Equity Option Return Predictability and Expiration Days

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Abstract

Prior studies have identified many reliable predictors of delta-hedged option returns and attributed them to mispricing. We show that most of this predictability can be attributed to intermediary frictions concentrated on two days. Each month, when covered call writers roll over their positions on the third Friday expiration and especially the following Monday, option market makers absorb large order imbalances causing price pressure. As a result, average option returns are highly negative on the two rollover days, but are slightly positive during the rest of month. The rollover effect helps explain the predictability of 18 option return anomalies - rollover days capture half of all abnormal returns across all stocks and the entire predictability in S&P 500 stocks. The rollover also affects returns for expiring options. Overall, systematic trading pressure on just two days each month drives the bulk of abnormal option returns.

Keywords: Option returns, option anomalies, expiration rollover, intermediary asset pricing.

JEL Classification: G11, G12, G14, G32.

1 Introduction

High-quality equity options data spanning several decades has stimulated research on option market efficiency, typically using delta-hedged returns to minimize underlying stock effects. Studies consistently find monthly option returns to be strongly predictable based on stock or option characteristics and typically attribute these anomalies to behavioral biases causing mispricing. Even after Duarte, Jones, Khorram, and Mo (2022) corrected for forward-looking biases in option returns, an average options anomaly earns monthly alphas of 0.5% and Sharpe ratios around 0.5. Moreover, these return patterns persist for years after academic publication (e.g., Cao and Han (2013)). Such persistent predictability challenges finance theory, which expects competitive markets to produce efficient prices that reflect all information and eliminate predictable returns not compensating for risk. Indeed, sophisticated market makers like Citadel Securities generate option prices, while institutional investors use advanced pricing models to detect and capitalize on mispricing.

In this paper, we provide a unifying explanation for option return anomalies by focusing on intermediary frictions that create predictable price pressure. Specifically, we identify a systematic pattern of order flow concentrated on just two days each month: the third Friday when monthly options expire and especially the following Monday. On these days, covered call writers roll over expiring positions by selling new options. This coordinated selling creates large order imbalances that overwhelm market makers' risk-bearing capacity, forcing them to lower prices to compensate for taking excess inventory. These intermediary frictions reflect the limited capital and inventory constraints of option market makers. Rather than indicating market inefficiency in processing information, predictable option returns may stem from liquidity provision during customer selling pressure.

To explore how the expiration rollover affects average option returns over a month, we split monthly option returns into two intervals: the two-day rollover and the rest of the month. For brevity, we use the terms option returns and delta-hedged call option returns interchangeably. We focus on calendar-month option returns (or the end-of-month to end-of-month) that accumulate daily delta-hedged returns.[1] Specifically, we follow Duarte et al. (2022), who correct the forward-looking bias in option returns. Option returns are measured over a calendar month to align with studies of monthly stock returns (e.g., Cao and Han (2013); Zhan, Han, Cao, and Tong (2021); and Bali, Beckmeyer, Mörke, and Weigert (2023)). Such returns use options with about 50-days-to-maturity and hold them until about 20 days-to-maturity.[2]

We begin by studying systematic order imbalances around option expiration focusing on non-expiring options. Muravyev (2016) shows extremely negative option imbalances around expiration due to investors rolling positions to later-expiring options, with particularly strong selling pressure on post-expiration Mondays.[3] During our sample period from May 2005 to December 2021, we find that customer order imbalances in non-expiring options are typically slightly positive (1%) but drop to −12% on the post-expiration Monday and continue to be negative for several more days. These negative imbalances in non-expiring options are preceded by positive imbalances in expiring options as many investors close their expiring option positions. Once existing option positions expire, investors open new option positions.

Turning to option returns, we find that conventional calendar month returns are slightly negative (−0.20%) on average, which is consistent with prior literature after adjusting for forward looking bias. However, we find a striking pattern as we decompose the calendar month returns into the expiration period and the rest of the month. The returns for non-expiring options over expiration Friday and post-expiration Monday are (−0.43%), while

[1] However, we obtain similar results when we test the robustness of our results using delta-hedged put option returns and straddles.

[2] We borrow terminology common in futures markets: at any given calendar date T, we denote the near contract as the one expiring earliest. The far contract is the contract that expires in the subsequent month $T+1$. It is likely that at date T, contracts expiring after month $T+1$, in month $T+2$, and so on, are simultaneously traded. As time advances, the far contract becomes the near contract.

[3] Earlier research by Bollen and Whaley (2004) and Gârleanu, Pedersen, and Poteshman (2009a) also confirms substantial demand pressure effects on option prices in general.

returns for these options during the rest of the calendar month are 0.19%. Both average returns are statistically significant. Thus, a brief two-day expiration window changes the sign of the average monthly returns.

After examining average returns and imbalances, we turn to option anomalies that highlight how option returns are higher for some stocks conditional on anomaly signals. Specifically, we consider 18 option anomalies from Zhan et al. (2021) and Duarte et al. (2022). Accounting-based anomalies include profitability, cash flow, equity issuance, and financial distress measures. Volatility anomalies include idiosyncratic and implied volatility, volatility mispricing, and term structure. Skewness-based anomalies consist of maximum daily return and risk-neutral skewness. We also include log stock price and the Amihud illiquidity. In the main analysis, we construct equally-weighted decile portfolios for each anomaly signal at the end of a calendar month.

An average option anomaly earns −0.64% per calendar month in our sample with a corresponding *t*-statistic of −7.77. The long-short returns are negative for each anomaly though not always statistically significant. Similar to our analysis of average returns, we find a striking pattern once calendar month returns are decomposed into the expiration period and the rest of the month. The two day rollover period accounts for more than half of monthly anomaly returns. An average option anomaly earns −0.36% per month during the expiration rollover, while −0.28% during the rest of the month. Moreover, the rest-of-month option returns are only statistically significant for seven out of 18 anomalies. Finally, the rollover days capture the entire anomaly predictability if we limit the sample to S&P 500 stocks. This sample has the most actively traded options and lowest transaction costs.

To ensure the reliability of our findings, we conduct extensive robustness checks. We examine daily and weekly delta-hedged returns, confirming that the negative returns are concentrated around expiration days, particularly Mondays following expirations. When excluding expiration periods, returns are typically insignificant. Our analysis extends to straddle positions, which similarly exhibit negative average monthly returns driven by expiration effects, while non-expiration periods show positive contributions. We verify that our results hold for put options, not just calls, with consistent patterns of negative returns around expiration dates. We also find that the patterns remain largely robust over the entire sample period. Finally, we investigate returns across different moneyness categories (ATM, OTM, ITM), finding the expiration effect is strongest for ATM and OTM options, likely reflecting investors' tendency to roll over positions in these categories. These tests collectively reinforce our central finding that expiration periods drive the negative delta-hedged returns documented in the literature.

Overall, we propose that intermediary frictions on two days a month play a crucial role in explaining patterns in average option returns and returns of option anomalies. Specifically, option investors extensively rebalance their portfolios as positions expire, creating large (and typically negative) order imbalances. Option market makers must accommodate these imbalances, moving prices significantly in response to this concentrated pressure. Remarkably, these brief expiration effects on just two days a month account for most documented anomaly returns. Our findings reveal that seemingly unrelated option anomalies are actually connected through a common intermediary channel during expiration rollovers. Prior literature typically attributes option anomalies to generic market inefficiency or behavioral biases. Instead, we argue that they largely reflect systematic liquidity demands that overwhelm market makers' risk-bearing capacity at predictable times.

The remainder of the paper is organized as follows. In Section 2, we review related work. Section 3 describes the data and the option return computation. Section 4 examines the role of the expiration rollover in explaining the negative average delta-hedged returns.

Section 5 studies how expiration rollover helps explain cross-sectional option anomalies. Section 6 reports robustness tests. Section 7 concludes.

2 Related Literature

We begin by setting out recent developments in the use of delta-hedged returns (and straddles) in selected recent studies of option market efficiency. In early work, Bakshi and Kapadia (2003a) use $S\&P$ index call options data from 1998-2005 and find that daily re-balanced monthly delta-hedged gains (as well as gains normalized by the index level or option price) are significantly negative. Bakshi and Kapadia (2003b) confirm, using a sample of 25 equity options, that delta-hedged gains of individual equity options are more negative than positive. Cao and Han (2013) find that, over the 1996-2009 period, the mean and median of delta-hedged option returns are negative. Specifically, about 78% of their sample of equity options have negative average delta-hedged call option returns, of which 32% are significantly negative. Finally, Christoffersen, Goyenko, Jacobs, and Karoui (2017) also finds that average delta-hedged daily options returns across moneyness are negative and significant. Similar evidence is also reported for straddles used instead of delta-hedged call and put option returns.

Both delta-hedged and straddle returns are used in tests of predictability by both stock and option-based characteristics. For example, Goyal and Saretto (2009) document that straddles or delta-hedged calls on stocks are on average negative. Further, they are negatively related to the lagged difference between implied and realized volatility. Cao and Han (2013) find that delta-hedged equity option returns are inversely related to the past idiosyncratic volatility of the underlying stock. Zhan et al. (2021) show that delta-hedged options returns have predictive ability for firm-level characteristics including stock price, profit margin, firm profitability, cash holding, cash flow variance, new shares issuance, total external financing, distress risk, and dispersion of analyst forecasts. Bali et al. (2023) find, using machine learning methods, that stock-based measures offer incremental predictive power relative to option-based characteristics. In contrast, Goyenko and Zhang (2022) find that option, rather than stock, characteristics are dominant predictors of option returns.

In a Black-Scholes world, delta-hedged options returns should be zero. Violations of assumptions underlying the Black-Scholes model or other economic frictions have also been proposed to explain negative delta-hedged options returns and their predictability. These include the presence of a negative volatility risk premium (Bakshi and Kapadia (2003a)) and jump risk (Green and Figlewski (1999)). Bali and Murray (2013), Byun and Kim (2016) attribute predictability to investors' preference for lottery-like trades. Cao and Han (2013) and Ramachandran and Tayal (2021) find that limits to arbitrage and constrained financial intermediaries play a role. Pan and Poteshman (2006) emphasize the role of information asymmetry. Zhan et al. (2021) attribute option return predictability to informational frictions and option mispricing. Related to our work, Bollen and Whaley (2004), Gârleanu, Pedersen, and Poteshman (2009b) and Muravyev (2016) link predictability to option demand pressure.

In related work on equity option contracts and market efficiency, Eisdorfer, Sadka, and Zhdanov (2022) study how investors mispriced options when they do not differentiate between option contracts that have 4 versus 5 weeks between expiration dates. Duarte, Jones, and Wang (2023) addresses issues related to portfolio weighting and biases due to measurement errors when option market data is used.

Our work also has implications for option return-based factor models. Factors in these models use delta-hedged monthly equity option returns. Examples include (Karakaya (2014); Zhan et al. (2021), Horenstein, Vasquez, and Xiao (2022) and Bali, Cao, Chabi-Yo, Song, and Zhan (2022) among others. Asset pricing model factors are also extracted from large panels of monthly delta-hedged option returns using various dimension reductions methods. Examples include Christoffersen, Fournier, and Jacobs (2017), Büchner and Kelly (2022), and Goyal and Saretto (2022).

