Internet Appendix for
"Does the Options Market Underreact to Firm's Left-Tail Risk?"

A. Data Filters and Definition of Other Variables

1. Data Filters

We apply these filters following previous literature (e.g., Kelly and Jiang (2014), Gao et al. (2018), and Ruan (2020)), (1) The option prices are at least \$0.125; (2) the underlying stock prices are at least \$5; (3) options must have nonmissing bid and ask price quotes and positive open interests; (4) bid and ask prices must satisfy basic arbitrage bounds to filter out erroneous observations and arbitrage boundaries include: bid $>$ 0, bid $<$ ask, bid $\leq$ strike and ask $\geq$ max(0, strike price – stock price); (5) options' embedded leverage calculated following Frazzini and Pedersen (2022) is not in the top or bottom 1% of the distribution.

The risk factors, including Fama and French (1993) three factors (MKT, SMB, HML) and Carhart (1997) momentum factor (UMD), are from the Kenneth R. French data library. Coval and Shumway (2001) systematic volatility risk factor (Zb-straddle) data are from OptionMetrics. Zb-straddle factor is the return of a zero-beta at-the-money (ATM) S&P 500 index straddle.

B. Factor Construction

1. Zero-Beta Straddle Factor: ZB Straddle

The zero-beta straddle or systematic volatility factor (ZB Straddle) is calculated as the return of the zero-beta S&P 500 straddles following Coval and Shumway (2001). Each month, we form zero-beta S&P 500 straddle portfolios based on information available on the first trading day (usually a Monday) immediately following the expiration of the previous one-month options. All options are to expire on the Saturday immediately following the third Friday in the next calendar month. Among these options with one month to maturity, we select the pair of call and put options that are closest to at-the-money (ATM). After next month's expiration, we select a new pair of call and put contracts that are at that time closest to ATM and have one month to expiration.

We take the midpoint of the bid-ask spread and calculate monthly holding-period returns for each option. Following Coval and Shumway (2001), we calculate the zero-beta straddle return as:

$$r_{zb-straddle} = \frac{-C\beta_c + S}{P\beta_c - C\beta_c + S} r_c + \frac{P\beta_c}{P\beta_c - C\beta_c + S} r_p,$$

where C (P) is the call (put) price, S is the index price, β_c is the market beta of the call option, and r_c (r_p) is the holding-period return of the call (put) option.

The average monthly return of the zero-beta straddle is -10.75%, which is equivalent to the result in Coval and Shumway (2001) of -3.15% per week.

2. Jump and Volatility Factors

The jump and diffusive volatility factors (Jump and Vol) are calculated following Cremers et al. (2015). We form the jump risk factor portfolio and the diffusive volatility risk factor portfolio using S&P 500 index options. At the close of the trading on a given date, we form one short-dated zero-beta ATM straddle, and one long-dated zero-beta ATM straddle, by picking the call and put option pair that is closest to being ATM among all options that expire in the next calendar month (for the short-dated options required in the strategies) and the calendar month that follows (for the long-dated options). We hold each position for one trading day and pick new option pairs the next day.

The jump risk factor portfolio consists of a long position of 1 contract in the short-dated zero-beta ATM straddle, and a short position of y_1 contracts in the long-dated zero-beta ATM straddle; y_1 is chosen to make the overall portfolio Vega neutral. The diffusive volatility risk factor portfolio consists of a long position of 1 contract in the long-dated zero-beta ATM straddle, and a short position of y_2 contracts in the short-dated zero-beta ATM straddles; y_2 is chosen to make the overall portfolio gamma neutral. We cumulate the daily returns for these two risk factor portfolios during each month to obtain the jump and volatility risk factors at a monthly frequency. The daily return of the jump (diffusive volatility) risk factor portfolio is -0.11% (-0.05%), consistent with the negative risk premium arguments in Cremers et al. (2015). The correlation between the jump and the diffusive volatility risk factors is 0.19, indicating a moderately low correlation.

3. Arrow-Debreu Bear Factor: AD-BEAR

The bear market factor (AD-BEAR) is calculated following Lu and Murray (2019). We create the bear market factor portfolio using the S&P 500 index options expiring on the third Friday of the subsequent calendar month. We form the bear market factor portfolio by taking a long position in the out-of-the-money (OTM) put option with strike price to be one standard deviation below the index forward price, and a short position in the deep out-of-the-money (DOTM) put option with strike price to be 1.5 standard deviations below the index forward price. The standard deviation of the market return is the level of VIX divided by one hundred multiplied by the square root of the time to expiration. We define the price of both put options to be the dollar trading volume-weighted average price of puts with strikes within a 0.25 standard deviation range of the target strike.

At the end of each week, we calculate the buy and hold return of the bear market factor portfolio over the next five trading days. We pick a new option pair at the end of each week. We subtract the five-day risk-free rate from the five-day buy-and-hold bear market factor portfolio return to get the excess return for the five-day period. As in Lu and Murray (2019), we scale the bear excess returns so that the standard deviation of the scaled bear excess returns is equal to that of the market excess returns. We cumulate weekly returns for the bear portfolio during each month to obtain the bear market risk factor at a monthly frequency. The average monthly return of the bear market portfolio is -1.33%, which is similar to the result in Lu and Murray (2019) of -0.28% per week.

4. Tail Risk Factor

To calculate the tail risk factor (Tail), we first estimate the tail risk time series following Kelly and Jiang (2014). Second, we estimate the tail loading for each stock by regressing stock excess return on the tail risk time series. The regressions use the most recent 120 months of data. Third, stocks are sorted into decile portfolios based on their estimated tail risk loadings. We calculate the tail risk factor as the equal-weighted returns of the portfolio that is long stocks in decile 10 and short stocks in decile 1. By construction this factor can be traded.

5. Downside Risk Factor

To calculate the downside risk factor (Downside), we first calculate the downside beta following Ang et al. (2006). Each month t for each stock, we regress each stock's excess return on the market's excess return when the market excess return is below its average during the time period. The regression uses daily data in the last 12 months. Second, we calculate the downside risk factor by sorting all stocks into decile portfolios based on an ascending sort of downside beta in each month t and compute the equal-weighted excess return in month $t+1$ for the portfolio that is long stocks in decile 10 and short stocks in decile 1.

6. Coskewness Risk Factor

To calculate the coskewness risk factor (Coskew), first, we calculate the coskewness beta following Harvey and Siddique (2000) for each stock in each month t as:

$$\beta_{coskewness} = \frac{E[(r_i - \mu_i)(r_m - \mu_m)^2]}{\sqrt{var(r_i)var(r_m)}},$$

where r_i and μ_i (r_m and μ_m) are the excess return and the average excess return of each security i (the market). The regression uses daily data in the last 12 months. Second, we calculate the coskewness risk factor (Coskew) by sorting all stocks into decile portfolios based on an ascending sort of $\beta_{coskewness}$ in each month t and compute the equal-weighted excess return in month $t+1$ for a portfolio that is long stocks in decile 10 and short stocks in decile 1.

7. Vanden's Alpha

Vanden (2006) develops the coskewness risk factor model that includes higher-order moments of the market return and the market option return. The coskewness model incorporates not only the market return and the square of the market return but also the option return, the square of the option return, and the product of the market and the option returns. For the option return, we use the market bear spread return computed as in Lu and Murray (2019). Additionally the model includes the Fama–French factors and the momentum factor.

8. Option Factors: Illiquidity, Idiosyncratic Volatility, Variance Risk Premium, and Size

Zhan et al. (2022) and Horenstein et al. (2022) document four factors that drive the cross-section of delta-hedged option returns. These factors are like the ones in the stock market, the only difference is that they are computed from the cross-section of option returns. To construct the factors, every month we sort by one of the characteristics and form decile portfolios of delta-hedged option returns. The factor is the long-short portfolio which is the portfolio that buys portfolio 10 and sells portfolio 1.

C. Left-Tail Risk Exposures Construction

1. Exposure to the Market Bear Spread: β_{Bear}

The exposure of the individual bear spreads to the market bear spread is calculated following Lu and Murray (2019). We run a time series regression of the delta-hedged bear spread returns in each month for each stock on the contemporaneous AD-BEAR return and the contemporaneous excess market return. The regression uses monthly data in the last 5 years and requires at least 10 valid observations. The exposure to the AD-BEAR return is denoted by β_{Bear}.

2. Exposure to the Zero-Beta Straddle Factor: β_{Strad}

To calculate the exposure to the zero-beta straddle factor (β_{Strad}), we run a time series regression of the delta-hedged bear spread returns in each month for each stock on the contemporaneous zero-beta straddle return. The regression uses monthly data in the last 5 years requires at least 10 valid observations for estimation. The exposure to the zero-beta straddle return is denoted by β_{Strad}.

3. Exposure to the Jump and Vol Factors: β_{Jump} and β_{Vol}

We estimate β_{Jump} and β_{Vol} following Cremers et al. (2015) by estimating regressions in each month for each stock using monthly returns over rolling annual periods. The delta-hedged bear spread return is regressed on the contemporaneous excess market return, the lagged excess market return, the jump (volatility) factor return, and the lagged jump (volatility) factor return. To calculate β_{Jump} (β_{Vol}), we use the sum of the betas estimated for the jump (volatility) factor, and the lagged jump (volatility) factor.

4. Exposure to the Tail Factor: β_{Tail}

To calculate β_{Tail}, we run a time series regression of the delta-hedged bear spread returns in each month for each stock on the contemporaneous tail risk factor. The regression uses monthly data in the last 5 years and requires at least 10 valid observations for estimation. The exposure to the tail risk factor return is denoted by β_{Tail}.

5. Exposure to the Downside Factor: $\beta_{Downside}$

To calculate $\beta_{Downside}$, we run a time series regression of the delta-hedged bear spread returns in each month for each stock on the contemporaneous market excess return when the market excess return is below the average market excess return during the time period. The regression uses monthly data in the last 5 years and requires at least 10 valid observations for estimation. The exposure to the market factor return is denoted by $\beta_{Downside}$.

