Technical supplement: Buying the Dip or Catching a Falling Knife? Testing Short-Term Trading Strategies and Cross-Sectional Quality Sorting Following Technology Sell-Offs (2018-2026)

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Technical supplement to the paper of the same title, article `ms_01M7B9BNEEBZV14WN4FA1NAQGD`, version 1: the full methods, every robustness check, and the data and code the validators re-ran.

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Abstract

When technology equities suffer an acute sell-off—such as the November 5, 2026 post-midterm election rotation, when the Technology Select Sector SPDR (XLK) dropped -8.0000%, the VanEck Semiconductor ETF (SMH) fell -11.2122%, the Invesco QQQ Trust (QQQ) fell -6.4889%, the S&P 500 (SPY) fell -4.4092%, and the CBOE Volatility Index (VIX) surged +69.6568% to 28.1800—investors face a recurring tension between conditioned historical dip-buying memory and fundamental valuation or capital-expenditure concerns. Rather than relying on market lore, this study conducts a pre-registered, outcome-blind empirical backtest across 2,478 trading days from January 3, 2017 to November 6, 2026, identifying 126 raw candidate shock days and 51 completed historical macro technology sell-off episodes (using a 15-trading-day cooldown, plus 2 active late-2026 forward-tracking shocks), alongside a cross-sectional panel of 2,469 firm-shock observations across 50 liquid U.S. technology firms, a trailing 716-trading-day sample of regular-hours 1-hour intraday bars (December 20, 2023 to November 6, 2026), and a general volatility control panel of 792 high-VIX stress days.

We evaluate five ex-ante trading rules (Strategies S1 through S5) against two benchmarks (Benchmark B0 Constant Zero Cash and Benchmark B1 Passive SPY) over 5, 10, 21, and 42 trading-day horizons (20 strategy-horizon cells, family-wise Bonferroni threshold $\alpha = 0.05/20 = 0.0025$) and report four findings, foregrounding strict overlap-free attenuation (where 42-day Strategy S3 is null at +3.8473%, $p = 0.0917$ and Strategy S1 is marginally nominal at +5.5575%, $p = 0.0498$ on the 26-shock overlap-free subsample), pre-registered hypothesis tests (Hypothesis H1 on VIX

backwardation refuted at 21 days and non-robust at 42 days, unconditional pooled Hypothesis H2 on cross-sectional quality refuted, and unconditional paired Hypothesis H3a on Barbell downside protection refuted), ex-post multiple-testing and survivor-lock boundaries on Table 2 regime interactions, and high-VIX control power bounds showing absence of statistically significant evidence of a technology-specific index rebound premium (rather than positive proof of equivalence):

1. **Aggregate Rebound, Strict 42-Day Overlap-Free Attenuation, and Non-Technology High-VIX Stress Control (Strategy S1 and Hypothesis H1):** Across all 51 completed historical technology sell-off shock episodes from 2018 to 2026, the arithmetic mean 21-trading-day forward return of unconditional equal-weighted 50-stock dip-buying (Strategy S1) is 3.4018 (+3.4018%, median = +3.0943%, standard deviation = 10.4513%, gross zero-benchmark Sharpe ratio = +0.3255, one-sample t vs zero = +2.3245, nominal unadjusted p = 0.0242, Newey-West HAC p = 0.0177, which does not survive the 20-cell Bonferroni threshold alpha = 0.0025 at Bonferroni-adjusted p = 0.4840 and attenuates to +3.4329%, p = 0.0815 on the strict 30-trading-day non-overlapping subsample of 33 shocks). On the strict 42-trading-day non-overlapping subsample of 26 shocks (the only subsample where zero 42-day horizon overlap is mathematically possible), the 42-day forward return of unconditional equal-weighted 50-stock dip-buying (Strategy S1) is only marginally nominal at +5.5575% (t = +2.0619, p = 0.0498; +6.5431%, p = 0.0143 on the 33-shock 30-day subsample), whereas across all 51 partially overlapping 15-day-cooldown episodes from 2018 to 2026, the arithmetic mean 42-trading-day forward return of Strategy S1 is 6.0539 (+6.0539%, median = +5.2050%, standard deviation = 13.4742%, gross zero-benchmark Sharpe ratio = +0.4493, one-sample t vs zero = +3.2086, unadjusted p = 0.0023, Bonferroni-adjusted p = 0.0460 across 20 cells, Newey-West HAC p = 0.0027). In the pre-registered Hypothesis H1 macro regression across all 51 completed shocks, regressing 21-day Strategy S1 return on VIX term-structure backwardation, the below-200-day moving average indicator, and Day-0 XLK return with an intercept, the ordinary least squares coefficient on VIX backwardation is 8.9239 (+8.9239%, HC1 standard error = 2.7462%, t = +3.2495, p = 0.0012; Rademacher wild bootstrap median p = 0.0040; median quantile regression slope = +8.0992%, p = 0.0385; ex-2020 subsample of 42 shocks slope = +10.1888%, p = 0.0003; continuous VIX-to-VIX3M ratio slope = +4.3085% per +0.10 ratio increase or +3.5236% per one-standard-deviation increase of 0.0818 across the observed 0.8432-to-1.2214 range, raw per-unit slope = +43.0855%, p = 0.0505), refuting the pre-registered directional prediction that VIX backwardation on Day 0 predicts lower 21-day rebounds while attenuating at extreme inversion above 1.05 (+5.8908%, p = 0.2438, n = 9). In the pre-registered Hypothesis H1 42-day macro regression across all 51 completed shocks, regressing 42-day Strategy S1 return on VIX term-structure backwardation, the below-200-day moving average indicator, and Day-0 XLK return with an intercept, the 42-day VIX backwardation effect is mean-driven and non-robust—statistically null under median quantile regression (+4.1238%, standard error = 5.3824%, t = +0.7662, p = 0.4474) and marginal under Rademacher wild bootstrap inference (median p = 0.0520)—while the ordinary least squares coefficient is 8.5005 (+8.5005%, HC1 standard error = 3.9041%, t = +2.1773, normal-approximation p = 0.0295). Crucially, in the non-technology high-VIX stress-day identification control across all 792 completed high-VIX stress sessions from 2018 to 2026 (where VIX is at least 20.0 or the single-day VIX jump is at least +20.0%), the difference in mean 21-trading-day forward XLK return between the 51 completed study technology shocks (mean = +2.7350%) and the 741 other high-VIX stress days (mean = +3.0220%) is -0.2870 (-0.2870 percentage points, unadjusted Welch standard error = 1.2647 percentage points, df = 54.86, p = 0.8213, 95% confidence interval [-2.8217, +2.2477] percentage points; because con-

secutive stress days among the 741 sessions have overlapping 21-day windows that violate independence, valid overlap-free inference rests on the 66 non-overlapping 21-day-spaced stress episodes, where 13 study shocks average +1.8873% vs +2.3856% across 53 other stress episodes, difference = -0.4983 percentage points, Welch standard error = 1.7344 percentage points, df = 21.64, p = 0.7766, 95% confidence interval [-4.0988, +3.1021] percentage points, and +0.2365 percentage points, p = 0.8930 on the matched 15-trading-day cooldown control of 82 episodes), providing no statistically significant evidence of a technology-specific index rebound premium above general high-VIX stress days while noting that the wide confidence intervals reflect low statistical power in the 66-episode overlap-free test and cannot prove positive equivalence.

2. **Pre-Registered Refutation 2 on Unconditional Pooled Quality (Hypothesis H2) vs. Ex-Post Regime-Conditional Quality Sorting and Overlap-Free Attenuation (Strategy S3):** On the strict 42-trading-day non-overlapping subsample of 26 shocks (the only subsample where zero 42-day horizon overlap is mathematically possible), the 42-day forward return of Top-Quartile Quality Technology (Strategy S3) is statistically null at +3.8473% (t = +1.7539, p = 0.0917; +5.3850%, p = 0.0168 on the 33-shock 30-day subsample), demonstrating that 20-cell Bonferroni survival occurs only when pooling the 51 partially overlapping 15-day-cooldown episodes from 2018 to 2026, where the arithmetic mean 42-trading-day forward return of Strategy S3 is 5.3748 (+5.3748%, median = +6.0031%, standard deviation = 11.2891%, gross zero-benchmark Sharpe ratio = +0.4761, net Sharpe after 25 bps costs = +0.4540, excess Sharpe after 25 bps costs and 2.5% risk-free rate = +0.4168, one-sample t vs zero = +3.4001, unadjusted p = 0.0013, Bonferroni-adjusted p = 0.0260, Newey-West HAC p = 0.0011). Within the underpowered 2024 to 2026 Out-of-Sample test cohort of 15 completed shocks (df = 14, 80%-power minimum detectable effect size MDES = +/- 7.05 percentage points at two-sided alpha = 0.05), the exploratory descriptive arithmetic mean 42-trading-day forward return of Top-Quartile Quality Technology (Strategy S3) is 6.5011 (+6.5011%, 95% confidence interval [+1.4841%, +11.5181%], median = +6.0031%, standard deviation = 9.0596%, gross zero-benchmark Sharpe ratio = +0.7176, excess Sharpe after 25 bps costs and 4.5% Treasury bill rate = +0.6072, one-sample t vs zero = +2.7792, nominal unadjusted p = 0.0148, which does not survive the 20-cell Bonferroni threshold alpha = 0.0025 at Bonferroni-adjusted p = 0.2960 and is an underpowered descriptive subsample rather than out-of-sample statistical corroboration). In the pre-registered Hypothesis H2 unconditional pooled panel regression across all 2,469 firm-shock observations, regressing 21-day forward stock return on the composite ex-ante quality score, Day-0 stock return, trailing 20-day momentum, trailing 20-day volatility, VIX backwardation, and sub-industry indicators with an intercept, the ordinary least squares coefficient on the composite ex-ante quality score is 0.7052 (+0.7052%, firm-clustered standard error = 0.5398%, t = +1.3063, p = 0.1914; +1.0618%, standard error = 0.7659%, p = 0.1656 at 42 trading days), refuting the pre-registered unconditional Hypothesis H2 when pooling contango pullbacks and VIX-backwardation liquidations together. In the ex-post regime-interaction decomposition of Hypothesis H2 across all 2,469 firm-shock observations (selected ex post after observing the unconditional pooled null of +0.7052%, p = 0.1914 and subject to November 2026 50-firm survivor-lock conditioning), regressing 21-day forward stock return on Top-Quartile Quality membership, VIX backwardation, their interaction, Day-0 stock return, trailing 20-day momentum, trailing 20-day volatility, and sub-industry indicators with an intercept, the ordinary least squares coefficient on Top-Quartile Quality membership during non-backwardation pullbacks is 2.7974 (+2.7974%, firm-clustered standard error = 0.7462%, p = 0.0002; shock-clustered standard error = 1.0490%, p = 0.0077; Cameron-Gelbach-Miller two-way firm-by-shock standard error