3 Data and Methodology

Our data is standard and is the basis for much of literature on properties of option returns. We first describe sources of our option market data and then move to the stock market data. We also follow the literature and use standard filters, described later, before using the data and only when we initiate our option positions.

3.1 Option and Stock Data

Option Data We collect data from both stock and equity options markets. Our US equity stock options data is from the OptionMetrics IvyDB database over the period January 1996 to December 2021. We focus on the end-of-day bid and ask quotes, trading volume, open interest, strike prices, deltas, and implied volatility.

At the end of the first day of the month and for each optionable stock, we extract from the OptionMetrics IvyDB database a pair of a call and a put that is closest to being at the money and with more than one month to expiration. Our main results are based on options with moneyness between 0.8 and 1.2 but we also show results using different moneyness intervals.

Following prior work, we include those options that meet the following criteria: (i) The best bid price is positive and smaller than the best offer price, (ii) the price does not violate non-arbitrage bounds, (iii) open interest is positive, (iv) the midpoint of bid and ask quotes being at least 0.125 dollars. We apply these filters only when we initiate our option positions (at the end of the month or on the first trading day after the third Friday).

Similar to the return predictability literature and in order to avoid forward-looking bias, we compute daily delta-hedged returns applying filters only when we initiation our option positions (Duarte et al. (2022)).

Signed Option Volume We also collect daily option buy and sell volume from four exchanges: NASDAQ GEMX (GEMX), NASDAQ International Security Exchange (ISE), NASDAQ Options Market (NOTO), and NASDAQ PHLX (PHOTO). Specifically, the dataset includes option volume of open buy, open sell, close buy and close sell orders. Each category includes different types of participants: broker/dealer, proprietary firms, and public customers. Then, we sum the buy and sell trades to compute option imbalances at the stock level. The four exchanges account for a significant portion of the options market. However, we do not consider other exchanges and OTC markets. The datasets cover different time periods. Specifically, ISE covers the period of May 2005 to December 2021, GEMINI is from August 2013 to December 2021, NOTO is from November 2011 to December 2021, and PHOTO is from January 2009 to December 2021.

We define, following Muravyev (2016), option order imbalances as the difference between the number of option buy and sell transactions by non-market makers divided by the total number of option trades on a given day. For example, market makers are net sellers of options if the order imbalance is positive. Importantly, the data identify which trade side is taken by option market makers. Order imbalance is estimated using the following expression:

$$OIMB_{i,t} = \frac{\sum_{i=1}^{N}(Buy_{i,t} - Sell_{i,t})}{\sum_{i=1}^{N} Buy_{i,t} + Sell_{i,t}} \tag{1}$$

where $\text{Buy}_{i,t}$ ($\text{Sell}_{i,t}$) represents the buyer (seller)-initiated transactions and is defined as $\text{Buy}_{i,t}$ ($\text{Sell}_{i,t}$) for option i at time t. In other words, a positive (negative) option order imbalance means that investors tend on average to buy (sell) options on a particular stock assigning upward (downward) price pressure on their prices.

Stock Data Our daily and monthly stock prices and daily trading volume come from the Center for Research in Security Prices (CRSP), including New York Stock Exchange (NYSE), American Stock Exchange (AMEX), and NASDAQ markets, as well as common stocks with share codes 10 and 11, financials and non-financials. We also exclude stocks with prices below \$5. To this, we add firm-level accounting data for these stocks from the Compustat database. Since U.S. individual stock options are of the American type an option is excluded if the underlying stock pays a dividend during the remaining life of the option. Our results are similar if we also include dividend paying stocks.

We now turn to the computation of delta-hedged option returns and how they are affected by expiration day activity.

3.2 Monthly and Intra-monthly delta-hedged option return computation

Monthly delta-hedged call option returns are usually computed using a calendar month holding period from the end of a month to the end of the following month. It is computed using the following expression:

$$\Pi_{t+\tau} = C_{t+\tau} - C_t - \sum_{n=0}^{N-1} \Delta_{C,t_n} \left[S(t_{n+1}) - S(t_n) \right] - \sum_{n=0}^{N-1} \frac{a_n r_{t_n}}{365} \left[C(t_n) - \Delta_{C,t_n} S(t_n) \right] \quad (2)$$

Here, $C_{t+\tau}$ is the call price based on the mid-point of its bid-ask spread at the end of the month while C_t is the call price at the end of the previous month. S_t is the stock price and Δ_{C,t_n} is the delta of the option at time t_n. r_{t_n} is the annualized risk free rate, and a_n is the number of calendar days between t_n and t_{n+1}. For call options, the delta-hedged option return is the delta-hedged option gain $\Pi_{t+\tau}$ scaled by the absolute value of the initial investment, i.e. $\Delta_{C,t}S_t - C_t$. Examples of use of this convention include Cao and Han (2013), Zhan et al. (2021) and Bali et al. (2023) among many others. We note that the calendar month holding period here is the same as for stock portfolios. Figure A1 in the Internet Appendix provides an illustration of the end-of-month to end-of-month holding period. These returns might be affected by rolling activity over the period when the near contract expires within that month.

In our preliminary analysis of the option data we find, plotting the time series of trading volume, that there are large cyclical spikes of option volume around expiration Fridays which might affect option prices and consequently, option returns. For that reason, we partition the monthly delta-hedge return into its components, in order to study what drives movements around expiration Fridays, as follows:

$$\frac{C_{t+\tau}}{|\Delta_{C,t}S_t - C_t|} \tag{3}$$

$$\frac{C_t}{|\Delta_{C,t}S_t - C_t|} \tag{4}$$

$$\frac{\sum_{n=0}^{N-1} \Delta_{C,t_n}[S(t_{n+1}) - S(t_n)]}{|\Delta_{C,t}S_t - C_t|} \tag{5}$$

$$\frac{\sum_{n=0}^{(N-1)} \frac{a_n r_{t_n}}{365}[C(t_n) - \Delta_{C,t_n}S(t_n)]}{|\Delta_{C,t}S_t - C_t|} \tag{6}$$

4 Empirical Results

We now turn to our empirical results, beginning with an analysis of option returns around expiration Fridays. We then investigate how these returns vary throughout the month before examining the connection between option rolling and the negative returns observed over the expiration period.

4.1 Option Returns around Expiration Days

Figure 1 presents the time-series variation in average call and put option volumes, averaged across all firms in our sample, for the year 2021. This figure focuses on options expiring in the third week of each month. The graph clearly reveals cyclical patterns in option trading activity, with sharp volume spikes occurring on every monthly Friday expiration. This phenomenon is evident for both call and put volumes individually, as well as their combined total. To maintain clarity, Figure 1 displays data from a single year, but we observe similar patterns across all sample years. The concentration of options liquidity near expiry reflects traders' tendency to close or roll positions rather than take delivery. As a result, options liquidity exhibits strong seasonality, with heightened trading activity in the week surrounding expiration.

In demand-based option pricing theory, fluctuations in demand affect option prices only when the contract cannot be perfectly hedged. To examine whether demand fluctuations around expiration impact delta-hedged option returns, we conduct a simple test. Figure 2 presents an event study of average daily delta-hedged returns around the standard monthly expiration. The blue line represents the daily returns of an investor holding an option with more than one month to expiration, initiating the position at the end of one month and closing it at the end of the next. To ensure consistency with the monthly return calculation, we maintain the same denominator while computing delta-hedged dollar gains separately for each day. The graph shows a sharp decline around expiration Friday, with an even more pronounced drop on the Monday after expiration, suggesting that seasonal liquidity patterns play a crucial role in shaping the sign and magnitude of monthly delta-hedged returns.

4.2 Intra-month Options Returns

Motivated by this evidence, we first confirm the presence of negative call option returns in Panel A of Table 1. A standard approach in the literature is to delta-hedge options daily rather than relying on a one-time hedge at the start of the holding period. This is because large price movements in the underlying stock can lead to substantial directional exposure even if the initial hedge is delta-neutral. Tian and Wu (2023) estimate that a one-time delta hedge removes about 70% of an option's directional risk, whereas daily delta-hedging eliminates over 90%. Our main results rely on daily delta-hedged returns, though we also report one-time delta-hedged results in the Appendix. As outlined in the data section, we apply filters only at position initiation to maintain consistency with the stock return predictability literature and to avoid forward-looking bias. We also skip a day between portfolio formation and trading inception.

Table 1 shows that the average daily delta-hedged return in our sample is -0.202%, while the median return is considerably lower, at approximately -0.60%. The return distribution exhibits high skewness and kurtosis, reflecting the presence of extreme observations.

Next, we turn to Table 2, which reports average daily delta-hedged returns for different intra-month intervals, based on the patterns observed in Figure 2. We divide each month into three intervals: (i) from the end of the month to one day before expiration, (ii) from one day before expiration to two days after expiration, and (iii) from two days after expiration to the end of the month.

Panel A of Table 2 provides key insights into expiration effects on delta-hedged returns. Returns around expiration dominate all other intra-month intervals, ultimately driving negative monthly returns. Consistent with Figure 2, the average delta-hedged return from the end of the month to one day before expiration is positive at 0.188%. In sharp contrast, the average return from one day before expiration to two days after expiration is highly negative, at -0.430%. Returns for the remainder of the month, from two days after expiration to the end of the month, rebound slightly to 0.039%.

The negative delta-hedged return around expiration arises because buying a call option before expiration is more expensive than immediately after expiration. As a result, delta-hedged option returns turn sharply negative over these two days. Notably, call option prices remain low for the remainder of the month, indicating a persistent effect. Consistent with this, Table A1 in the Internet Appendix reports similar findings for one-time delta-hedged call option returns, confirming that our results are not driven by daily delta hedging. Moreover, returns around expiration overwhelmingly dominate all other intra-month intervals.

4.3 Option Rolling Activity and Option Returns

In the previous section, we found that average monthly delta-hedged returns are negative, primarily due to the negative contribution of returns around expiration dates. We now explore a potential explanation: the concentration of option liquidity near expiry, driven by investors' aversion to assignment risk and option rolling activity.

Rolling an option involves closing an existing position and opening a new one with a different strike price and/or expiration date. For instance, an investor holding January 2021 120 calls on Apple may sell that position and purchase February 2021 130 calls—an example of rolling long calls. Many brokers facilitate rolling within a single trade ticket, reducing execution risk and commission costs. Li, Musto, and Pearson (2022) document elevated complex volume around expiration dates, consistent with the use of multi-leg trades to roll expiring options.

The incentive to roll is highest as expiration approaches. Unlike stocks, options have a finite lifespan and either expire worthless or convert into a position in the underlying security. Rolling prevents assignment and maintains exposure. Since investors are, on average, net short call and put options (Lakonishok, Lee, Pearson, and Poteshman, 2006), rollovers create significant selling pressure in non-expiring contracts. Muravyev (2016) finds that order imbalances turn sharply negative around expiration due to this activity.

