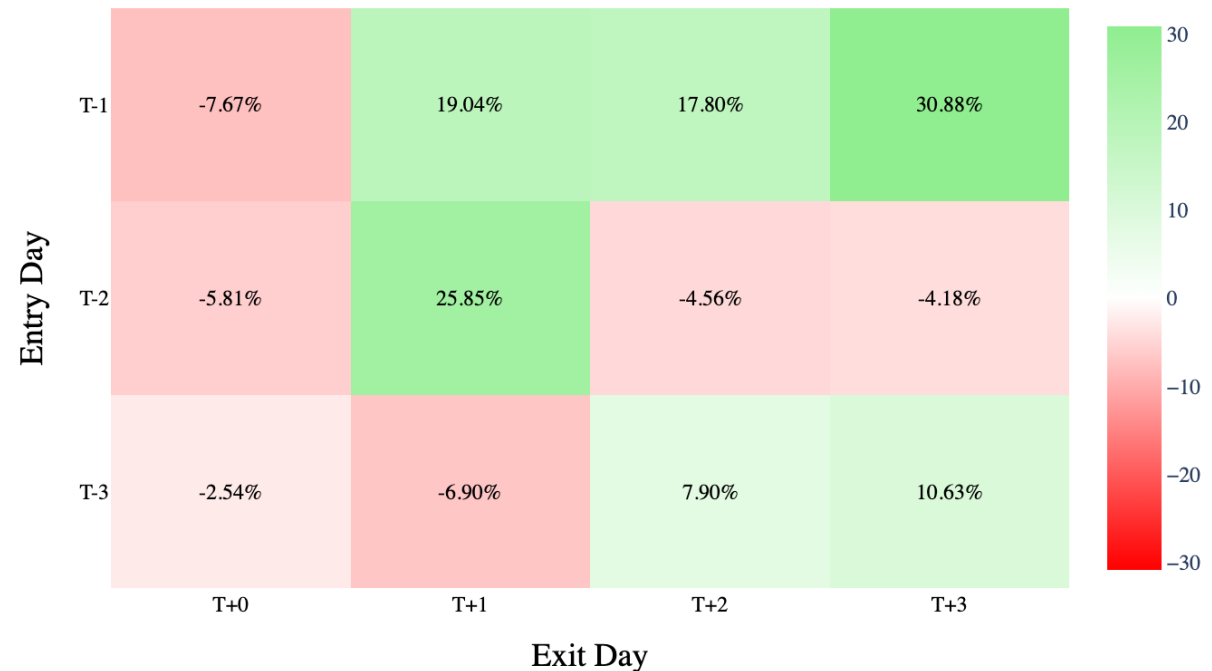
Top Performer: Amazon (AMZN) -> Massive +246% Return

Worst Performer: Apple (AAPL) -> Net -24% Loss

Results and Findings; Part IV. Product Launches

In-Sample Walk-Forward Training Data (2016-2022)

Best Window Found: Long Straddle, Entry T-1, Exit T+3.
Entering earlier → premium overpay (IV bloat)
Holding longer → theta decay + IV crush
This window maximizes price shock capture vs decay



Results and Findings; Part IV. Product Launches

Out-of-Sample Performance (2023–2025)

