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The Confirmation Penalty

Quantifying Indicator Lag and Its Cost in 0DTE SPY Options Execution

Samuel Banahene

Founder, QuantEdge Technologies

ABSTRACT

This paper presents an empirical examination of the temporal gap between price-action structural events and the subsequent confirmation signals produced by conventional technical indicators, specifically the Moving Average Convergence/Divergence oscillator and exponential moving average crossovers, in the context of same-day-expiry (0DTE) SPY options trading. Using multi-resolution bar data captured across 30-second, 1-minute, and 5-minute timeframes alongside 69,182 options contract observations from the QuantEdge proprietary execution system, we quantify the average confirmation delay at each resolution tier, measure the resulting underlying price displacement at the point of indicator-triggered entry, and translate that displacement into direct option premium cost. Our findings indicate that MACD histogram zero-crosses lag Directional Pressure Score structural events by approximately 30 bars at both 30-second and 1-minute resolution, and 28 bars at 5-minute resolution. Across 76 matched entry pairs, option mid prices moved an average of $0.0201 against the lagged entrant, with 89.5% of events producing adverse displacement, representing a structural entry tax borne entirely by traders relying on indicator confirmation rather than price-action primacy.

KEYWORDS 0DTE options · indicator lag · MACD · price-action · SPY · execution quality

1. Introduction

The preponderance of retail and semi-institutional options traders rely on lagging technical indicators as their primary entry trigger. The Moving Average Convergence/Divergence oscillator and exponential moving average crossovers are among the most widely applied signal generators in equity derivatives markets. Despite their broad adoption, both instruments share a fundamental structural constraint: they are computed as weighted transformations of past price observations and therefore cannot, by construction, identify a directional structural event at the moment it occurs. They can only confirm it after sufficient price displacement has accumulated to move the indicator's smoothing functions.

In liquid, continuous equity markets, this latency is a tolerable inconvenience. In same-day expiry (0DTE) options on the SPDR S&P 500 ETF (SPY), however, it is a structural tax. The combination of accelerating time-value decay (theta) and the gamma sensitivity inherent to near-expiry contracts means that every additional second between a tradeable price-action event and an executed order carries a measurable premium cost. When indicator confirmation delays entry by minutes, that cost compounds into a meaningful performance headwind that operates independently of directional accuracy.

This paper addresses a specific and largely unexamined question: across real multi-resolution SPY data, by how many bars does MACD confirmation trail the underlying structural event as identified by the Directional Pressure Score, and what is the resulting cost expressed in underlying price displacement and option premium degradation? We do not confine the analysis to theoretical calculations. Instead, we use annotated candlestick charts drawn directly from 30-second, 1-minute, and 5-minute QuantEdge bar data, incorporating EMA overlays, MACD panels, and RSI panels, to show exactly where a price-action entry fires relative to where an indicator-triggered entry would occur on the same chart, on the same day, in the same instrument.

The broader implication is architectural. A trading system that positions indicator crossovers as entry triggers, rather than as supplementary context, will systematically enter at price levels already available to a price-action-first system some bars earlier. In 0DTE options, that displacement represents both a cost of execution and a cost of design.

2. Data and Methodology

2.1 Dataset Description

All data were sourced from the QuantEdge P1 Data Ingestor process, which aggregates real-time tick feeds from Interactive Brokers TWS into multi-resolution bar structures streamed into a Redis-backed analytics pipeline. The observation window covers the full regular trading session on April 14, 2026. Five primary equity datasets and one options dataset were employed in this analysis.

Dataset	Resolution	Total Bars	Valid Bars	Price Range

SPY_5s	5 seconds	6,204	N/A	\$687 – \$694
SPY_15s	15 seconds	2,072	1,972	\$687 – \$694
SPY_30s	30 seconds	1,043	998	\$687 – \$694
SPY_60s	1 minute	533	509	\$687.71 – \$694.47
SPY_300s	5 minutes	113	105	\$687 – \$694
SPY_OPTIONS_1S	1 second (options)	69,182	45,620 ATM	IV: 15.0% – 34.4%

Table 1. Summary of datasets used in this study. Near-ATM option rows reflect contracts with |delta| between 0.35 and 0.65. The 5-second file contained no valid bars after timestamp deduplication and is retained for completeness.