= 1.0584%, t = +2.6431, df = 49, p = 0.0110, which does not survive a 36-test Table 2 family-wise Bonferroni threshold alpha = 0.0014 at Bonferroni-adjusted p = 0.3960 and is fragile at 21 days—attenuating to statistical insignificance at +1.6922%, firm-clustered p = 0.0975 and two-way standard error = 1.4757%, t = +1.1468, df = 32, p = 0.2602 on the strict 30-day non-overlapping subsample of 33 shocks and 1,594 rows, and to +1.6696%, firm-clustered p = 0.0093 and two-way df = 49, p = 0.0572 using purely dynamic quality; across alternative overlapping specifications it is +2.8285%, two-way df = 49, p = 0.0143 under equal-weighted quality components, +2.2733%, p = 0.0035 under two-way firm and shock fixed effects, +2.5455%, two-way df = 42, p = 0.0080 on the balanced 43-firm panel of 2,193 rows, and +1.8755%, firm-clustered p = 0.0062 and two-way df = 42, p = 0.0376 when combining the balanced 43-firm panel with purely dynamic quality). In the ex-post Hypothesis H2 21-day regime-interaction regression across all 2,469 firm-shock observations, the ordinary least squares interaction coefficient between Top-Quartile Quality membership and VIX backwardation is -4.0546 (-4.0546%, firm-clustered standard error = 1.3045%, p = 0.0019; shock-clustered standard error = 1.3417%, p = 0.0025; Cameron-Gelbach-Miller two-way standard error = 1.4255%, t = -2.8444, df = 49, p = 0.0065, 36-test Table 2 Bonferroni-adjusted p = 0.2340), showing that high-volatility beaten-down stocks snap back harder than defensive quality stocks during VIX-backwardation liquidations. In the ex-post Hypothesis H2 42-day regime-interaction regression across all 2,469 firm-shock observations (introduced as a post-hoc regime-conditioning specification after the unconditional pooled Hypothesis H2 was found to be null at +1.0618%, p = 0.1656 and conditioned on the November 2026 50-firm survivor lock), regressing 42-day forward stock return on Top-Quartile Quality membership, VIX backwardation, their interaction, Day-0 stock return, trailing 20-day momentum, trailing 20-day volatility, and sub-industry indicators with an intercept, the ordinary least squares coefficient on Top-Quartile Quality membership is 4.6123 (+4.6123%, firm-clustered standard error = 1.0708%, p < 0.0001; shock-clustered standard error = 1.4660%, p = 0.0017; Cameron-Gelbach-Miller two-way standard error = 1.5453%, t = +2.9848, df = 49, p = 0.0044, which does not survive a 36-test Table 2 family-wise Bonferroni correction alpha = 0.0014 at Bonferroni-adjusted p = 0.1584; interaction slope = -5.7906%, two-way df = 49, p = 0.0036, 36-test Bonferroni p = 0.1296; across unadjusted post-hoc sensitivity rows—none of whose two-way p-values survives 36-test Bonferroni correction—the slope is +4.5139%, two-way df = 49, p = 0.0063 under equal-weighted quality components, +4.1216%, p = 0.0001 under two-way firm and shock fixed effects, +4.3759%, two-way df = 42, p = 0.0027 on the balanced 43-firm panel, +3.4025%, firm-clustered p = 0.0077 and two-way standard error = 1.5547%, t = +2.1885, df = 32, p = 0.0360, 36-test Bonferroni p = 1.0000 on the strict 30-day non-overlapping subsample of 33 shocks and 1,594 rows where df = min(50, 33) - 1 = 32, +3.0147%, firm-clustered p = 0.0068 and two-way df = 49, p = 0.0425 using purely dynamic price/volatility quality without the static cash-flow tier, and +3.0977%, firm-clustered p = 0.0096 and two-way df = 42, p = 0.0431 when combining the balanced 43-firm panel with purely dynamic quality).

3. **Pre-Registered Refutation 3 on Unconditional Paired Barbell Protection (Hypothesis H3a) vs. Exploratory Rotation Buffering (Strategy S4 and Hypothesis H3b):** In the pre-registered Hypothesis H3a full-sample paired comparison across all 51 completed shocks, the arithmetic mean paired difference between the Policy-Rotation Barbell (Strategy S4) and Unconditional Dip-Buying (Strategy S1) at 21 trading days is -1.3947 (-1.3947 percentage points, paired t = -2.0019, p = 0.0507, Wilcoxon p = 0.0535, worst drawdown -23.9923% vs -17.2025%; and -2.3072 percentage points, paired t = -2.1937, p = 0.0329 at 42 trading days), refuting the unconditional full-sample downside-reduction hypothesis because utilities and

industrials sold off simultaneously with technology during the 20 VIX-backwardation liquidations (-4.5607 percentage points, p = 0.0001 at 21 days; H3b VIX backwardation slope = -4.9522%, p = 0.0001), whereas across the 31 non-backwardation pullbacks the paired difference is +0.6479 percentage points (p = 0.4180) with worst 21-day drawdown reduced from -17.2025% to -11.3720%. Within the underpowered 2024 to 2026 Out-of-Sample test cohort of 15 completed shocks (df = 14, 80%-power minimum detectable effect size MDES = +/- 4.21 percentage points at two-sided alpha = 0.05), the exploratory descriptive arithmetic mean 21-trading-day forward return of the Policy-Rotation and Physical-Infrastructure Barbell (Strategy S4) is 3.9717 (+3.9717%, 95% confidence interval [+0.9769%, +6.9665%], median = +3.7864%, standard deviation = 5.4078%, gross zero-benchmark Sharpe ratio = +0.7344, excess Sharpe after 25 bps costs and 4.5% Treasury bill rate = +0.6179, win rate = 86.67%, worst loss = -3.9381% vs -9.0800% for Strategy S1, one-sample t vs zero = +2.8445, nominal unadjusted p = 0.0130, which does not survive the 20-cell Bonferroni threshold alpha = 0.0025 at Bonferroni-adjusted p = 0.2600 and is an underpowered descriptive subsample rather than out-of-sample corroboration, whereas full-sample paired Hypothesis H3a across all 51 shocks refutes unconditional downside protection at -1.3947 percentage points, p = 0.0507 at 21 days and -2.3072 percentage points, p = 0.0329 at 42 days).

4. **Auxiliary Background Note on Intraday Serial Correlation (Hypothesis H4a) and Exploratory Narrative Regime Attribution (Hypothesis H4b):** In the exploratory Hypothesis H4b regression across all 51 completed shocks, regressing the 21-day Top-minus-Bottom Quartile quality spread on artificial-intelligence capex salience, interest-rate and inflation salience, and VIX backwardation with an intercept, the ordinary least squares coefficient on interest-rate and inflation salience is 10.0770 (+10.0770%, HC1 standard error = 3.9768%, t = +2.5339, unadjusted p = 0.0113, while artificial-intelligence capex salience is -1.0958%, p = 0.8388; however, because the episode dossiers scored by the two LLM judges incorporate retrospective calendar-era descriptions, interest-rate salience correlates at r = 0.8599 with the 2021-2023 rate-hiking era indicator and attenuates to +1.1577%, p = 0.8502 when that calendar indicator is added). As an unverified auxiliary background check outside the 14 verified daily-panel claims (because the underlying 716-day 1-hour XLK bar series from the Yahoo Finance API was summarized at ingestion time rather than included in the three released daily CSV datasets), first-hour XLK returns (09:30 to 10:30 ET) across the 716 full regular-hours trading days from December 20, 2023 to November 6, 2026 exhibit near-zero correlation with rest-of-day returns (r = +0.0357, p = 0.3401), and across 122 sell-off mornings where first-hour XLK return is at or below -1.00% (mean = -1.8428%), rest-of-day returns average -0.0362% and continue lower 50.00% of the time.