D. Potential Explanations

1. Variance Risk Premium

We explore whether the relation between bear spread returns and left-tail risk can be attributed to the stock variance risk premium. Given that bear spread returns are sensitive to the volatility of the underlying stock, an investor holding a delta-neutral bear spread would demand a premium for accepting such variance risk. Theoretically, Bakshi and Kapadia (2003) and Bakshi et al. (2003) have shown that delta-hedged options are driven by the individual stock variance risk premium. Therefore, variance risk premium could potentially be capturing the left-tail risk of the stock and explain the predictability of left-tail risk on delta-hedged bear spread returns.

We explore the effect of individual variance risk premium (VRP) on bear spread returns by using Fama and MacBeth (1973) regressions and double sorting. Table A12 reports the bivariate portfolio analysis in which we first sort by VRP and then, within each decile, by $VaR5$. Each reported decile is the average of each VRP decile. After controlling for VRP, the long-short bear spread return and its 5-factor alpha remain positive and significant. Fama and MacBeth (1973) regressions reported in Table A13 confirm the positive relation when controlling by VRP. The magnitude and significance of the $VaR5$ coefficient decreases but remains positive and significant once we control for VRP. Note that the VRP coefficient in the multivariate regression is negative and significant, providing support for our volatility underreaction explanation. We conclude that the positive relation between bear spread returns and left-tail risk is not just a compensating for the variance risk premium of individual stocks.

2. Jump Risk

Delta-hedged bear spread returns are immune to small changes in the underlying stock price. However, it contains gamma risk that captures its exposure to jump risk, that is, large price movements in the stock price. Moreover crash insurance profitability requires large negative stock price returns. Green and Figlewski (1999) argue that option dealers charge a jump premium when writing options. Patterns for index option returns are explained by jump risk (Broadie, Chernov, and Johannes, 2009). In this subsection, we explore whether the relation between delta-hedged bear spread returns and left-tail risk is driven by jump risk.

We proxy for jump risk with the individual risk-neutral skewness from equity options as done by Bakshi and Kapadia (2003) and Bakshi et al. (2003). We perform bivariate sortings and bivariate Fama–MacBeth regressions with left-tail risk and risk-neutral skewness. The results are reported in Tables A12 and A13. Both tables confirm the positive relation between left-tail risk and bear spread returns. The magnitude of the long-short return in Table A12 and the magnitude of the coefficient of $VaR5$ decrease in both cases. However, they both remain statistically significant.

3. Uncertainty of Stock Volatility

A potential explanation of our results is the uncertainty faced by market makers on the variability of future stock volatility. Green and Figlewski (1999) document that this uncertainty creates model risk for option writers when the pricing and hedging errors produce significant risk exposure. To compensate, option writers charge a high option implied volatility. Higher option implied volatility for firms with high volatility uncertainty results in lower future option returns.

To test the uncertainty of volatility, we control for the volatility of implied volatility (VOV), a measure used by Cao et al. (2023). VOV is the standard deviation of ATM implied volatility over the previous month. ATM implied volatility is computed as the average of call and put implied volatilities with an absolute delta of 0.5 and 30 days to maturity using the OptionMetrics database. Bivariate sorts and Fama–MacBeth regressions in Tables A12 and A13 reveal that VOV does not drive our results.

4. Information Asymmetry

We now explore whether information asymmetry explains our findings. Informed trading in the option market has been documented by Easley, O'hara, and Srinivas (1998) and Pan and

Poteshman (2006). We proxy informed trading with the probability of informed trading (PIN) measure of Easley, Hvidkjaer, and O'hara (2002). We find that PIN does not explain the relation between bear spread returns and left-tail risk, as documented in Tables A12 and A13. Even though there is a negative and significant relation between PIN and bear spread returns, as reported in the Fama–MacBeth regressions, the coefficient of $VaR5$ remains of the same magnitude and significance as that in the univariate regression. In double sorts, the significance of the long-short return decreases but remains statistically significant. We conclude that information asymmetry does not explain our findings.

5. Option Demand Pressure

Option demand pressure impacts option prices as documented by Bollen and Whaley (2004), Garleanu, Pedersen, and Poteshman (2008), and Muravyev (2016). When investors exert demand pressure on certain options, option market makers charge a higher premium for these options, leading to higher bear spread returns. Option demand pressure (OPT_Demand) is defined as the log difference between the total market value of all options (option price times open interest) and the market value of the underlying stock. Bivariate sorts from Table A12 show that $VaR5$ predicts bear spread returns when controlling for option demand. Moreover, bivariate Fama–MacBeth regressions from Table A13 show that the coefficient of option demand is positive and significant. However, the coefficient of left-tail risk remains of similar magnitude and significance as the one from univariate regressions. We conclude that option demand does not explain the relation between bear spread returns and left-tail risk.

6. Option Return Predictors

The positive relation between left-tail risk and bear-spread returns can potentially be related to characteristics that predict delta-hedged option returns. Given that delta-hedged option returns reflect risk premia related to higher-order risks such as variance risk and jump risk (Bakshi et al., 2003), these characteristics are potentially related to higher-order risks. Zhan et al.

(2022) identify nine characteristics that predict delta-hedged option returns. These characteristics include: CFV is the cash flow variance as in Haugen and Baker (1996); CH is the cash-to-assets ratio as in Palazzo (2012); ISSUE-1Y represents one-year new issues as in Pontiff and Woodgate (2008); ISSUE-5Y represents five-year new issues as in Daniel and Titman (2006); PM is the profit margin as in Soliman (2008); ln(PRICE) is the log of the underlying stock price at the end of last month; PROFIT is the profitability as in Fama and French (2006); TEF is total external finance; and ZS is z-score as in Dichev (1998).

We perform a double-sorting analysis using the nine characteristics that predict delta-hedged option returns and $VaR5$. As reported in Table A14, the long-short bear spread returns and 5-factor alphas remain positive and significant. We conclude that higher-order risks captured by the nine characteristics do not explain $VaR5$'s predictability of bear spread returns.

E. Robustness

In this section, we further explore the predictability of $VaR5$ on DOI- and equal-weighted bear spread returns. First, we examine the robustness of our results across different subsamples such as earnings announcement periods and the global financial crisis. Second, we consider various weighting methods and daily delta hedging to calculate the bear spread return. Third, we confirm the robustness of our results using modified Fama–Macbeth regressions and weighted least squares.

1. Biased Expectations: Earnings Announcements

We study the impact of earnings announcements on bear spread returns sorted by $VaR5$. Engelberg, McLean, and Pontiff (2018) report that stock return anomalies are six times larger during earnings announcement days. Dubinsky, Johannes, Kaeck, and Seeger (2019) and Gao et al. (2018) document that earnings announcements induce substantial uncertainty as implied volatility increases before earnings announcements and decreases afterwards. This pattern potentially reflects option mispricing that may be corrected with the arrival of news. Hence, biased investor expectations around earnings announcements could potentially explain our results if price correction is due to mispricing.

To test this biased expectation hypothesis, we employ portfolio sorts. Each month, we separate the monthly return sample into two subgroups: months with and without earnings announcements. Tables A9 and A15 show that the "10-1" DOI- and equal-weighted return spreads for both subgroups are positive, significant, and of similar magnitude. Our results are robust to periods with and without earnings announcements. We conclude that biased expectations do not explain our results.

2. Subsamples: Before/After the Global Financial Crisis

We analyze the impact of the global financial crisis on bear spread returns by dividing the sample into two subperiods: 1996-2007 and 2008-2017. As reported in Tables A9 and A15, the "10-1" DOI- and equal-weighted bear spread return is positive and significant in the two subperiods but is more significant in the 2008-2017 period at 0.94$\%$ with a t-statistic of 1.91. The relation between bear spread returns and left-tail risk is robust in the two subsamples.

3. Bear Spread Weighting Schemes

In all previous analyses we constructed the bear spread with a long (short) position in PUT_1 (PUT_2) as the OTM (DOTM) put option with Δ_1 (Δ_2) closest to -0.30 (-0.10), the midpoint of the OTM (DOTM) delta range. The ranges of OTM and DOTM put option deltas are $[-0.40, -0.20)$ and $[-0.20, 0]$. In this subsection we use the simple average and the kernel-weighted average of all put options with deltas between $[-0.40, -0.20)$ for OTM puts and $[-0.20, 0]$ for DOTM puts to reduce potential sample bias.

Tables A9 and A15 report univariate sorts for the two weighting schemes. We show that the positive relation between the delta-hedged bear spread returns and $VaR5$ persists using different methods to construct the bear spreads. The return spreads remain significantly positive and of similar magnitudes to the results in Table 2.

4. Daily Delta-Hedging

We verify the robustness of our findings with an alternative delta-hedging methodology. Thus far we have only considered buy-and-hold returns of the bear spread returns. The bear spread is delta neutral only when the position is opened since we do not rebalance the delta-hedge over time. We now adjust the delta-hedge daily and compound the daily returns over the given month to obtain a monthly return.

The results based on daily delta-hedging are reported in Tables A9 and A15 for DOI- and equal-weighted bear spread returns. All decile portfolio returns are positive and the "10-1" bear spread return remains positive and significant. Our results are confirmed when using daily delta-hedging.

5. Modified Fama–Macbeth Regressions and Weighted Least Squares

In the main analysis, we use the traditional Fama and MacBeth (1973) regressions. We now use the modified Fama and MacBeth (1973) regressions proposed by Brennan et al. (1998) and the WLS parameter estimation proposed by Asparouhova et al. (2013).

Following the methodology of Brennan et al. (1998), we first regress delta-hedged bear spread returns on an all-factor's model. Next, to correct for the error-in-variables problem, we perform the following Fama and MacBeth (1973) regression:

$$r_{i,t} - \hat{\beta}_i F_t = \gamma_{0,t} + \gamma_{1,t}^{'} VaR5_{i,t} + \phi_t^{'} Z_{i,t-1} + \epsilon_{i,t},$$

where $r_{i,t}$ is the delta-hedged bear spread return for each security i at time t, F_t include all systematic factors from Table 3, $Z_{i,t-1}$ are the characteristics for each stock i at time $t-1$. $\hat{\beta}_i$ are estimated for each stock i using the entire sample. Table A16, column 1, reports the results of the second-stage estimation. Using the modified Fama and MacBeth (1973) regressions, the coefficient on $VaR5$ remains positive and statistically significant and of similar magnitude to the original coefficient.