Investors rolling short positions extend their shorts to later expiration dates, affecting delta-hedged returns computed over a calendar month. The conventional delta-hedged strategy involves buying an option expiring the following month. If rolling short positions shifts demand to longer expirations, it exerts heavy selling pressure on options used in monthly return calculations. When rolling, traders simultaneously buy to close expiring shorts and sell to open new ones. This selling pressure depresses call option prices post-expiration, contributing to the negative returns observed over the month.

Figure 3 presents an event study of average order imbalances around monthly option expirations, which typically occur on the third Friday of the month. The grey line represents order imbalances across all options, including both opening and closing positions. The blue line focuses only on opening positions, while the orange line tracks closing positions. The order imbalance for open positions declines sharply on the Monday following expiration before gradually rising over the next few trading days. The closing position order imbalance, in contrast, surges before and on expiration day and then declines afterward. The overall order imbalance closely follows the pattern observed in open positions, suggesting that investors tend to roll their short positions around expiration. The increase in closing position imbalances on expiration Friday aligns with the process of investors buying to close expiring short positions. On the other hand, the sharp drop in open position imbalances on post-expiration Monday indicates that investors initiate new short positions with longer expiration dates only after the near-term contract expires.

We now show how the pattern in Figure 3 aligns with option rolling activity and its impact on option returns in end-month to end-month portfolios. If monthly returns in these portfolios are affected by demand pressure on the post-expiration Monday, we should observe positive delta-hedged returns for stocks where investors predominantly buy options and negative delta-hedged returns for stocks where selling pressure is dominant. To test this, we sort stocks monthly based on their order imbalances on expiration Friday and analyze their delta-hedged returns.

Table 3 reports average daily delta-hedged monthly returns for equally weighted decile portfolios sorted each month based on post-expiration Monday order imbalances. Panel A presents results based on both opening and closing positions, Panel B focuses on open positions only, and Panel C examines closing positions. The findings show that when option order imbalances are highly negative on the post-expiration Monday, monthly option returns are also significantly negative. Conversely, monthly option returns are strongly positive when order imbalances are positive. This effect stems primarily from investors opening new short positions. Since investors are, on average, net sellers of options, the large selling pressure introduced by rolling activity explains why delta-hedged returns are negative on average.

5 Revisiting Option Return Predictability

We now present our main results in Table 4, which examines the predictability of option returns around expiration. Specifically, we analyze portfolios sorted by stock characteristics, fundamental characteristics, and option characteristics to assess whether expiration-related effects influence existing anomalies. We report results for individual anomalies as well as their arithmetic cross-anomaly average. Following standard methodology, we construct equally weighted decile portfolios based on each anomaly signal at the end of every month. Panel B of Table 1 provides the summary statistics of the stock and option characteristics. All characteristics are defined in the Internet Appendix.

A large body of research has documented that delta-hedged option returns are predictable based on various firm- and option-level characteristics. For instance, Zhan et al. (2021) show that factors such as stock price, cash flow variance, analyst forecast dispersion, and distress risk significantly predict delta-hedged option returns. Similarly, studies have identified the predictive role of liquidity risk (Christoffersen et al., 2017), idiosyncratic volatility (Cao and Han, 2013), lottery-like stocks (Byun and Kim, 2016), implied volatility deviations (Goyal and Saretto, 2009), and risk-neutral skewness (Bali and Murray, 2013). These findings suggest that systematic pricing distortions arise from investor demand, market frictions, and behavioral biases. However, prior work does not explicitly account for expiration-driven liquidity effects, which may play a key role in shaping return patterns.

To isolate the impact of expiration effects, we decompose delta-hedged option returns into two components: (i) the monthly return ex-rollover, which excludes the expiration window (the third Friday of the month and the following Monday), and (ii) the rollover return, which captures returns specifically over the expiration period. If expiration effects influence long and short positions equally, they should not systematically affect strategy returns. However, if expiration effects vary across portfolios, they could materially alter the mean return of anomaly-based strategies.

Table 4 reports average daily delta-hedged returns for long-short strategies across the full month, excluding expiration, and the expiration window separately. We find that long-short strategies generate significant and economically meaningful negative returns over the full month for most characteristics. The cross-anomaly average return is -0.640% (t-stat = -7.77), indicating strong predictability. However, when we exclude expiration Friday and the following Monday, the magnitude of all anomalies declines sharply. The cross-anomaly average return drops by more than half to -0.28%, and only 7 out of 18 characteristics remain statistically significant. This suggests that a significant portion of anomaly-driven return predictability is concentrated around expiration.

Conversely, when isolating the rollover period, we find that expiration effects dominate option return predictability. Nearly all anomalies, except distress risk, exhibit highly significant returns during this short window, with t-statistics ranging from -5 to -18. The cross-anomaly average return during expiration alone is -0.36% (t-stat = -13.7), accounting for more than half of the total anomaly return for the full month. This pattern highlights the role of expiration-induced selling pressure and order imbalances in driving return anomalies.

Consistent with these results, Figure 4 presents an event study of daily delta-hedged returns for the cross-anomaly long-short spread portfolio (10-1). Similar to Figure 2, the negative returns of the average anomaly portfolios are concentrated on expiration Friday and especially the Monday following expiration, reinforcing the significance of expiration effects.

To further examine these effects, we construct portfolios based on stocks belonging to the S&P 500 index. Options on non-S&P 500 stocks tend to be thinly traded, making them less relevant for most investors. By focusing on the most actively traded options with lower transaction costs, we ensure that our findings reflect broader market-wide dynamics rather than illiquidity effects. Table 5 replicates our previous analysis for S&P 500 stocks and confirms our earlier conclusions—expiration effects fully explain the observed anomaly predictability. The cross-anomaly average return for long-short portfolios over the full month is -0.10% (t-stat = -1.78), while the rollover return alone is -0.14% (t-stat = -11.20). While only 4 anomalies are significant for the full month, 16 out of 18 exhibit significant predictability during the expiration window.

In unreported results, we further demonstrate that a delta-hedged strategy—selling one call option contract while taking a long position in delta shares of the underlying S&P 500 stock—executed at the end of Thursday just before the standard expiration day and held until the end of the following Monday, with daily rebalancing, remains profitable in the top decile of characteristics-based portfolios even after accounting for standard option transaction costs. This suggests that the profitability of anomaly-based trading strategies is largely concentrated around expiration, where liquidity-driven price distortions create a unique and exploitable return pattern.

Taken together, these results demonstrate that expiration effects are a major determinant of option return patterns. Many well-documented anomalies weaken or disappear when the expiration window is excluded, while return predictability is concentrated around expiration. These findings underscore the importance of accounting for expiration-driven liquidity shifts when evaluating option return anomalies and suggest that market participants who time their trades around expiration may experience systematically different returns than those following conventional anomaly-based strategies.

6 Tests for Robustness

In this subsection, we conduct a battery of robustness checks for our results with regards to variations in the construction of delta-hedged option positions and the type of options used in the analyses (e.g. put options instead of call options, straddles, other option moneyness and maturity).

6.1 Daily and Weekly Delta-Hedge Call Option Returns

In previous tables, we show that expiration days returns are the driver of average negative monthly delta-hedged returns documented in the literature. We now study whether there are similar effects over periods shorter than a month using daily and weekly delta-hedged returns.

Panel A of Table 6 reports average delta-hedged option returns separately for the total number of days in the month, all Mondays, only Mondays after the third Friday expiration of the options and all days without Mondays after expiration. These results are for all call options and for different moneyness according to the option delta from Optionmetrics. We define OTM (out-of-the-money) options if $0.125 < \Delta <= 0.375$. ATM (at-the-money) corresponds to $0.375 < \Delta <= 0.625$ and the ITM (in-the-money) category corresponds to $0.625 < \Delta <= 0.875$. As in the case of monthly returns, we find that the average daily delta-hedged returns are negative. Average returns remain negative even when we partition our sample into different moneyness intervals, but the average negative returns for ITM options are not significant. Similar to Jones and Shemesh (2018), delta-hedged returns are very negative on Mondays, consistent with their results about the role of nontrading periods on delta-hedged option returns. Mondays represent the vast majority of nontrading period ends. More importantly, we find that this nontrading effect is mainly concentrated on Mondays after expiration. In other words, the third week non-trading period is different to the other three non-trading weekends. We also find that if we exclude the expiration Mondays the average returns over all trading days are not significant anymore. In Table A2 of the Internet Appendix we also form daily portfolios on the basis of maturity, measured as the number of trading days until option expiration, and moneyness.

Panel B of Table 6 presents results using weekly returns. In line with the literature, weekly returns are constructed using Tuesday-to-Tuesday quotes wherever possible. Results are similar if we define weekly results using different days of the week. Similar to daily and monthly returns, delta-hedged average returns are negative in all weeks. When we only consider expiration weeks, we find that the delta-hedged returns are much more negative as expected given the role of the expiration dates on the negative average delta-hedged returns. Finally, if we exclude expiration weeks we find that the weekly average returns are not significant anymore expect for the case of ITM options.

6.2 Straddle Monthly Option Returns

As indicated earlier, returns to delta neutral straddles on individual options are used in the literature together or instead of delta-hedged returns. Straddles combine approximately equal positions in a put and a call with the same maturity and strike price and are constructed to set each straddle's overall delta to zero. Similar to the case of delta-hedged option returns, the returns of these straddles are supposed to be invariant to the performance of the underlying stock.

Similar to Table 2, at the end of the month (*Panel A*) and on the first trading day after expiration (*Panel B*), we select two matching call/put pairs for each stock. We also focus here on at-the-money options. Results based on simple straddle returns, zero-delta straddle returns and daily-delta hedge straddle returns are reported in Table 7. We find that straddle returns have negative average means when we compute returns from a calendar month. As in the case of delta-hedged option returns, the average negative straddle returns documented in the literature arise due to the negative returns around the expiration of the options. The contribution to the monthly straddle return is very positive and significant when we exclude the period around the expiration of the options.

6.3 Delta-Hedged Put Option Returns

Our focus thus far has been on call options since at-the-money calls have much higher trading volume and higher frequency of trading than at-the-money puts (Christoffersen et al. (2017)). We now verify that our results also hold for put options.

Panel A of Table 8 reports time series averages of monthly delta-hedge put option returns during the holding period for calendar month holding periods. Similar to the case of call options, we find that monthly average delta-hedge returns are negative for put options (−0.216%). We also show that these negative returns depend on the negative contribution of the period around the expiration dates (−0.373%). The contribution to the monthly returns before expiration is positive (0.192%) and after expiration is close to zero (−0.035%). *Panel B* shows similar results when considering portfolios of options that expire the following month and starts the position one day after the expiration date of the options and close the position at the next expiration date.

6.4 Delta-Hedged Call Option Returns for different moneyness intervals

So far, our analysis has focused on the call option contract that is closest to ATM. Here, we present results for call options with different moneyness based on the option delta from Optionmetrics. As before, we define OTM (out-of-the-money) options where $0.125 < \Delta <= 0.375$. ATM (at-the-money) corresponds to $0.375 < \Delta <= 0.625$ and the ITM (in-the-money) category corresponds to $0.625 < \Delta <= 0.875$.

