

External appendix for “The decline of the S&P 500 variance risk premium”

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1 Returns scaled by the underlying

The main text reports option returns scaled by the initial option price. This appendix presents results for returns scaled instead by the level of the underlying (the S&P 500 index), as in Büchner and Kelly (2022). For the put, straddle, delta-hedged put, and delta-hedged straddle, the return is the excess payoff divided by the underlying at the beginning of the holding period. For the variance-swap proxy, the return is $RV_t - VIX_{t-1}^2$ in annualized variance units.

Figures 1 and 2 replicate the bar charts from the main text, Figure 3 shows cumulative returns and alphas, and table 1 reports the structural break tests, all using underlying-scaled returns.

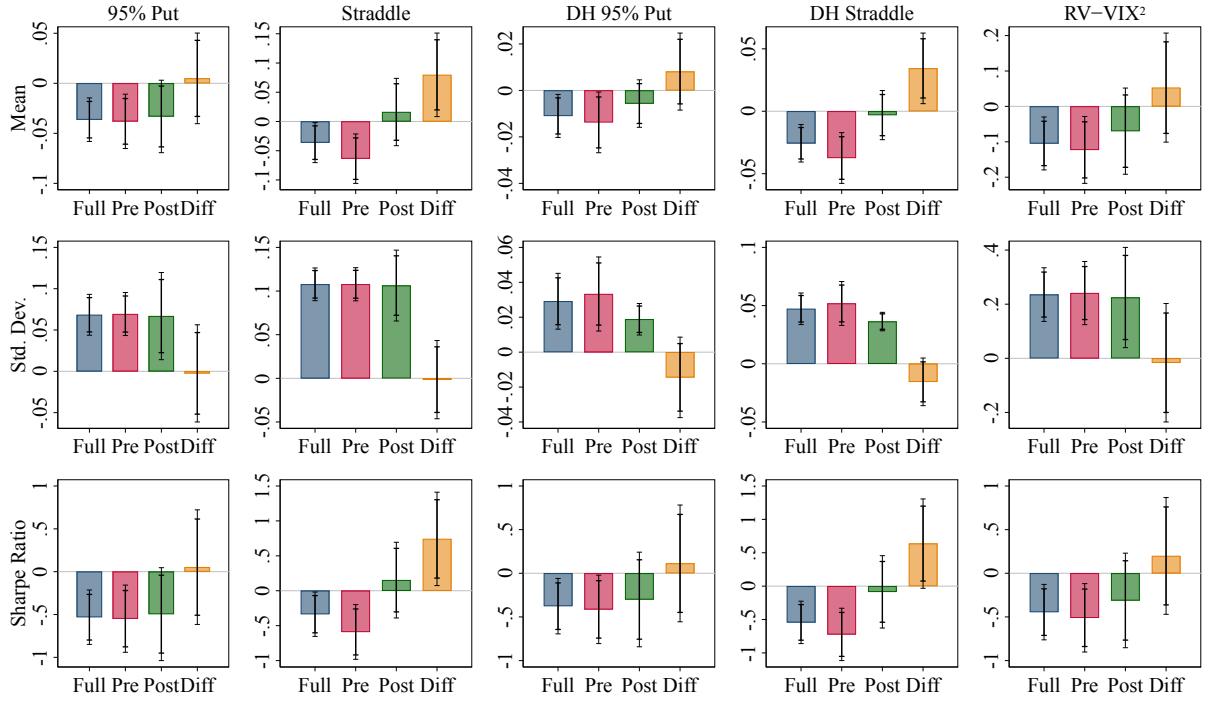
2 Results across strikes

This appendix reports results for individual option contracts at four strikes: -10% , -6% , -2% , and $+2\%$ relative to spot. For strikes below the spot, returns are computed from puts; for the $+2\%$ strike, returns are from calls.

Figures 4 and 5 report means, standard deviations, Sharpe ratios, CAPM alphas, betas, and information ratios for the four strikes, with pre/post comparisons around the August 2012 break date. Figures 6 and 7 present the same statistics for delta-hedged returns. Figure 8 plots HL break-test p -values across five strikes (the four above plus ATM) for both unhedged and delta-hedged returns. All returns are scaled by the initial option price.