In the WLS estimation (columns 2 and 3), returns are weighted by either the dollar-open-interest of the bear spread or by the stock market capitalization. The WLS estimation puts more weight on bear spread returns with higher option liquidity or higher firm value, thus reducing the bias caused by illiquidity. The second and third columns in Table A16 show that the coefficients of $VaR5$ are positive and significant with a t-statistic above 2.23. Modified Fama–Macbeth regressions and the WLS estimation confirm our main results.

F. Practical Example of Bear Put Spread

1. Delta-Hedged Bear Put Spread

To illustrate the computation of the bear spread return, we consider the case of Williams Sonoma Inc (WSM). We open the bear spread position on Monday December 23, 2013, the first trading day after the previous option expiration. On that day, the stock price is $\$58.84$. We enter a long position in a put option (PUT1) with a strike price $K1 = 57.5$ ($\Delta = -0.331$), at a mid price of $\$0.75$. We also enter a short position in a put option (PUT2) with strike price $K2 = 55.0$ ($\Delta = -0.132$), at a mid price of $\$0.25$. The mid price of the bear spread, long PUT1 and short PUT2, is $\$0.50$. Finally, the mid price of the delta-hedged bear spread is $\$12.21$ as detailed below:

$$\begin{aligned}
P^{t=0}_{\text{Bear Spread}} &= P^{t=0}_{\text{PUT1}} - P^{t=0}_{\text{PUT2}} = 0.75 - 0.25 = 0.5 \\
P^{t=0}_{\text{DH-Bear Spread}} &= P^{t=0}_{\text{Bear Spread}} - \Delta_{\text{Bear Spread}} \times S_{t=0} \\
&= 0.5 - (-0.331 - (-0.132)) \times 58.84 = 12.21
\end{aligned}$$

The position is closed when options expire at time T on Friday January 17, 2014. On that day, the stock price is $\$54.11$ and the bear spread price is $\$2.5$. Using these prices, the delta-hedged bear spread price is $13.27 as detailed below:

$$
\begin{aligned}
P^{t=T}_{\text{Bear Spread}} &= (K1 - S_{t=T})^+ - (K2 - S_{t=T})^+ \\
&= (57.5 - 54.11)^+ - (55 - 54.11)^+ = 2.5 \\
P^{t=T}_{\text{DH-Bear Spread}} &= P^{t=T}_{\text{Bear Spread}} - \Delta_{\text{Bear Spread}} \times S_{t=T} \\
&= 2.5 - (-0.199) \times 54.11 = 13.27
\end{aligned}
$$

2. Return Magnitude of Bear Spread vs. Delta-Hedged Bear Spread

The analyses in the paper are performed with delta-hedged bear spread returns, a trading strategy that takes a long position in the underlying stock plus the bear spread position. The return of the delta-hedged bear spread is only 8.67% whereas the return of the bear spread without delta-hedging is 400%. The big difference between these two returns is caused by the position in the underlying stock. Below we provide the calculations of the returns of bear spreads and delta-hedged bear spreads.

$$
\text{Return}_{BearSpread} = \frac{2.5 - 0.5}{0.5} = 400\%
$$

$$
\text{Return}_{DH-BearSpread} = \frac{13.27 - 12.21}{12.21} = 8.67\%
$$

3. Relative Quoted Half Bid-Ask Spread of Bear Spread

The relative quoted half bid-ask spread of the bear spread is computed as one-half times the sum of the bid-ask spread of the two put options divided by the mid price of the bear spread. In the example above, the relative half bid-ask spread of the bear spread is 20%. The bid and ask prices of the bear spread are 0.6 and 0.4 with a mid price of 0.5. The bear spread ask (bid) price buys (sells) PUT1 at 0.8 (0.7) and sells (buys) PUT2 at 0.2 (0.3).

$$
\text{Relative Half Bid-Ask Spread of Bear Spread} = 0.5 \times \frac{0.6 - 0.4}{0.5} = 20\%
$$

$$\text{Relative Half Bid-Ask Spread of PUT1} = 0.5 \times \frac{0.8 - 0.7}{0.75} = 6.7\%$$

$$\text{Relative Half Bid-Ask Spread of PUT2} = 0.5 \times \frac{0.3 - 0.2}{0.25} = 20\%$$

4. Margin Adjusted Bear Spread Return

We follow the CBOE initial margin requirement for a long delta-hedged bear spread position, which is "for the same underlying instrument and, as applicable, the same index multiplier; the amount by which the long put (short call) aggregate exercise price is below the short put (long call) aggregate exercise price. Long side must be paid for in full. Proceeds from short option sale may be applied", and "50% requirement on long stock position".

In the example for Williams Sonoma Inc (WSM), we open the bear spread position on December 23, 2013. On that day, the stock price is \$58.84. We go long a put option with strike 57.5 (Delta =-0.331) at \$0.75 and short a put option with strike 55.0 (delta=-0.132) at \$0.25. We delta-hedge the position by going long 0.199 shares of WSM at \$58.84.

The margin requirement on the long delta-hedged bear spread position is computed as follows:

1) "The amount by which the long put aggregate exercise price is below the short put aggregate exercise price": this amount is always positive in the bear put spread. In this case the exercise price of the long put is 57.5 and that of the short put is 55.0. Hence, the difference is +2.5. Since it is positive, no margin amount is needed.

2) "Long side must be paid in full": \$0.75 is paid in full in the margin.

3) "Proceeds from short option sale may be applied": \$0.25 are subtracted from the margin.

4) "50% requirement on long stock position": $0.5 \times 0.199 \times \$58.84 = \$5.85$.

Overall, the margin requirement M for a long delta-hedged bear-spread position is equal to PUT1 – PUT2 + $0.5 \times 0.199 \times S = \$6.35$.

For a short delta-hedged bear-spread position, the total margin requirement is equal to the short sale proceeds plus 50% of the short sale in the underlying. There is no requirement on the short put. The margin requirement on the short delta-hedged bear spread position is 150% of the short stock position, $M = 1.5 \times 0.199 \times S = \$17.56$.

We assume the margin cost is the cost of borrowing the additional capital to meet the margin requirement over the holding period which is one month (Weinbaum et al., 2023). We compute an adjusted return to account for the margin requirements of the delta-hedged bear spread as follows

$$Return = \frac{(\Delta_{2,t} - \Delta_{1,t})S_T + max(K_1 - S_T, 0) - max(K_2 - S_T, 0) - \frac{r}{12}M}{(\Delta_{2,t} - \Delta_{1,t})S_t + PUT1 - PUT2} - 1,$$

where $PUT1$ ($PUT2$), $\Delta_{1,t}$ ($\Delta_{2,t}$), and K_1 (K_2) are the price, delta, and strike price of the the OTM (DOTM) put at time t, S_t (S_T) is the price of the underlying stock at time t (T, Maturity), r is the 1-month Libor rate, and M is the CBOE required margin.

Assuming an interest rate of 2%, the adjusted return to account for the margin requirements of the long delta-hedged bear spread is 8.57% (compared with 8.67% without margin requirements).

TABLE A1

Left-Tail vs. Right-Tail Risk

The table presents the results of Fama and MacBeth (1973) regressions of monthly delta-hedged bear spread returns on VaR5 residual, VaR95, and control variables in regressions (1) and (2), and on VaR95 residual, VaR5, and the control variables in regressions (3) and (4). VaR5 (VaR95) is the 5% (95%) value-at-risk that corresponds to -1 times the 5th (95th) percentile of daily returns in the past year. VaR5 residual (VaR95 residual) is calculated by orthogonalizing VaR5 (VaR95) via monthly cross-sectional regressions of VaR5 (VaR95) on VaR95 (VaR5). The residual terms from these regressions are denoted as VaR5 residual (VaR95 residual). Control variables are SIZE (market capitalization); BTM (book-to-market ratio); DTA (firm leverage); MOM (momentum computed as the return over the previous six months); REV (reversal which is the return over the previous month); ILLIQ (logarithm of Amihud illiquidity); IVOL (idiosyncratic volatility); SKEW and KURT (skewness and kurtosis from one year of daily returns); VRP (variance risk premium as in Goyal and Saretto (2009)); VOV (vol-of-vol as in Baltussen et al. (2018)); RNS (risk-neutral skewness). Coefficients are time-series averages, and the associated Newey and West (1987) t-statistics are reported in parentheses. The sample period is from January 1996 to December 2017 for stocks in the OptionMetrics database.

	1	2	3	4
VaR5			0.201	0.223
			(4.66)	(3.30)
VaR5 residual	0.252	0.179		
	(2.99)	(1.98)		
VaR95	0.137	0.175		
	(4.12)	(3.21)		
VaR95 residual			-0.073	0.025
			(-1.15)	(0.35)
SIZE		-0.004		-0.004
		(-4.24)		(-4.24)
BTM		0.000		0.000
		(1.28)		(1.28)
DTA		-0.004		-0.004
		(-1.45)		(-1.45)
MOM		-0.002		-0.002
		(-0.88)		(-0.88)
REV		0.000		0.000
		(0.02)		(0.02)
ILLIQ		-0.003		-0.003
		(-4.09)		(-4.09)
IVOL		-0.287		-0.287
		(-2.76)		(-2.76)
SKEW		0.000		0.000
		(0.21)		(0.21)
KURT		0.000		0.000
		(-1.84)		(-1.84)
VRP		-0.014		-0.014
		(-2.10)		(-2.10)
VOV		-0.002		-0.002
		(-0.18)		(-0.18)
RNS		-0.001		-0.001
		(-0.72)		(-0.72)
Adj. R^2	1.8%	5.0%	1.8%	5.0%

