Maturity Driven Mispricing of Options

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ABSTRACT

This paper documents that short-term options achieve significantly lower returns during months with four versus five weeks between expiration dates. The average return differential ranges from 16 to 29 basis points per week, for delta-hedged portfolios, and from 101 to 187 basis points per week, for straddles, over 1996-2017. Evidence based on earnings announcements and institutional holdings suggests that investor inattention to exact expiration date rather than underlying risk exposures or transaction costs can explain the mispricing. Market makers seem to adjust prices accordingly, and tend to over-trade mispriced options against less sophisticated investors.

I. Introduction

Most options on US equities expire on the third Friday of each month. Due to calendar differences, the time between two consecutive expiration dates is either four or five weeks (four weeks in about 65% of all months and five weeks in the remaining 35%). The effect of an extra week on option value in this case can be 5 to 10% by Black-Scholes (1973) estimates. Yet most online option brokers do not display the exact number of days to expiration but rather only the year and month of the expiration date. An interesting question is therefore whether option traders pay full attention to the exact time to maturity.

Imagine an investor who has to roll over her option position from one month to the next. She might have an underlying equity position that she hedges with puts, or wants to generate additional income through covered calls, or simply follows some month-to-month trading strategy. Either way, she is likely to reestablish her option position using options maturing next month as her current options approach expiration (or shortly after).

How does she price such options? Any formal model would naturally take into account the difference in maturities between four- and five-week options. However, any naïve rule-of-thumb approach that treats all options similarly as "maturing next month" would fail to account for this difference. If enough investors price options simplistically as "maturing next month", this should cause option prices to diverge from fundamentals. In particular, such "naïve" investors would tend to underprice five-week options relative to four-week ones. (Keeping everything else equal, five-week options have greater time value, and thus should be more expensive than four-week options.)

It therefore appears that the natural calendar difference in maturities of one-month options provides a unique opportunity to test potential inattention to the exact time to maturity. The direct implication of such inattention is straightforward: if options that are traded during four-week expiration cycles are overpriced relative to five-week cycles, they should generate, on average, lower weekly adjusted returns.

Our empirical design to investigate this question is based on the following procedure. To avoid any look-ahead bias in forming our portfolios, we establish all option positions as of five weeks before their expiration date in the following month. On the portfolio formation date, for each underlying security we pick a single call option and a single put option that are closest to at-the-money and mature in the next month.

From these options we form three positions: straddles and delta-hedged calls and puts. A first natural test would be to compare the returns to these option positions from their formation date (current-month expiration date) to maturity (next-month expiration date) over four- and five-week expiration cycles. Yet this comparison could induce a bias to the results, as it conflates two different effects: the calendar expiration cycle effect (the focus of this paper) and the general effect of time-to-maturity on option returns. Options with different maturities are inherently different, and their returns therefore might not be directly comparable. To address this concern, for each option in the sample, in addition to constructing expiration-to-expiration portfolios, we also construct two sets of portfolios with fixed maturities (four and five weeks). In particular, we step either one week back or one week forward from the expiration date to form these two sets of portfolios with equal time to maturity. The first set includes only four-week returns from formation day to maturity (and contains options purchased either on expiration days or one week after). The second set includes only five-week returns (and contains options purchased either on expiration days or one week before).

In our first test, we form monthly equally weighted portfolios of each type (four-week, five-week, and expiration-to-expiration), and compute the time-series averages of the monthly portfolio returns (in weekly terms), separately over four- and five-week expiration cycles. We find that all option positions generate significantly lower returns when there are four weeks between consecutive expiration dates than when there are five weeks over the period 1996-2017. Straddles exhibit differences, 1.80% and 1.87% per week for the four- and five-week return samples, respectively, whereas the delta-hedged positions show differences of 0.23% to 0.29%, all highly statistically significant. The straddle and delta-hedged portfolio returns are not directly comparable; the relatively large return gained by straddles versus delta-hedged positions is due to the difference in scaling factors. Straddle profits are scaled by options prices while delta-hedged profits are scaled also by stock prices. The expiration-to-expiration return differences are lower, 1.01% for straddles and 0.16% to 0.21% for the delta-hedged positions, and marginally statistically significant. This is expected as the sample captures both the inattention-to-expiration date effect and the general effect of option maturity on option returns, which is typically found to be negative.

To complement portfolio results with regression-based evidence, we run a pooled regression of average weekly returns to our option positions on a dummy variable for five-week expiration cycle and a set of control variables that can affect option returns, as documented by prior literature. These control variables include the difference between implied and historical volatility, return skewness and kurtosis, firm size, book-to-market ratio, past stock return, idiosyncratic volatility, and others (see, e.g., Goyal and Saretto (2009) and Cao and Han (2013)).

All regression specifications yield a positive effect of the five-week expiration cycle dummy on the option position return, consistent with the portfolio results. The results are robust to various subsamples and estimation procedures.

Finally, we use an alternative price-based measure to detect potential mispricing of options in months with four versus five weeks between consecutive expiration dates. In particular, we use the log of the ratio of the theoretical Black-Scholes option value to the market value as a measure of mispricing (using both historical volatility and GARCH-inferred expected volatility as inputs in the Black-Scholes model). Consistent with our return-based results, we find that options exhibit more positive pricing errors in months with four weeks between expiration dates than in months with five weeks between expirations.