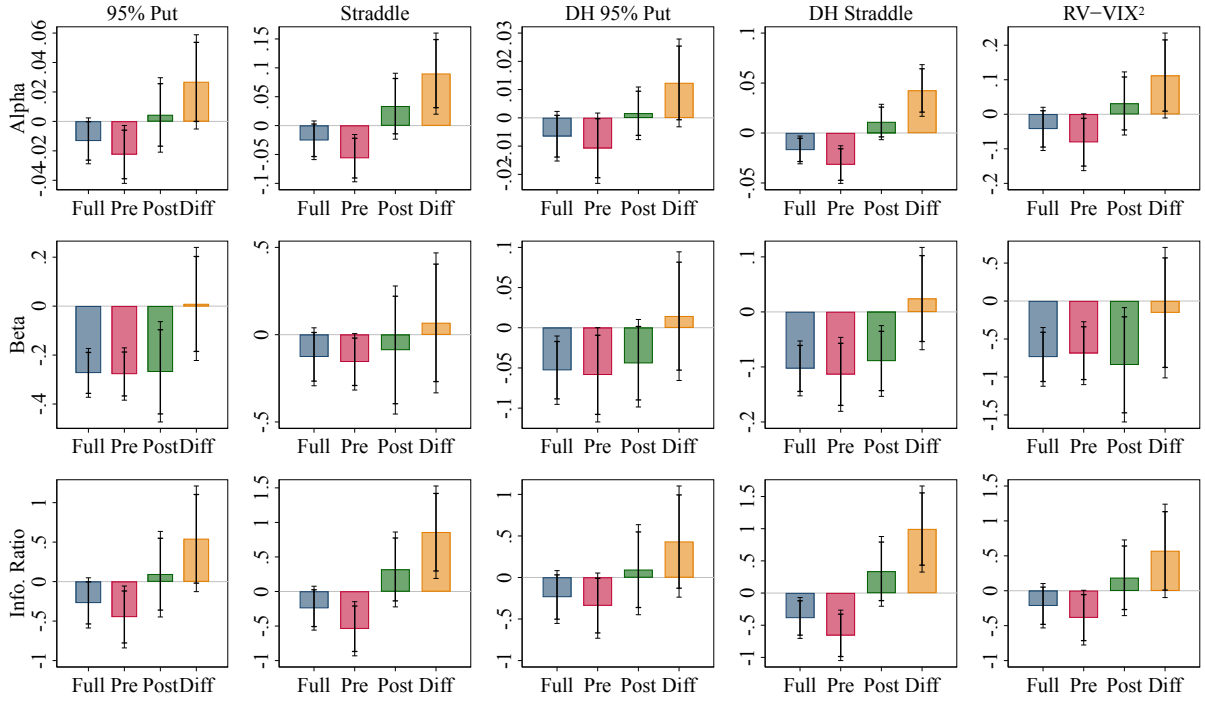
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Figure 1: Mean, standard deviation, and Sharpe ratio: underlying-scaled returns