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1. Introduction and Theoretical Motivation

Sharp technology sector sell-offs attract intense retail and institutional attention. Prior empirical literature shows that individual investors are net buyers of attention-grabbing stocks, including stocks in the news, stocks experiencing high abnormal trading volume, and stocks with extreme one-day returns [1]. In the behavioral overreaction literature on aggregate stock market drops, severe market downturns are followed by above-average subsequent market returns, consistent with extreme return reversal following market sell-offs [2]. In equilibrium models of aggregate stock market trading volume and the serial correlation of daily stock returns, first-order daily return autocorrelation declines with volume because risk-averse market makers accommodate buying or

selling pressure from liquidity or noninformational traders and require higher expected return rewards when absorbing larger order imbalances [3]. At the industry and stock level, pervasive intra-industry return reversals driven by order imbalances and noninformational shocks are stronger following aggregate market declines [4]. When market-wide implied volatility spikes—measured by the CBOE Volatility Index (VIX) constructed from S&P index option prices as an investor fear gauge [5]—the expected returns to short-term return-reversal strategies that proxy for liquidity provision rise predictably with VIX levels during market turmoil [6], and spikes in search-based household fear indices similarly predict temporary return reversals [7]. Moreover, theoretical and empirical models of the term structure of option-implied volatilities construct and test the relation between short- and long-term implied volatilities across mean-reverting, GARCH, and EGARCH volatility specifications, concluding that EGARCH best describes the implied-volatility term structure [8].

At the same time, volatility-managed portfolio theory shows that scaling down equity exposure when realized variance is elevated increases unconditional Sharpe ratios because variance spikes are not proportionally offset by higher unconditional mean returns across all horizons [9]. In the cross-section of equities, investor sentiment waves disproportionately affect speculative, high-volatility, young, and unprofitable growth stocks whose valuations are subjective and difficult to arbitrage [10], while high-quality firms—those with profitable, stable, cash-flow-generative operations—command higher risk-adjusted returns than speculative "junk" equities [11]. Finally, historical analyses of cross-sectional stock return predictors across the twentieth century demonstrate that the majority of accounting-based return anomalies weaken out-of-sample—with lower average returns and Sharpe ratios and higher volatilities and correlations—indicating that many cross-sectional predictors are artifacts of data snooping [12].

This study tests how these competing forces—liquidity-provision reversals during high-VIX turmoil [6] [4], implied-volatility term-structure modeling [8], realized-variance-managed portfolio scaling [9], and cross-sectional quality versus sentiment-sensitive volatility sorting [10] [11]—interact following acute technology sell-offs between 2018 and 2026. As our high-VIX stress-day identification control demonstrates, unconditional index-level dip-buying after technology sell-offs (Strategy S1 and XLK) shows no statistically significant rebound premium above general high-VIX stress days (-0.2870 percentage points, $p = 0.8213$ across all 792 sessions; -0.4983 percentage points, $p = 0.7766$ across 66 non-overlapping episodes), so the study's technology-specific inquiry centers on whether cross-sectional quality sorting within the technology sector outperforms unconditional sector beta.

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2. Data Architecture, Shock Identification, and Methodological Hygiene

2.1 Asset Universe and Survivorship Scope (50 Firms, Dynamically Rebalanced ETFs, and 716-Day Intraday Sample)

We examine 12 macro and sector indices (QQQ, XLK, SMH, IGV, SPY, RSP, IWM, XLU, XLI, XLF, VIX, and 3-month VIX3M) and a fixed universe of 50 liquid U.S. technology and AI-ecosystem firms across four sub-industries (Semiconductors and AI Compute: 15; Hyperscalers and Platforms: 8; Enterprise SaaS and AI Software: 18; Cybersecurity and Networking Infrastructure: 9 reference). Because the 50-stock list was locked in November 2026, selecting surviving 2026 leaders introduces ex-post constituent look-ahead bias relative to firms that delisted or stagnated after 2018, and the 2024–2026 Out-of-Sample cohort is chronological out-of-sample on shock timing

rather than independent of the 2026 universe lock. Specifically, 43 firms trade continuously across all 51 historical shocks (2,193 balanced rows), while 7 post-2018 IPOs (ZS, DDOG, CRWD, NET, SNOW, PLTR, APP) contribute 276 post-IPO rows (2,469 total rows).

To bound constituent selection bias—explicitly separating index-level validation from stock-level quality sorting—we report four checks: 1. **Dynamically Rebalanced Index ETFs (Validates Index-Level Dip-Buying Only):** Replacing the 50-stock basket in Strategy S1 with dynamically rebalanced XLK (point-in-time constituents with zero survivorship bias) yields a 21-day mean of +2.7350% ($p = 0.0315$) and a 42-day mean of +4.6364% ($p = 0.0051$) across the 51 shocks. Crucially, **dynamically rebalanced XLK validates only index-level dip-buying; all stock-level cross-sectional quality sorts (Strategy S3 and Table 2) remain conditioned on survival to the November 2026 50-firm universe lock, leaving delisted-firm survivorship bias for cross-sectional quality sorting unaddressed**. 2. **Balanced 43-Firm Continuously Traded Panel (2,193 Rows, Conditioned on 2026 Survival):** Restricting Hypothesis H2 to the 43 continuously traded firms removes post-2018 IPO entry composition shifts (+2.5455%, firm $p = 0.0012$, two-way CGM $p = 0.0080$ at 21D; +4.3759%, firm $p = 0.0001$, two-way CGM $p = 0.0027$ at 42D), though these 43 firms still require survival to November 2026. 3. **Two-Way Firm and Shock Fixed Effects:** Including 50 firm and 51 shock fixed effects absorbs time-invariant firm differences and static cash-flow tiers among the 50 surviving firms (+2.2733%, $p = 0.0035$ at 21D; +4.1216%, $p = 0.0001$ at 42D). 4. **Simultaneous Balanced 43-Firm Panel and Purely Dynamic Quality Ranking:** Removing both the 7 post-2018 IPOs and the static cash-flow tier (2,193 rows ranked on trailing 60-day run-up and 20-day volatility) yields +1.8755% (firm $p = 0.0062$, two-way CGM $p = 0.0376$, interaction -2.7559%, $p = 0.0246$) at 21D and +3.0977% (firm $p = 0.0096$, two-way CGM $p = 0.0431$, interaction -4.2191%, $p = 0.0074$) at 42D.

For our intraday test (Hypothesis H4a), 1-hour regular-hours XLK bars were retrieved from the Yahoo Finance API using its maximum trailing 725-trading-day window ending November 6, 2026 (December 20, 2023 to November 6, 2026). Retaining full regular-hours sessions with ≥ 6 hourly bars (09:30–16:00 ET) excludes 9 holiday half-days (4 bars, 09:30–13:00 ET), yielding 716 complete trading days ($725 - 9 = 716$). Because the raw 716-day 1-hour XLK bar series was summarized at ingestion time rather than included in the three released daily CSV files, Hypothesis H4a is reported strictly as an unverified auxiliary background check outside the 14 verified daily-panel claims.

2.2 Outcome-Blind Shock Day Rule, Threshold Sensitivity Grid, and Sample Attrition

Across 2,478 trading days from January 3, 2017 to November 6, 2026 (2017 warm-up), a day between January 1, 2018 and November 5, 2026 is a candidate technology shock day (126 raw days) if: 1. Single-day XLK $\leq -2.50\%$, OR single-day QQQ $\leq -2.50\%$, OR 3-day XLK $\leq -4.50\%$ with Day-0 XLK $\leq -1.50\%$; **AND** 2. VIX ≥ 20.0 OR single-day VIX jump $\geq +20.0\%$.

A sequential 15-trading-day cooldown yields 51 completed historical shocks (February 2, 2018 to July 29, 2026, with complete 21D and 42D windows), split into In-Sample (2018–2023, 36 shocks) and Out-of-Sample (2024–2026, 15 shocks). Two late-2026 episodes—October 16, 2026 (XLK -3.0234%, QQQ -2.5000%, SPY -1.11%, VIX 19.9900, +21.4459% jump satisfying Condition 2) and November 5, 2026 (XLK -8.0000%, SMH -11.2122%, QQQ -6.4889%, SPY -4.4092%, RSP -2.8926%, XLU -0.7108%, XLI -4.1249%, VIX 28.1800, +69.6568% jump, VIX3M 25.5500, ratio 1.1029)—occur after the July 29, 2026 42D cutoff and are excluded automatically from all 51 historical backtests and 2,469 panel rows; the 14-day live-event exception affects only the descriptive Section 4.4 Day+1

scoreboard.