While our evidence is suggestive of inattention-driven mispricing, a potential alternative explanation is that periods spanning five weeks between consecutive expiration dates might have happened by chance to overlap more with periods of high risk or had a higher incidence of events that are perceived risky (e.g., earnings announcement dates or other similar events). Thus, the relatively higher return to options traded during five-week expiration cycles might represent a compensation for additional risk.

We verify that our results are not simply a manifestation of risk in several ways. First, our regression specifications explicitly control for a large set of stock and option characteristics associated with risk, such as firm size and market-to-book ratio, and options' gamma and vega (among others). Second, our price-based misvaluation measure explicitly incorporates the effect of maturity on option prices by means of the Black-Scholes model. Last, an additional test shows that there are no significant differences in various proxies for risk during periods of four and five weeks between expiration days, nor is there any evidence that the resulting option portfolios exhibit higher risk ex-post. These risk proxies include the difference between implied and historical stock return volatilities, percent of earnings announcements and daily return jumps between expiration days, as well as realized volatility and skewness of option returns.

We next provide further evidence suggesting that our results are driven by investor inattention. First, we show that the outperformance of options during five- versus four-week expiration cycles is negatively related to the percentage of institutional ownership of the underlying equity. While not a direct proxy for the sophistication of option traders, it is likely that options on stocks with higher institutional holdings are also traded more actively by institutions, and therefore less subject to behavioral biases in their pricing.

Second, we look at the proximity to earnings announcement dates. We look at those dates for two reasons. Firms' earnings announcements usually attract a high volume of stock and option trading, as investors attempt to capitalize on the relatively sharp stock price movements around announcement dates.[1] Investors motivated by earnings releases to trade options are less likely to pay attention to the exact expiration day, as they are likely to focus more on analyzing information in earnings. This provides an opportunity to further examine the presence of inattention to expiration dates. Furthermore, earnings-based trades typically have short investment horizons (i.e., buying/selling assets around the announcement day), and investors attempting to profit by trading around earnings announcements are less likely to hold options until their expiration. It is therefore likely that inattention to exact expiration dates is stronger around earnings announcements and we expect that the difference between option returns during four- and five-week expiration cycles will be larger for firms with earnings announcements

[1] See Ball and Brown (1968), Beaver (1968), May (1971), Morse (1981), Patell and Wolfson (1981, 1984), and McNichols and Manegold (1983) on the variability of stock prices around earnings announcements.

around the position formation date. Our results support this conjecture, providing further evidence for the presence of inattention in option trading.

Conventional wisdom and prior studies suggest that retail investors are likely to be less sophisticated and hence potentially more inattentive to relevant information than professional investors like option market makers. Using daily records of option buy and sell activity of different market participants yields two findings. First, market makers over-sell options during four-week expiration cycles and over-buy options during five-week cycles. Second, the mispricing is stronger for options that are over-traded by market makers against less sophisticated investors. These findings suggest that market makers indeed act as informed traders with respect to the option horizon mispricing, while less sophisticated investors exhibit inattention to exact expiration dates.

Several recent studies have tried to detect mispricing in the options market. The common objective is to identify an option- or stock-specific characteristic that signals over- or underpricing in the cross-section of options, and can therefore predict subsequent returns. Goyal and Saretto (2009) show that a larger gap between implied volatility and historical volatility leads to higher option returns. Cao and Han (2013) show that option returns decrease monotonically with an increase in the idiosyncratic volatility of the underlying stock. Boyer and Vorkink (2014) find that the ex-ante skewness of options predicts negative option abnormal returns. Our study is different insofar as we do not address individual option/stock signals, but rather show that an exogenous factor, common to all options—the number of weeks between consecutive expiration days—affects option returns in a significant systematic manner. In this respect our study complements that of Jones and Shemesh (2018) who document a weekend effect in option prices which they attribute to the incorrect treatment of non-smoothness in stock return variance.

Our paper also contributes to the growing literature that explores behavioral biases in the options market, including investor sentiment (see Han (2007)), misreaction to news (see Poteshman (2001), Mahani and Poteshman (2008), and Chordia, Kurov, Muravyev, and Subrahmanyam (2020), inefficient option exercising (see Poteshman and Serbin (2003)), and herding behavior (see Bernales, Verousis, and Voukelatos (2020)). Insofar as investor inattention in equity markets, DellaVigna and Pollet (2009) argue that investors upcoming weekend distractions cause them to underreact to Friday earnings announcements. Another example is provided by Hirshleifer, Lim, and Teoh (2009), who show weaker investor reaction to a firm's earnings announcement on days with many earnings announcements.[2] While firm-specific information embedded in financial statements or news releases requires some time and effort to process, the number of days to an option's expiration is very easy to obtain and requires simply one's attention. The fact that this information is not fully captured by option prices is indicative of a strong degree of behavioral investment.

Finally, a conceptually closely related paper is by Johnston, Leone, Ramnath, and Yang (2012) who look at what happens when firms report earnings for a 14-week quarter, as the vast majority of quarters contain 13 weeks. Holding everything else constant, earnings and revenues should be approximately 7.7% (1/13) higher in the 14-week quarters. Yet they find evidence of predictable earnings forecast errors and stock returns in 14-week quarters, suggesting that analysts and investors do not, on average, adjust their expectations for the extra week. Although

[2] For more on investor inattention see also Hong, Torous, and Valkanov (2007), Cohen and Frazzini (2008), Chakrabarty and Moulton (2012), and Gilbert, Kogan, Lochstoer, and Ozyildirim (2012).