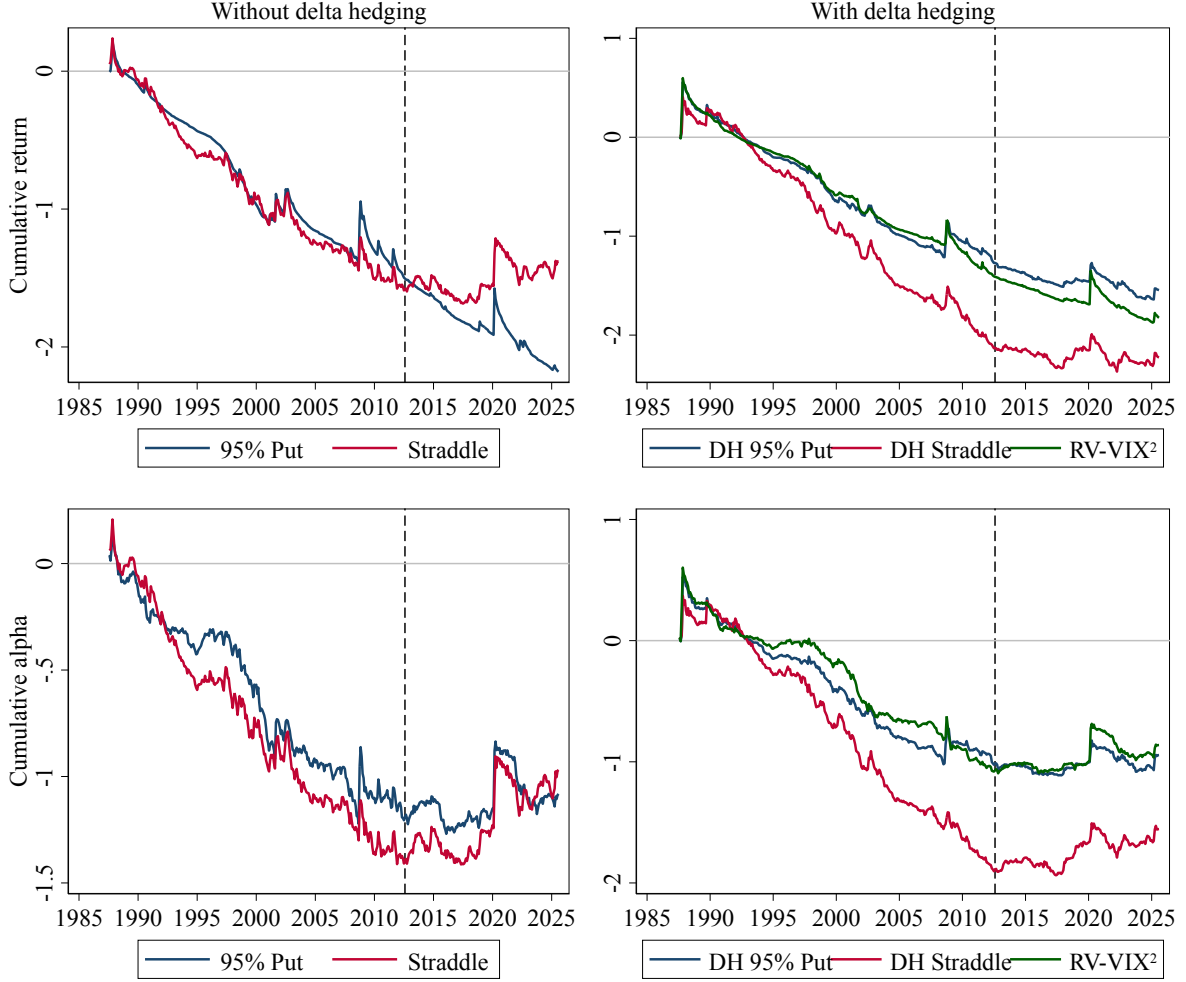
Note: Means, standard deviations, and Sharpe ratios for five option strategies with returns scaled by the underlying ($RV_t - VIX_{t-1}^2$ for the variance-swap series). Bars show full sample (navy), pre-break (red), post-break (green), and post – pre difference (orange). Whiskers show 90% (thick) and 95% (thin) confidence intervals. The break date is August 2012.

Figure 2: Alpha, beta, and information ratio: underlying-scaled returns



Note: CAPM alphas, betas, and information ratios for five option strategies with returns scaled by the underlying ($RV_t - VIX_{t-1}^2$ for the variance-swap series). Bars show full sample (navy), pre-break (red), post-break (green), and post – pre difference (orange). Whiskers show 90% (thick) and 95% (thin) confidence intervals. Alphas and betas use a full-sample CAPM regression. The break date is August 2012.