Across an 8-specification sensitivity grid (which shares nested shock episodes from the same 2018–2026 series and reports unadjusted nominal p-values): - **Looser Thresholds:** Drop $\leq -2.0\%$, VIX $\geq$ 18.0 (15D cooldown) yields 66 shocks (XLK 21D +3.0389%, $p = 0.0017$; 42D +5.4628%, $p = 0.0001$); drop $\leq -2.0\%$, VIX ≥ 20.0 yields 60 shocks (XLK 21D +2.8037%, $p = 0.0086$; 42D +5.1697%, $p = 0.0006$). - **Stricter Thresholds:** Drop $\leq -3.0\%$, VIX ≥ 20.0 yields 39 shocks (XLK 21D +3.8058%, $p = 0.0103$; 42D +6.5665%, $p = 0.0005$); drop $\leq -3.0\%$, VIX ≥ 22.0 yields 34 shocks (XLK 21D +3.4495%, $p = 0.0233$; 42D +7.1562%, $p = 0.0005$). - **Cooldown Spacing (10, 15, 21, 30, and 42 Days):** Baseline trigger yields 57 shocks at 10D (XLK 21D +2.7500%, $p = 0.0123$; 42D +4.6685%, $p = 0.0017$), 51 shocks at 15D (XLK 21D +2.7350%, $p = 0.0315$; 42D +4.6364%, $p = 0.0051$), 43 shocks at 21D (XLK 21D +3.1641%, $p = 0.0059$; 42D +4.8945%, $p = 0.0064$), 33 shocks on our strict 30D non-overlapping subsample (S1 21D +3.4329%, $p = 0.0815$; 42D +6.5431%, $p = 0.0143$; S3 42D +5.3850%, $p = 0.0168$), and 26 shocks on the strict 42D non-overlapping subsample where zero 42-day overlap is possible (S1 21D +4.8683%, $t = +3.1366, p = 0.0043$; 42D +5.5575%, $t = +2.0619, p = 0.0498$; S3 21D +3.1253%, $t = +2.2895, p = 0.0308$; 42D +3.8473%, $t = +1.7539, p = 0.0917$).

2.3 Two-Judge LLM Regime Scoring and Retrospective Dossier Caveat

Each shock episode was scored across six 0-to-1 salience constructs by two open-weight LLM judges (DeepSeek V4.1 Flash and Meta Llama 3.3 70B Instruct), evaluated via intraclass correlation [13]. Two-rater absolute agreement ICC(2,2) ranges from 0.8444 (panic severity) to 0.9135 (tariff/geopolitical salience), with AI capex salience at 0.8702 and interest-rate salience at 0.9086. Because episode dossiers used calendar-year regime lookups, these scores represent retrospective era classifications rather than ex-ante news signals, and none of Strategies S1–S5 uses any LLM variable.

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3. Backtest of Short-Term Trading Strategies (Strategies S1 Through S5)

We test five rules triggered at the close of shock day t_0 over horizons $H \in \{5, 10, 21, 42\}$ trading days: - **Strategy S1 (Unconditional Dip-Buying):** Buy 100% of the equal-weighted 50-stock technology basket at t_0. - **Strategy S2 (Volatility-Stabilization Filter):** Enter at t_0 if $\text{VIX}_{t_0}/\text{VIX3M}_{t_0} \leq 1.00$ and $\text{VIX}_{t_0} < 28.0$; otherwise hold cash (0.0000%) and enter on the first day $t \in [t_0 + 1, t_0 + 10]$ when $\text{VIX}_t/\text{VIX3M}_t \leq 1.00$ and $\text{VIX}_t < \text{VIX}_{t-1}$. - **Strategy S3 (Top-Quartile Quality Technology):** Rank the 50 stocks at t_0 on composite quality $(0.45 \times z_{\text{FCF}} - 0.30 \times z_{\text{runup60}} - 0.25 \times z_{\text{vol20}})$ and buy the Top Quartile (Q1, 12 stocks, long-only). - **Strategy S4 (Policy-Rotation Barbell):** Allocate 50% to Strategy S3 and 50% equal-weighted across XLU, XLI, and RSP. - **Strategy S5 (200-DMA Trend Filter):** Buy 100% of the 50-stock basket at t_0 if XLK and SPY close above their 200-DMAs, 50% if XLK is in a $\leq -25.0\%$ 252-day drawdown with cooling VIX, and 0.0000% cash otherwise. - **Benchmarks B0 and B1:** Benchmark B0 is Constant Zero Cash (0.0000% return and 0.0000% SD; one-sample t and Sharpe vs. zero are marked Undefined due to zero variance, while each strategy's t vs. zero is identically its paired test vs. B0), and Benchmark B1 is Passive SPY.

Table 1 reports summary statistics across **all 20 Full-Sample strategy-horizon cells** and the Out-of-Sample cohort (15 shocks), with Gross Sharpe defined as mean divided by SD versus 0.0000% cash:

Cohort & Horizon	Strategy	Mean (%)	Median (%)	SD (%)	Gross Sharpe (vs. 0% Cash)	Win (%)	Worst (%)	t vs. Zero / B0 (p)	Diff vs. S1 (p)
Full 51 Shocks, 5D	Strategy S1 Unconditional Dip-Buy	+0.6869%	+0.6426%	5.3611%	+0.1281	58.82%	-13.0797%	+0.9150 (0.3646)	+0.0000% (1.0000)
Full 51 Shocks, 5D	Strategy S2 Volatility Filter	+0.0138%	+0.0000%	4.2572%	+0.0033	49.02%	-13.0797%	+0.0232 (0.9816)	-0.6730% (0.1177)
Full 51 Shocks, 5D	Strategy S3 Quality Tech Q1	+0.6499%	+1.0523%	4.1910%	+0.1551	58.82%	-10.7005%	+1.1074 (0.2734)	-0.0370% (0.8974)
Full 51 Shocks, 5D	Strategy S4 Barbell	+0.3627%	+0.7463%	3.4261%	+0.1059	56.86%	-9.0695%	+0.7559 (0.4532)	-0.3242% (0.4240)
Full 51 Shocks, 5D	Strategy S5 200-DMA Filter	+0.9044%	+0.0000%	3.2266%	+0.2803	41.18%	-8.4317%	+2.0016 (0.0508)	+0.2175% (0.7153)
Full 51 Shocks, 5D	Benchmark B1 Passive SPY	+0.1902%	+0.5695%	3.4234%	+0.0556	52.94%	-9.0667%	+0.3967 (0.6932)	-0.4967% (0.2425)
Full 51 Shocks, 5D	Benchmark B0 Constant Zero Cash	+0.0000%	+0.0000%	0.0000%	Undefined	0.00%	+0.0000%	Undefined	-0.6869% (0.3646)
Full 51 Shocks, 10D	Strategy S1 Unconditional Dip-Buy	+1.2953%	+1.1701%	7.8158%	+0.1657	60.78%	-14.8106%	+1.1836 (0.2422)	+0.0000% (1.0000)
Full 51 Shocks, 10D	Strategy S2 Volatility Filter	+0.3838%	+1.1701%	6.0056%	+0.0639	58.82%	-12.4161%	+0.4564 (0.6501)	-0.9115% (0.1519)
Full 51 Shocks, 10D	Strategy S3 Quality Tech Q1	+1.3047%	+1.1808%	6.9552%	+0.1876	54.90%	-16.4483%	+1.3397 (0.1864)	+0.0094% (0.9807)
Full 51 Shocks, 10D	Strategy S4 Barbell	+0.8840%	+0.4389%	5.6012%	+0.1578	56.86%	-15.7819%	+1.1271 (0.2651)	-0.4113% (0.3962)
Full 51 Shocks, 10D	Strategy S5 200-DMA Filter	+0.8810%	+0.0000%	5.1082%	+0.1725	39.22%	-14.8106%	+1.2316 (0.2238)	-0.4143% (0.6228)
Full 51 Shocks, 10D	Benchmark B1 Passive SPY	+0.4896%	+1.1874%	5.1685%	+0.0947	54.90%	-14.9464%	+0.6766 (0.5018)	-0.8057% (0.1185)
Full 51 Shocks, 10D	Benchmark B0 Constant Zero Cash	+0.0000%	+0.0000%	0.0000%	Undefined	0.00%	+0.0000%	Undefined	-1.2953% (0.2422)
Full 51 Shocks, 21D	Strategy S1 Unconditional Dip-Buy	+3.4018%	+3.0943%	10.4513%	+0.3255	64.71%	-17.2025%	+2.3245 (0.0242)	+0.0000% (1.0000)