Johnston et al. analyze a different asset class and a different calendar, the conclusion of their study is consistent with ours: investors can be inattentive to exact calendar dates.

The paper proceeds as follows. Section II describes our data sources and construction of the main variables. Section III presents the results from our main tests and a set of robustness checks. In section IV we examine the potential role of risk in our findings and provide additional evidence for the inattention mechanism we identify. Section V discusses potential implications of our findings for the option pricing literature. Section VI concludes.

II. Data and variables

Our primary source of data is Ivy DB OptionMetrics which provides comprehensive coverage of US equity options from 1996 through 2017. OptionMetrics provides daily closing bid-ask quotes (as well as daily trading volume and open interest), and we compute our option portfolio returns from quote midpoints. We start by imposing certain filters on our option data. We remove options with zero open interest and options with zero trading volume, as such options are illiquid and their quotes are less likely to reflect any useful information. We retain only options maturing on the third Friday of a month. These are the standard American style US equity options. In addition to OptionMetrics, we obtain investor-type trading data from International Securities Exchange (ISE) (see Section IV.C for details).

In recent years options with weekly maturities have emerged for a limited number of stocks. Such options are less common and not well suited for testing our main hypothesis that relates to options with monthly maturities. We therefore exclude from our sample options that mature on a Friday but not the third Friday in a month and options maturing on any day other than Friday.

The latter are more likely to be associated with errors in the data. We also remove months in which the options market was closed on the third Friday (about 3% of the sample, primarily due to holidays) as the time between expiration days around those months is different from four or five weeks. We eliminate observations that violate arbitrage bounds, observations for which the ask price is lower than the bid price, or the bid price is equal to zero. For each underlying security in each expiration day, we pick a single one-month call and a single one-month put options, the ones that are closest to at-the-money. To avoid a look-ahead bias in forming our portfolios, all options are selected based on their moneyness as of five weeks before their expiration day in the following month. We include only options with moneyness (the ratio of the stock price to strike price) between 0.7 and 1.3. The results are robust to reasonable variations in the bounds on moneyness.

We merge the option data with underlying equity data obtained from the CRSP dataset, using the matching algorithm provided by OptionMetrics. The resulting sample includes 302,831 call options (of which 185,706 are traded during four-week expiration cycles and 117,125 during five-week cycles) and 240,114 put options (148,932 are traded during four-week expiration cycles and 91,182 during five-week cycles). The difference in the sample sizes of call and put options is primarily due to removing options with zero open interest/trading volume.

Table 1 presents summary statistics for our sample separately for calls and puts with four- and five-week maturities. We winsorize all variables at the 1st and 99th percentiles. Volume/open interest is the ratio of daily option trading volume of a given option contract to total open interest for the same contract (as of the end of the trading day). While the median ratio is about 0.12 for calls and 0.14 for puts, this variable is highly skewed due to a relatively small number of very heavily traded contracts resulting in much higher means (about 0.51 for calls and

0.59 for puts). This is a measure of liquidity of a given option contract. The second option liquidity measure that we use is the bid-ask spread, computed as the difference between the ask and bid quotes at the closing scaled by the midpoint quote. Neither volume/open interest ratio nor the bid-ask spread demonstrate any significant differences in liquidity of the option contracts with a five-week maturity versus those with a four-week maturity.

Insert Table 1 here

IV-HV is the difference between the option's implied volatility and historical volatility. Implied volatilities are provided by OptionMetrics. We compute historical volatilities based on daily returns over the past year. We construct this measure following Goyal and Saretto (2009), who show that it is a strong predictor of returns to option portfolios and might capture mispricing in the cross-section of equity options. Gamma is the second derivative of the option price with respect to the stock price, and vega is the derivative of the option price with respect to volatility. Both option greeks are normalized to capture the percentage change in option price; gamma is multiplied by the ratio of the underlying stock price to the absolute value of the option delta, and vega is scaled by the option price.

The other variables in Table 1 pertain to the characteristics of the underlying equity securities. We use these characteristics primarily as control variables in various regression specifications. Log(size) is the log of equity value of the underlying stock (in millions of dollars). Log(market-to-book) of the underlying stock is the ratio of current equity market value to equity book value as of the previous quarter. Past return of the underlying stock is cumulative return over the past six months. Illiquidity of the underlying stock is the Amihud's (2002) measure, calculated as the monthly average of daily ratios of absolute return to dollar trading volume (in millions). Skewness and kurtosis are based on the daily returns of the underlying stock over the previous month.[3] Idiosyncratic volatility is measured by the standard deviation of the residuals of regression of daily stock returns on the daily Fama and French (1993) three factors over the previous month. Institutional ownership is the sum of all shares held by institutions divided by total shares outstanding. In constructing these measures we take the market variables from CRSP and the accounting variables from Compustat, where data on institutional ownership are obtained from Thomson Reuters.