Figure 3: Cumulative returns and alphas: underlying-scaled returns



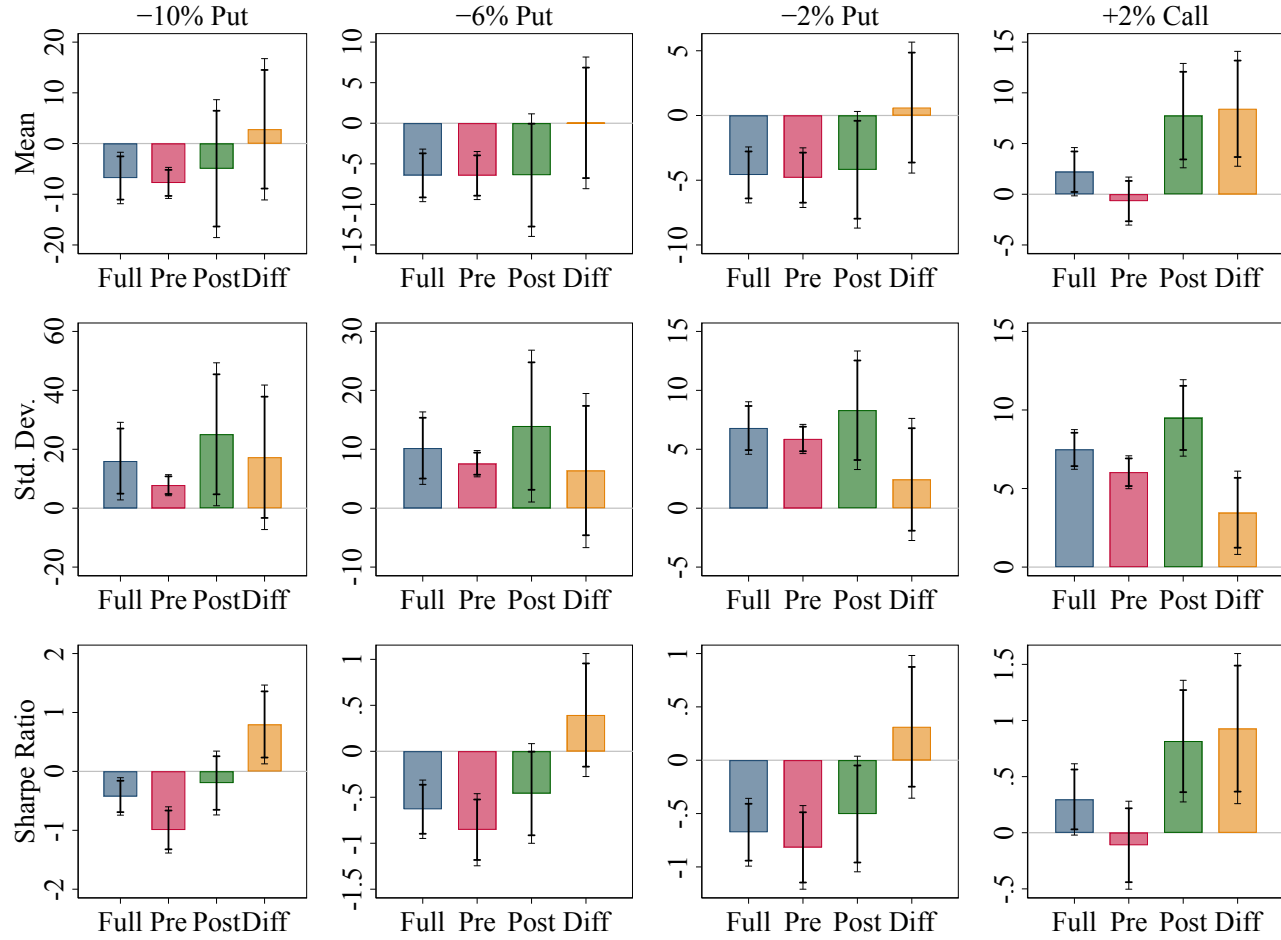
Note: Top panels show cumulative returns and bottom panels show cumulative CAPM alphas for the five option strategies, with returns scaled by the underlying ($RV_t - VIX_{t-1}^2$ for the variance-swap series). Cumulation is done by simple summation. Left panels show strategies without delta hedging (95% put and ATM straddle) and right panels show delta-hedged strategies. All series are standardized to have the same monthly standard deviation as the straddle before cumulating. The dashed vertical line marks August 2012.

Table 1: Break tests for option strategy returns: underlying scaling

		Change	<i>p</i> -value	Date
<i>Panel A: Beta-adjusted returns</i>				
95% Put	Fixed date	0.0022	0.10	8/2012
	HL	0.0023	0.16	12/2012
	Andrews	0.0026	0.28	10/2008
Straddle	Fixed date	0.0075	0.01	8/2012
	HL	0.0072	0.01	1/2010
	Andrews	0.0075	0.05	1/2012
DH 95% Put	Fixed date	0.0010	0.12	8/2012
	HL	0.0012	<0.01	8/2008
	Andrews	0.0012	0.32	3/2016
DH Straddle	Fixed date	0.0035	<0.01	8/2012
	HL	0.0035	<0.01	8/2012
	Andrews	0.0035	0.01	8/2012
RV – VIX ²	Fixed date	0.0093	0.07	8/2012
	HL	0.0080	<0.01	9/2010
	Andrews	0.0096	0.35	12/2012
<i>Panel B: Raw returns</i>				
95% Put	Fixed date	0.0004	0.83	8/2012
	HL	0.0000	0.08	1/1997
	Andrews	0.0020	1.00	3/2001
Straddle	Fixed date	0.0066	0.03	8/2012
	HL	0.0063	0.03	1/2010
	Andrews	0.0066	0.09	1/2012
DH 95% Put	Fixed date	0.0007	0.34	8/2012
	HL	0.0008	<0.01	12/2012
	Andrews	0.0009	0.66	9/2015
DH Straddle	Fixed date	0.0029	0.02	8/2012
	HL	0.0029	<0.01	8/2012
	Andrews	0.0029	0.11	11/2012
RV – VIX ²	Fixed date	0.0044	0.50	8/2012
	HL	−0.3386	0.02	12/1987
	Andrews	0.0046	1.00	2/2013