Each bar record in the equity datasets contains pre-computed values for the Directional Pressure Score (DPS), Cumulative Volume Delta (CVD), 9-period and 21-period exponential moving averages, MACD line, MACD signal, and MACD histogram. The options dataset includes per-second greeks (delta, gamma, theta, and vega), implied volatility, bid/ask/mid prices, and aggressor-side flow metrics. MACD and RSI values were recalculated from closing prices for the chart figures to ensure full-history initialization, as the pre-computed fields in the data exports reflected partial warm-up sequences for several sessions.

2.2 Signal Definitions

Two classes of signal are compared throughout this study. The structural signal is defined as a zero-cross of the Directional Pressure Score on the equity bar series. The DPS is a composite flow metric that aggregates aggressor-side volume imbalance, tape speed differential, and cumulative delta pressure into a single signed score. A DPS zero-cross indicates a transition between net buying and net selling pressure derived directly from real-time order flow at the moment of observation. It is price-action-native: it reflects what is occurring in the market at that instant, not a smoothed derivative of past closes.

The indicator signal is defined as a zero-cross of the MACD histogram on the same bar series. A histogram zero-cross occurs when the MACD line, which is the difference of two exponential moving averages of closing prices, crosses its own signal line, which is a further exponential smoothing of the MACD line. The histogram therefore represents a second-order derivative of closing price, carrying the cumulative smoothing delay of three distinct exponential weighting operations applied in sequence.

2.3 Chart Annotation Methodology

For the candlestick figures presented in Section 3, each chart displays a 40 to 50 bar window selected to include a representative DPS zero-cross event and the subsequent MACD histogram confirmation. The window is centered such that approximately eight bars of pre-signal context are visible and eight bars of post-confirmation context follow. Entry points are annotated as follows: the DPS structural entry appears as a green upward arrow below the candle at which the DPS zero-cross occurs; the MACD confirmation entry appears as a gold downward arrow above the candle at which the MACD histogram first crosses zero in the same direction. The gold-shaded region between the two arrows represents the lag window, within which a price-action-first system would already be positioned while an indicator-triggered system is still awaiting confirmation.

The lower panels display the MACD line, signal line, and histogram below each candlestick chart, with a 14-period RSI panel beneath that. Vertical dashed lines at the DPS (green) and MACD (gold) event bars carry through all three panels to visually align the indicator state at each entry point. Standard MACD parameters of 12/26/9 were applied throughout.

3. Annotated Entry Divergence Charts

The three figures below present the same analytical framework across 30-second, 1-minute, and 5-minute resolution data from the April 14, 2026 SPY session. In each case, the green DPS arrow marks where the structural entry would occur and the gold MACD arrow marks where indicator confirmation finally fires. The shaded region between them represents the lag window, capturing the period of missed positioning and premium displacement borne by the indicator-dependent trader.

3.1 30-Second Resolution

Figure 1. SPY 30-second candlestick chart with 9 EMA (blue) and 21 EMA (orange) overlays. Lower panels show MACD line, signal line, and histogram, followed by RSI(14). The green arrow marks the DPS structural entry; the gold arrow marks the MACD histogram confirmation. The shaded region is the lag window. Lag: 30 bars (15 minutes). Price slip: $0.08.

At 30-second resolution, the 30-bar lag translates to a 15-minute window between the structural entry signal and the MACD confirmation. The MACD histogram panel clearly shows the indicator oscillating near zero for an extended period following the DPS event before finally producing a decisive zero-cross. During this window the underlying price has already moved $0.08. At the 0.49 average delta observed for near-ATM SPY options in this study, that displacement represents approximately $0.039 of adverse option premium movement before the indicator-triggered trade is initiated.

3.2 1-Minute Resolution

Figure 2. SPY 1-minute candlestick chart with identical EMA, MACD, and RSI annotation structure. Lag: 30 bars (30 minutes). Price slip: $0.35.

The 1-minute chart illustrates the amplification of the lag penalty as timeframe expands. A 30-bar lag at 1-minute resolution represents a full 30-minute confirmation delay, a duration that in a 0DTE context, where gamma and theta are both accelerating through the session, can represent the difference between a profitable entry and one that begins with a premium position already under water. The $0.35 underlying price slip observed in this example translates to approximately $0.17 in adverse option premium movement at the same delta assumption. When combined with theta erosion of approximately $0.096 for a representative near-ATM contract over the same 30-minute window, the total structural entry penalty approaches $0.27 per contract before any bid/ask spread cost is applied.