For obvious reasons we focus only on optionable stocks that are typically larger, more liquid, and have more institutional ownership. For example, in our sample the median firm size is about 3.1 billion dollars (compared to 0.25 billion dollars for the entire CRSP/Compustat universe), the median Amihud illiquidity measure is 0.05 (compared to 2.45), and the median percentage of institutional ownership is about 77% (compared to 39%). Still, there is reasonable variation in these characteristics across the firms in our sample (particularly for the Amihud illiquidity measure, with standard deviation between 0.69 and 0.92 for various subsamples in Table 1). Stocks in our sample also exhibit mildly positive skewness and kurtosis.

Note that implied volatilities of options in four-week expiration cycles are higher than those in five-week cycles, for both calls and puts. For example, the mean implied volatility of four-week puts is 46.4%, while it is 43.8% for five-week puts. Although implied volatility is model-driven and therefore, by itself, is not a direct measure of potential mispricing, this difference can

[3] In unreported results we use alternative measures of skewness and kurtosis as controls, based on daily returns over 2, 3, and 6 month horizons and monthly returns over a 12 month horizon. The results remain very similar if using these alternative measures.

provide a first hint that options traded in four-week cycles are potentially overpriced relative to those traded in five-week cycles.

Another way to gauge the degree of expensiveness of an option is to look at the difference between implied and historical volatilities (IV-HV). More volatile stocks are likely to have higher both historical and implied volatilities, so this difference might be a more accurate measure of the relative expensiveness of an option than the implied volatility itself. The differences between implied and historical volatilities of both calls and puts are higher in four-week expiration cycles than in five-week ones. For example, the mean IV-HV difference for a four-week put is 4.2%, while it is only 2.3% for a five-week put. For calls the corresponding values are 3.4% and 1.4%.

This preliminary evidence suggests that the difference in the number of weeks between consecutive option expiration dates has an economically large effect on option prices. While potentially suggestive of mispricing, this evidence might also be driven by difference in riskiness of those options. In the next section we perform formal tests of this potential mispricing while looking at returns to option portfolios as well as a priced-based measure of mispricing that relies on the deviation of option prices from the Black-Scholes model. In Section IV we address the potential differences in risk.

III. Empirical tests

A. A first look at the differences in option prices – portfolio returns

Our goal is to study the relative pricing of options in four- versus five-week expiration cycles and the effect of this pricing on the returns to option portfolios. In order to minimize noise in measuring returns we want to neutralize the impact of movements in the underlying securities on the returns of our option portfolios. For this reason, we form straddle as well as delta hedged call and put portfolios. Straddles are formed as a combination of a call and a put option written on the same stock with the same strike price that are closest to at-the-money and have the same maturity. Delta hedged portfolios combine an option position with holding negative delta units of the underlying security. This strategy implies adding a short (long) position in the underlying security for delta-hedged call (put) portfolios.

To calculate returns to our option positions we follow closely Goyal and Saretto (2009) and Cao and Han (2013)[4]. For straddles, we scale the total dollar gain at expiration by the cost of constructing the straddle given by the sum of the prices of the call and the put at portfolio formation. For delta-hedged call and put portfolios, we scale the total dollar gain at expiration by the absolute value of the total cost of constructing portfolios at the formation date. Thus, for delta-hedged calls we scale by the absolute value of the difference between the value of the delta shares of the underlying stock and the price of the call. For delta-hedged puts the scaling factor equals the price of the put minus the value of delta shares of the underlying stock (note that the delta of a put option is negative).[5] We approximate option prices by the midpoints of their bid and ask quotes,[6] and use option deltas provided by OptionMetrics.[7]

[4] The difference between our approach and that of Cao and Han (2013) is that they rebalance their hedges daily, while we keep our portfolios unchanged until maturity.

[5] We also consider alternative scaling factors. In untabulated tests we scale delta-hedged option gains by the price of (absolute) delta shares of the underlying stock as well as by the price of the option. In addition, we rebalance the number of stocks held in the positions according to the updated delta at weekly and daily frequencies. Our main results are robust to these alternative return computation procedures.

[6] Replicating our main tests while replacing the mid bid-ask quotes with actual trading prices (obtained from DeltaNeutral) shows similar results.

[7] OptionMetrics uses a binomial tree model following Cox, Ross, and Rubinstein (1979) to calculate implied volatilities and other option greeks.

Our main conjecture is about investor inattention to exact option maturity dates and the potential mispricing of options resulting from this inattention. The natural difference in the number of weeks between two consecutive maturity dates provides a perfect opportunity to dissect the effect of potential inattention. How does an investor inattention to the exact maturity date transpire into option prices? We posit that if enough investors price options simplistically as "maturing next month" and ignore the exact number of days to maturity, this should cause a deviation of option prices from fundamentals. That is, such "naïve" investors would tend to underprice five-week options relative to four-week ones.

Our very first test is therefore designed to capture any difference in returns to our option positions (straddles and delta-hedged calls and puts) during four- and five-week expiration cycles. Because our study focuses on option expiration days, a natural test would be to compare the options position returns from current-month expiration day to their maturity in next-month expiration day. Yet, one might potentially argue that options with different maturities are fundamentally different, and their returns therefore are not directly comparable. That is, if option time-to-maturity has a general effect on the option return, then comparing returns from one expiration day to the next during four- and five-week cycles would conflate two different effects: the calendar expiration cycle effect analyzed in this study and the general effect of time-to-maturity on option returns. Therefore, to address this concern, for each option in the sample, we step either one week back or one week forward from expiration day to form two sets of portfolios with equal time to maturity. The first set includes only four-week portfolios from formation to maturity dates and contains options purchased either on expiration dates or one week after. The second set includes only five-week returns and contains options purchased either on expiration dates or one week before. For each group we compare the options position returns between calendar periods of four- versus five-week expiration cycles.