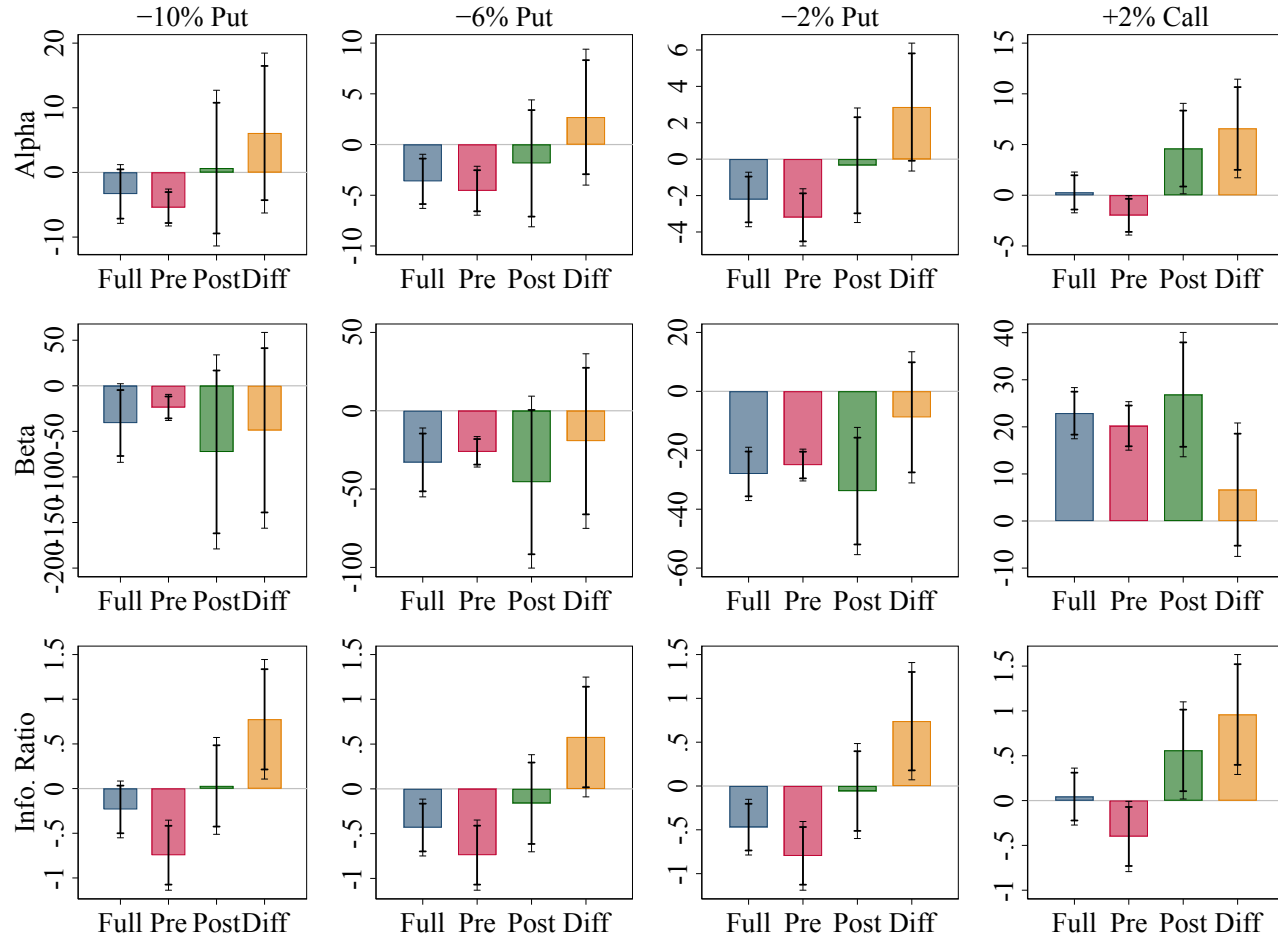
Note: Each panel reports results from three break tests for each of the five strategies, using returns scaled by the underlying. *Fixed date* is a Wald test (HC-robust) for a shift in the mean at the known break date of August 2012. *HL* is the Hodges–Lehmann test of Dehling, Fried, and Wendler (2020), which estimates the break date endogenously. *AP* is the Andrews–Ploberger (1994) exponential-Wald statistic. “Change” is the estimated shift in the monthly mean return. “Date” is the estimated or assumed break date. Panel A uses beta-adjusted returns (subtracting the full-sample CAPM beta times the market return); Panel B uses raw returns.