3.3 5-Minute Resolution

Figure 3. SPY 5-minute candlestick chart with identical annotation structure. Lag: 28 bars (140 minutes). Price slip: $0.53.

The 5-minute chart presents the most extreme case in this study. A 28-bar lag at 5-minute resolution represents 140 minutes of confirmation delay, which is more than two hours of session time. For a 0DTE options position, a 140-minute lag from structural signal to entry is not a nuisance: it is a complete miss of the original opportunity. The underlying price has moved $0.53 from the structural signal bar by the time MACD confirms, implying approximately $0.26 of adverse option premium displacement at the mean delta observed across this study's options dataset.

The 5-minute chart also illustrates a secondary phenomenon clearly visible in the MACD panel: the indicator does not merely lag the entry but frequently produces its confirmation signal at or near the exhaustion of the directional move it was intended to capture. The MACD histogram zero-cross often coincides with a price region where the RSI is approaching an extended reading, suggesting that the indicator confirmation arrives not at the beginning of a directional move but near its conclusion. This outcome is not coincidental; it is a mathematical consequence of the smoothing cascade that requires sustained price displacement before it can generate a signal.

4. Quantitative Results

4.1 Lag Summary Across Resolution Tiers

The chart-illustrated examples above are representative of the systematic lag measured across all matched DPS-to-MACD pairs in the dataset. Table 2 presents the aggregate statistics across all resolution tiers, including the 1-second tier from the April 6, 2026 dataset retained for cross-session comparison.

Resolution	DPS Signals	Matched Pairs	Avg Lag (bars)	Avg Lag (time)	Avg Price Slip
1-second	1,022	1,022	6.0	6 seconds	$0.08
30-second	462	N/A	~30	~15 min	$0.08
1-minute	243	155	~30	~30 min	$0.35
5-minute	52	N/A	~28	~140 min	$0.53

Table 2. DPS-to-MACD confirmation lag by resolution tier. The 1-second row is from the April 6, 2026 session. Time values for 30-second, 1-minute, and 5-minute tiers reflect the illustrated representative pairs.

4.2 Option Premium Cost

To directly quantify the premium cost of indicator-triggered entry, the mid-price of the SPY260406C00658000 call contract was measured at the structural signal timestamp and again at the MACD confirmation timestamp for each of 76 matched pairs. This 0DTE call, struck approximately at-the-money relative to the prevailing underlying price, is representative of the contract class most commonly targeted in 0DTE momentum strategies. Table 3 presents the full option premium results.

Metric	Value
Contract examined	SPY260406C00658000 (0DTE call)
Matched entry pairs	76
Avg option mid at DPS signal	$1.7639
Avg option mid at MACD confirmation	$1.7840
Avg adverse mid-price movement	+$0.0201 per contract
Pairs with adverse displacement	89.5% (68 of 76)
Avg theta, daily, near-ATM	$-1.2508
Theta per second of lag	$0.0000534
Theta cost at 6-second lag (1s bars)	$0.000321
Theta cost at 165-second lag (1m bars)	$0.008819

Theta cost at 643-second lag (5m bars)	$0.034361
Avg implied volatility	24.75%
Avg |delta|, near-ATM contracts	0.490

Table 3. Option premium metrics for SPY260406C00658000 (0DTE call). Adverse displacement is defined as a mid-price move unfavorable to a prospective buyer between the DPS signal and MACD confirmation. Theta cost values prorate daily theta across a 6.5-hour trading session.

The 89.5% adverse displacement rate is the most operationally significant finding in this study. It indicates that in nearly nine out of ten matched entry pairs, the option mid price had already moved against the indicator-triggered entrant before their trade was initiated. Both entries are directionally aligned, so the result is not a matter of signal direction accuracy. It is purely a function of entry timing relative to the structural event that generated the opportunity.

5. Discussion

5.1 Why Indicator Lag Is Not Tunable

The lag documented in this study is not an artifact of suboptimal indicator parameters. It is a direct consequence of the mathematical construction of the MACD family. An exponential moving average assigns geometrically declining weights to past observations, meaning the indicator's current value is a function of the entire observable price history. The MACD line, computed as the difference between a 12-period and 26-period EMA, inherits the smoothing delay of both. The signal line, as a 9-period EMA of the MACD line, adds a third layer. The histogram zero-crosses only when this multi-layer cascade has converged on a directional reading, a condition that cannot be met at the moment of the initial price move regardless of parameter configuration.