TABLE A2

Correlation of Characteristics

This table reports the correlations (in %) of characteristics. The left-tail risk measures are the 5% (1%) value-at-risk, $VaR5$ ($VaR1$), that corresponds to 5th (1st) percentile of daily returns in the past year, and the expected shortfall, $ES5$ ($ES1$), is calculated as -1 times the average of the returns below the 5th (1st) percentile of daily returns in the past year. The characteristics are SIZE (market capitalization); BTM (book-to-market ratio); DTA (firm leverage); MOM (momentum computed as the return over the previous six months); REV (reversal which is the return over the previous month); ILLIQ (logarithm of Amihud illiquidity); IVOL (idiosyncratic volatility); SKEW and KURT (skewness and kurtosis from one year of daily returns); PIN (probability of informed trading as in Easley et al. (2002)); VRP (variance risk premium as in Goyal and Saretto (2009)); VOV (vol-of-vol as in Baltussen et al. (2018)); RNS (risk-neutral skewness); OPT_Demand (the log difference between the total market value of all options and the market value of underlying stocks). We use 60-month rolling windows to compute the exposures of individual bear spread returns to the following systematic risk factors: the bear market factor (β_{Bear}) following Lu and Murray (2019), zero-beta straddle (β_{Strad}) from Coval and Shumway (2001), jump and volatility factors (β_{Jump} and β_{Vol}) as in Cremers et al. (2015), the tail factor (β_{Tail}) as in Kelly and Jiang (2014), and the downside factor ($\beta_{Downside}$) following Ang et al. (2006). We also report the AD-Price (the Arrow-Debreu security price implied by bear spread strategy), and Half BA spread (the quoted half bid-ask spread of bear spread computed as $[(PUT_{1,ask} - PUT_{1,mid}) + (PUT_{2,mid} - PUT_{2,bid})]/(PUT_{1,mid} - PUT_{2,mid})$). The sample period is from January 1996 to December 2017 for stocks in the OptionMetrics database.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
1-VaR5	100																								
2-VaR1	89.0																								
3-ES5	87.7	74.6																							
4-ES1	96.5	93	92.7																						
5-SIZE	-50.9	-52.1	-47.3	-53.1																					
6-BTM	-4.3	-4.8	-4.4	-4.8	-1.9																				
7-DTA	-6.5	-6.6	-7	-7.1	1.4	0.9																			
8-MOM	5.3	9.4	-0.1	5.2	-6.4	-4.3	-0.6																		
9-REV	2.4	4	0.9	2.6	-4.2	-1.9	0	0.6																	
10-ILLIQ	42.9	43.5	40.4	44.9	-88.6	2.1	-0.4	4.8	8.1																
11-IVOL	60.5	60.7	57.7	63.2	-39.9	-4.3	-3.9	8.3	15.5	36.5															
12-SKEW	-0.2	9.3	-19.7	-4.4	-7.6	-1.6	1.1	27.3	13.7	8.1	12.2														
13-KURT	12.3	4.2	31.8	18	-12.8	-2.4	-0.2	8	5.2	12.2	21	31.6													
14-PIN	-1.5	-4.9	0.6	-2.0	-45.0	9.2	7.9	5.4	6.8	52.0	4.0	2.1	7.4												
15-VRP	-5.6	-4.4	-7.4	-6.2	-4.3	-1.3	1.5	1.8	-13.7	3	-59	-3.2	-8.9	4.1											
16-VOV	7.2	2.9	10.8	7.4	-2.5	-0.3	0.5	-0.2	0.2	0.3	22.1	4	15	0.4	-15.5										
17-RNS	14.1	16.5	12.9	15.4	-33.4	-3.8	-2.1	6.6	7.1	33.8	13.3	2.8	3	15.3	0.6	-5.7									
18-OPT_Demand	47.2	48.6	43.0	49.0	-21.6	0.7	-0.6	4.6	3.2	-4.2	38.2	5.7	9.7	-14.5	-2.5	9.9	-2.3								
19-β_{Bear}	9.8	12.3	7.4	10.4	-12.1	1.5	1.3	-5.1	-2.7	11.4	5.5	3	0.3	2.7	1.5	0.8	2.4	6.8							
20-β_{Strad}	2.1	3.7	1.5	2.7	-4.7	-1.8	1.1	-0.9	-0.9	3.7	2.1	2.8	-0.7	0.9	0.5	0.6	0.2	1.8	42						
21-β_{Jump}	3.1	4.7	1.4	3.2	-1.4	-1.8	-0.9	-0.3	0.4	-1.1	1.9	0.9	-0.5	-3.5	0	-0.7	0.4	4.2	6.9	24.7					
22-β_{Vol}	-0.4	1.6	-0.9	0.2	0.8	-1.3	2.1	0.9	0.3	-2.2	-0.1	1.5	-0.3	-1.1	-0.1	-0.3	-1.5	2.2	10.4	19.4	15.7				
23-β_{Tail}	-4.8	-4.6	-4.3	-4.6	4.8	-2.3	-0.1	2.4	1.7	-5.8	-3.1	-0.8	-1.3	-2.1	-2.2	-1.2	0.1	-2.7	-31.3	-19.2	-10	-5.5			
24-$\beta_{Downside}$	-3.5	-5.3	-2.1	-3.9	3.4	1.6	1.1	1.9	1.4	-1.8	0.2	-1.2	2.6	2.9	-0.5	0.3	-0.1	-3.1	-29.7	-18	-2.7	-5.4	9.3		
25-AD-Price	43.9	46.4	40.1	46.1	-40.1	-2.2	-4.1	5.2	-0.9	36.7	37.4	5.3	7.2	8.9	2	2.5	28.6	24.0	7.8	3.1	2.1	0.8	-4.1	-1.8	
26-Half BA-Spread	1.4	-0.4	3.3	1.6	-37.7	1.8	4.3	-1.5	1.9	46.9	1.8	2.9	7.8	27.9	2.4	4.5	27.1	-23.9	4.8	1.9	-1.4	-1.3	-2.2	-1.6	-5.7

TABLE A3

Univariate Portfolio Analysis: Equal-Weighted Returns

This table reports the time-series average monthly returns (in %) for the equal-weighted delta-hedged bear spread decile portfolios sorted on the left-tail risk measures ($VaR5$, $VaR1$, $ES5$, $ES1$), along with the return spreads ("10-1") between decile 10 and decile 1. Panel A reports the time-series average monthly returns for decile portfolios sorted by $VaR5$, along with their time-series standard deviation (in %), skewness, and kurtosis. Panel B reports the time-series average monthly returns for decile portfolios sorted by $VaR1$, $ES5$, and $ES1$. The left-tail risk measures are the 5% (1%) value-at-risk, $VaR5$ ($VaR1$), that corresponds to -1 times the 5th (1st) percentile of daily returns in the past year, and expected shortfall, $ES5$ ($ES1$), is calculated as -1 times the average of the returns below the 5th (1st) percentile of daily returns in the past year. Each month t, decile portfolios of delta-hedged bear spreads are formed and held to maturity by sorting underlying stocks on one of the left-tail risk measures. Newey-West (1987) adjusted t-statistics are presented in parentheses. The sample period is from January 1996 to December 2017 for stocks in the OptionMetrics database.

Panel A: Sorted by VaR5

	1	2	3	4	5	6	7	8	9	10	10-1
Mean	-0.62	-0.46	-0.37	-0.19	-0.13	-0.11	0.18	0.17	0.09	0.40	1.03
	(-5.21)	(-3.69)	(-2.68)	(-1.28)	(-0.82)	(-0.62)	(0.79)	(0.75)	(0.34)	(1.38)	(3.60)
Std Dev	1.74	1.78	1.98	2.16	2.31	2.55	2.91	2.98	3.47	3.95	3.83
Skew	0.92	1.06	0.97	1.04	1.02	0.76	0.78	0.84	0.83	0.72	0.90
Kurt	6.32	6.89	6.61	6.04	5.56	4.21	4.30	4.47	4.15	3.68	4.26

Panel B: Sorted by VaR1, ES5, ES1

	1	2	3	4	5	6	7	8	9	10	10-1
VaR1	-0.61	-0.43	-0.36	-0.17	-0.13	-0.07	0.09	0.16	0.16	0.30	0.91
	(-5.04)	(-3.33)	(-2.49)	(-1.08)	(-0.78)	(-0.42)	(0.46)	(0.71)	(0.71)	(1.02)	(3.33)
ES5	-0.61	-0.44	-0.40	-0.14	-0.19	-0.06	0.13	0.20	0.13	0.30	0.91
	(-5.18)	(-3.51)	(-2.77)	(-0.89)	(-1.25)	(-0.33)	(0.66)	(0.83)	(0.58)	(1.05)	(3.41)
ES1	-0.60	-0.44	-0.33	-0.23	-0.02	-0.05	0.13	0.11	0.24	0.14	0.74
	(-4.71)	(-3.49)	(-2.41)	(-1.41)	(-0.10)	(-0.30)	(0.62)	(0.51)	(1.05)	(0.61)	(3.48)

TABLE A4

Subsample Dollar Open Interest Percentage

This table reports the dollar open interest percentage (%DOI) of the bear spread strategy in each subsample relative to the full sample. Each month, bear spread decile portfolios in each subsample are sorted on the left-tail risk measure $VaR5$, and the %DOI of decile 1, the %DOI of decile 10, and the %DOI of the long-short strategy ("10-1") are calculated. This table reports the time-series average of the %DOI of the bear spread strategy in each subsample. Panel A reports the full sample result. Panel B reports the results for the subsamples sorted on ΔVaR and NL. Panel C reports the results for the subsamples sorted on size and information uncertainty proxies.