Figure 4: Mean, standard deviation, and Sharpe ratio across strikes



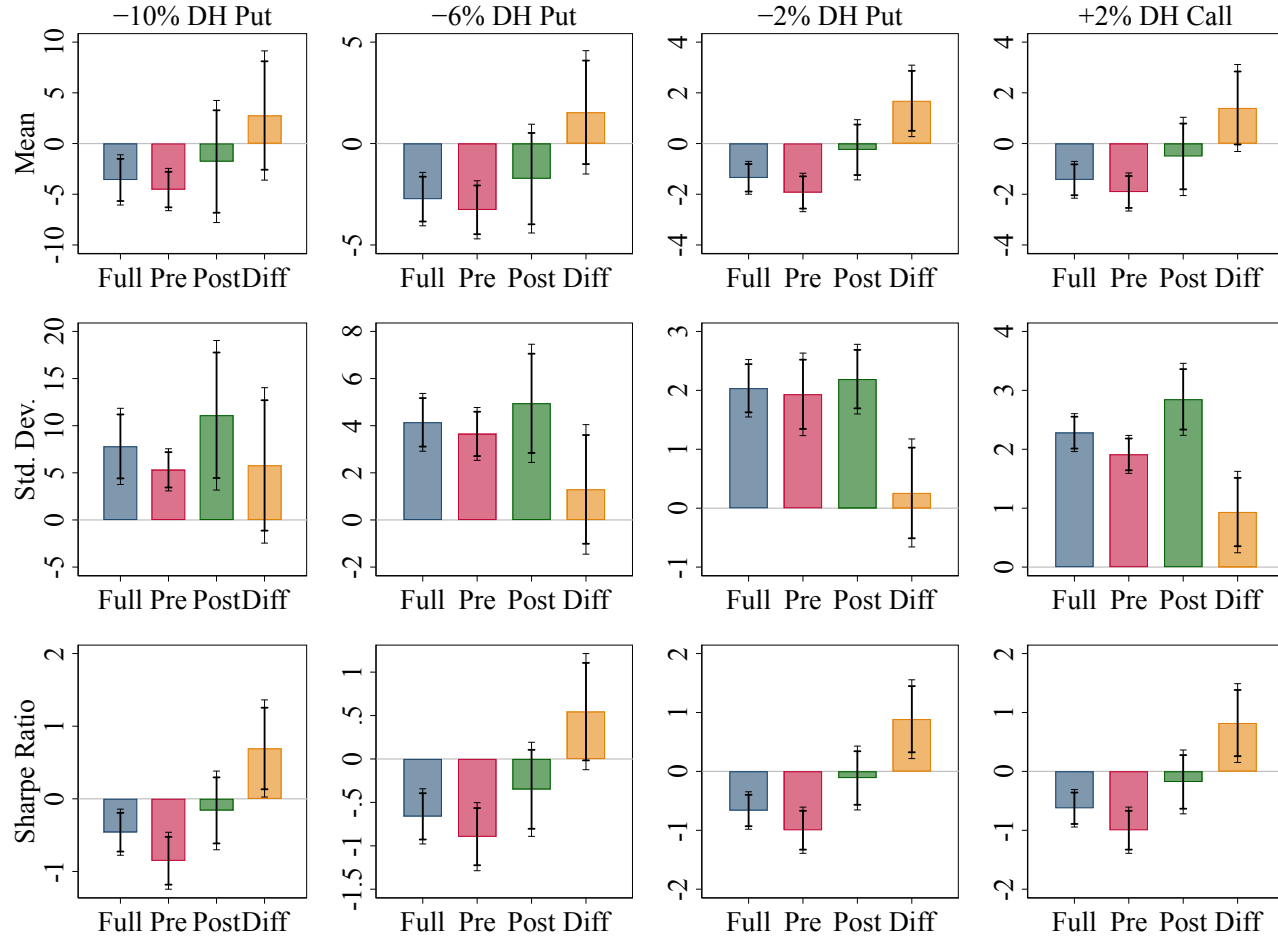
Note: Means, standard deviations, and Sharpe ratios for traded options at four strikes (-10% , -6% , -2% , and $+2\%$), with returns scaled by the initial option price. For strikes below ATM, returns are from puts; above ATM, from calls. Bars show full sample (navy), pre-break (red), post-break (green), and post – pre difference (orange). Whiskers show 90% (thick) and 95% (thin) confidence intervals. The break date is August 2012.