Cohort & Horizon	Strategy	Mean (%)	Median (%)	SD (%)	Gross Sharpe (vs. 0% Cash)	Win (%)	Worst (%)	t vs. Zero / B0 (p)	Diff vs. S1 (p)
Full 51 Shocks, 21D	Strategy S2 Volatility Filter	+2.2780%	+1.7576%	7.9756%	+0.2856	64.71%	-17.2025%	+2.0398 (0.0467)	-1.1238% (0.1590)
Full 51 Shocks, 21D	Strategy S3 Quality Tech Q1	+2.8090%	+2.7626%	9.3040%	+0.3019	64.71%	-18.2273%	+2.1561 (0.0359)	-0.5928% (0.2586)
Full 51 Shocks, 21D	Strategy S4 Barbell	+2.0071%	+1.7855%	7.6757%	+0.2615	72.55%	-23.9923%	+1.8674 (0.0677)	-1.3947% (0.0507)
Full 51 Shocks, 21D	Strategy S5 200-DMA Filter	+1.3704%	+0.0000%	5.9905%	+0.2288	41.18%	-16.2365%	+1.6337 (0.1086)	-2.0314% (0.1090)
Full 51 Shocks, 21D	Benchmark B1 Passive SPY	+1.4362%	+1.3247%	7.0097%	+0.2049	60.78%	-24.1425%	+1.4632 (0.1497)	-1.9656% (0.0097)
Full 51 Shocks, 21D	Benchmark B0 Constant Zero Cash	+0.0000%	+0.0000%	0.0000%	Undefined	0.00%	+0.0000%	Undefined	-3.4018% (0.0242)
Full 51 Shocks, 42D	Strategy S1 Unconditional Dip-Buy	+6.0539%	+5.2050%	13.4742%	+0.4493	74.51%	-18.2112%	+3.2086 (0.0023)	+0.0000% (1.0000)
Full 51 Shocks, 42D	Strategy S2 Volatility Filter	+4.4167%	+5.6159%	11.1287%	+0.3969	66.67%	-19.2553%	+2.8343 (0.0066)	-1.6372% (0.1003)
Full 51 Shocks, 42D	Strategy S3 Quality Tech Q1	+5.3748%	+6.0031%	11.2891%	+0.4761	68.63%	-22.4094%	+3.4001 (0.0013)	-0.6791% (0.3473)
Full 51 Shocks, 42D	Strategy S4 Barbell	+3.7467%	+3.6975%	9.0346%	+0.4147	68.63%	-24.9856%	+2.9616 (0.0047)	-2.3072% (0.0329)
Full 51 Shocks, 42D	Strategy S5 200-DMA Filter	+2.0613%	+0.0000%	7.4119%	+0.2781	45.10%	-18.2112%	+1.9861 (0.0525)	-3.9925% (0.0211)
Full 51 Shocks, 42D	Benchmark B1 Passive SPY	+2.5994%	+3.3155%	8.0062%	+0.3247	68.63%	-23.0419%	+2.3186 (0.0245)	-3.4545% (0.0019)
Full 51 Shocks, 42D	Benchmark B0 Constant Zero Cash	+0.0000%	+0.0000%	0.0000%	Undefined	0.00%	+0.0000%	Undefined	-6.0539% (0.0023)
OOS 15 Shocks, 5D	Strategy S5 200-DMA Filter	+1.9084%	+0.3831%	2.8223%	+0.6762	53.33%	-0.8904%	+2.6188 (0.0202)	-0.4027% (0.7931)
OOS 15 Shocks, 21D	Strategy S1 Unconditional Dip-Buy	+6.2134%	+4.7318%	9.4110%	+0.6602	80.00%	-9.0800%	+2.5571 (0.0228)	+0.0000% (1.0000)

Cohort & Horizon	Strategy	Mean (%)	Median (%)	SD (%)	Gross Sharpe (vs. 0% Cash)	Win (%)	Worst (%)	t vs. Zero / B0 (p)	Diff vs. S1 (p)
OOS 15 Shocks, 21D	Strategy S4 Barbell	+3.9717%	+3.7864%	5.4078%	+0.7344	86.67%	-3.9381%	+2.8445 (0.0130)	-2.2417% (0.1236)
OOS 15 Shocks, 21D	Benchmark B1 Passive SPY	+3.4919%	+3.3555%	5.0055%	+0.6976	73.33%	-4.7378%	+2.7018 (0.0172)	-2.7215% (0.0541)
OOS 15 Shocks, 21D	Benchmark B0 Constant Zero Cash	+0.0000%	+0.0000%	0.0000%	Undefined	0.00%	+0.0000%	Undefined	-6.2134% (0.0228)
OOS 15 Shocks, 42D	Strategy S1 Unconditional Dip-Buy	+8.5816%	+6.5319%	13.4166%	+0.6396	80.00%	-8.6675%	+2.4773 (0.0266)	+0.0000% (1.0000)
OOS 15 Shocks, 42D	Strategy S3 Quality Tech Q1	+6.5011%	+6.0031%	9.0596%	+0.7176	73.33%	-6.8420%	+2.7792 (0.0148)	-2.0804% (0.2444)
OOS 15 Shocks, 42D	Benchmark B1 Passive SPY	+4.2596%	+4.4729%	6.2321%	+0.6835	80.00%	-5.1027%	+2.6472 (0.0191)	-4.3219% (0.0480)
OOS 15 Shocks, 42D	Benchmark B0 Constant Zero Cash	+0.0000%	+0.0000%	0.0000%	Undefined	0.00%	+0.0000%	Undefined	-8.5816% (0.0266)

3.1 Multiple-Testing Corrections, Overlap-Free Attenuation, Turnover, Trading Frictions, and Conditional Strategy S5 Returns

We evaluate five diagnostic checks on Table 1: 1. **Family-Wise 20-Cell Bonferroni Correction and Underpowered Out-of-Sample Subsample Caveat:** Across 20 strategy-horizon cells ($\alpha = 0.05/20 = 0.0025$) on the 51-shock 15-day-cooldown sample, only 42-day Strategy S3 ($p = 0.0013$, Bonferroni $p = 0.0260$) and Strategy S1 ($p = 0.0023$, Bonferroni $p = 0.0460$) survive family-wise correction, whereas all other 18 cells—including 42D S4 ($p = 0.0047$, Bonferroni $p = 0.0940$), 42D S2 ($p = 0.0066$, Bonferroni $p = 0.1320$), 21D S1 ($p = 0.0242$, Bonferroni $p = 0.4840$), and 21D S3 ($p = 0.0359$, Bonferroni $p = 0.7180$)—do not survive 20-cell Bonferroni correction. Within the 2024–2026 Out-of-Sample cohort ($n = 15$ shocks, df $= 14$), statistical power is low (80%-power MDES at $\alpha = 0.05$ is ± 7.05 percentage points for Strategy S3 42D and ± 4.21 percentage points for Strategy S4 21D), 95% confidence intervals are wide ([+1.4841%, +11.5181%] for Strategy S3 42D and [+0.9769%, +6.9665%] for Strategy S4 21D), and no OOS mean (S4 21D $p = 0.0130$, Bonferroni $p = 0.2600$; S3 42D $p = 0.0148$, Bonferroni $p = 0.2960$; S5 5D $p = 0.0202$, Bonferroni $p = 0.4040$; S1 21D $p = 0.0228$, Bonferroni $p = 0.4560$) survives 20-cell Bonferroni correction; they are reported strictly as underpowered descriptive subsample summaries rather than out-of-sample statistical corroboration. 2. **Newey–West HAC Standard Errors vs. Strict 30-Day and 42-Day Non-Overlapping Subsample Attenuation:** Newey–West HAC standard errors with 3 shock lags (≥ 45 trading days) yield $t_{\text{HAC}} = +2.3718$ ($p_{\text{HAC}} = 0.0177$, $\text{SE}_{\text{HAC}} = 1.4342\%$) for 21D S1, $t_{\text{HAC}} = +2.9969$ ($p_{\text{HAC}} = 0.0027$, $\text{SE}_{\text{HAC}} = 2.0201\%$) for 42D S1, $t_{\text{HAC}} = +2.4035$ ($p_{\text{HAC}} = 0.0162$, $\text{SE}_{\text{HAC}} = 1.1687\%$) for 21D S3, and $t_{\text{HAC}} = +3.2759$ ($p_{\text{HAC}} = 0.0011$, $\text{SE}_{\text{HAC}} = 1.6407\%$) for 42D S3. On the strict 30-day

non-overlapping subsample (33 shocks), 42D S1 averages +6.5431% ($p = 0.0143$) and S3 averages +5.3850% ($p = 0.0168$), while 21D S1 attenuates to +3.4329% ($p = 0.0815$) and S3 to +2.4482% ($p = 0.1452$). Crucially, on the **strict 42-trading-day non-overlapping subsample (26 shocks)—the only subsample where zero 42-day return window overlap is mathematically possible—the Strategy S3 42-day mean attenuates to statistical insignificance (+3.8473%,** $t = +1.7539, p = 0.0917$**) and Strategy S1 is only marginally nominal (+5.5575%,** $t = +2.0619, p = 0.0498$), demonstrating that the Bonferroni-surviving $p = 0.0013$ for 42-day Strategy S3 on the 51-shock sample depends on partially overlapping 15-day-cooldown episodes. 3. **Equal-Weighted Quality Composite and Portfolio Turnover:** Equal one-third weights ($+1/3z_{\text{FCF}}, -1/3z_{\text{runup60}}, -1/3z_{\text{vol20}}$) yield a 42D S3 mean of +5.0735% (Gross Sharpe +0.4618, $p = 0.0018$) and a 21D mean of +2.6280% ($p = 0.0426$) across the 51 shocks. Across consecutive shocks, the 12-stock S3 basket has a mean one-way turnover of 38.05% (median 39.02%, or ~4.6 of 12 stocks replaced per shock). 4. **Stylized Transaction Cost and Risk-Free Rate Deductions (and Unmodeled Stress-Regime Market Impact):** Deducting a stylized 25-bps (0.25%) round-trip transaction cost per shock yields a net 42D S3 mean of +5.1248% (net Sharpe +0.4540, $t = +3.2419, p = 0.0021$) and a net 42D S1 mean of +5.8039% (net Sharpe +0.4307, $t = +3.0761, p = 0.0034$); further deducting a 2.5% annualized risk-free rate over 42 days (0.42%, total deduction 0.67%) yields an excess 42D S3 mean of +4.7048% (excess Sharpe +0.4168, $t = +2.9762, p = 0.0045$). In the 15-shock OOS cohort, deducting 25 bps and a 4.5% annualized Treasury bill rate (0.75% over 42D, 0.38% over 21D) yields an excess 42D S3 mean of +5.5011% (excess Sharpe +0.6072, $t = +2.3517, p = 0.0339$) and an excess 21D S4 mean of +3.3417% (excess Sharpe +0.6179, $t = +2.3933, p = 0.0313$). These fixed 25-bps and fixed risk-free rate deductions are stylized approximations that do not capture time-varying bid-ask spread widening, intraday depth contraction, or market impact when rebalancing equal-weighted 50-stock or 12-stock baskets during VIX ≥ 20 stress episodes. 5. **Conditional-on-Investment Performance of Strategy S5:** Strategy S5 holds 0.0000% cash in 21 of 51 shocks. Across the 30 active investment episodes, S5 averages +1.5374% (median +2.2662%, SD 4.1162%, Gross Sharpe +0.3735, win rate 70.00%, $t = +2.0458, p = 0.0499$) at 5D, +1.4977% (median +2.4924%, SD 6.6358%, Gross Sharpe +0.2257, win rate 66.67%, $t = +1.2362, p = 0.2263$) at 10D, +2.3298% (median +3.2279%, SD 7.7175%, Gross Sharpe +0.3019, win rate 70.00%, $t = +1.6535, p = 0.1090$) at 21D, and +3.5043% (median +5.0984%, SD 9.4597%, Gross Sharpe +0.3704, win rate 76.67%, $t = +2.0290, p = 0.0517$) at 42D. Because S5 holds 100% of S1 on all 30 active above-trend pullbacks (0.0000% paired difference) while sitting in cash during 21 below-200-DMA shocks (where S1 averages -0.5282% at 5D, +1.0063% at 10D, +4.9333% at 21D, and +9.6962% at 42D), the 30-episode conditional means reflect non-random regime selection rather than per-trade alpha over S1.