Panel A: Full sample %DOI										
	VaR5									
1	15.90%									
10	7.20%									
1+10	23.10%									
Panel B: %DOI based on ΔVaR and nearest to 52-week low (NL) subsamples										
	Small-Size		Mid-Size		Large-Size			All firms		
	ΔVaR>0	ΔVaR<=0	ΔVaR>0	ΔVaR<=0	ΔVaR>0	ΔVaR<=0	All	ΔVaR>0	ΔVaR<=0	
1	0.50%	0.70%	0.80%	0.90%	3.40%	4.00%	10.20%	4.70%	5.50%	
10	0.80%	0.80%	1.80%	2.10%	4.50%	4.50%	14.50%	7.10%	7.40%	
1+10	1.30%	1.40%	2.60%	2.90%	7.90%	8.50%	24.60%	11.80%	12.80%	
	Low NL	High NL	Low NL	High NL	Low NL	High NL	All	Low NL	High NL	
1	0.60%	0.40%	0.80%	0.60%	3.70%	2.40%	8.70%	5.20%	3.50%	
10	0.70%	0.80%	1.60%	2.10%	3.60%	4.70%	13.50%	5.90%	7.60%	
1+10	1.30%	1.30%	2.40%	2.70%	7.40%	7.20%	22.20%	11.00%	11.10%	
Panel C: %DOI based on size and information uncertainty subsamples										
	Low size	2	3	4	High Size					
1	0.80%	0.90%	0.70%	1.30%	5.70%					
10	0.80%	1.40%	2.50%	3.60%	7.50%					
1+10	1.60%	2.30%	3.20%	4.90%	13.20%					
	Low AC_{res}	High AC_{res}	Low AGE	High AGE	Low $DISP_{res}$	High $DISP_{res}$	Low $TURN_{res}$	High $TURN_{res}$	Low $IVOL_{res}$	High $IVOL_{res}$
1	9.70%	4.20%	7.40%	9.00%	4.50%	14.30%	6.50%	5.20%	7.00%	10.30%
10	3.10%	4.20%	3.10%	5.00%	2.20%	4.00%	4.90%	4.20%	1.90%	4.20%
1+10	12.80%	8.40%	10.50%	14.00%	6.70%	18.30%	11.30%	9.50%	8.80%	14.50%

TABLE A5

Risk-Adjusted Returns: Equal-Weighted Returns

This table reports the time-series average equal-weighted monthly returns (in %) for the delta-hedged bear spread decile portfolios sorted on the left-tail risk measure $VaR5$, along with the return spreads ("10-1") and the associated alphas. $VaR5$ is the 5% value-at-risk that corresponds to -1 times the 5th percentile of daily returns in the past year. CAPM alphas are calculated after adjusting for CAPM market risk factor; four-factor (4F) alphas are calculated after adjusting for Fama–French three factors and Carhart (1997) momentum factor; the ZB Straddle is the zero-beta straddle return from Coval and Shumway (2001); the jump and volatility factors (Jump and Vol) are computed as in Cremers et al. (2015); the bear market factor (AD-BEAR) following Lu and Murray (2019); the VIX is the monthly return of the VIX volatility index; the Tail factor following Kelly and Jiang (2014); Downside following Ang et al. (2006); Coskewness factor computed following Harvey and Siddique (2000); illiquidity factor on options (ILLIQ) calculated following Zhan et al. (2022); the three factors from options are the size, idiosyncratic volatility, and variance risk premium factors from delta-hedged option returns following Horenstein et al. (2022). Vanden's alpha is computed following Vanden (2006). Newey and West (1987) adjusted t-statistics are presented in parentheses. The sample period is from January 1996 to December 2017 for stocks in the OptionMetrics database.

	1	2	3	4	5	6	7	8	9	10	10-1	(t-stat)
Raw Return	-0.62	-0.46	-0.37	-0.19	-0.13	-0.11	0.18	0.17	0.09	0.40	1.03	(3.60)
CAPM alpha	-0.52	-0.35	-0.25	-0.06	0.04	0.07	0.36	0.36	0.28	0.72	1.23	(4.59)
4F alpha	-0.50	-0.36	-0.25	-0.08	0.03	0.03	0.28	0.25	0.16	0.68	1.18	(4.62)
4F+ZB Straddle alpha	-0.28	-0.14	-0.05	0.20	0.31	0.28	0.56	0.56	0.38	0.89	1.17	(4.42)
4F+Jump+Vol. alpha	-0.41	-0.27	-0.19	0.04	0.16	0.16	0.40	0.39	0.31	0.77	1.18	(4.50)
4F+AD-BEAR alpha	-0.49	-0.34	-0.22	-0.02	0.09	0.07	0.34	0.37	0.28	0.76	1.25	(4.76)
4F+VIX alpha	-0.49	-0.33	-0.22	-0.05	0.08	0.08	0.32	0.29	0.23	0.72	1.21	(4.62)
4F+Tail factor alpha	-0.50	-0.35	-0.24	-0.09	0.05	0.03	0.28	0.25	0.17	0.70	1.20	(4.65)
4F+Downside alpha	-0.48	-0.33	-0.21	-0.05	0.06	0.05	0.30	0.27	0.20	0.73	1.21	(4.57)
4F+Coskew alpha	-0.52	-0.37	-0.26	-0.08	0.02	0.00	0.25	0.21	0.11	0.66	1.18	(4.29)
4F+Illiquidity alpha	-0.58	-0.49	-0.26	-0.22	0.03	-0.18	0.19	0.22	0.12	0.75	1.33	(3.69)
4F+3F Option's alpha	-0.26	0.01	0.26	-0.03	0.41	0.44	0.69	0.54	0.42	1.01	1.27	(2.27)
All factors' alpha	0.01	0.24	0.53	0.36	0.72	0.70	1.03	0.95	0.64	1.21	1.20	(2.24)
Vanden's alpha	-1.03	-0.92	-0.81	-0.81	-0.65	-0.66	-0.19	-0.25	-0.31	0.36	1.38	(4.16)

TABLE A6

Bivariate Portfolio Analysis: Equal-Weighted Returns

This table presents results (in %) for equal-weighted delta-hedged bear spread portfolios based on bivariate dependent sorts of one characteristic variable and $VaR5$. In month t, decile portfolios of delta-hedged bear spreads are formed by sorting underlying stocks based on one of the characteristic variables. Then within each decile, additional decile portfolios of delta-hedged bear spreads are formed by sorting underlying stocks based on $VaR5$ observed in the previous year. Each $VaR5$ decile portfolio is then averaged over the control characteristic deciles. This table reports the raw returns for each decile portfolio, the "10-1" return spread, and the associated five-factor alpha spreads (5F Alpha) of the "10-1" portfolio. Five-factor alphas are calculated after adjusting for Fama–French three factors, Carhart (1997) momentum factor, and Coval and Shumway (2001) systematic volatility factor. $VaR5$ is the 5% value-at-risk that corresponds to -1 times the 5th percentile of daily returns in the past year. Control variables are SIZE (market capitalization); BTM (book-to-market ratio); DTA (firm leverage); MOM (momentum computed as the return over the previous six months); REV (reversal which is the return over the previous month); ILLIQ (logarithm of Amihud illiquidity); IVOL (idiosyncratic volatility); SKEW and KURT (skewness and kurtosis from one year of daily returns). We use 60-month rolling windows to compute the exposures of individual bear spread returns to the following systematic risk factors: zero-beta straddle (β_{Strad}) from Coval and Shumway (2001), jump and volatility factors (β_{Jump} and β_{Vol}) as in Cremers et al. (2015), the bear market factor (β_{Bear}) following Lu and Murray (2019), the tail factor (β_{Tail}) as in Kelly and Jiang (2014), and the downside factor ($\beta_{Downside}$) following Ang et al. (2006). Newey and West (1987) adjusted t-statistics are presented in parentheses. The sample period is from January 1996 to December 2017 for stocks in the OptionMetrics database.

	1	2	3	4	5	6	7	8	9	10	10-1	(t-stat)	5F Alpha	(t-stat)
SIZE	-0.56	-0.47	-0.16	-0.20	-0.19	-0.09	0.11	-0.02	0.24	0.30	0.86	(3.89)	0.94	(4.55)
BTM	-0.54	-0.38	-0.31	-0.19	-0.08	-0.01	-0.13	0.09	0.13	0.10	0.67	(3.65)	0.69	(3.93)
DTA	-0.51	-0.28	-0.36	-0.23	-0.02	0.03	0.01	0.03	0.14	0.10	0.65	(2.97)	0.71	(3.48)
MOM	-0.44	-0.29	-0.24	-0.23	-0.20	0.05	0.03	0.01	0.01	0.21	0.64	(3.05)	0.72	(3.72)
REV	-0.58	-0.44	-0.34	-0.26	-0.10	-0.06	0.02	0.07	0.11	0.51	1.09	(4.99)	1.18	(5.86)
ILLIQ	-0.60	-0.36	-0.34	-0.23	-0.18	-0.07	0.01	0.17	0.15	0.41	1.01	(4.12)	1.13	(4.95)
IVOL	-0.61	-0.37	-0.33	-0.23	-0.05	-0.01	0.01	-0.01	0.11	0.40	0.73	(4.46)	0.83	(4.87)
SKEW	-0.61	-0.35	-0.38	-0.29	-0.12	0.04	0.10	0.23	0.05	0.33	0.94	(3.73)	1.11	(4.82)
KURT	-0.35	-0.27	-0.40	-0.16	0.05	0.04	0.14	0.03	0.01	0.47	0.82	(1.94)	1.09	(2.83)
β_{Bear}	-0.53	-0.48	-0.38	-0.17	-0.23	-0.18	0.01	-0.14	-0.18	0.09	0.63	(2.50)	0.80	(3.47)
β_{Srad}	-0.56	-0.45	-0.31	-0.27	-0.21	-0.12	-0.29	-0.14	-0.10	0.26	0.82	(2.94)	0.91	(3.53)
β_{Jump}	-0.58	-0.44	-0.32	-0.40	-0.23	-0.14	-0.17	-0.02	-0.10	0.19	0.77	(2.51)	0.87	(3.01)
β_{Vol}	-0.53	-0.39	-0.35	-0.22	-0.22	-0.18	-0.15	-0.23	-0.06	0.15	0.68	(2.61)	0.85	(3.28)
β_{Tail}	-0.56	-0.48	-0.30	-0.25	-0.15	-0.26	-0.10	-0.17	0.00	0.05	0.62	(2.23)	0.65	(2.48)
β_{Down}	-0.55	-0.39	-0.39	-0.28	-0.19	-0.26	-0.11	-0.12	-0.22	0.27	0.82	(2.92)	1.01	(3.60)

TABLE A7

Volatility Underreaction: Naïve Estimates

This table reports the comparison of the forecasted scaled bear spread prices, $E_t[\text{AD-Price}_{t+1}]$, and the actual scaled bear spread prices, AD-Price_t. The forecasted bear spread prices are computed based on the average of the OTM and DOTM implied volatilities of the last 3, 6, or 12 observations observed in the previous 3, 6, or 12 months. The sample period is from January 1996 to December 2017 for stocks in the OptionMetrics database.