Table 9 reports average returns of ATM, OTM and ITM call options during the holding period. *Panel A* of Table 9 shows average delta-hedge returns over a calendar month, while *Panel A* reports returns from one day after expiration to the next expiration date. In all cases, returns around the expiration period are very negative and they are the main reason behind the average negative returns for the whole holding period. We also find that this effect is much larger for ATM and OTM options than it is for ITM options. Intuitively, option investors tend to rollover their positions more on ATM and OTM options with later expiration dates.

7 Conclusions

This paper identifies expiration-driven liquidity effects as a key driver of option return anomalies. We show that predictable option returns are largely concentrated around expiration, when investors rolling over positions create large order imbalances that overwhelm market makers' risk-bearing capacity. These frictions lead to significant price distortions, explaining much of the observed anomaly predictability.

Our findings reveal that more than half of the monthly anomaly returns occur during the two-day expiration window, while returns outside this period are significantly weaker. This pattern holds across a broad set of stock, fundamental, and option characteristics and is particularly pronounced for S&P 500 stocks, where expiration fully accounts for anomaly returns.

These results challenge the view that option anomalies reflect behavioral biases or inefficiencies. Instead, they highlight the role of intermediary constraints and systematic liquidity demands in shaping option prices. Future research could further explore the impact of expiration dynamics on market participants and whether similar patterns exist in other derivative markets.

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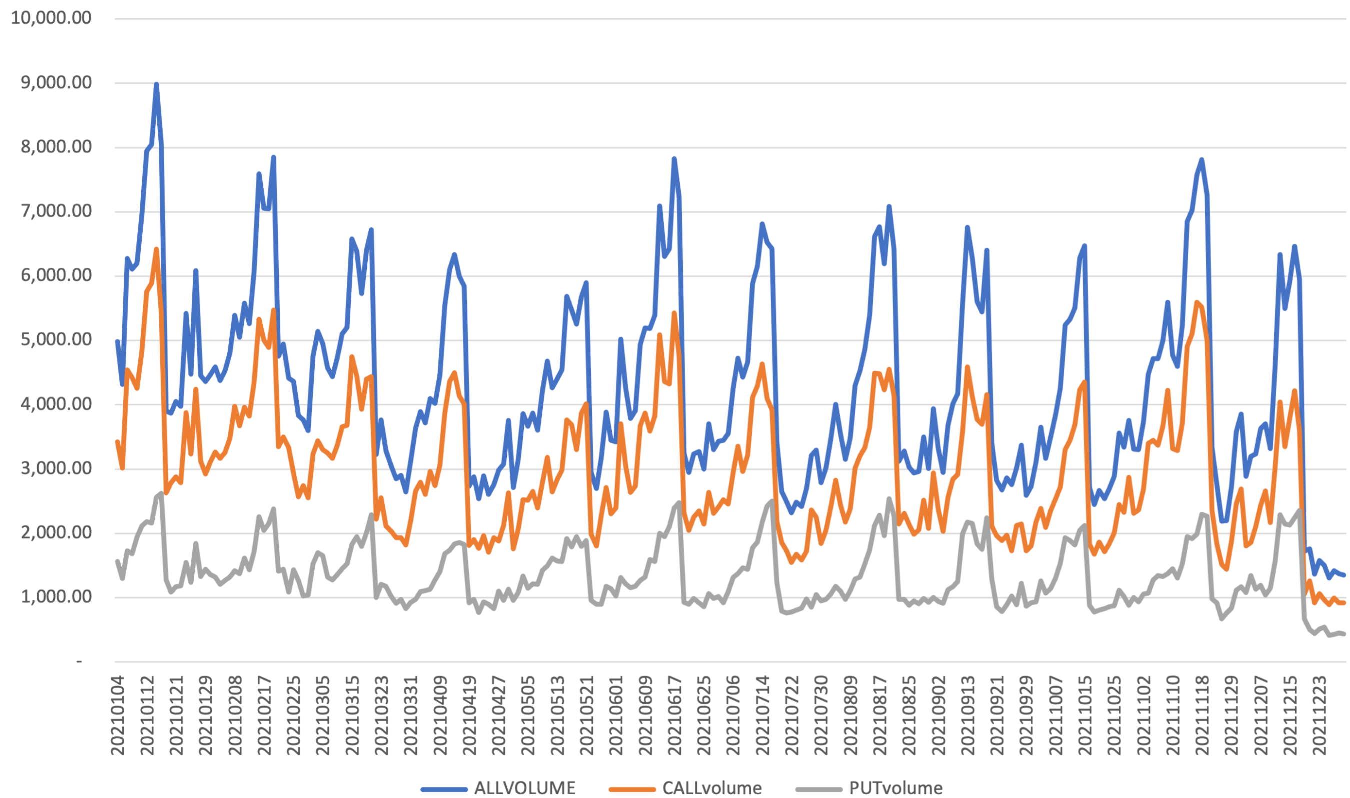
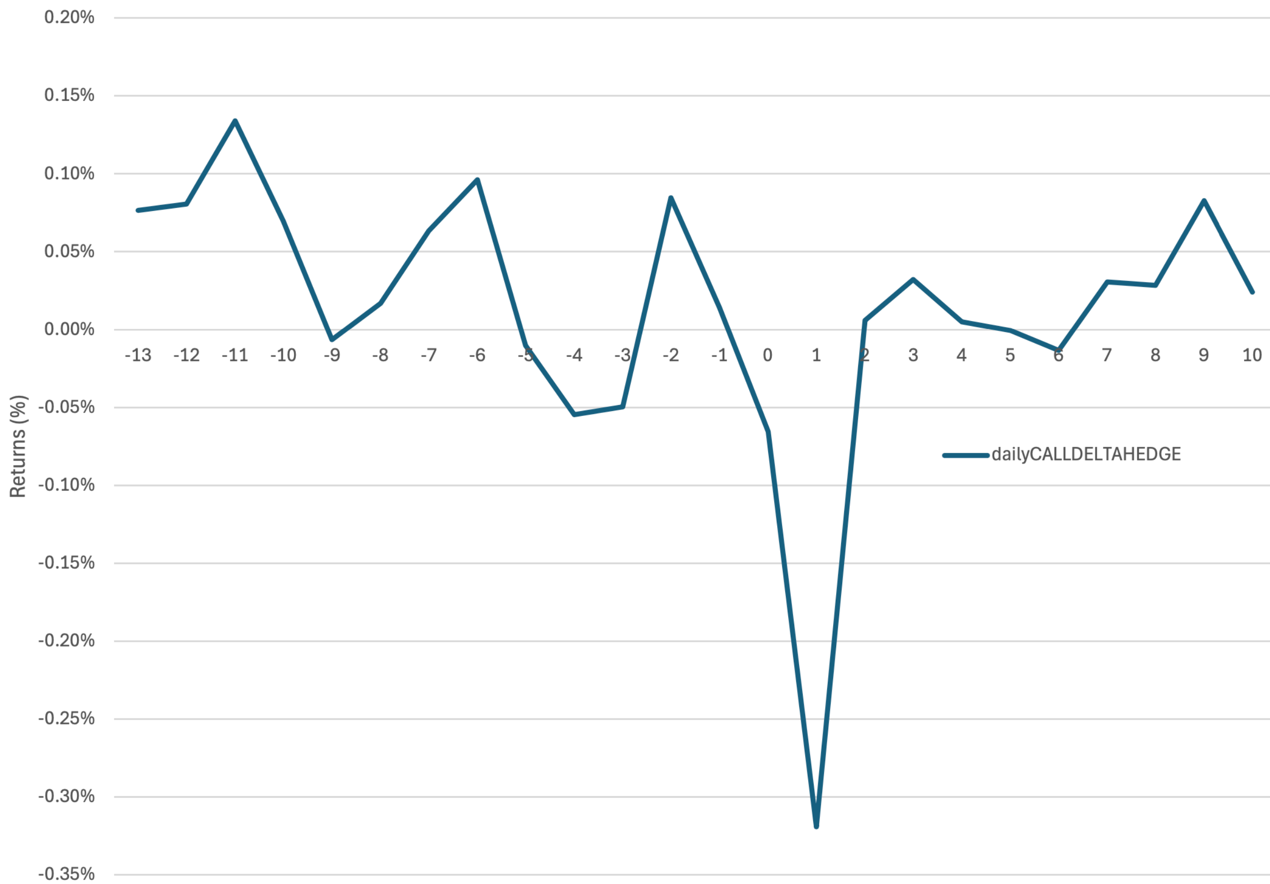
Figure 1. ***Option Volume Cycles around the Expiration Dates***



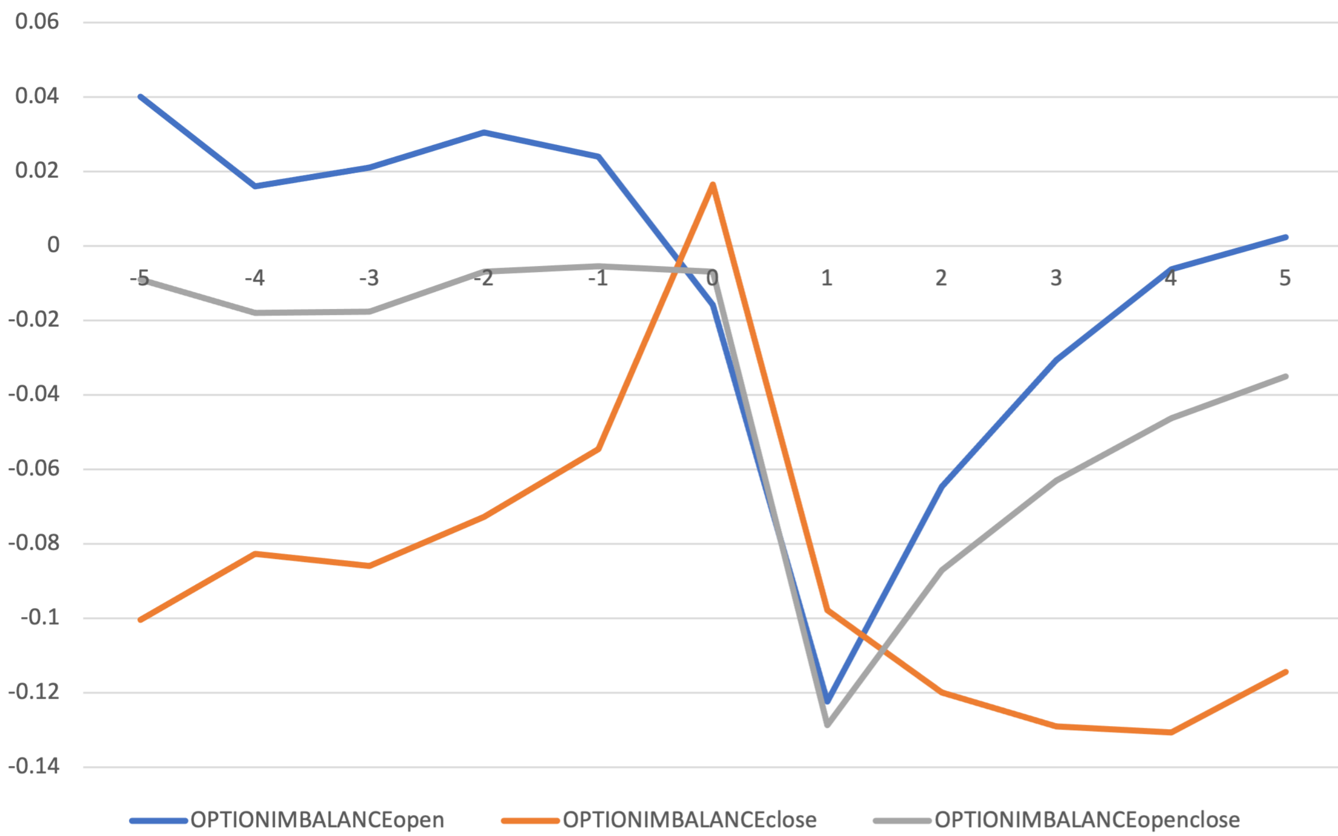
This graph depict the mean of total volume for calls and puts during 2021 for options expiring the third week of the month. We first compute the daily sum of option volume for each of the firms in our sample in 2021, and then we average over all firms. The data are collected from OptionMetrics and CRSP.