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4. Econometric Hypothesis Tests, Identification Controls, and Robustness

4.1 Macro Volatility Term Structure (21-Day Hypothesis H1 Refutation, 42-Day Non-Robustness) and High-VIX Stress-Day Control

Pre-registered Hypothesis H1 predicted that VIX backwardation ($\text{VIX}_{t_0}/\text{VIX3M}_{t_0} > 1.00$) would predict weaker 21D and 42D rebounds. Evaluating H1 with HC1 standard errors, Rademacher wild bootstrap inference [14], and median quantile regression ($q = 0.50$) refutes that prediction at 21 days (+8.9239%, $p = 0.0012$, wild bootstrap median $p = 0.0040$, median regression +8.0992%, $p = 0.0385$). At 42 days, the VIX backwardation effect is mean-driven and non-robust: median quantile regression is statistically null (+4.1238%, SE = 5.3824%, $t = +0.7662, p = 0.4474$) and Rademacher wild bootstrap inference is marginal ($p = 0.0520$), whereas the OLS mean slope

is +8.5005% (normal-approximation $p = 0.0295$). Excluding 2020 shocks (42 shocks) yields a 21D slope of +10.1888% ($p = 0.0003$) and a 42D slope of +9.1648% ($p = 0.0230$). Across the 51 shocks, $\text{VIX}_{t_0}/\text{VIX3M}_{t_0}$ has mean 0.9846, median 0.9788, SD 0.0818, and range 0.8432–1.2214 (span 0.3782); rescaling raw continuous slopes (+43.0855% at 21D, $p = 0.0505$; +49.3623% at 42D, $p = 0.0354$) gives +4.3085% per +0.10 ratio (+3.5236% per 1-SD) at 21D and +4.9362% per +0.10 ratio (+4.0369% per 1-SD) at 42D. Binary VIX ratio thresholds above 1.00 (+8.9239%, $p = 0.0012, n = 20$) and above 1.02 (+8.1888%, $p = 0.0154, n = 14$) attenuate at extreme inversion above 1.05 (+5.8908%, SE = 5.0545%, $p = 0.2438, n = 9$).

To test whether the aggregate index rebound (Strategy S1 and XLK) differs from general market-wide volatility spikes, we compare our 51 completed technology shocks against all 741 other high-VIX stress days from 2018 to 2026 (VIX $\geq$ 20.0 or single-day VIX jump $\geq$ +20.0%). Across all 792 sessions, 21-day XLK returns average +2.7350% after study shocks versus +3.0220% after the 741 other stress days (difference = -0.2870 percentage points, unadjusted Welch SE = 1.2647 percentage points, df = 54.86, $p = 0.8213$, 95% CI $[-2.8217, +2.2477]$ percentage points). Because consecutive stress days share overlapping 21-day windows and violate independence, valid overlap-free inference rests on the **66 non-overlapping 21-day-spaced stress episodes** (13 study shocks averaging +1.8873% vs. 53 other episodes averaging +2.3856%, difference = -0.4983 percentage points, Welch SE = 1.7344 percentage points, df = 21.64, Welch $p = 0.7766$, 95% CI $[-4.0988, +3.1021]$ percentage points) and the **matched 15-day cooldown control** (82 episodes, S1 21D +3.1653% vs. +3.4018%, diff = +0.2365 percentage points, $p = 0.8930$; 42D +6.6167% vs. +6.0539%, diff = -0.5628 percentage points, $p = 0.8071$). Because the valid overlap-free 66-episode test ($n = 13$ vs. $n = 53$) has low power and wide 95% confidence intervals ($[-4.0988, +3.1021]$ percentage points) encompassing economically meaningful premia, this non-significant difference represents **absence of statistically significant evidence of a technology-specific index rebound premium** rather than positive proof of equivalence.

4.2 Unconditional Hypothesis H2 Refutation and Ex-Post Regime-Conditional Quality Sorting Under Multiway Clustering

In our stock-shock panel (2,469 rows across 50 firms and 51 independent macro shocks), effective degrees of freedom are bounded by the number of firms and shocks in each specification rather than the pooled row count. We therefore compute one-way firm-clustered (G firms), one-way shock-clustered (K shocks), and nonnested two-way firm-by-shock cluster-robust standard errors evaluated against the t-distribution with df $= \min(G, K) - 1$ degrees of freedom [15] [14] for each specification's exact cluster dimensions: df $= \min(50, 51) - 1 = 49$ on the full 50-firm by 51-shock panel, df $= \min(43, 51) - 1 = 42$ on the balanced 43-firm by 51-shock panel, and df $= \min(50, 33) - 1 = 32$ on the strict 30-day non-overlapping 50-firm by 33-shock subsample. Table 2 summarizes the pre-registered unconditional pooled model alongside the ex-post regime-interaction and robustness specifications for Hypothesis H2 (reporting both firm-clustered p_{firm} and two-way CGM p_{CGM} with each row's exact two-way degrees of freedom df):

Specification (2,469 rows unless noted)	Top-Quartile / Composite Quality (21D)	Quality x Backwardation (21D)	Top-Quartile / Composite Quality (42D)	Quality x Backwardation (42D)
Pre-Registered Unconditional Pooled Quality (Refuted)	+0.7052% ($p_{\text{firm}} = 0.1914$)	—	+1.0618% ($p_{\text{firm}} = 0.1656$)	—

Specification (2,469 rows unless noted)	Top-Quartile / Composite Quality (21D)	Quality x Backwardation (21D)	Top-Quartile / Composite Quality (42D)	Quality x Backwardation (42D)
Ex-Post Interaction (Firm-Clustered, 50 Firms)	+2.7974% ($p_{\text{firm}} = 0.0002$)	-4.0546% ($p_{\text{firm}} = 0.0019$)	+4.6123% ($p_{\text{firm}} < 0.0001$)	-5.7906% ($p_{\text{firm}} = 0.0001$)
Ex-Post Interaction (Shock-Clustered, 51 Shocks)	+2.7974% ($p_{\text{shock}} = 0.0077$)	-4.0546% ($p_{\text{shock}} = 0.0025$)	+4.6123% ($p_{\text{shock}} = 0.0017$)	-5.7906% ($p_{\text{shock}} = 0.0047$)
Ex-Post Interaction (CGM Two-Way, df = 49)	+2.7974% ($p_{\text{CGM}} = 0.0110$)	-4.0546% ($p_{\text{CGM}} = 0.0065$)	+4.6123% ($p_{\text{CGM}} = 0.0044$)	-5.7906% ($p_{\text{CGM}} = 0.0036$)
Equal-Weighted Quality ($+1/3, -1/3, -1/3$, df = 49)	+2.8285% ($p_{\text{firm}} = 0.0002, p_{\text{CGM}} = 0.0143$)	-4.5587% ($p_{\text{firm}} = 0.0005, p_{\text{CGM}} = 0.0031$)	+4.5139% ($p_{\text{firm}} < 0.0001, p_{\text{CGM}} = 0.0063$)	-6.1594% ($p_{\text{firm}} = 0.0001, p_{\text{CGM}} = 0.0046$)
Two-Way Fixed Effects (Firm + Shock Fixed Effects)	+2.2733% ($p_{\text{firm}} = 0.0035$)	-3.9757% ($p_{\text{firm}} = 0.0006$)	+4.1216% ($p_{\text{firm}} = 0.0001$)	-5.7154% ($p_{\text{firm}} = 0.0002$)
Balanced Continuously Traded Panel (43 Firms, 51 Shocks, df = 42, 2,193 Rows)	+2.5455% ($p_{\text{firm}} = 0.0012, p_{\text{CGM}} = 0.0080$)	-2.8410% ($p_{\text{firm}} = 0.0310, p_{\text{CGM}} = 0.0335$)	+4.3759% ($p_{\text{firm}} = 0.0001, p_{\text{CGM}} = 0.0027$)	-4.3325% ($p_{\text{firm}} = 0.0039, p_{\text{CGM}} = 0.0071$)
Strict 30-Day Non-Overlapping (50 Firms, 33 Shocks, df = 32, 1,594 Rows)	+1.6922% ($p_{\text{firm}} = 0.0975, p_{\text{CGM}} = 0.2602$)	-3.8402% ($p_{\text{firm}} = 0.0220, p_{\text{CGM}} = 0.0565$)	+3.4025% ($p_{\text{firm}} = 0.0077, p_{\text{CGM}} = 0.0360$)	-5.3831% ($p_{\text{firm}} = 0.0100, p_{\text{CGM}} = 0.0420$)
Purely Dynamic Quality (Zero Static Cash-Flow Tier, df = 49)	+1.6696% ($p_{\text{firm}} = 0.0093, p_{\text{CGM}} = 0.0572$)	-2.1850% ($p_{\text{firm}} = 0.1001, p_{\text{CGM}} = 0.1561$)	+3.0147% ($p_{\text{firm}} = 0.0068, p_{\text{CGM}} = 0.0425$)	-3.7621% ($p_{\text{firm}} = 0.0266, p_{\text{CGM}} = 0.0955$)
Balanced 43 Firms + Purely Dynamic (43 Firms, 51 Shocks, df = 42, 2,193 Rows)	+1.8755% ($p_{\text{firm}} = 0.0062, p_{\text{CGM}} = 0.0376$)	-2.7559% ($p_{\text{firm}} = 0.0246, p_{\text{CGM}} = 0.0944$)	+3.0977% ($p_{\text{firm}} = 0.0096, p_{\text{CGM}} = 0.0431$)	-4.2191% ($p_{\text{firm}} = 0.0074, p_{\text{CGM}} = 0.0696$)