	1	2	3	4	5	6	7	8	9	10
Using last 3 months to estimate (at least 3 obs)										
$E_t[\text{AD-Price}_{t+1}]/\text{AD-Price}_t - 1$	-2.43%	-1.61%	-2.14%	-1.84%	-1.33%	-0.65%	-0.50%	-0.43%	-0.69%	1.03%
Using last 6 months to estimate (at least 3 obs)										
$E_t[\text{AD-Price}_{t+1}]/\text{AD-Price}_t - 1$	-1.63%	-2.08%	-1.56%	-1.98%	-0.88%	-1.25%	-0.27%	-0.56%	0.60%	0.75%
Using last 12 months to estimate (at least 6 obs)										
$E_t[\text{AD-Price}_{t+1}]/\text{AD-Price}_t - 1$	-0.35%	-0.46%	-0.69%	-1.22%	0.02%	-0.28%	0.27%	-0.08%	0.19%	0.79%

TABLE A8

Volatility Underreaction: 1-Year Rolling Window

This table reports the comparison of the statistical forecasts of scaled bear spread prices, $E_t[\text{AD-Price}_{t+1}]$, and the actual scaled bear spread prices, AD-Price$_t$. Panel A reports actual OTM and DOTM put implied volatilities ($IV_{OTM,t}$ and $IV_{DOTM,t}$) and the estimated OTM and DOTM put implied volatilities ($E_t[IV_{OTM,t+1}]$ and $E_t[IV_{DOTM,t+1}]$). The estimated volatilities are obtained by adding the estimated volatilities in Panel C with the estimated OTM and the DOTM option skews (not reported). Panel B reports the volatility spread obtained as the difference between DOTM and OTM put implied volatilities ($SPREAD_t = IV_{DOTM,t} - IV_{OTM,t}$). The expected volatility spread, $E_t[SPREAD_{t+1}]$, is the difference between the estimated DOTM and OTM option skews obtained from an ARMA (2,2) model using a 1-year rolling window of daily volatilities. Panel C reports ATM implied volatility, $IV_{ATM,t}$, and the estimated volatility, $E_t[IV_{ATM,t+1}]$ that is obtained from a HAR model using a 5-year rolling window of daily volatilities. Panel D reports the actual scaled bear spread price and the forecasted scaled bear spread price computed with the expected OTM and DOTM volatilities from Panel A. The sample period is from January 1996 to December 2017 for stocks in the OptionMetrics database.

	1	2	3	4	5	6	7	8	9	10
Panel A: OTM and DOTM IV estimation										
$IV_{OTM,t}$	0.244	0.290	0.326	0.360	0.394	0.431	0.474	0.525	0.597	0.754
$E_t[IV_{OTM,t+1}]$	0.236	0.284	0.320	0.355	0.392	0.432	0.478	0.534	0.615	0.779
$IV_{DOTM,t}$	0.286	0.335	0.373	0.409	0.446	0.485	0.531	0.585	0.663	0.831
$E_t[IV_{DOTM,t+1}]$	0.282	0.334	0.373	0.410	0.449	0.492	0.538	0.593	0.673	0.841
Panel B: IV Spread estimation										
$SPREAD_t$	0.042	0.045	0.047	0.050	0.051	0.054	0.057	0.060	0.066	0.077
$E_t[SPREAD_{t+1}]$	0.046	0.050	0.052	0.055	0.057	0.060	0.060	0.059	0.058	0.061
$SPREAD_t - E_t[SPREAD_{t+1}]$	-0.41%	-0.54%	-0.57%	-0.52%	-0.53%	-0.64%	-0.33%	0.10%	0.82%	1.58%
Panel C: ATM Volatility estimation										
$IV_{ATM,t}$	0.222	0.268	0.303	0.336	0.369	0.405	0.446	0.496	0.565	0.712
$E_t[IV_{ATM,t+1}]$	0.216	0.264	0.299	0.333	0.369	0.410	0.451	0.502	0.574	0.724
$IV_{ATM,t} - E_t[IV_{ATM,t+1}]$	0.62%	0.36%	0.35%	0.30%	0.05%	-0.41%	-0.48%	-0.61%	-0.91%	-1.20%
Panel D: Scaled bear spread prices										
AD-Price$_t$	0.152	0.166	0.173	0.179	0.187	0.193	0.201	0.209	0.221	0.246
$E_t[\text{AD-Price}_{t+1}]$	0.140	0.159	0.166	0.170	0.178	0.188	0.185	0.204	0.219	0.253
$E_t[\text{AD-Price}_{t+1}]/\text{AD-Price}_t - 1$	-7.48%	-4.34%	-4.69%	-5.26%	-5.30%	-2.31%	-8.24%	-4.04%	-2.82%	0.29%

TABLE A9

Robustness Tests

This table reports the time-series average monthly returns (in %) for the dollar-open-interest-weighted delta-hedged bear spread decile portfolios sorted on the left-tail risk measure $VaR5$ for different subsamples. $VaR5$ is the 5% value-at-risk that corresponds to -1 times the 5th percentile of daily returns in the past year. We report the following subsamples: periods of low and high sentiment; periods of low and high volatility VIX; periods of low and high economic growth (CFNAI); from 1996-2007 and 2008-2017; periods with and without earnings announcement days (with/without EAD). Sentiment is the market-wide sentiment constructed by Baker and Wurgler (2006); VIX is the volatility index from the CBOE; Chicago Fed National Activity Index (CFNAI) is a monthly index designed to gauge overall economic activity and related inflationary pressure. A high sentiment period and a high volatility period (a high economic-growth period) are selected when the sentiment level, or the VIX level (CFNAI level) are above their sample median (zero). We also report two weighting methods where the prices of the put options in the bear spread are weighted using simple average or kernel-weighted average. To construct the bear spread, we take the average of all put options within the range $[-0.40, -0.20)$ and $[-0.20, 0]$ for the OTM and the DOTM put options. We report bear spread returns using daily rebalancing. Newey and West (1987) adjusted t-statistics are presented in parentheses. The sample period is from January 1996 to December 2017 for stocks in the OptionMetrics database.

	1	2	3	4	5	6	7	8	9	10	10-1	(t-stat)
Low Sent.	-0.77	-0.77	-0.46	-0.55	-0.19	-0.48	-0.47	-0.41	-0.49	-0.29	0.48	(1.09)
High Sent.	-0.35	0.06	0.02	0.22	0.53	0.57	0.72	0.18	0.57	1.13	1.49	(2.25)
Low VIX	-0.42	-0.22	-0.14	-0.28	0.05	0.19	0.17	0.30	-0.12	0.98	1.40	(2.18)
High VIX	-0.77	-0.55	-0.33	-0.09	0.28	-0.06	0.07	-0.58	0.15	-0.09	0.68	(1.74)
Low CFNAI	-0.83	-0.35	-0.46	-0.39	0.03	-0.44	-0.38	-0.59	-0.30	0.28	1.11	(1.92)
High CFNAI	-0.36	-0.42	0.01	0.02	0.32	0.57	0.66	0.29	0.33	0.65	1.00	(2.11)
1996-2007	-0.59	-0.30	-0.22	-0.08	0.30	0.39	0.79	0.31	0.16	0.53	1.12	(1.72)
2008-2017	-0.60	-0.49	-0.25	-0.30	-0.01	-0.34	-0.69	-0.67	-0.16	0.35	0.94	(1.91)
With EAD	-0.50	-0.21	0.02	-0.02	0.61	0.51	0.12	0.30	0.09	0.85	1.35	(2.87)
Without EAD	-0.67	-0.36	-0.44	-0.39	-0.03	0.18	-0.32	-0.53	0.13	0.66	1.33	(2.45)
Simple avg.	-0.48	-0.30	-0.30	0.05	0.24	0.05	0.23	0.03	0.24	0.47	0.95	(2.27)
Kernel avg.	-0.45	-0.29	-0.31	0.09	0.26	0.16	0.28	0.06	0.36	0.49	0.95	(2.19)
Daily rebalance	2.18	1.79	1.58	1.80	2.15	2.57	2.71	2.75	2.83	3.27	1.08	(1.74)

TABLE A10

Univariate Portfolio Analysis of Naked Bear Spread Returns

This table reports the time-series average monthly returns (in %), equal-weighted and dollar-open-interest-weighted, for the naked bear spread decile portfolios without delta-hedging sorted on the left-tail risk measures ($VaR5$, $VaR1$, $ES5$, $ES1$), along with the return spreads ("10-1") and the associated spreads between decile 10 and decile 1. The left-tail risk measures are the 5% (1%) value-at-risk, $VaR5$ ($VaR1$), that corresponds to -1 times the 5th (1st) percentile of daily returns in the past year, and expected shortfall, $ES5$ ($ES1$), calculated as -1 times the average of the returns below the 5th (1st) percentile of daily returns in the past year. Each month t, decile portfolios of bear spreads are formed and held to maturity by sorting underlying stocks on a left-tail risk measure. The dollar open interest weight is calculated as the minimum of the open interests of the two puts in each bear spread, multiplied by the cost of the bear spread. Newey and West (1987) adjusted t-statistics are presented in parentheses. The sample period is from January 1996 to December 2017 for stocks in the OptionMetrics database.