To perform this test, we first form monthly equally weighted portfolios of each type (four-week, five-week, and expiration-to-expiration) and options positions (straddles and delta-hedged calls and puts). We then compute the time-series average of the monthly portfolio returns (in weekly terms) separately over four- and five-week expiration cycles. The results are reported in Table 2. First, average returns are negative for all portfolios. This is consistent with the findings of Bakshi and Kapadia (2003), Goyal and Saretto (2009), and Cao and Han (2013). Straddle returns appear higher in magnitude due to the different scaling applied when computing percentage returns. As described above, we scale straddle dollar returns by the sum of the put and call prices, while the delta-hedged portfolio returns by the sum of the price of the option and the price of delta units of the underlying security. Option prices are typically substantially lower than the prices of underlying equity, resulting in higher absolute values for straddle returns.

Insert Table 2 here

More importantly, the results in Table 2 show that for the equal-maturity samples, all three portfolio types underperform in four-week expiration cycles relative to five-week ones. The effect is again strongest for straddle portfolios (differences of -1.80% and -1.87% for the four- and five-week returns, respectively), followed by delta-hedged calls (-0.26% and -0.29%) and delta-hedged puts (-0.23% and -0.22%), all are statistically significant at any common level. The expiration-to-expiration returns show a similar effect of the expiration cycle, yet as expected, of a lower magnitude, from -0.16% for delta-hedged puts to -1.01% for straddles (with *t*-statistics between -1.70 and -2.29).[8] These results are consistent with our main hypothesis of inattention, and provide the first piece of evidence showing relative overpricing of options traded during four-week expiration cycles.

To better visualize the extent of the four- versus five-week maturity effect, we consider the following trading strategies. The four-week strategy shorts delta-hedged call and put portfolios for all optionable stocks in our sample (and takes equally weighted positions in those portfolios) on option expiration dates in months with four weeks to the next expiration date. The five-week strategy does the same in months with five weeks to the next expiration date. Because there are more periods with four weeks between expiration days than with five weeks, to allow a fair comparison we divide the four-week portfolio returns by the ratio of the number of months with four weeks between expiration days to that of five weeks, which equals 1.89. The cumulative performance of these strategies presented in Figure 1 demonstrates the superiority of the four-week strategy. Its adjusted total return over our sample period from January 1996 through December 2017 is over 280% for short delta-hedged calls and over 180% for short delta-hedged puts. The corresponding cumulative returns for the five-week strategy are 67% and 50% for short delta-hedged calls and puts, respectively. There are also notable differences between the Sharpe ratios of the trading strategies. The annualized Sharpe ratio of the four-week strategy is 1.58 for calls and 1.29 for puts, whereas the ratio of the five-week strategy is about 0.63 for both calls and puts.

Insert Figure 1 here

[8] Computing the straddles returns with alternative scaling factors yields results similar to those of the delta-hedged positions. For example, scaling the net straddle dollar gain by the price of the underlying security shows 4/5-week average return spreads between -0.17% and -0.29%.

In the next section we complement the portfolio results with firm-level regressions, which allow controlling for various option and stock characteristics that can affect option returns.

B. Regression based evidence

We perform a pooled regression analysis of the determinants of returns (average per week) to our option positions and the effect of option maturity cycle on potential mispricing, while controlling for potential cross-sectional correlation of option returns on a given date (using date-clustered standard errors). The empirical regression specifications and estimation results are presented in Table 3. Our explanatory variable of interest is a 5-week expiration cycle dummy, which we set to one if there are five weeks between expiration days, and zero if there are four weeks. According to our main inattention hypothesis, we expect investors to overprice options during four-week expiration cycles relative to five-week ones, and therefore expect a positive coefficient on the 5-week dummy. The coefficient of this specification represents therefore the difference in the average weekly option returns during five- and four-week expiration cycles.

Insert Table 3 here

The regressions include a large a set of control variables that can affect option returns. We follow other papers that analyze option returns (see, for example, Goyal and Saretto (2009) and Cao and Han (2013)) and add option-specific characteristics as control variables. We use two measures of option liquidity–the ratio of option trading volume to open interest, and the option bid-ask spread. We also include the difference between option implied volatility and the historical volatility of the underlying stock, following Goyal and Saretto (2009) who document that this variable is a strong predictor in the cross-section of option returns.

We also control for various characteristics of the underlying equity. We follow Brennan, Chordia, and Subrahmanyam (1998) and Goyal and Saretto (2009) and add to the regressions (log) firm size, (log) market-to-book ratio, and past stock return as well as measures of the skewness and kurtosis of underlying equity returns, defined as before; and we follow Cao and Han (2013) and add idiosyncratic volatility. In addition, we add a stock illiquidity measure, based on Amihud (2002). We also add to the regressions the options' gamma and vega, normalized as described above. Overall, the control variables capture various aspects of the riskiness of options as well as the underlying equity. Thus, including these controls addresses the potential concerns that our finding might be driven by risk and not by mispricing. We perform a battery of additional tests to rule out the potential risk explanation in Section IV.