Figure 2. ***Average Returns around the standard monthly expiration day***



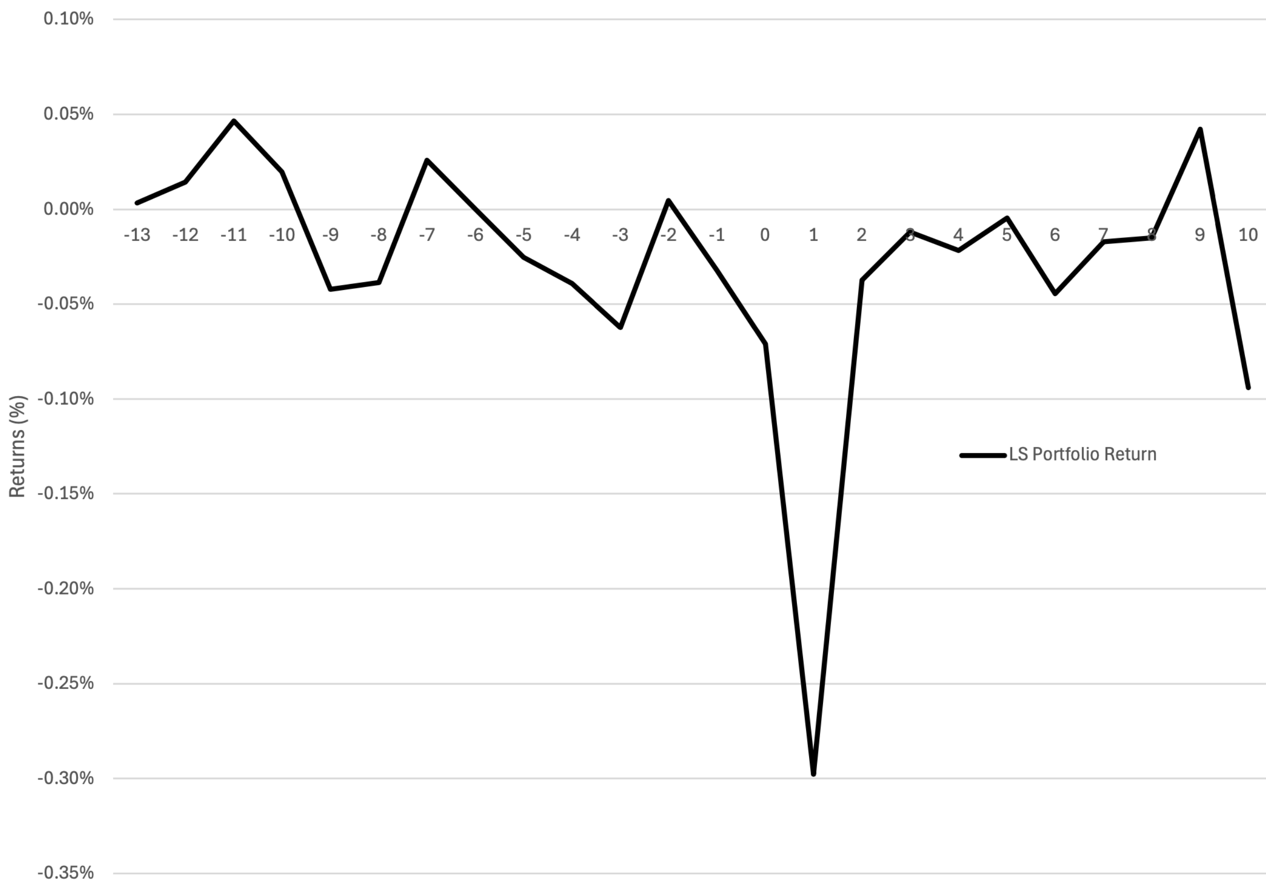
This figure illustrates the average daily delta-hedged option returns surrounding the standard monthly expiration day of options. The delta-hedged option returns are derived from a strategy initiated at the beginning of each month and adjusted daily for one month. The value of zero on the timeline corresponds to the third Friday of the month, marking the expiration of standard monthly options.

Figure 3. ***Option Order Imbalances around the standard monthly expiration day***



This graph displays an event study of average order imbalances around the expiration of the options on the third week of the month (usually a Friday). The grey line depicts average order imbalances for open and close positions for all options. The blue line depicts option order imbalances for opening positions only. The yellow line shows average order imbalances for closing positions only. The data are collected from NASDAQ GEMX (GEMX), NASDAQ International Security Exchange (ISE), NASDAQ Options Market (NOTO), and NASDAQ PHLX (PHOTO), OptionMetrics and CRSP and contain daily series from May 2005 to December 2021.

Figure 4. ***Average Returns of portfolios of delta-hedged calls sorted by equity and option characteristics around the standard monthly expiration date***



This figure presents the average daily delta-hedged option returns around the standard monthly expiration date, which occurs on the third Friday of each month. The analysis focuses on the average spread portfolio (10-1) formed by sorting decile portfolios based on various stock and option characteristics known to predict option returns. The delta-hedged option returns are calculated from a strategy initiated at the beginning of the month and adjusted daily over a one-month period. The timeline zero represents the third Friday of the month, when standard monthly options expire.

Table 1. Summary Statistics

This table provides descriptive statistics for monthly delta-hedged option returns, equity characteristics and option characteristics. Panel A presents a pooled summary of daily delta-hedged option returns. A delta-hedged position consists of purchasing one equity call option contract and taking a short position in delta shares of the underlying stock, where delta is calculated using the Black-Scholes model. The position is rebalanced daily throughout the month. The analysis focuses on at-the-money (ATM) options with more than one month to expiration, initiated at the end of the first trading day of the month and closed at the end of the month. Panel B reports time-series averages of cross-sectional statistics for equity and option characteristics. These characteristics are detailed in the Internet Appendix. The data spans January 1996 to December 2021, sourced from CRSP, Compustat, IBES, and OptionMetrics.

Panel A: Daily-Delta hedged Call Option Returns

		Mean	Median	Standard Deviation	Skewness	Kurtosis	10th percentile	Lower quartile	Upper quartile	90th percentile
Daily Delta-hedged gain until month end	(%)	-0.203	-0.607	6.072	371.074	10671.032	-4.960	-2.464	1.403	4.726

Panel B: Stock and Option Characteristics

	Mean	Median	Standard Deviation	Skewness	Kurtosis	10th percentile	Lower quartile	Upper quartile	90th percentile
CFV	0.192	0.001	6.130	100.255	12791.336	0.000	0.000	0.006	0.034
CH	0.224	0.130	0.238	1.289	0.819	0.013	0.039	0.339	0.601
DISP	0.210	0.043	1.425	53.418	5370.901	0.010	0.019	0.117	0.313
$\text{ISSUE}_1 Y$	0.437	0.013	19.548	164.542	27528.447	-0.039	-0.002	0.075	0.424
$\text{ISSUE}_5 Y$	6.012	0.223	115.282	52.603	3240.060	-0.144	-0.004	1.809	5.716
PM	-4.612	0.049	161.435	-98.332	12743.812	-0.319	-0.009	0.108	0.189
PRICE	40.253	25.980	73.921	17.138	499.413	8.480	14.188	45.300	74.563
PROFIT	0.168	0.235	7.103	-53.985	5366.262	-0.112	0.110	0.369	0.571
TEF	0.058	0.003	0.586	-199.990	49383.211	-0.101	-0.042	0.074	0.326
ZS	-8.452	-3.959	30.930	-63.876	7055.730	-16.470	-7.221	-2.337	-1.235
VOL DEVIATION	0.014	0.005	0.169	3.084	90.781	-0.120	-0.049	0.069	0.162
IVOL	0.023	0.018	0.017	6.622	227.874	0.008	0.012	0.028	0.042
AMIHUD	0.006	0.001	0.028	91.056	18450.709	0.000	0.000	0.004	0.014
Ln(ME)	8.049	1.570	34.184	23.216	1013.104	0.292	0.604	4.736	15.007
MF SKEW	-0.420	-0.395	0.558	-0.035	2.508	-1.080	-0.695	-0.120	0.165
CALL IV ATM	0.489	0.436	0.243	1.653	5.321	0.241	0.319	0.602	0.802
IV TERM	-0.023	-0.010	0.088	-3.241	34.798	-0.101	-0.046	0.017	0.043
MAX(1)	0.066	0.049	0.063	12.636	624.203	0.022	0.032	0.079	0.125

Table 2. Intra-Month Average Delta-Hedged Returns

This table reports time series averages of delta-hedged option returns during the holding period. The delta-hedged is rebalanced on each trading day. We focus on options with more than one month to expiration and start the position at the end of the month and close the position at the end of the following month. We compute average delta-hedge option returns from end-of-month to the next end-of-month period; from one day before expiration of the options to two days after expiration; and from two days after expiration and to end-of-month. Returns are reported on a monthly basis and in percentage terms. We also partition the delta-hedged return into its different components. The data are collected from OptionMetrics and CRSP and contain daily series from January 1996 to December 2021

		End-month to End-month	End-Month to One-day Before Exp	One-day Before Exp to Two-days after Exp	Two-days After Exp to End-month
$\frac{C_{t+\tau}-C_t-\sum_{n=0}^{N-1}\Delta_{C,t_n}[S(t_{n+1})-S(t_n)]-\sum_{n=0}^{N-1}\frac{a_n r_{t_n}}{365}[C(t_n)-\Delta_{C,t_n}S(t_n)]}{\lvert\Delta_{C,t}S_t-C_t\rvert}$	(%)	-0.203	0.188	-0.430	0.039
$\frac{C_{t+\tau}}{\lvert\Delta_{C,t}S_t-C_t\rvert}$	(%)	16.384	16.768	16.096	16.384
$\frac{C_t}{\lvert\Delta_{C,t}S_t-C_t\rvert}$	(%)	16.006	16.006	16.768	16.096
$\frac{\sum_{n=0}^{N-1}\Delta_{C,t_n}[S(t_{n+1})-S(t_n)]}{\lvert\Delta_{C,t}S_t-C_t\rvert}$	(%)	0.821	0.712	-0.201	0.310
$\frac{\sum_{n=0}^{N-1}\frac{a_n r_{t_n}}{365}[C(t_n)-\Delta_{C,t_n}S(t_n)]}{\lvert\Delta_{C,t}S_t-C_t\rvert}$	(%)	-0.241	-0.138	-0.041	-0.062

Table 3. Option Returns and Order Imbalances on the Post-Expiration Monday

This table reports time series averages of monthly delta-hedged option returns for portfolios of call options sorted based on option order imbalances accomodated by market-makers at the stock level on the post-expiration Monday. The delta-hedge is rebalanced on each trading day. Panel A focuses on option order imbalances computed based on open and close positions. Panel B considers option order imbalances computed based on open positions only. Panel B show results for option order imbalances computed based on close positions only. We also report the average value of the order imbalances on the post-expiration Monday. The data are collected from OptionMetrics and CRSP and contain daily series from May 2005 to December 2021.