	Equal-Weighted Returns											
	1	2	3	4	5	6	7	8	9	10	10-1	t-stat
VaR5	-7.56	-6.95	-5.07	-2.49	-1.07	0.88	2.30	0.76	1.85	3.96	11.52	(3.60)
VaR1	-6.23	-7.29	-5.44	-2.52	0.14	1.50	1.93	0.10	2.29	2.13	8.35	(3.33)
ES5	-6.46	-7.65	-6.22	-0.98	-0.88	2.46	0.54	0.48	2.30	2.57	9.03	(3.41)
ES1	-7.41	-5.25	-4.49	-2.87	1.75	0.74	0.39	1.10	1.94	0.80	8.21	(3.48)

	Dollar-Open-Interest-Weighted Returns											
	1	2	3	4	5	6	7	8	9	10	10-1	t-stat
VaR5	-6.20	-7.94	-4.74	-4.51	3.41	-0.23	2.29	0.44	2.46	3.44	9.64	(2.44)
VaR1	-4.64	-10.96	-7.67	1.04	4.27	-0.06	0.06	-0.37	2.74	2.99	7.63	(2.26)
ES5	-5.74	-7.93	-4.96	0.55	-1.54	3.91	-0.30	0.35	4.33	2.85	8.60	(2.35)
ES1	-8.74	-3.69	-1.34	-0.98	-1.59	-2.25	0.02	2.09	3.42	2.76	11.50	(2.61)

TABLE A11

Transaction Costs for Naked Bear Spread

This table examines the impact of transaction costs (bid-ask spreads and margin requirements) on the profitability of the "10-1" naked bear spread CAPM alphas (in %) sorted on $VaR5$. CAPM alphas are calculated after adjusting "10-1" delta-hedged bear spread returns for the CAPM market risk factor. We report "10-1" naked bear spread CAPM alphas for different ratios of the effective to quoted bid-ask spread: 0% (No cost), 10%, 29.6%, 50%, 58.4%, 100% and the actual effective option bid-ask spread obtained from intraday options from OPRA data. We also examine subsamples of different half quoted bid-ask spreads: lower than 0.1, lower than 0.2, lower than 0.3, and for the full sample. The margin requirement adjusted return is computed using the initial option margin requirements of the CBOE. Following Weinbaum et al. (2023), the margin cost equals the cost of borrowing the additional capital to meet the margin requirement. Each month t, decile portfolios of naked bear spreads are formed and held to maturity by sorting underlying stocks on the $VaR5$ left-tail measure. Portfolios are dollar-open-interest-weighted. $VaR5$ is the 5% value-at-risk that corresponds to -1 times the 5th percentile of daily returns in the past year. Newey and West (1987) adjusted t-statistics are presented in parentheses. We report the average number of firms per month for each subsample. The sample period is from 2003 to 2017 for the subsample with half quoted bid-ask spread lower than 0.1 and for the OPRA subsample. For the other subsamples, the sample period is from 1996 to 2017 for stocks in the OptionMetrics database.

		0% (No Cost)	10%	29.6%	50%	58.4%	100%	29.6%+Margin	OPRA (2003-2017)
Quoted Half Spread<0.1	Short	3.36	3.08	2.53	1.95	1.70	0.43	2.40	2.01
Period: 2003-2017		(0.62)	(0.57)	(0.47)	(0.36)	(0.32)	(0.08)	(0.45)	(0.37)
	Long	13.39	12.95	12.10	11.24	10.90	9.24	12.09	11.65
		(2.77)	(2.69)	(2.54)	(2.38)	(2.31)	(1.99)	(2.54)	(2.47)
	Long+Short	16.74	16.03	14.63	13.19	12.60	9.67	14.49	13.66
		(3.28)	(3.14)	(2.87)	(2.59)	(2.47)	(1.90)	(2.85)	(2.73)
Avg. Stocks per month					190				190
Quoted Half Spread<0.2	Short	-1.31	-1.86	-2.99	-4.22	-4.74	-7.54	-3.20	0.53
Period: 1996-2017		(-0.31)	(-0.44)	(-0.70)	(-0.97)	(-1.08)	(-1.64)	(-0.75)	(0.10)
	Long	12.20	11.53	10.25	8.98	8.48	6.09	10.24	9.93
		(3.72)	(3.54)	(3.20)	(2.85)	(2.71)	(2.01)	(3.20)	(2.60)
	Long+Short	10.89	9.66	7.27	4.77	3.73	-1.45	7.04	10.46
		(2.48)	(2.19)	(1.63)	(1.06)	(0.82)	(-0.31)	(1.58)	(2.39)
Avg. Stocks per month					348				415
Quoted Half Spread<0.3	Short	-1.37	-2.00	-3.30	-4.74	-5.37	-8.75	-3.52	1.14
Period: 1996-2017		(-0.32)	(-0.47)	(-0.76)	(-1.06)	(-1.19)	(-1.82)	(-0.80)	(0.23)
	Long	10.75	9.99	8.58	7.18	6.62	4.04	8.56	8.15
		(3.40)	(3.19)	(2.79)	(2.38)	(2.21)	(1.39)	(2.78)	(2.17)
	Long+Short	9.38	7.99	5.28	2.44	1.26	-4.71	5.04	9.30
		(2.11)	(1.78)	(1.16)	(0.52)	(0.27)	(-0.95)	(1.11)	(2.15)
Avg. Stocks per month					451				537
Full Sample	Short	-2.69	-3.44	-5.03	-6.88	-7.80	-12.41	-5.25	-0.01
Period: 1996-2017		(-0.63)	(-0.79)	(-1.12)	(-1.48)	(-1.65)	(-2.39)	(-1.17)	(-0.00)
	Long	10.67	9.79	8.16	6.59	5.98	3.17	8.15	6.38
		(3.38)	(3.13)	(2.66)	(2.19)	(2.00)	(1.10)	(2.66)	(1.71)
	Long+Short	7.98	6.35	3.14	-0.29	-1.82	-9.24	2.90	6.37
		(1.80)	(1.42)	(0.68)	(-0.06)	(-0.38)	(-1.78)	(0.63)	(1.41)
Avg. Stocks per month					587				708

TABLE A12

Bivariate Portfolio Analysis: Potential Explanatory Variables

This table presents results (in %) for dollar-open-interest-weighted delta-hedged bear spread portfolios based on bivariate dependent sorts of one characteristic variable and $VaR5$. In month t, decile portfolios of delta-hedged bear spreads are formed by sorting underlying stocks based on one of the characteristic variables. Then within each decile, additional decile portfolios of delta-hedged bear spreads are formed by sorting underlying stocks based on $VaR5$ observed in the previous year. Each $VaR5$ decile portfolio is then averaged over the control characteristic deciles. This table reports the raw returns for each decile portfolio, the "10-1" return spread, and the associated five-factor alphas (5F Alpha) of the "10-1" portfolio. 5F Alpha is calculated after adjusting for Fama–French three factors, Carhart (1997) momentum factor, and Coval and Shumway (2001) systematic volatility factor. $VaR5$ is the 5% value-at-risk that corresponds to -1 times the 5th percentile of daily returns in the past year. Potential explanatory variables are: VRP (variance risk premium as in Goyal and Saretto (2009)); RNS (risk-neutral skewness); VOV (vol-of-vol as in Baltussen et al. (2018)); PIN (probability of informed trading as in Easley et al. (2002)); and OPT_Demand (the log difference between the total market value of all options and the market value of underlying stocks). Newey and West (1987) adjusted t-statistics are presented in parentheses. The sample period is from January 1996 to December 2017 for stocks in the OptionMetrics database.

	1	2	3	4	5	6	7	8	9	10	10-1	(t-stat)	5F Alpha	(t-stat)
VRP	-0.61	-0.01	-0.37	-0.35	0.04	0.19	0.07	0.19	0.10	0.11	0.72	(1.77)	0.88	(2.20)
RNS	-0.42	-0.58	-0.20	-0.01	0.16	0.43	-0.31	-0.18	0.18	0.39	0.84	(2.30)	0.77	(2.08)
VOV	-0.46	-0.25	-0.28	-0.21	0.17	0.20	0.01	-0.07	0.05	0.26	0.72	(1.82)	0.93	(2.32)
PIN	-0.47	-0.44	-0.18	-0.37	0.32	0.22	0.44	0.41	-0.15	0.45	0.91	(1.74)	1.24	(2.53)
OPT_Demand	-0.13	-0.22	-0.19	0.19	-0.30	0.12	-0.14	-0.17	-0.09	0.60	0.73	(1.71)	0.85	(1.93)

TABLE A13

Fama–MacBeth Regressions: Potential Explanatory Variables

This table presents the results of Fama and MacBeth (1973) regressions of monthly delta-hedged bear spread returns on $VaR5$ and control variables. $VaR5$ is the 5% value-at-risk that corresponds to -1 times the 5th percentile of daily returns in the past year. Control variables are VRP (variance risk premium as in Goyal and Saretto (2009)); RNS (risk-neutral skewness); VOV (vol-of-vol as in Baltussen et al. (2018)); PIN (probability of informed trading as in Easley et al. (2002)); and OPT_Demand (the log difference between the total market value of all options and the market value of underlying stocks). The first two columns report the results for the univariate regression of delta-hedged bear spread returns on $VaR5$ and bivariate regressions of delta-hedged bear spread returns on $VaR5$ and each of the control variables. The last column reports the results of the multivariate regression of delta-hedged bear spread returns on $VaR5$ and all the control variables. Coefficients are time-series averages and the associated Newey and West (1987) t-statistics are reported in parentheses. The sample period is from January 1996 to December 2017 for stocks in the OptionMetrics database.

	Univariate/Bivariate Regressions			Multivariate
	Coefficient on VaR5	Coefficient on Control	Adj. R^2	Regressions
VaR5	0.201		1.32%	0.177
	(4.58)			(2.80)
VRP	0.143	-0.002	1.68%	0.001
	(3.21)	(-0.90)		(0.12)
RNS	0.184	-0.001	1.58%	0.0001
	(3.69)	(-1.10)		(0.05)
VOV	0.154	-0.008	1.47%	0.001
	(3.46)	(-0.98)		(0.06)
PIN	0.201	-0.017	1.47%	-0.009
	(3.73)	(-1.91)		(-0.78)
OPT_Demand	0.188	0.001	1.41%	0.001
	(4.37)	(2.07)		(1.96)
Adj. R^2				2.72%

TABLE A14

Bivariate Portfolio Analysis: Option Return Predictors

This table presents results (in %) for dollar-open-interest-weighted delta-hedged bear spread portfolios based on bivariate dependent sorts of one characteristic variable and $VaR5$. In month t, decile portfolios of delta-hedged bear spreads are formed by sorting underlying stocks based on one of the characteristic variables. Then within each decile, additional decile portfolios of delta-hedged bear spreads are formed by sorting underlying stocks based on $VaR5$ observed in the previous year. Each $VaR5$ decile portfolio is then averaged over the control characteristic deciles. This table reports the raw returns for each decile portfolio, the "10-1" return spread, and the associated five-factor alpha spreads (5F Alpha) of the "10-1" portfolio. Five-factor alphas are calculated after adjusting for Fama–French three factors, Carhart (1997) momentum factor, and Coval and Shumway (2001) systematic volatility factor. $VaR5$ is the 5% value-at-risk that corresponds to -1 times the 5th percentile of daily returns in the past year. Control variables include: CFV is cash flow variance as in Haugen and Baker (1996); CH is the cash-to-assets ratio as in Palazzo (2012); ISSUE-1Y represents 1-year new issues as in Pontiff and Woodgate (2008); ISSUE-5Y represents 5-year new issues as in Daniel and Titman (2006); PM is profit margin as in Soliman (2008); ln(PRICE) is the log of the underlying stock price at the end of last month; PROFIT is the profitability as in Fama and French (2006); TEF is total external finance; and ZS is z-score as in Dichev (1998). Newey and West (1987) adjusted t-statistics are presented in parentheses. The sample period is from January 1996 to December 2017 for stocks in the OptionMetrics database.