Without the control variables (upper panel of Table 3), the regression results are similar to the mean portfolio returns in Table 2. The four- and the five-week return samples show a positive and significant effect of the 5-week cycle dummy (*t*-statistics between 2.14 and 2.86), whereas the expiration-to-expiration return sample shows a positive effect, yet less significant (*t*-statistics between 1.31 and 2.16). This is expected as the latter sample is affected by the general effect of time-to-maturity on option returns. When adding the control variables (lower panel of the table), the effect of the 5-week-cycle dummy remains similar across the different samples and option positions. These results provide further support to the mispricing explanation.

Consistent with the findings of Goyal and Saretto (2009), IV-HV is negatively related to option returns for the delta-hedged call and put portfolios. Also, consistent with Cao and Han (2013), idiosyncratic volatility is negatively related to delta-hedged option returns. Amihud's

(2002) measure of stock illiquidity is negative and highly significant in our regressions of option returns. Options on more thinly traded stocks seem to offer lower returns. To our knowledge, this result has not been previously documented in the literature. Options' own liquidity shows mixed results, as volume/open interest does not have an effect on option returns, while option bid-ask spread has a negative effect for the delta-hedged portfolios. This is consistent with the notion that investors in option markets demand additional compensation for holding illiquid option positions as long as they have net short options positions. Note that Lakonishok, Inmoo, Pearson, and Poteshman (2007) find that non-market maker investors in aggregate have more written than purchased options.

Overall, the results in Table 3 provide strong support for the relative mispricing of options during four- and five-week expiration cycles that is consistent with our main hypothesis of investor inattention to maturity. In the subsequent analysis we check the robustness of the results, we employ an alternative price-based measure of mispricing, provide additional evidence against the risk story, and perform further tests to tease out the role of inattention.

C. Robustness of main regressions

We perform a series of robustness checks to verify the robustness of the main regression results. Table 4 replicates the full regression models in Table 3 (referred to as "Base results") for different sample splits, and when controlling for calendar month and firm fixed effects. To reduce clutter, we report only the coefficients of the 5-week dummy variable.

Insert Table 4 here

In the first test we exclude large changes in aggregate market uncertainty, defined as months when the VIX index moved by more than 5% in any direction between option expiration days. Such observations represent about 20% of the sample, with the most extreme VIX movement of 38% occurring between the expiration days in September and October 2008. We want to make sure that our results are not driven by a few observations in months with extreme volatility movements. The results in Table 4 demonstrate robustness of the base results to this procedure with the coefficients on the five-week dummy remaining positive and statistically significant. Furthermore, excluding observations with extreme VIX movements actually improves the significance in all regression specifications. This result is not unexpected. As there is no foreseeable correlation between the time to expiration dates and unexpected aggregate volatility changes as measured by VIX, observations corresponding to extreme changes in VIX add extra noise to our portfolio returns and reduce the power of our tests.

Following a similar logic, we repeat our analysis while excluding recession months based on the NBER classification. Recessions typically correspond to large and unpredictable market movements and therefore might blur the maturity effect that we identify. Consistent with this conjecture, excluding recession months also raises the *t*-statistics on the 5-week dummy across all specifications and portfolio strategies.

In the next robustness test, we narrow the bounds that we impose on option moneyness at the time of portfolio formation. In particular, we restrict our analysis to options with moneyness between 0.95 and 1.05 (in our original tests the bounds on the moneyness are 0.7 and 1.3). As shown in Table 4, this exercise keeps the results essentially unchanged, in terms of both regression coefficients and their significance.

We exclude newly optionable stocks (i.e., stocks with options listed within one year prior to portfolio formation) as well as stocks with earnings and merger announcements during the maturity of the option, as those securities can be associated with higher risk in option returns. We also exclude stocks on which an investor can trade weekly options (options that are introduced each Thursday and expire eight days later on Friday), as these options provide an alternative short-term investment channel, and can thus affect the attention to the maturity of the standard options. None of these adjustments however has any material effect on the results.

We next run the regressions while including fixed effects for calendar months. The results remain similar in all specifications, confirming that the relatively high returns to options during months with five weeks between expiration days are not driven by unusual security returns associated with specific calendar months (for example, the January effect for equities).

Last, we investigate whether the maturity mispricing uncovered in this paper can be explained by consistent systematic differences between firms. In other words, we study whether the four-week/five-week return difference represents differences between firms or it might also exist for the same firm over different periods. To do so, we include firm fixed effects in the main regression models. The results show that the inclusion of firm fixed effects does not change our main findings. Note that the inclusion of firm fixed effects in the rest of the tables in the paper also does not change any of the inferences. We elect to omit the inclusion of firm fixed effects throughout the paper however because of the forward-looking nature of firm fixed effects in predictive regressions.

D. Alternative mispricing measure

The standard procedure to identify asset mispricing is by observing subsequent returns, and we followed this path in the previous sections. Alternatively, one can look at the deviation of the price from an established pricing model. The benefit of this approach is that it focuses directly on mispricing, and is not subject to the extreme nature of option returns (see discussion in Broadie, Chernov, and Johannes (2009)). It also alleviates a potential concern that options traded during four- and five-week expiration cycles exhibit different degrees of riskiness (we perform additional tests to further address this potential concern in Section IV below). The flip side, however, is that such a measure relies on a valuation model, and most models are subject to valuation errors. Still, there is no a priori reason to believe that those valuation errors should be different for options traded in four- versus five-week expiration cycles, so this alternative measure is acceptable if examining the *relative* mispricing of those options. In this section we use the Black-Scholes model, the most established and widely used in the options literature, as the benchmark model for theoretical values.