Panel A: Option Order Imbalances based on Open and Close Positions

	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P10-P1	All stocks
	Average Option Order Imbalances on the Post-Expiration Monday											
Mean	-0.944	-0.618	-0.391	-0.247	-0.139	-0.055	0.009	0.093	0.266	0.719	1.662	-0.129
	Daily-Delta Hedged Monthly Call Option Returns											
Mean	-0.499	-0.589	-0.508	-0.365	-0.233	-0.105	-0.005	0.174	0.162	0.191	0.690	-0.228

Panel B: Option Order Imbalances based on Open Positions

	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P10-P1	All stocks
	Average Option Order Imbalances on the Post-Expiration Monday											
Mean	-0.973	-0.711	-0.463	-0.294	-0.160	-0.051	0.040	0.161	0.374	0.820	1.793	-0.097
	Daily-Delta Hedged Monthly Call Option Returns											
Mean	-0.554	-0.642	-0.625	-0.471	-0.285	-0.158	0.045	0.273	0.330	0.298	0.852	-0.228

Panel C: Option Order Imbalances based on Close Positions

	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P10-P1	All stocks
	Average Option Order Imbalances on the Post-Expiration Monday											
Mean	-1.000	-0.976	-0.761	-0.490	-0.257	-0.042	0.197	0.517	0.862	0.995	1.995	-0.098
	Daily-Delta Hedged Monthly Call Option Returns											
Mean	-0.195	-0.026	0.157	0.190	0.056	-0.052	-0.123	-0.312	-0.507	-0.508	-0.313	-0.228

Table 4. Average Returns of portfolios of delta-hedged calls sorted by equity and option characteristics

This table reports the average monthly returns of daily delta-hedged equity call options, sorted by various stock and option characteristics that are known to predict option returns. It also includes the average returns for all stock and option characteristics (average anomalies). For each stock, we purchase one call option contract and hedge it with a short position in delta shares of the underlying stock. The average daily delta-hedged option returns are calculated for the holding period from the end of the first trading day of the month to the end of the same month (monthly return). The monthly return is decomposed into two components: the monthly return ex-rollover, which excludes returns around the standard options expiration (the third Friday of the month and the subsequent Monday), and the rollover return, which captures returns during this expiration window. The table reports returns for the bottom (Decile 1) and top (Decile 10) decile option portfolios, as well as the spread return (10-1). All characteristics are defined in Table A1 of the Internet Appendix. Option returns are equal-weighted (EW). T-statistics, calculated using Newey-West standard errors with optimal lags, are reported in parentheses. All returns are presented on a monthly basis and expressed as percentages. The data spans from January 1996 to August 2023 and is sourced from CRSP, Compustat, IBES, and OptionMetrics.

Daily Delta-Hedged Monthly Call Option Returns									
	Full Month			*Full Month Ex-rollover*			*Rollover*		
	D1	D10	D10-D1	D1	D10	D10-D1	D1	D10	D10-D1
AVERAGE ANOMALIES	**0.17**	**-0.48**	**-0.64**	**0.46**	**0.18**	**-0.28**	**-0.29**	**-0.66**	**-0.36**
	(1.71)	**(-3.35)**	**(-7.77)**	**(4.87)**	**(1.33)**	**(-3.90)**	**(-13.20)**	**(-16.51)**	**(-13.69)**
CFV	0.23	-0.32	-0.54	0.50	0.24	-0.25	-0.27	-0.56	-0.29
	(2.16)	(-2.16)	(-4.76)	(4.78)	(1.76)	(-2.34)	(-11.79)	(-14.68)	(-9.37)
CH	0.26	-0.61	-0.87	0.54	0.09	-0.46	-0.28	-0.70	-0.42
	(2.28)	(-4.12)	(-7.49)	(4.96)	(0.63)	(-4.20)	(-9.93)	(-17.95)	(-13.27)
DISP	0.16	-0.08	-0.24	0.41	0.46	0.04	-0.25	-0.54	-0.28
	(1.69)	(-0.60)	(-3.54)	(4.47)	(3.67)	(0.70)	(-10.78)	(-14.56)	(-11.01)
ISSUE$_1Y$	0.13	-0.31	-0.45	0.41	0.29	-0.12	-0.28	-0.60	-0.33
	(1.31)	(-2.18)	(-4.69)	(4.19)	(2.21)	(-1.63)	(-11.19)	(-15.36)	(-10.12)
ISSUE$_5Y$	0.19	-0.39	-0.59	0.45	0.16	-0.29	-0.26	-0.55	-0.30
	(1.89)	(-2.70)	(-6.30)	(4.57)	(1.22)	(-4.10)	(-11.48)	(-13.48)	(-8.57)
-PM	0.13	-0.63	-0.76	0.51	0.11	-0.40	-0.38	-0.74	-0.35
	(1.14)	(-4.07)	(-6.88)	(4.70)	(0.74)	(-4.46)	(-12.87)	(-17.96)	(-9.68)
-Ln(PRICE)	0.14	-0.57	-0.71	0.36	0.21	-0.15	-0.22	-0.78	-0.56
	(1.33)	(-3.27)	(-4.67)	(3.51)	(1.24)	(-1.07)	(-9.74)	(-14.82)	(-11.35)
-PROFIT	0.03	-0.22	-0.26	0.37	0.35	-0.02	-0.34	-0.57	-0.24
	(0.32)	(-1.71)	(-3.56)	(3.54)	(2.86)	(-0.27)	(-12.42)	(-14.99)	(-9.40)
TEF	0.13	-0.41	-0.54	0.43	0.27	-0.16	-0.30	-0.69	-0.39
	(1.42)	(-2.72)	(-5.04)	(4.88)	(1.90)	(-1.68)	(-12.34)	(-14.72)	(-9.51)
-ZS	-0.25	-0.43	-0.18	0.31	0.21	-0.10	-0.56	-0.64	-0.08
	(-1.78)	(-2.66)	(-1.32)	(2.32)	(1.37)	(-0.76)	(-13.34)	(-13.92)	(-1.76)
-VOL DEVIATION	0.57	-1.19	-1.76	0.95	-0.55	-1.51	-0.38	-0.64	-0.25
	(4.06)	(-7.20)	(-9.30)	(6.96)	(-3.63)	(-8.92)	(-12.45)	(-14.32)	(-7.20)
IVOL	0.17	-0.61	-0.77	0.35	0.15	-0.21	-0.19	-0.75	-0.57
	(2.01)	(-3.90)	(-6.55)	(4.48)	(0.96)	(-1.92)	(-9.04)	(-16.75)	(-15.35)
Ln(AMIHUD)	0.08	-0.02	-0.09	0.33	0.55	0.22	-0.26	-0.57	-0.31
	(0.73)	(-0.10)	(-0.61)	(3.31)	(3.23)	(1.40)	(-10.84)	(-11.18)	(-6.49)
Ln(ME)	0.10	-0.27	-0.37	0.33	0.37	0.04	-0.24	-0.64	-0.40
	(0.97)	(-1.61)	(-2.46)	(3.48)	(2.18)	(0.24)	(-10.24)	(-11.71)	(-7.83)
MF SKEW	0.39	0.06	-0.33	0.62	0.54	-0.09	-0.24	-0.48	-0.24
	(3.93)	(0.43)	(-3.95)	(6.35)	(3.87)	(-1.13)	(-9.45)	(-10.65)	(-6.54)
CALL IV ATM	0.36	-1.49	-1.85	0.50	-0.47	-0.98	-0.14	-1.01	-0.87
	(3.92)	(-7.64)	(-10.31)	(5.79)	(-2.66)	(-6.37)	(-7.54)	(-18.08)	(-17.13)
-IV TERM	0.03	-0.66	-0.69	0.52	0.05	-0.47	-0.49	-0.72	-0.22
	(0.25)	(-4.18)	(-5.93)	(4.58)	(0.33)	(-4.46)	(-14.92)	(-13.71)	(-5.93)
MAX(1)	0.14	-0.41	-0.55	0.35	0.25	-0.11	-0.21	-0.66	-0.44
	(1.45)	(-2.72)	(-4.99)	(3.86)	(1.69)	(-1.10)	(-9.50)	(-16.74)	(-14.33)

Table 5. Average Returns of portfolios of delta-hedged calls sorted by equity and option characteristics for stocks belonging to the SP500 index

This table reports the average monthly returns of daily delta-hedged equity call options, sorted by various stock and option characteristics that are known to predict option returns for stocks belonging to the SP500 index. It also includes the average returns for all stock and option characteristics (average anomalies). For each stock, we purchase one call option contract and hedge it with a short position in delta shares of the underlying stock. The average daily delta-hedged option returns are calculated for the holding period from the end of the first trading day of the month to the end of the same month (monthly return). The monthly return is decomposed into two components: the monthly return ex-rollover, which excludes returns around the standard options expiration (the third Friday of the month and the subsequent Monday), and the rollover return, which captures returns during this expiration window. The table reports returns for the bottom (Decile 1) and top (Decile 10) decile option portfolios, as well as the spread return (10-1). All characteristics are defined in Table A1 of the Internet Appendix. Option returns are equal-weighted (EW). T-statistics, calculated using Newey-West standard errors with optimal lags, are reported in parentheses. All returns are presented on a monthly basis and expressed as percentages. The data spans from January 1996 to August 2023 and is sourced from CRSP, Compustat, IBES, and OptionMetrics.