Main Content

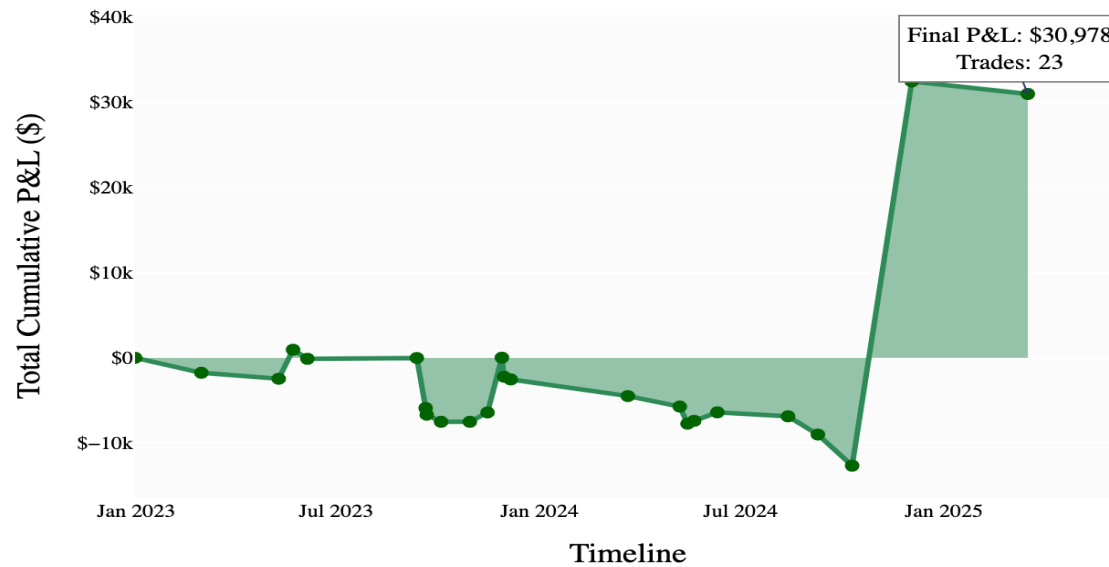
Strategy: Long (T-1 → T+3)

Mean Return: ~13.4% per trade

Total P&L: +\$30,978

Trades: 23

Out-Of-Sample Walk-Forward Equity Curve (2023-2025)



Results and Findings; Part IV. Product Launches

Short vs Long

Short Straddles

Win Rate: 61%

Total P&L: -\$22,868

Rare losses → catastrophic (large directional moves)

Long Straddles

Win Rate: ~30%

Total P&L: +\$30,978

Losses capped, winners massive

Even though short straddles achieve a higher win rate, this does not translate into profitability. The strategy is highly exposed to tail risk, where infrequent but extreme directional stock movements lead to outsized losses that wipe out prior gains. In contrast, long straddles operate with limited downside and significant upside convexity, allowing a smaller number of large winning trades to drive overall profitability. As a result, long volatility is the structurally superior approach in product launch events.