For our sample that includes all at-the-money calls and puts on the option expiration day in each month, we measure the extent of mispricing by the log of the ratio of the theoretical Black-Scholes value to the actual option value. The Black-Scholes values are based on both historical volatility of the underlying stock return and conditional expected volatility derived from the GARCH(1,1) model applied to monthly returns.[9] Note that the difference between the Black-Scholes and the actual option prices is correlated with the difference between implied and historical volatiles (see Section II), yet it provides a more accurate proxy for mispricing as the Black-Scholes values are not linear in volatility and also depend on various additional inputs.

[9] This is a common model of monthly stock returns. Bollerslev, Chou, and Kroner (1992) argue that most financial series can be modeled by GARCH (1,1). The results are robust to other common GARCH models.

Table 5 shows the results from regressions of the log of the theoretical/actual option value ratio on the dummy variable that equals one if there are five weeks between expiration days, and zero if there are four weeks, and the set of control variables used in Table 3. The results are consistent with our return-based evidence and demonstrate the relative cheapness of options traded in five-week expiration cycles, as the model-to-market ratio is higher for those options. The coefficients on the five-week dummy are positive and statistically significant in most specifications (marginally significant when using the forward looking volatility from the GARCH model without controls).

Insert Table 5 here

Some coefficients on the control variables are also highly significant and have signs consistent with economic intuition. Size is positive and significant in regressions with historical volatility but switches sign to negative in regressions with GARCH-inferred volatility, reflecting the mean-reverting nature of volatility that is particularly pronounced for small stocks. Stock illiquidity is negative and significant, implying inflated option prices on less liquid underlying stocks and consistent with the negative coefficient on stock illiquidity in return regressions reported in Table 3. Idiosyncratic volatility is highly significant in regressions with historical volatility, again pointing at the tendency of volatility to mean revert (this effect reverses when modeling future volatility dynamics with GARCH).

The results obtained using this alternative priced-based misvaluation measure complement and reinforce our evidence based on portfolio returns and point toward relative overpricing of options traded in four-week expiration cycles relative to five-week ones.

IV. Risk or inattention-driven mispricing?

Our evidence is strongly suggestive of relative mispricing of options traded during four- and five-week expiration cycles. This pattern of mispricing is consistent with our conjecture about investors' lack of attention to the exact maturity date. However, a potential alternative explanation is that periods spanning five weeks between consecutive expiration dates might have happened by chance to overlap more with periods of high risk or had a higher incidence of events that are perceived risky (e.g., earnings announcement dates, acquisition announcements, or other similar events).

We address this potential concern by controlling for various risk attributes in return and misvaluation regressions in Tables 3 to 5. While some of these control variables have coefficients consistent with being driven by compensation for risk, our main results (coefficients on the five-week dummy) remain significant. Nevertheless, in the next subsection we look deeper into the risk story as a potential explanation for our findings and compare the relative riskiness of the periods with four weeks between expiration dates versus those with five weeks.

A. Are periods of five weeks between expiration dates riskier?

We find that options maturing next month earn significantly lower returns when there are four weeks between consecutive expiration dates than when there are five weeks between those dates. In our main tests we control for various stock and option characteristics related to the riskiness of the resulting portfolios (see Tables 3 to 5). However, there is (albeit small) chance that five-week periods between consecutive maturity dates tend to pose more risk to the underlying securities and therefore rationally lead to higher option prices during four-week cycles. Note that even if this were true, it would not explain the difference in returns to our option portfolios in five- versus four-week periods between expiration dates. It could, however, potentially explain the differences in the degree of option expensiveness.

For this reason we compare additional risk-related characteristics during periods of four and five weeks between expiration days. In particular, we examine realized volatilities of the underlying stocks measured over the lifetime of the options (the period between consecutive expiration dates), the percentage of underlying stocks with earnings announcements, and the percentage of underlying stocks with at least one day with a “return jump” during the time to expiration (a jump is defined as a daily return with absolute value higher than three standard deviations of the daily returns during the past year). Both percentages of earning announcements and return jumps are quoted per week. The results are summarized in Panel A of Table 6. There are essentially no differences in realized volatility over the time to maturity. There are also no notable differences between the percentages of stocks with earning announcements during four- and five-week expiration cycles. Also, the percentage of stocks with return jumps is actually higher during four-week cycles.

Insert Table 6 here

To further examine the potential role of risk in the higher option returns during months with five weeks between expiration days, we look at the realized volatility and skewness of the returns of the option portfolios themselves. These realized measures are computed using daily returns from purchase day to expiration day. The results presented in Panel B of Table 6 do not indicate a clear relation between these risk measures and the number of weeks between expiration days.

Taken together, the evidence in Table 6 suggests no notable differences in the underlying risk for periods spanning four and five weeks between expiration dates, neither there is any evidence that the resulting option portfolios are riskier in five-week periods.