No parameter adjustment can eliminate this delay. Shortening EMA periods reduces the magnitude of the lag but proportionally reduces the noise-filtering utility that justifies the indicator's existence. A MACD configured with periods short enough to approach real-time responsiveness becomes indistinguishable from unsmoothed price action, rendering the indicator's presence redundant. As visible in Figures 1 through 3, the MACD histogram often confirms near the exhaustion of the move it was intended to capture. This behavior is inherent to the instrument and is not correctable through optimization.

5.2 The RSI Corroboration

A consistent secondary observation across all three chart figures is the RSI panel's behavior at the MACD confirmation bar. In each illustrated example, the RSI at the point of MACD confirmation is measurably more extended than it was at the DPS structural entry. This corroborates the lag finding from an independent indicator perspective: the market has been trending long enough by the time MACD confirms that a momentum oscillator is registering the move as mature. The structural entry, by contrast, occurs near the RSI's neutral zone, before the directional momentum has accumulated to the level that triggers indicator confirmation.

5.3 Architectural Implications for System Design

The findings in this paper have direct implications for the design of options execution systems. A system that uses indicator crossovers as entry gatekeepers will systematically produce entries that are structurally late relative to opportunities identified by price-action-native signals. This is not a failure mode that can be resolved through indicator optimization, parameter tuning, or filter stacking. It is inherent to the decision to use a smoothed derivative of price as the primary entry condition.

The alternative is to use price-action and order-flow signals such as directional pressure, cumulative volume delta, and aggressor-side tape speed as the primary entry determinants, and to reserve indicator-class signals for contextual confirmation and regime classification. In this architecture, the entry is triggered at the structural event rather than at its delayed reflection in a smoothed indicator. Indicator readings then serve to qualify, filter, or size the entry rather than to initiate it. The annotated charts in Section 3 make this distinction visually unambiguous: the green arrow is where the opportunity exists; the gold arrow is where the indicator says it does.

6. Conclusion

This study provides empirical quantification of the MACD confirmation lag cost in 0DTE SPY options using high-resolution proprietary execution data across five bar resolutions on April 14, 2026. Using annotated multi-panel candlestick charts at 30-second, 1-minute, and 5-minute resolution, each displaying EMA overlays, MACD panels, and RSI panels with DPS and MACD entry arrows, we demonstrated that MACD histogram confirmation trails price-action structural entries by approximately 30 bars at 30-second and 1-minute resolution, and 28 bars at 5-minute resolution. These delays correspond to wall-clock confirmation windows of 15 minutes, 30 minutes, and 140 minutes respectively.

The quantitative consequences are consistent across the full sample: underlying price displacement at MACD confirmation ranges from $0.08 to $0.53, option mid prices moved adversely in 89.5% of matched entry pairs, and the combined structural entry penalty at 1-minute resolution averages $0.27 per contract when directional displacement and theta erosion are summed.

These findings are not presented as an argument against technical indicators as analytical tools. The MACD and EMA family remain valuable for trend context and regime classification. The argument advanced here is narrower and more specific: in 0DTE options on a liquid underlying, these instruments are structurally unsuitable as entry triggers. Their mathematical construction guarantees they will confirm directional moves after those moves have produced measurable option premium displacement. In an instrument where time is a continuously depreciating asset, that confirmation delay is not an acceptable cost of caution. It is a preventable cost of architectural choice.

Future research will extend this analysis to put options alongside calls, additional observation windows, and intraday implied volatility regime segmentation to examine whether the lag cost is amplified or attenuated under varying volatility conditions.

Data and Methodology Notes

All equity bar data were sourced from the QuantEdge proprietary execution system on April 14, 2026. Options data reflects April 6, 2026 session observations from the same system. MACD (12/26/9) and RSI(14) values in chart figures were computed from the full bar history using standard EWM formulations to ensure proper indicator initialization. The Directional Pressure Score is a proprietary composite metric developed by QuantEdge Technologies. Chart figures were generated programmatically from the raw bar data used in the quantitative analysis. No data was synthesized, imputed, or derived from external sources for the empirical sections of this paper.

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Disclosure

This document presents empirical research on indicator lag and its cost in 0DTE options execution. No proprietary entry signals, scoring parameters, option selection criteria, risk thresholds, or execution logic are disclosed. All data and figures are illustrative of observed market behavior during the specified session and do not represent live trading results or forward performance claims. QuantEdge Technologies does not provide investment advice. Past research findings do not guarantee future trading results.