Figure 5: Alpha, beta, and information ratio across strikes



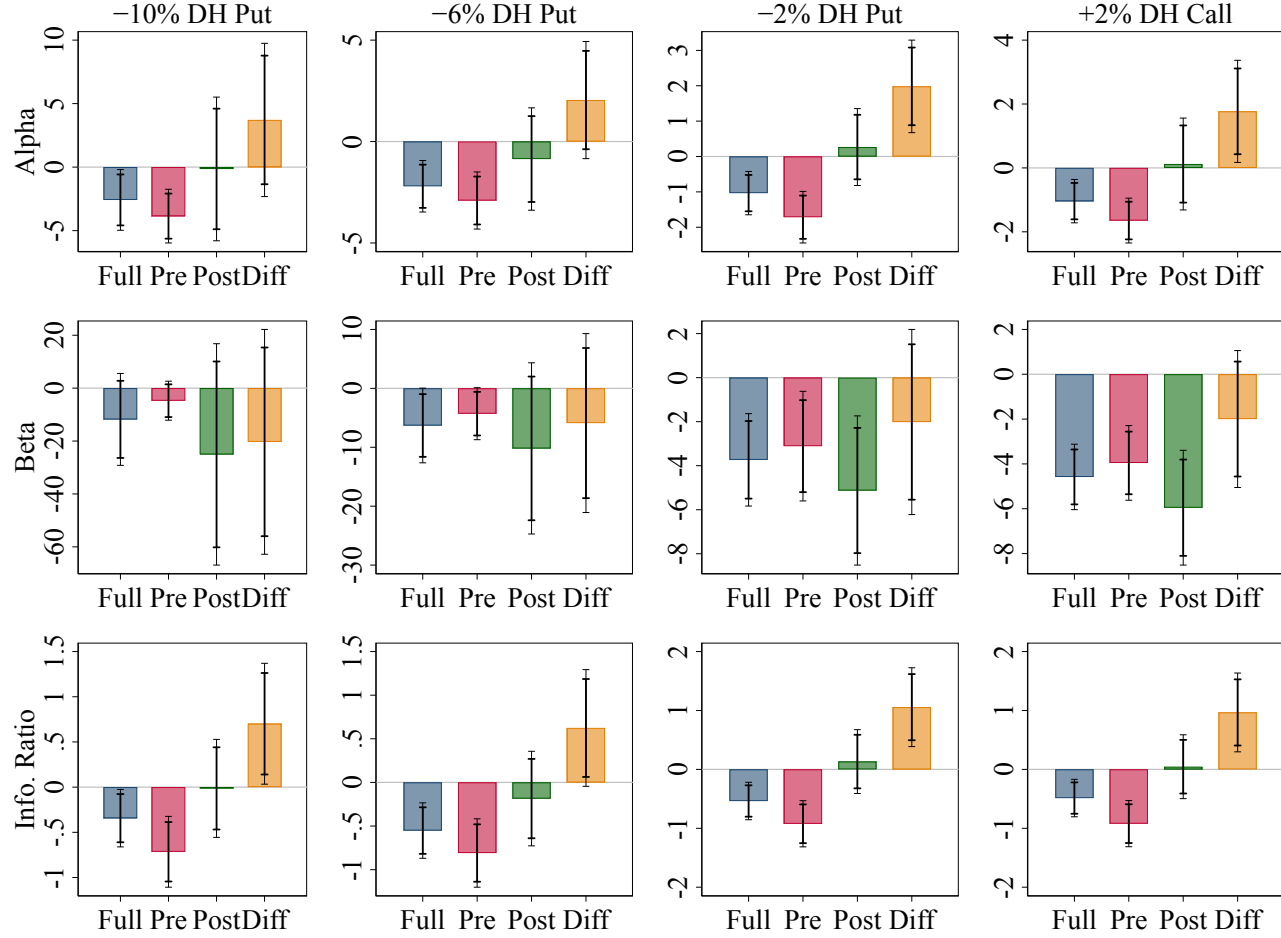
Note: CAPM alphas, betas, and information ratios for traded options at four strikes (-10% , -6% , -2% , and $+2\%$), with returns scaled by the initial option price. Bars show full sample (navy), pre-break (red), post-break (green), and post – pre difference (orange). Whiskers show 90% (thick) and 95% (thin) confidence intervals. Alphas and betas use a full-sample CAPM regression. The break date is August 2012.