Daily Delta-Hedged Monthly Call Option Returns									
	Full Month			*Full Month Ex-rollover*			*Rollover*		
	D1	D10	D10-D1	D1	D10	D10-D1	D1	D10	D10-D1
AVERAGE ANOMALIES	**0.08**	**-0.02**	**-0.10**	**0.30**	**0.34**	**0.04**	**-0.22**	**-0.36**	**-0.14**
	(0.85)	**(-0.22)**	**(-1.78)**	**(3.51)**	**(3.01)**	**(0.68)**	**(-10.33)**	**(-11.63)**	**(-11.20)**
CFV	0.09	-0.05	-0.14	0.33	0.33	0.00	-0.23	-0.37	-0.14
	(1.01)	(-0.37)	(-1.69)	(3.56)	(2.76)	(-0.00)	(-9.73)	(-11.69)	(-6.21)
CH	0.07	0.09	0.03	0.31	0.43	0.12	-0.24	-0.34	-0.10
	(0.76)	(0.78)	(0.29)	(3.63)	(3.57)	(1.33)	(-9.73)	(-9.69)	(-3.58)
DISP	0.04	0.01	-0.04	0.23	0.38	0.15	-0.18	-0.37	-0.19
	(0.52)	(0.05)	(-0.36)	(2.87)	(2.88)	(1.59)	(-8.11)	(-10.87)	(-7.57)
ISSUE$_1Y$	0.02	0.05	0.03	0.25	0.36	0.11	-0.23	-0.31	-0.08
	(0.27)	(0.42)	(0.38)	(3.05)	(3.13)	(1.51)	(-9.43)	(-10.05)	(-4.20)
ISSUE$_5Y$	0.03	0.06	0.03	0.25	0.37	0.12	-0.22	-0.31	-0.09
	(0.33)	(0.51)	(0.44)	(2.62)	(3.12)	(1.84)	(-10.05)	(-10.41)	(-4.78)
-PM	0.09	-0.03	-0.12	0.37	0.31	-0.06	-0.28	-0.34	-0.07
	(0.91)	(-0.28)	(-2.37)	(3.71)	(2.80)	(-1.25)	(-9.79)	(-10.68)	(-3.39)
-Ln(PRICE)	0.08	-0.01	-0.09	0.28	0.39	0.10	-0.20	-0.40	-0.20
	(0.71)	(-0.10)	(-0.77)	(2.55)	(3.01)	(0.94)	(-8.15)	(-10.65)	(-8.09)
-PROFIT	0.02	-0.04	-0.06	0.25	0.31	0.06	-0.23	-0.35	-0.12
	(0.19)	(-0.40)	(-0.94)	(3.03)	(3.05)	(1.10)	(-9.10)	(-10.82)	(-5.90)
TEF	0.01	0.14	0.13	0.25	0.46	0.21	-0.24	-0.32	-0.08
	(0.11)	(1.27)	(2.00)	(3.21)	(4.03)	(3.16)	(-9.48)	(-10.78)	(-4.96)
-ZS	0.06	-0.03	-0.10	0.36	0.32	-0.04	-0.30	-0.35	-0.06
	(0.53)	(-0.30)	(-0.84)	(3.14)	(2.95)	(-0.37)	(-8.87)	(-9.89)	(-1.81)
-VOL$_DEVIATION$	0.17	-0.33	-0.50	0.44	-0.02	-0.47	-0.28	-0.31	-0.03
	(1.42)	(-2.93)	(-3.68)	(3.89)	(-0.22)	(-3.77)	(-9.67)	(-9.87)	(-1.07)
IVOL	0.06	-0.08	-0.14	0.23	0.37	0.14	-0.17	-0.44	-0.28
	(0.79)	(-0.54)	(-1.37)	(3.12)	(2.54)	(1.29)	(-9.48)	(-11.23)	(-9.47)
Ln(AMIHUD)	-0.01	0.10	0.12	0.22	0.39	0.17	-0.24	-0.29	-0.05
	(-0.14)	(0.93)	(1.30)	(2.39)	(3.64)	(1.95)	(-9.15)	(-10.27)	(-2.52)
Ln(ME)	0.05	0.01	-0.04	0.26	0.34	0.08	-0.22	-0.33	-0.12
	(0.49)	(0.09)	(-0.41)	(2.93)	(3.31)	(0.98)	(-8.65)	(-10.66)	(-5.50)
MF SKEW	0.15	-0.04	-0.19	0.36	0.27	-0.10	-0.21	-0.31	-0.10
	(1.28)	(-0.42)	(-2.78)	(3.05)	(2.72)	(-1.51)	(-9.36)	(-10.30)	(-3.90)
CALL IV ATM	0.21	-0.03	-0.24	0.35	0.48	0.13	-0.14	-0.51	-0.37
	(2.41)	(-0.15)	(-1.53)	(4.26)	(2.72)	(0.89)	(-7.93)	(-10.27)	(-8.85)
-IV TERM	0.16	-0.18	-0.34	0.41	0.23	-0.17	-0.25	-0.41	-0.17
	(1.42)	(-1.21)	(-2.55)	(3.84)	(1.56)	(-1.32)	(-9.43)	(-10.49)	(-5.91)
MAX(1)	0.05	-0.08	-0.13	0.23	0.33	0.10	-0.18	-0.41	-0.24
	(0.60)	(-0.60)	(-1.25)	(2.81)	(2.32)	(0.92)	(-9.49)	(-10.86)	(-8.38)

Table 6. Average Delta Hedge Call Option Returns for daily and weekly strategies

This table reports time series averages of daily and weekly delta-hedge call option returns. Panel A considers daily option returns separately for all days of the month, all Mondays, Mondays after expiration and non-expiration Mondays. We consider only options with five consecutive days of positive trading volume when computing daily delta-hedge option returns. Panel B shows weekly call option returns. Weekly option returns are constructed using Tuesday-to-Tuesday quotes wherever possible. We show results for all the weeks of the month and we separate expiration from non-expiration weeks. The option returns are computed using closing bid-ask price midpoints. OTM (out-of-the-money) corresponds to $0.125 < \Delta <= 0.375$, where Δ is the Black-Scholes delta. ATM (at-the-money) corresponds to $0.375 < \Delta <= 0.625$ and ITM (in-the-money) corresponds to $0.625 < \Delta <= 0.875$. Values in parentheses are t -statistics computed from Newey-West standard errors with 18 lags for daily returns and 11 lags for weekly returns. Returns are reported in percentage terms. The data are collected from OptionMetrics and CRSP and contain daily series from January 1996 to December 2021.

Panel A: Daily-Delta Hedge Option Returns

		All options	OTM	ATM	ITM
All days	(%)	-0.042	-0.028	-0.030	-0.009
		(-3.30)	(-2.63)	(-4.13)	(-1.20)
All Mondays	(%)	-0.178	-0.253	-0.212	-0.075
		(-9.21)	(-9.25)	(-8.90)	(-2.92)
Mondays After Expiration only	(%)	-0.514	-0.769	-0.511	-0.165
		(-8.81)	(-9.18)	(-9.05)	(-2.25)
All days without Expiration Mondays	(%)	-0.019	0.077	-0.006	-0.001
		(-1.47)	(0.69)	(-0.85)	(-0.11)

Panel B: Daily-Delta Hedge Weekly Option Returns

		All options	OTM	ATM	ITM
All Weeks	(%)	-0.144	-0.131	-0.083	-0.153
		(-2.46)	(-1.10)	(-2.39)	(-6.62)
Expiration Weeks	(%)	-0.355	-0.485	-0.424	-0.277
		(-8.42)	(-6.99)	(-9.80)	(-10.53)
Non-Expiration Weeks	(%)	-0.073	-0.011	0.032	-0.111
		(-1.00)	(-0.07)	(0.84)	(-4.09)

Table 7. Average Straddle Monthly Option Returns

This table reports time series averages of straddle option returns during the holding period. We show results for simple straddle returns, zero-delta straddles and daily-delta hedge straddle returns. We focuse on options with more than one month to expiration and start the position at the end of the month and close the position at the end of the following month. We compute average delta-hedge option returns from end-of-month to the next end-of-month period; from one day before expiration of the options to two days after expiration; and from two days after expiration and to end of month. Returns are reported on a monthly basis and in percentage terms. The data are collected from OptionMetrics and CRSP and contain daily series from January 1996 to December 2021.

		End-month to End-month	End-Month to One-day Before Exp	One-day Before Exp to Two-days after Exp	Two-days After Exp to End of month
Simple Straddle Returns	(%)	-1.682	2.379	-3.077	-0.984
Zero-Delta Straddle Returns	(%)	-1.980	2.365	-3.157	-1.188
Daily-Delta Hedge Straddle Returns	(%)	-0.976	1.458	-2.501	0.067

Table 8. Average Daily-Delta Hedge Monthly Put Option Returns

This table reports time series averages of put delta-hedged option returns during the holding period. The delta-hedge is rebalanced on each trading day. Panel A focuses on options with more than one month to expiration and starts the position at the end of the month and close the position at the end of the following month. We compute average delta-hedge option returns from end-of-month to the next end-of-month period; from one day before expiration of the options to two days after expiration; and from two days after expiration and to end of month. Panel B considers options that expire the following month and starts the position one day after the expiration date of the options (usually the third Friday of the month) and close the position at the next expiration date. We compute average delta-hedge option returns from the first trading day after expiration to the next expiration date; from the first trading day after expiration to one day before the next expiration date; and from one-day before expiration to expiration. Returns are reported on a monthly basis and in percentage terms. The data are collected from OptionMetrics and CRSP and contain daily series from January 1996 to December 2021.

		End-month to End-month	End-Month to One-day Before Exp	One-day Before Exp to Two-days after Exp	Two-days After Exp to End of month
$\frac{P_{t+\tau}-P_t-\sum_{n=0}^{N-1}\Delta_{P,t_n}[S(t_{n+1})-S(t_n)]-\sum_{n=0}^{N-1}\frac{a_n r t_n}{365}[P(t_n)-\Delta_{P,t_n}S(t_n)]}{\lvert P_t-\Delta_{P,t}S_t\rvert}$	(%)	-0.216	0.192	-0.373	-0.035
$\frac{P_{t+\tau}}{\lvert P_t-\Delta_{P,t}S_t\rvert}$	(%)	12.200	12.985	12.641	12.200
$\frac{P_t}{\lvert P_t-\Delta_{P,t}S_t\rvert}$	(%)	13.019	13.019	12.985	12.641
$\frac{\sum_{n=0}^{N-1}\Delta_{P,t_n}[S(t_{n+1})-S(t_n)]}{\lvert P_t-\Delta_{P,t}S_t\rvert}$	(%)	-0.823	-0.353	-0.009	-0.462
$\frac{\sum_{n=0}^{N-1}\frac{a_n r t_n}{365}[P(t_n)-\Delta_{P,t_n}S(t_n)]}{\lvert P_t-\Delta_{P,t}S_t\rvert}$	(%)	0.220	0.127	0.037	0.056

Table 9. Daily-Delta Hedge Monthly Option Returns using different Moneyness intervals

This table reports time series averages of monthly delta hedge returns in where the delta-hedge is rebalanced on each trading day. We focus on options with more than one month to expiration and start the position at the end of the month and close the position at the end of the following month. We compute average delta-hedge option returns from end-of-month to the next end-of-month period; from one day before expiration of the options to two days after expiration; and from two days after expiration and to end of month. The option returns are computed using closing bid-ask price midpoints. OTM (out-of-the-money) corresponds to $0.125 < \Delta <= 0.375$, where Δ is the Black-Scholes delta. ATM (at-the-money) corresponds to $0.375 < \Delta <= 0.625$ and ITM (in-the-money) corresponds to $0.625 < \Delta <= 0.875$. Values in parentheses are t -statistics computed from Newey-West standard errors with optimal lags. Returns are reported on a monthly basis and in percentage terms. The data are collected from OptionMetrics and CRSP and contain daily series from January 1996 to December 2021.