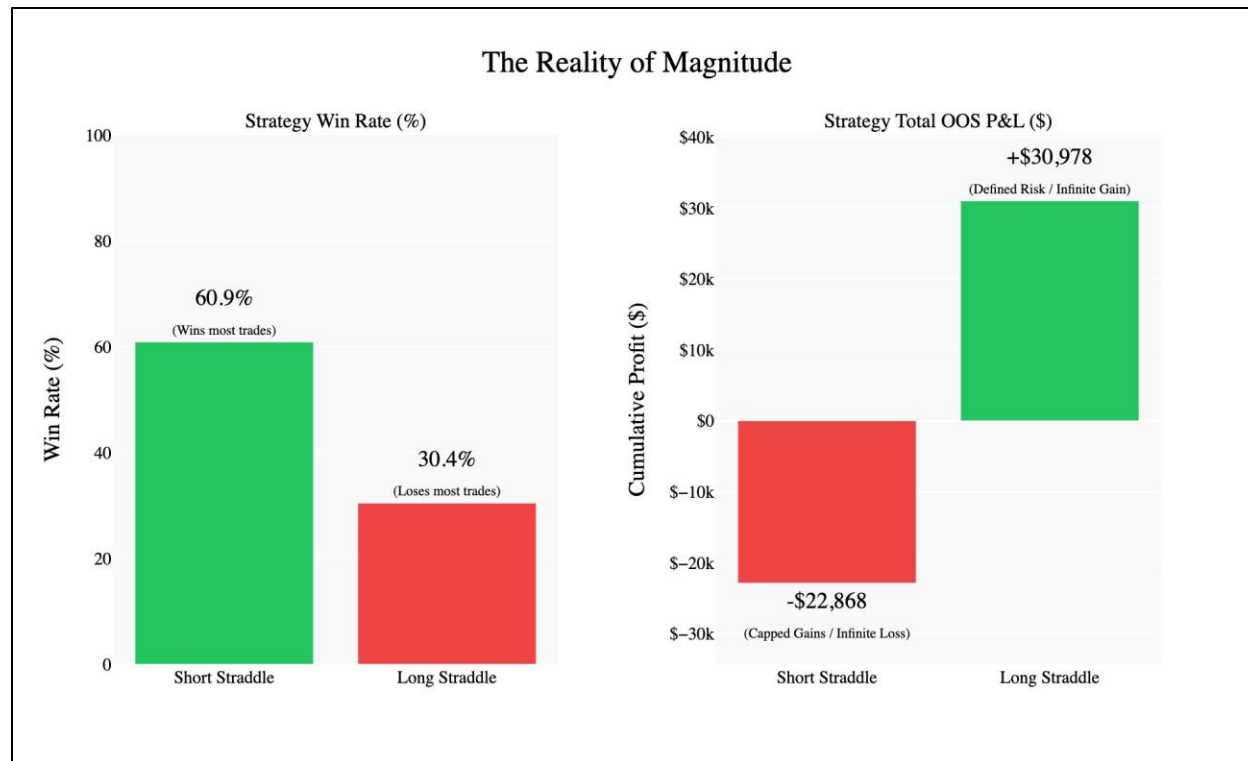


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Limitations, Risk Considerations, and Next Steps

Trading Strategy

Steps to turn the results into an actionable strategy

The strategy does not take into account **implied volatility vs. historical volatility**. For this to be an actionable strategy, a **volatility guardrail** would be implemented to reduce the number of trades by only **going long when IV is below HV** or only **going short when IV is above HV**.

The current strategy has a rigid framework for exiting the position and does not implement **early exits** nor **rolling**. Ideally, a trading strategy would calculate the live **lambda** of the option intra-day to identify optimal opportunities to close positions. In addition, **lambda allows for rolling up, rolling down, or rolling out of positions**.

Data Collection

Limitations of the data

The data is sourced from Massive (previously Polygon) and the initial subscription only allowed for five years of historical options data. This hindered the FOMC results as either the train or test split would be heavily biased. We opted for the test split being skewed as it is less relevant to the results of the strategy.

Skew (Δ call / Δ put)	Meaning	Action
> 3.0	Put leg dying	ROLL PUT UP / ROLL CALL DOWN
< 0.33	Call leg dying	ROLL CALL DOWN / ROLL PUT UP
$0.33 - 3$	Both legs alive	Follow regime action above

Limitations, Risk Considerations, and Next Steps

Early Exercise Risk (Short Straddle)

Assignment risk when one leg of the short straddle is exercised

When selling a straddle, both the short call and short put are **American-style options**, meaning the counterparty can exercise at any time before expiration. If one side of the straddle is exercised before we close the position, the strategy's risk profile changes fundamentally.

Short Call Exercised — We are assigned a **short stock position** at the strike price while still holding the short put. This creates a **directionally bearish** position (short stock + short put), with **unlimited upside risk** if the underlying continues to rally.

Short Put Exercised — We are assigned a **long stock position** at the strike price while still holding the short call. This creates a **covered call equivalent**, but with **full downside exposure** on the long stock if the underlying drops further.

In both cases, the position shifts from a **delta-neutral volatility trade** to a **directional stock position** with a remaining short option leg. The backtest does not account for this scenario, and in practice, early assignment typically occurs when the option is **deep in-the-money** or near an **ex-dividend date**. Monitoring and unwinding the resulting position requires additional capital and margin management.

Limitations, Risk Considerations, and Next Steps

Lambda Regime	What It Means	Long Straddle Action	Short Straddle Action
$\Lambda < 1$ (deep ITM)	Option acts like stock. $\Delta \approx 1$, no convexity left.	EXIT ITM leg	BUY BACK ITM leg
$\Lambda 1-3$ (near ITM)	Low leverage. Capital-heavy for its payoff.	ROLL OUT to later expiry — reload gamma at lower daily theta.	HOLD — ideal zone. Fat premium, low leverage, theta working for you.
$\Lambda 3-7$ (ATM sweet spot)	Balanced leverage. Both legs have meaningful Δ and Γ .	HOLD — max gamma per dollar of premium. Monitor leg skew.	HOLD but roll out if DTE < 7.
$\Lambda 7-15$ (one leg drifting OTM)	Elevated leverage. Asymmetry building between legs.	ROLL OTM leg closer to ATM to refresh Δ .	ROLL heavily OTM leg inward and buy back expensive leg + ROLL outward.
$\Lambda 15-30$ (one leg deep OTM)	Lottery ticket on OTM side. Position is directional.	ROLL OUT + RESTRIKE close dead OTM leg, open new closer to ATM at further expiry.	ROLL OUT ITM leg to same strike — collect more extrinsic value.
$\Lambda > 30$ (one leg worthless)	Effectively single-leg. Straddle thesis is broken.	CLOSE both. Re-enter ATM straddle or convert to strangle/spread.	BUY BACK dead leg for pennies (free margin). Add wing → credit spread.
Λ decreasing fast	Post-event IV crush. Both legs lose extrinsic simultaneously.	EXIT — this is your payoff. Close before theta accelerates.	TAKE PROFIT. If next event near, roll into T-3 for next cycle.