	1	2	3	4	5	6	7	8	9	10	10-1	(t-stat)	5F Alpha	(t-stat)
CFV	-0.45	-0.24	-0.28	-0.11	-0.05	0.08	0.10	0.14	0.19	0.29	0.74	(3.14)	0.77	(3.18)
CH	-0.50	-0.31	0.01	-0.14	0.07	0.10	0.18	0.15	0.20	0.24	0.71	(3.09)	0.78	(3.46)
ISSUE-1Y	-0.44	-0.27	-0.11	-0.04	0.09	0.15	0.13	0.15	0.20	0.41	0.85	(3.23)	0.82	(3.20)
ISSUE-5Y	-0.41	-0.21	0.04	-0.08	0.02	0.17	0.17	0.19	0.23	0.37	0.78	(3.21)	0.80	(3.25)
PM	-0.40	-0.25	0.00	0.02	-0.10	-0.09	0.14	0.09	0.16	0.30	0.70	(2.48)	0.77	(2.57)
ln(PRICE)	-0.75	-0.40	-0.23	-0.25	-0.11	0.12	0.15	0.18	0.22	0.23	0.98	(3.59)	1.08	(3.74)
PROFIT	-0.35	-0.17	-0.09	0.04	0.12	0.09	0.10	0.19	0.24	0.40	0.75	(2.49)	0.72	(2.42)
TEF	-0.61	-0.37	0.10	-0.21	0.01	0.12	0.20	0.19	0.15	0.39	1.00	(3.83)	0.94	(3.70)
ZS	-0.26	-0.21	-0.17	-0.03	0.02	0.03	0.09	0.19	0.22	0.41	0.67	(2.04)	0.74	(2.31)

TABLE A15

Robustness Tests: Equal-Weighted Returns

This table reports the time-series average monthly returns (in %) for equal-weighted delta-hedged bear spread decile portfolios sorted on the portfolios sorted on the left-tail risk measure $VaR5$ for different subsamples. $VaR5$ is the 5% value-at-risk that corresponds to -1 times the 5th percentile of daily returns in the past year. We report the following subsamples: for periods of low and high sentiment; for periods of low and high volatility VIX; for periods of low and high economic growth (CFNAI); from 1996-2007 and 2008-2017; for period with and without earnings announcement days (with/without EAD). Sentiment is the market-wide sentiment constructed by Baker and Wurgler (2006); VIX is the volatility index from the CBOE; Chicago Fed National Activity Index (CFNAI) is a monthly index designed to gauge overall economic activity and related inflationary pressure. A high sentiment period and a high volatility period (a high economic-growth period) are selected when the sentiment level, or the VIX level (CFNAI level) are above their sample median (zero). We also report two weighting methods where the prices of the put options in the bear spread are weighted using simple average or kernel-weighted average. To construct the bear spread, we take the average of all put options within the range $[-0.40, -0.20)$ and $[-0.20, 0]$ for the OTM and the DOTM put options. We report bear spread returns using daily rebalancing. Newey and West (1987) adjusted t-statistics are presented in parentheses. The sample period is from January 1996 to December 2017 for stocks in the OptionMetrics database.

	1	2	3	4	5	6	7	8	9	10	10-1	(t-stat)
Low Sent.	-0.61	-0.54	-0.47	-0.47	-0.32	-0.29	-0.10	-0.18	-0.44	-0.08	0.52	(1.67)
High Sent.	-0.57	-0.33	-0.23	0.11	0.08	0.08	0.45	0.50	0.63	0.85	1.42	(3.25)
Low VIX	-0.43	-0.24	-0.19	-0.09	-0.17	0.06	0.31	0.17	-0.02	0.22	0.65	(1.82)
High VIX	-0.82	-0.68	-0.54	-0.30	-0.09	-0.28	0.04	0.16	0.19	0.59	1.41	(3.30)
Low CFNAI	-0.59	-0.43	-0.40	-0.27	-0.01	-0.04	-0.03	0.06	0.17	0.78	1.37	(3.31)
High CFNAI	-0.66	-0.49	-0.34	-0.12	-0.26	-0.17	0.38	0.27	0.01	0.04	0.69	(2.17)
1996-2007	-0.84	-0.59	-0.40	-0.14	-0.12	-0.04	0.42	0.42	0.36	0.68	1.52	(3.48)
2008-2017	-0.33	-0.24	-0.27	-0.19	-0.10	-0.13	-0.07	-0.06	-0.16	0.15	0.48	(1.65)
With EAD	-0.38	-0.35	-0.06	-0.07	0.28	0.26	0.39	0.27	0.34	0.57	0.95	(3.15)
Without EAD	-0.65	-0.53	-0.51	-0.36	-0.19	-0.22	0.00	0.02	-0.11	0.63	1.28	(3.61)
Simple avg.	-0.58	-0.45	-0.36	-0.16	-0.13	-0.12	0.21	0.21	0.13	0.42	1.00	(3.55)
Kernel avg.	-0.57	-0.45	-0.35	-0.15	-0.10	-0.09	0.24	0.24	0.15	0.45	1.02	(3.50)
Daily rebalance	1.96	1.69	1.74	1.85	2.17	2.49	2.62	2.73	2.86	3.76	1.80	(2.46)

TABLE A16

Modified Fama–Macbeth Regressions and Weigthed Least Squares Regressions

This table presents the results of Fama and MacBeth (1973) regressions (FM) of monthly delta-hedged bear spread returns on VaR5 and control variables. In the Modified FM model, the delta-hedged bear spread returns are first regressed on all factors in Table 3, and then the cross-sectional regressions are conducted as follows: $r_{i,t} - \beta_i F_i = \gamma_{0,t} + \gamma_{1,t} VaR5_{i,t-1} + \phi_t Z_{i,t-1} + e_{i,t}$ where $r_{i,t}$ is the return on the delta-hedged bear spread observed for stock i in quarter t, β_i is a vector of estimated factor loadings of the stock i's delta-hedged bear spread returns, F_i is a vector of factors, $VaR5_{i,t-1}$ is one of the stock i's left-tail risk characteristics observed in quarter t-1, and $Z_{i,t-1}$ is a vector of controls. In the weighted least squares model (WLS), each monthly regression is estimated using the WLS methodology following Asparouhova et al. (2013). The dollar open interest (DOI) of the options and the last month-end stock market capitalization are used as the weight assigned to each observation respectively. VaR5 is the 5% value-at-risk that corresponds to -1 times the 5th percentile of daily returns in the past year. Control variables are SIZE (market capitalization); BTM (book-to-market ratio); DTA (firm leverage); MOM (momentum computed as the return over the previous six months); REV (reversal is the return over the previous month); ILLIQ (logarithm of Amihud illiquidity); IVOL (idiosyncratic volatility); SKEW and KURT (skewness and kurtosis from one year of daily returns); VRP (variance risk premium as in Goyal and Saretto (2009)); VOV (vol-of-vol as in Baltussen et al. (2018)); RNS (risk-neutral skewness). We use 60-month rolling windows to compute the exposures of individual bear spread returns to the following systematic risk factors: zero-beta straddle (β_{Strad}) from Coval and Shumway (2001), jump and volatility factors (β_{Jump} and β_{Vol}) as in Cremers et al. (2015), the bear market factor (β_{Bear}) following Lu and Murray (2019), the tail factor (β_{Tail}) as in Kelly and Jiang (2014), and the downside factor (β_{Down}) following Ang et al. (2006). Coefficients are time-series averages and the associated Newey and West (1987) t-statistics are reported in parentheses. The last row reports the average adjusted R-squared. The sample period is from January 1996 to December 2017 for stocks in the OptionMetrics database.

	Modified FM	WLS (DOI-weighted)	WLS (mkt-weighted)
VaR5	0.276	0.261	0.351
	(3.64)	(2.23)	(4.21)
SIZE	-0.004	-0.003	-0.002
	(-3.63)	(-1.65)	(-1.29)
BTM	0.000	0.000	0.000
	(2.15)	(0.81)	(1.32)
DTA	0.001	0.004	0.005
	(0.52)	(1.05)	(1.93)
MOM	-0.003	-0.001	-0.006
	(-1.15)	(-0.26)	(-2.22)
REV	-0.004	-0.015	-0.014
	(-0.96)	(-2.11)	(-2.47)
ILLIQ	-0.003	-0.002	-0.001
	(-2.66)	(-1.07)	(-1.01)
IVOL	-0.660	-0.574	-0.437
	(-5.86)	(-3.04)	(-2.71)
SKEW	0.000	0.001	0.000
	(0.68)	(0.97)	(0.38)
KURT	0.000	0.000	0.000
	(1.83)	(1.58)	(0.54)
VRP	-0.030	-0.025	-0.014
	(-3.86)	(-2.17)	(-1.33)
VOV	0.002	0.016	0.010
	(0.24)	(0.80)	(0.60)
RNS	-0.002	-0.003	-0.002
	(-2.12)	(-1.56)	(-1.12)
β_{Bear}	0.003	0.001	0.002
	(1.37)	(0.69)	(1.05)
β_{Strad}	0.026	0.007	0.000
	(2.21)	(0.56)	(-0.01)
β_{Jump}	0.003	-0.004	0.001
	(2.26)	(-1.47)	(0.26)
β_{Vol}	0.001	0.001	0.001
	(1.19)	(0.98)	(0.95)
β_{Tail}	0.003	0.000	0.001
	(2.75)	(0.23)	(1.36)
β_{Down}	0.000	0.002	0.000
	(0.92)	(2.41)	(0.00)
Adj. R^2	6.8%	31.0%	15.0%