		End-month to End-month	End-Month to One-day Before Exp	One-day Before Exp to Two-days after Exp	Two-days After Exp to End of month
OTM	(%)	0.120	0.560	-0.636	0.197
ATM	(%)	-0.453	0.039	-0.515	0.023
ITM	(%)	-0.411	-0.122	-0.264	-0.026

Internet Appendix to

"Equity Option Return Predictability and Expiration Days"

(Not for publication)

Appendix A: Anomaly Dictionary

In this section we provide a detailed description of the stocks and option characteristics use as option predictors.

CFV: Cash flow variance, following Haugen and Baker (1996), is the variance of the monthly ratio of annual cash flow to the market value of equity over the past 60 months, requiring at least 36 non-missing monthly observations. Annual cash flow is defined as Net Income (Compustat item NI) plus Depreciation and Amortization (item DP), scaled by monthly updated market value of equity. Accounting items are assumed to be publicly available 4 months after the fiscal year end, with data older than 15 months excluded to avoid staleness.

CH: Cash-to-assets ratio, as defined by Palazzo (2012), is calculated by dividing cash holdings (Compustat quarterly item CHEQ) by total assets (item ATQ). Quarterly data is assumed to be available 4 months after the fiscal quarter end, and information older than 6 months is not used.

DISP: Analyst forecast dispersion, from Diether et al. (2002), is calculated as the ratio of the standard deviation of earnings forecasts (IBES item STDEV) to the consensus mean forecast (item MEANEST) for the current fiscal year, in USD. Stocks with a mean forecast of zero are placed in the highest dispersion group, and firms with fewer than two forecasts are excluded.

ISSUE1Y: One-year new issues, following Pontiff and Woodgate (2008), are measured as the natural log of the ratio between split-adjusted shares outstanding at the end of the fiscal year and 12 months prior. Split-adjusted shares are calculated by multiplying shares outstanding (Compustat item CSHO) by an adjustment factor (item AJEX). Data is assumed to be publicly available 4 months post-fiscal year, with information older than 15 months excluded.

ISSUE5Y: Five-year new issues, based on Daniel and Titman (2006), are the log growth rate of market equity not attributable to stock returns, computed monthly. The calculation is log(Met/Met-60) minus cumulative log stock returns over the past 60 months, where Met represents the market equity on the last trading day.

PM: Profit margin, per Soliman (2008), is defined as Earnings Before Interest and Taxes (Compustat item EBIT) divided by Revenue (item REVT). Data is assumed publicly available 4 months after fiscal year-end, with information older than 15 months excluded.

ln(PRICE):The natural log of the stock price at the end of the last month, based on Blume and Husic (1973).

PROFIT: Profitability, following Fama and French (2006), is earnings divided by current book equity. Earnings are defined as Income Before Extraordinary Items (Compustat item IB). Book equity includes stockholders' book equity, balance sheet deferred taxes, investment tax credit (if available), and excludes the book value of preferred stock. Stockholders' equity is taken from Compustat (item SEQ) if available, otherwise derived from common equity (item CEQ) plus preferred stock par value (item PSTK), or assets (item AT) minus liabilities (item LT). Data is assumed to be publicly available 4 months post-fiscal year, avoiding older information.

TEF: Total external financing, from Bradshaw et al. (2006), is calculated for a fiscal year-end and scaled by the average of total assets at the same and prior fiscal year-end. It includes net equity and net debt financing, calculated based on Compustat items for stock sales, repurchases, dividends, debt issuance, and debt payments. Data is assumed publicly available 4 months after fiscal year-end, with information older than 15 months excluded.

ZS: Z-score, constructed using Dichev (1998), is calculated as:

$$Z = 1.2WCTA + 1.4RETA + 3.3EBITTA + 0.6METL + SALETA, \tag{7}$$

in which WCTA is working capital (Compustat annual item ACT minus item LCT) divided by total assets (item AT), RETA is retained earnings (item RE) divided by total assets, EBITTA is earnings before interest and taxes (item OIADP) divided by total assets, METL is the market equity (from CRSP, at fiscal year end) divided by total liabilities (item LT), and

SALETA is sales (item SALE) divided by total assets. For firms with multiple share classes, market equity is combined before calculating Z.

VOL deviation: Volatility mispricing, as defined by Goyal and Saretto (2009), is the log difference between realized volatility and Black-Scholes implied volatility for at-the-money options at the end of the last month.

IVOL: Idiosyncratic volatility, following Ang et al. (2006) and Cao and Han (2013), is the standard deviation of the residuals from regressing individual stock returns on the Fama and French (1993) three factors using daily data from the previous month.

AMIHUD: Amihud (2002) stock illiquidity measure, computed as the average of the daily ratio of absolute stock returns to dollar volume over the prior month.

SIZE: The natural logarithm of the firm's market value of equity, following Fama and French (1993).

MF SKEW: Risk-neutral skewness, per Bali and Murray (2013), uses 30-day risk-neutral skewness. The method follows Bakshi and Kapadia (2003), and data is available online from Grigory Vilkov.

CALL IV ATM: Black-Scholes implied volatility for at-the-money options at the end of the last month.

MAX(1): Maximum daily return over the previous month, based on Bali et al. (2001).

Figure A1. Example of End-of-Month to End-of-Month Portfolio Formation and Holding Period

FEBRUARY 2020

Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	Options Expire 21	22	23
24	25	26	27	Forming Portfolios: Buy Options 28	29	

MARCH 2020

Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
						Holding Period 1
Holding Period 2	Holding Period 3	Holding Period 4	Holding Period 5	Holding Period 6	Holding Period 7	Holding Period 8
Holding Period 9	Holding Period 10	Holding Period 11	Holding Period 12	Holding Period 13	Holding Period 14	Holding Period 15
Holding Period 16	Holding Period 17	Holding Period 18	Holding Period 19	Holding Period Options Expire 20	Holding Period 21	Holding Period 22
Holding Period 23	Holding Period 24	Holding Period 25	Holding Period 26	Holding Period 27	Holding Period 28	Holding Period 29
Holding Period 30	Holding Period: Sell Options 31					

Table A1. One-Time Delta-Hedged Call Option Returns during the holding period

This table reports time series averages of delta-hedge option returns during the holding period. The delta-hedge is rebalanced at initiation only. We focus on options with more than one month to expiration and start the position at the of the month and close the position at the end of the following month. We compute average delta-hedge option returns from end-of-month to the next end-of-month period; from one day before expiration of the options to two days after expiration; and from two days after expiration and to end of month. Returns are reported on a monthly basis and in percentage terms. The data are collected from OptionMetrics and CRSP and contain daily series from January 1996 to December 2021.

		End-month to End-month	End-Month to One-day Before Exp	One-day Before Exp to Two-days after Exp	Two-days After Exp to End of month
$\frac{C_{t+\tau}-C_t-\Delta_{C,t}(S_{t+\tau}-S_t)-\frac{a_\tau r_t}{365}(C_t-\Delta_{C,t}S_t)}{\lvert\Delta_{C,t}S_t-C_t\rvert}$	(%)	-0.337	0.285	-0.754	-0.122
$\frac{C_{t+\tau}}{\lvert\Delta_{C,t}S_t-C_t\rvert}$	(%)	16.384	16.768	16.096	16.384
$\frac{C_t}{\lvert\Delta_{C,t}S_t-C_t\rvert}$	(%)	16.006	16.006	16.768	16.096
$\frac{\Delta_{C,t}(S_{t+\tau}-S_t)}{\lvert\Delta_{C,t}S_t-C_t\rvert}$	(%)	0.953	0.613	-0.192	0.396
$\frac{\frac{a_t r_\tau}{365}(C_t-\Delta_{C,t}S_t)}{\lvert\Delta_{C,t}S_t-C_t\rvert}$	(%)	-0.239	-0.137	-0.041	-0.063

Table A2. Average Delta-Hedged Call Option Returns for daily strategies

This table reports time series averages of daily delta-hedge call option returns. Panel A considers daily option returns separately for all days of the month, all Mondays, Mondays after expiration and non-expiration Mondays. We consider only options with five consecutive days of positive trading volume when computing daily delta-hedge option returns. The option returns are computed using closing bid-ask price midpoints. Panel B considers only OTM options with $0.125 < \Delta <= 0.375$, where Δ is the Black-Scholes delta. Panel C show results for ATM (at-the-money) with $0.375 < \Delta <= 0.625$ and Panel D, ITM (in-the-money) with $0.625 < \Delta <= 0.875$. Values in parentheses are t -statistics computed from Newey-West standard errors with 18 lags. Returns are reported in percentage terms. The data are collected from OptionMetrics and CRSP and contain daily series from January 1996 to December 2021.

Panel A: All Options

		All maturities	11-53 days	54-118 days	119-252 days
All days	(%)	-0.021	-0.032	-0.005	0.006
		(-2.53)	(-3.88)	(-0.54)	(0.69)
All Mondays	(%)	-0.141	-0.189	-0.117	-0.077
		(-7.26)	(-8.80)	(-6.31)	(-3.79)
Mondays After Expiration only	(%)	-0.419	-0.522	-0.412	-0.352
		(-8.88)	(-9.39)	(-8.65)	(-7.07)
All days without Expiration Mondays	(%)	-0.001	-0.008	0.016	0.024
		(-0.12)	(-0.88)	(1.70)	(2.54)

Panel B: OTM options

		All maturities	11-53 days	54-118 days	119-252 days
All days	(%)	-0.012	-0.029	0.002	0.023
		(-1.10)	(-2.75)	(0.18)	(1.95)
All Mondays	(%)	-0.195	-0.258	-0.165	-0.094
		(-7.85)	(-9.41)	(-7.21)	(-3.92)
Mondays After Expiration only	(%)	-0.591	-0.748	-0.591	-0.448
		(-9.14)	(-9.81)	(-9.43)	(-7.26)
All days without Expiration Mondays	(%)	0.172	0.007	0.032	0.046
		(1.55)	(0.60)	(2.81)	(3.81)

Panel C: ATM Options

		All maturities	11-53 days	54-118 days	119-252 days
All days	(%)	-0.015	-0.033	-0.011	-0.000
		(-2.24)	(-4.64)	(-1.52)	(-0.06)
All Mondays	(%)	-0.134	-0.197	-0.118	-0.079
		(-7.63)	(-9.40)	(-6.99)	(-4.40)
Mondays After Expiration only	(%)	-0.393	-0.506	-0.387	-0.334
		(-9.65)	(-9.22)	(-9.12)	(-8.21)
All days without Expiration Mondays	(%)	0.002	-0.009	0.074	0.016
		(0.33)	(-1.22)	(0.95)	(1.96)

Panel D: ITM Options

		All maturities	11-53 days	54-118 days	119-252 days
All days	(%)	-0.025	-0.023	-0.003	-0.012
		(-5.12)	(-5.21)	(-0.59)	(-1.75)
All Mondays	(%)	-0.079	-0.101	-0.046	-0.052
		(-5.84)	(-7.80)	(-3.08)	(-3.15)
Mondays After Expiration only	(%)	-0.220	-0.248	-0.179	-0.215
		(-8.07)	(-9.15)	(-7.53)	(-6.03)
All days without Expiration Mondays	(%)	-0.015	-0.012	0.006	-0.001
		(-3.05)	(-2.56)	(1.01)	(-0.21)