Appendix A: Initial Write-Up

Research Proposal: Event-Driven Implied Volatility Mispricing

Motivation

Options pricing around events

Implied volatility (IV) follows a predictable lifecycle around scheduled events: it rises as traders buy options for protection or speculation, peaks at the announcement, then collapses sharply as uncertainty resolves. This pattern, known as **IV crush**, is well-documented but its pricing efficiency is an open question.

This research investigates whether systematic IV mispricings around scheduled market events can be exploited through **event-driven straddle strategies**, without requiring a directional view on the underlying asset.

Limitations of Conventional Approaches

Standard vol trading strategies rely on:

1. Implied vs. realized volatility spreads
2. Term structure analysis across maturities
3. Skew and surface arbitrage models

These treat IV as continuous, failing to capture the **discrete, event-driven** nature of vol spikes around scheduled announcements.

Proposed Strategy Framework

Exploiting the IV lifecycle through ATM straddles

1. **Event Identification:** Catalog scheduled events across four types: earnings announcements, FOMC rate decisions, CPI/unemployment releases, and geopolitical shocks.
2. **Trade Construction:** ATM straddles (long call + long put) entered during the pre-announcement IV run-up window, exited before or shortly after the event.
3. **Universe:** 541 S&P 500 constituents (2016-2025) for earnings, plus 15 liquid sector ETFs for macro events. Framework draws from Gao, Xing & Zhang (2018).
4. **Direction-Neutral:** No directional view required. Profits come from the behavior of uncertainty itself, not from predicting directional event outcomes.

Research Question: How does implied volatility behave around scheduled market events, and can that behavior be systematically exploited through event-driven straddle strategies?

Appendix B: Signal Construction

B.1 Implied Volatility Series Definition

Let IV_t denote the ATM implied volatility on day t . Signals are computed on daily IV levels to capture the pre-event run-up and post-event crush in **volatility premium** relative to recent history.

B.2 Straddle Return & Implied Move

The ATM straddle value at time t is:

$$V_t = C_t + P_t$$

The straddle return over the holding period is:

$$R^{straddle} = (V_{exit} - V_{entry}) / V_{entry}$$

The implied move, expressing the market-priced expected magnitude of the underlying move as a percentage of spot:

$$IM = (C_t + P_t) / S_t$$

Where C_t and P_t are the ATM call and put premiums, and S_t is the spot price of the underlying.

B.3 Black-Scholes Model for Implied Volatility

Implied volatility is the value of σ that equates the Black-Scholes theoretical price to the observed market price of the option. For a European call:

$$C = S \cdot N(d_1) - K \cdot e^{-rT} \cdot N(d_2)$$

Here S is the spot price, $N(d_1)$ represents the delta of the option, K the strike price, r the risk-free rate, T the time to expiration, and $N(d_2)$ represents the probability that the option will expire in-the-money

Appendix C: Evaluation Metrics

C.1 Daily Strategy Return

$$r_t = \sum_{i=1}^N w_i \cdot r_{i,t}$$

C.2 Cumulative Return (NAV)

$$NAV_t = \prod_{s=1}^t (1 + r_s)$$

C.3 Annualized Return

$$\mu_{ann} = r \cdot 252$$

C.4 Annualized Volatility

$$\sigma_{ann} = \sigma_r \sqrt{252}$$

C.5 Sharpe Ratio

$$Sharpe = \frac{\mu_{ann} - r_f}{\sigma_{ann}}$$

C.6 Implied Leverage (Lambda)

$$\lambda_t = \Delta_t \times \frac{S_t}{C_t}$$