Figure 6: Mean, standard deviation, and Sharpe ratio across strikes: delta-hedged



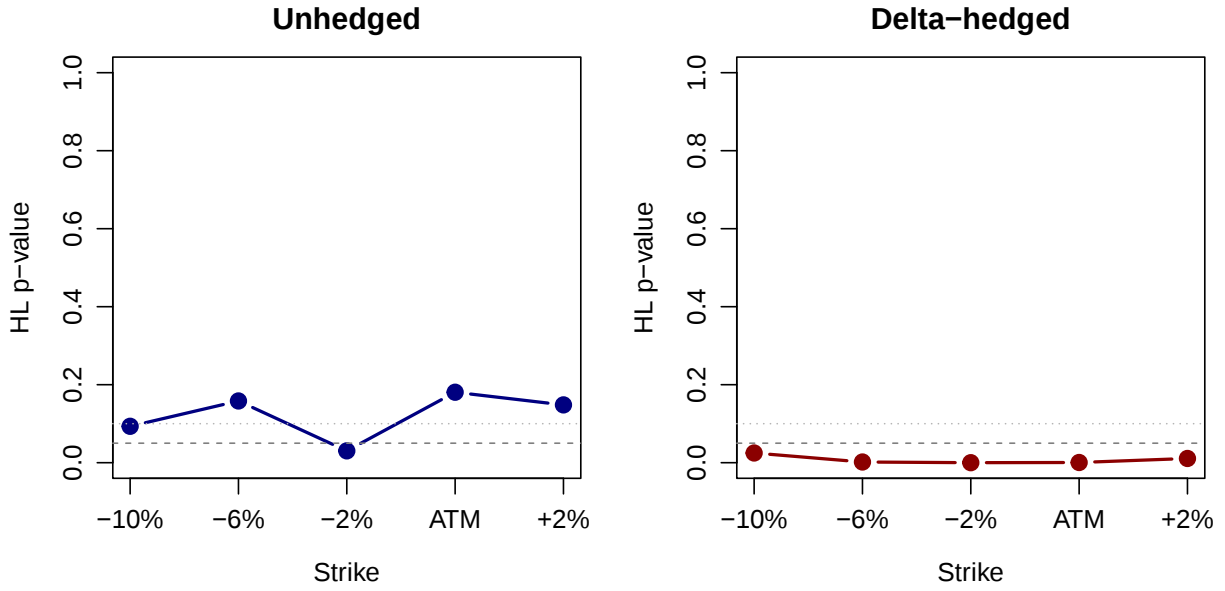
Note: Means, standard deviations, and Sharpe ratios for delta-hedged traded options at four strikes (-10% , -6% , -2% , and $+2\%$), with returns scaled by the initial option price. Bars show full sample (navy), pre-break (red), post-break (green), and post – pre difference (orange). Whiskers show 90% (thick) and 95% (thin) confidence intervals. The break date is August 2012.

Figure 7: Alpha, beta, and information ratio across strikes: delta-hedged



Note: CAPM alphas, betas, and information ratios for delta-hedged traded options at four strikes (-10% , -6% , -2% , and $+2\%$), with returns scaled by the initial option price. Bars show full sample (navy), pre-break (red), post-break (green), and post – pre difference (orange). Whiskers show 90% (thick) and 95% (thin) confidence intervals. Alphas and betas use a full-sample CAPM regression. The break date is August 2012.

Figure 8: HL break-test p -values across strikes



Note: Hodges–Lehmann break-test p -values for beta-adjusted option returns at five strikes (-10% , -6% , -2% , ATM, and $+2\%$), with returns scaled by the initial option price. The left panel shows unhedged returns; the right panel shows delta-hedged returns. Dashed lines mark the 5% and 10% significance levels.