Table 2 establishes four transparent empirical properties and methodological boundaries: 1. **Refutation of Unconditional Pooled Hypothesis H2, Ex-Post Selection of the VIX-Backwardation Interaction, and 36-Test Family-Wise Bonferroni Failure:** In the pre-registered unconditional pooled specification across all 2,469 observations, the composite quality score is statistically null (+0.7052%, $p = 0.1914$ at 21 days; +1.0618%, $p = 0.1656$ at 42 days), refuting unconditional quality outperformance across all sell-offs. Crucially, **conditioning Hypothesis H2 on the VIX-backwardation regime was introduced ex post after observing the unconditional pooled null and after observing that VIX backwardation proxies for acute market-wide stress in Hypoth-**

esis H1, and Table 2 evaluates 36 post-hoc interaction coefficients across its 9 interaction rows (9 specifications times 4 coefficients, family-wise Bonferroni threshold $\alpha = 0.05/36 = 0.0014$). Under two-way firm-by-shock cluster-robust inference (p_{CGM}), none of the 36 post-hoc regime-interaction coefficients in Table 2 survives a 36-test family-wise Bonferroni correction—including the baseline 21-day quality coefficient (+2.7974%, two-way df $= 49, p_{\text{CGM}} = 0.0110$, 36-test Bonferroni $p = 0.3960$), the 21-day interaction (-4.0546%, two-way df $= 49, p_{\text{CGM}} = 0.0065$, 36-test Bonferroni $p = 0.2340$), the baseline 42-day quality coefficient (+4.6123%, two-way df $= 49, p_{\text{CGM}} = 0.0044$, 36-test Bonferroni $p = 0.1584$), the 42-day interaction (-5.7906%, two-way df $= 49, p_{\text{CGM}} = 0.0036$, 36-test Bonferroni $p = 0.1296$), and the strict 30-day non-overlapping 42-day subsample (+3.4025%, two-way df $= 32, p_{\text{CGM}} = 0.0360$, 36-test Bonferroni $p = 1.0000$). Thus, all Table 2 regime-interaction estimates must be interpreted as exploratory ex-post decompositions that do not survive family-wise multiple-testing correction. 2. **Insensitivity to Quality Weight Selection:** Replacing the baseline $(0.45, -0.30, -0.25)$ weights with equal weights $(+1/3, -1/3, -1/3)$ leaves the unadjusted non-backwardation quality coefficient and interaction similar at +2.8285% (two-way df $= 49, p_{\text{CGM}} = 0.0143$, 36-test Bonferroni $p = 0.5148$) and -4.5587% (two-way df $= 49, p_{\text{CGM}} = 0.0031$, 36-test Bonferroni $p = 0.1116$) over 21 days, and +4.5139% (two-way df $= 49, p_{\text{CGM}} = 0.0063$, 36-test Bonferroni $p = 0.2268$) and -6.1594% (two-way df $= 49, p_{\text{CGM}} = 0.0046$, 36-test Bonferroni $p = 0.1656$) over 42 days. 3. **Two-Way Fixed Effects and 21-Day Fragility Under Purely Dynamic Rankings:** Absorbing time-invariant firm differences among the 50 surviving firms via two-way fixed effects yields +2.2733% ($p = 0.0035$) at 21 days and +4.1216% ($p = 0.0001$) at 42 days. However, dropping the static cash-flow tier entirely (purely dynamic quality) halves the point estimate and renders the 21-day effect statistically null under two-way clustering (+1.6696%, firm-clustered $p = 0.0093$, two-way df $= 49, p_{\text{CGM}} = 0.0572$, with the 21-day interaction attenuating to -2.1850%, firm $p = 0.1001$, two-way df $= 49, p_{\text{CGM}} = 0.1561$) and leaves the 42-day slope only nominally significant before multiple-testing correction (+3.0147%, firm-clustered $p = 0.0068$, two-way df $= 49, p_{\text{CGM}} = 0.0425$, 36-test Bonferroni $p = 1.0000$; interaction -3.7621%, firm $p = 0.0266$, two-way df $= 49, p_{\text{CGM}} = 0.0955$). 4. **Attenuation at 21 Days and Non-Significance After Multiple-Testing Correction on the Strict 30-Day Non-Overlapping Subsample (df $= 32$):** On the strict 30-trading-day non-overlapping subsample ($G = 50$ firms across $K = 33$ shocks, 1,594 rows, where two-way degrees of freedom are df $= \min(50, 33) - 1 = 32$), the 21-day non-backwardation quality coefficient attenuates to statistical insignificance (+1.6922%, firm-clustered $p = 0.0975$, two-way standard error = 1.4757%, $t = +1.1468, \text{df} = 32, p_{\text{CGM}} = 0.2602$; interaction -3.8402%, firm-clustered $p = 0.0220$, two-way standard error = 1.9403%, $t = -1.9792, \text{df} = 32, p_{\text{CGM}} = 0.0565$), while the 42-day non-backwardation quality coefficient (+3.4025%, firm-clustered $p = 0.0077$, two-way standard error = 1.5547%, $t = +2.1885, \text{df} = 32, p_{\text{CGM}} = 0.0360$) and 42-day backwardation interaction (-5.3831%, firm-clustered $p = 0.0100$, two-way standard error = 2.5415%, $t = -2.1181, \text{df} = 32, p_{\text{CGM}} = 0.0420$) do not survive 36-test Bonferroni correction (Bonferroni $p = 1.0000$).

4.3 Barbell Regime Conditioning (Hypotheses H3a and H3b), Intraday Microstructure (Hypothesis H4a), and Narrative Regime Collinearity (Hypothesis H4b)

Hypotheses H3a and H3b (Reconciling Full-Sample Refutation with Regime-Conditional Buffering): In Hypothesis H3a, the full-sample paired comparison across all 51 shocks refutes unconditional downside protection: Strategy S4 underperforms Strategy S1 by -1.3947 percentage points ($t = -2.0019, p = 0.0507$, Wilcoxon $p = 0.0535$, worst drawdown -23.9923% vs. -17.2025%) at 21 days and -2.3072 percentage points ($t = -2.1937, p = 0.0329$, Wilcoxon $p = 0.0690$) at 42 days. Partitioning the 51 shocks by the VIX term structure (Hypothesis H3b, where the VIX backwarda-

tion slope on S4 − S1 is -4.9522%, standard error = 1.2483%, $t = -3.9672, p = 0.0001$) explains the divergence between the full sample and the 2024–2026 Out-of-Sample cohort: - Across the 20 VIX-backwardation liquidations (including February–March 2020), utilities and industrials sold off simultaneously with technology and lagged the subsequent high-beta snapback, causing Strategy S4 to underperform Strategy S1 by -4.5607 percentage points ($p = 0.0001$) at 21 days (worst drawdown -23.9923% vs. -16.2365%) and -6.1134 percentage points ($p = 0.0035$) at 42 days. - Across the 31 non-backwardation pullbacks, Strategy S4 matches Strategy S1 in mean return (+0.6479 percentage points, $p = 0.4180$ at 21 days; +0.1484 percentage points, $p = 0.8908$ at 42 days) while reducing worst-case 21-day drawdown by 5.8305 percentage points (-11.3720% vs. -17.2025%). Because the 15-shock Out-of-Sample cohort (2024–2026) contains predominantly sector-rotation and non-backwardation pullbacks rather than a March-2020-style cross-asset liquidation, Strategy S4 reduced worst-case 21-day loss to -3.9381% versus -9.0800% in that 15-shock window (paired mean difference -2.2417 percentage points, $p = 0.1236$).

Hypothesis H4a (Auxiliary Background Note on Hourly Intraday Microstructure Across 716 Trading Days from December 20, 2023 to November 6, 2026): As an auxiliary background check on execution timing, we examined the 716 full regular-hours trading sessions (≥ 6 hourly bars per session between 09:30 and 16:00 ET, excluding 9 shortened holiday half-days) available in the maximum 725-trading-day Yahoo Finance 1-hour API window from December 20, 2023 through November 6, 2026. Across those 716 trading days, first-hour XLK return (09:30 to 10:30 ET) exhibits near-zero linear correlation with rest-of-day return from 10:30 to 16:00 ET ($r = +0.0357, p = 0.3401$), and across the 122 sell-off mornings in which XLK drops at or below -1.00% during the first hour (mean first-hour return = -1.8428%), rest-of-day XLK returns average -0.0362% and continue lower 50.00% of the time. Because the underlying 716-day 1-hour XLK bar series was summarized at ingestion time rather than included as a raw CSV in the three released daily panel files, these intraday figures cannot be rederived from the three released daily CSV files and are reported strictly as an unverified auxiliary background note outside the 14 verified daily-panel claims.

Hypothesis H4b (Exploratory Narrative Regime Salience and Calendar-Era Collinearity): In Hypothesis H4b, while LLM-scored interest-rate and inflation salience has a nominal slope of +10.0770% ($p = 0.0113$) on the 21-day Top-minus-Bottom Quartile quality spread (and artificial-intelligence capex salience is null at -1.0958%, $p = 0.8388$), interest-rate salience is derived from retrospective calendar-era dossier strings and exhibits $r = 0.8599$ correlation with the 2021–2023 rate-hiking era indicator; adding that calendar indicator reduces the interest-rate salience slope to +1.1577% ($p = 0.8502$). Thus, Hypothesis H4b is an exploratory retrospective era description rather than an ex-ante text signal.

4.4 Live Event Anatomy: The November 5, 2026 Post-Midterm Tech Sell-Off and Official November 6, 2026 Close

On November 5, 2026 (focal live shock episode 53, occurring 14 trading days after the incomplete October 16, 2026 episode), XLK fell -8.0000%, SMH fell -11.2122%, QQQ fell -6.4889%, SPY fell -4.4092%, RSP fell -2.8926% (a technology-minus-equal-weight rotation gap of -5.1074%), XLU fell -0.7108%, and XLI fell -4.1249%, while VIX jumped +69.6568% to 28.1800 against VIX3M at 25.5500 (VIX/VIX3M = 1.1029, backwardation indicator = 1, below-200-DMA indicator = 1, technology-rotation indicator = 1). At the November 5, 2026 close, the Strategy S3 Top-Quartile Quality basket (12 stocks: CSCO, AMAT, AVGO, LRCX, KLAC, GOOGL, ADBE, IBM, ANET, PANW, CDNS, ADI) and Bottom-Quartile Extended basket (12 stocks: TTD, INTC, PLTR, MRVL, APP, DDOG, HUBS, TSLA, CRWD, AMD, TEAM, ZS) were locked ex-ante. On Day+1 (official 16:00 ET close

on November 6, 2026, when VIX settled at 25.6400 and VIX3M at 24.6000, ratio 1.0423), Strategy S3 Top-Quartile Quality gained +2.1203% and Bottom-Quartile Extended gained +2.0051% (Day+1 spread +0.1152 percentage points, Welch $t = +0.0491, p = 0.9614$), compared with +1.4634% for Strategy S1 (50-stock equal-weight), +1.4534% for XLK, +0.9522% for Strategy S4 Barbell, +0.3124% for Benchmark B1 Passive SPY, and 0.0000% cash for Strategies S2, S5, and Benchmark B0. With only $n = 12$ stocks per quartile on a single trading day, this Day+1 Welch test has minimal statistical power and is presented strictly as a descriptive single-episode illustration that is uninformative for generalizing multi-week regime-conditional quality effects.

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5. Limitations and Scope Summary

1. **Absence of Evidence in High-VIX Stress Control vs. Ex-Post Regime-Conditional Quality Decomposition:** In the non-technology high-VIX stress-day control, the 21-day XLK rebound following study technology shocks does not differ significantly from other high-VIX stress days (-0.2870 percentage points, unadjusted Welch $p = 0.8213$, 95% confidence interval $[-2.8217, +2.2477]$ percentage points across all 792 sessions; and -0.4983 percentage points, Welch $p = 0.7766$, 95% confidence interval $[-4.0988, +3.1021]$ percentage points across the 66 non-overlapping 21-day-spaced stress episodes). Because the valid overlap-free 66-episode test ($n = 13$ vs. $n = 53$) has low statistical power and wide confidence intervals that include large positive or negative premia, this result establishes **absence of statistically significant evidence of a technology-specific index rebound premium** rather than positive proof of equivalence. Within the technology sector, the pre-registered unconditional pooled Hypothesis H2 is also statistically null (+0.7052%, $p = 0.1914$ at 21 days; +1.0618%, $p = 0.1656$ at 42 days); cross-sectional quality outperformance (+2.7974%, two-way CGM df = 49, $p = 0.0110$ at 21 days and +4.6123%, two-way CGM df = 49, $p = 0.0044$ at 42 days during non-backwardation pullbacks, vs. -4.0546% and -5.7906% interactions during VIX-backwardation snapbacks) emerges only after conditioning on the VIX-backwardation indicator, which was selected ex post after observing the unconditional null, and none of the 36 two-way clustered interaction p-values in Table 2 survives a 36-test family-wise Bonferroni correction ($\alpha = 0.0014$).
2. **Stock-Level Delisted-Firm Survivorship Bias, Stylized Cost Deductions, Subsample Degrees of Freedom, and Unreleased Intraday Bars:** While dynamically rebalanced XLK (+2.7350%, $p = 0.0315$ at 21D; +4.6364%, $p = 0.0051$ at 42D) validates index-level dip-buying without constituent look-ahead bias, **all stock-level cross-sectional quality sorts (including the balanced 43-firm continuously traded panel and two-way fixed effects) remain conditioned on survival to the November 2026 50-firm universe lock, leaving delisted-firm survivorship bias for cross-sectional quality sorting unaddressed**. Moreover, on the strict 30-day non-overlapping subsample ($G = 50$ firms, $K = 33$ shocks, df = $\min(50, 33) - 1 = 32$, 1,594 rows) and under purely dynamic quality, the 21-day quality coefficient attenuates to statistical insignificance (+1.6922%, two-way df = 32, $p = 0.2602$; +1.6696%, two-way df = 49, $p = 0.0572$), and the 42-day non-overlapping slope (+3.4025%, two-way SE = 1.5547%, $t = +2.1885$, df = 32, $p = 0.0360$) does not survive 36-test Bonferroni correction. In addition, the fixed 25-basis-point transaction cost and fixed 2.5%/4.5% risk-free rate deductions are stylized approximations that ignore time-varying bid-ask spread widening and market impact during VIX ≥ 20 stress episodes. Similarly, because the 716-day 1-hour XLK bar series from the trailing Yahoo Finance API window (December 20, 2023 to November

6, 2026) is not included in the three released daily CSV files, the Hypothesis H4a intraday analysis ($r = +0.0357, p = 0.3401$) is reported strictly as an unverified auxiliary background check outside the 14 verified daily-panel claims.

3. **Multiple Testing, Strict 42-Day Overlap-Free Attenuation, Underpowered Out-of-Sample Means, and Pre-Registered Hypothesis Tests:** Across the 20 strategy-horizon cells in Table 1, only the 42-day full-sample returns of Strategy S3 ($p = 0.0013$, Bonferroni $p = 0.0260$, HAC $p = 0.0011$) and Strategy S1 ($p = 0.0023$, Bonferroni $p = 0.0460$, HAC $p = 0.0027$) survive the 20-test Bonferroni threshold ($\alpha = 0.0025$) on the 51-shock 15-day-cooldown sample, **and on the strict 42-trading-day non-overlapping subsample of 26 shocks (where zero 42-day window overlap is possible), Strategy S3 attenuates to statistical insignificance (+3.8473%,** $t = +1.7539, p = 0.0917$**) and Strategy S1 is only marginally nominal (+5.5575%,** $t = +2.0619, p = 0.0498$**)**, while the 15-shock Out-of-Sample cohort means (Strategy S3 42D +6.5011%, $p = 0.0148$, Bonferroni $p = 0.2960$, MDES $\pm$7.05%; Strategy S4 21D +3.9717%, $p = 0.0130$, Bonferroni $p = 0.2600$, MDES $\pm$4.21%) are underpowered descriptive summaries that do not survive 20-cell Bonferroni correction. Across the three pre-registered unconditional hypotheses, (i) Hypothesis H1 is refuted at 21 days (where VIX backwardation predicts higher 21-day rebounds at +8.9239%, $p = 0.0012$, wild bootstrap $p = 0.0040$, median regression +8.0992%, $p = 0.0385$) while at 42 days the VIX backwardation effect is mean-driven and not robust (OLS +8.5005%, $p = 0.0295$, vs. Rademacher wild bootstrap median $p = 0.0520$ and a statistically null median quantile regression slope of +4.1238%, $p = 0.4474$), (ii) unconditional pooled Hypothesis H2 is refuted (+0.7052%, $p = 0.1914$ at 21 days and +1.0618%, $p = 0.1656$ at 42 days), and (iii) unconditional paired Hypothesis H3a is refuted (-1.3947 percentage points, $p = 0.0507$ at 21 days and -2.3072 percentage points, $p = 0.0329$ at 42 days), alongside the exploratory calendar-era collinearity of Hypothesis H4b ($r = 0.8599$).

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