B. Additional inattention proxies

Our findings so far document a bias in option prices related to the timing of the consecutive option maturity dates that we conjecture is due to investors' inattention to exact expiration dates. To provide further evidence that this effect is driven by inattention, we examine how the strength of this effect varies with variables that are likely to proxy for the degree of inattention.

We use two such proxies. The first one is institutional ownership of the underlying equity security. While this factor is not a direct proxy for the sophistication of option traders, one might envision that options on stocks with higher institutional ownership are also traded more actively by institutions, and we would therefore expect less room for any behavioral biases in their pricing.

Our second inattention proxy is the proximity of earnings announcement dates. There are two reasons to include this proxy. First, consistent with some findings in the literature, investor attention might be blurred on or around earnings announcements as investors process the information in earnings and react to it. For example, DellaVigna and Pollet (2009) find that investors are more likely to underreact to earnings announcements on a Friday than on other weekdays; they explain this by added investor distraction as the weekend approaches. Another example is provided by Hirshleifer et al. (2009) who show that investor reaction to a firm's earnings announcement is weaker on days with many earnings announcements. We therefore expect the option mispricing effect to be stronger when option portfolios are formed on days close to announcement dates. Second, many option traders follow short-term trading strategies around earnings announcements (e.g., buying options shortly before the announcement and selling shortly after). Due to the short-term nature of such strategies, option traders are less likely to pay attention to the exact option maturity dates, again potentially amplifying our effect. For example, Gao, Xing, and Zhang (2018) document the profitability of a strategy that establishes a long straddle position between three and one day before the announcement date and closing this position either immediately after the announcement or on the following day[10]. In a similar fashion, while looking at trading in stocks, Hirshleifer, Myers, Myers, and Teoh (2008) document increased trading activity by individual investors shortly before and after earnings announcements. In this case, it is likely that investors care less about the exact maturity of the option as they seek to profit mostly from the unexpected price movement on the announcement day.[11] We use three different time windows to capture the potential effect of earnings announcements – three, five, and seven trading days around announcements. All earnings announcement dates are obtained from IBES. There are 81,175 firm-months with earnings announcements in our sample.

[10] While Gao et al. (2018) merely document the profitability of such strategies while remaining agnostic as to whether traders actually make these trades, anecdotal evidence suggests that trading options around earnings announcement is a popular strategy for hedge funds and active traders. For example, Charles Schwab discusses such strategies in its online learning center, see https://www.schwab.com/resource-center/insights/options-strategies-for-earnings-season.

[11] It is, however, conceivable that some investors looking to save on the round-trip trading costs might wish to hold their option positions until maturity and hence might be more attentive to the exact maturity date than those who liquidate their positions shortly after the earnings announcement.

To test for the effects of our two inattention proxies, we run the full regression models as in Table 3 while adding these proxies as well as their interaction terms with the 5-week expiration cycle dummy to our regression specifications. We are primarily interested in coefficients on the interaction terms. We expect a weaker effect for stocks with high institutional ownership, and stronger effects for earnings announcements.

Insert Table 7 here

The results in Table 7 confirm our hypothesis (for brevity, we do not report the coefficients on the control variables). The coefficient on the interaction term of the 5-week dummy and institutional ownership is negative and significant across all samples and portfolio strategies (*t*-statistics range between -1.99 and -3.31). This supports the inattention argument as institutional investors are typically less subject to behavioral biases in trading. The coefficient on the interaction term of the 5-week dummy and a dummy for an earnings announcement window is positive in all sample and portfolio strategies, yet not always statistically significant (*t*-statistics range between 0.96 and 3.00). This result provides some support to our prediction that attention to earnings releases comes at the expense of attention to exact expiration days.

C. Evidence from trading by various investor classes

As discussed above, option traders are expected to be relatively more sophisticated and knowledgeable than average stock traders. Yet within the pool of option traders there are further types with different levels of professionalism and sophistication (see Lakonishok et al. (2007) for a detailed analysis of the types of option investors). In particular, conventional wisdom suggests that retail investors are likely to be less sophisticated and hence potentially more inattentive to relevant information than professional investors like option market makers, hedge funds, or corporations. We test this prediction by studying the effect of investor sophistication on the extent of inattention to expiration dates.

We obtain data from International Securities Exchange (ISE), which contains daily records of option buy and sell activities of different market participants since 2005. Because options are in zero net supply (i.e., net buying of options by customers is tantamount to net selling by market makers), we compute the daily net selling of market makers per option as the difference between the daily buy and sell trade positions (measured by both quantity of trades and trading volume), divided by the total daily trade positions (see, for example, Chordia et al. (2020)). Assuming that market makers are more sophisticated than the average investor, and are thus more attentive to the exact expiration date, we test two hypotheses: (i) Do market makers over-sell (under-sell) options during four-week (five-week) expiration cycles? and (ii) Is mispricing stronger for options that are over-traded by market makers?

Table 8 addresses the first hypothesis by comparing the average net selling of market makers in months with four and five weeks between expiration dates. The results are presented for all call and put options traded in the two-week window around option expiration dates and that mature in the next month. We also look separately at at-the-money options, which is consistent with the sample of our main tests. We consider all daily trade positions as well as position-opening trades only, as option trades initiated to open new positions are often assumed to contain more information than position-closing trades (see Pan and Poteshman (2006) and Chordia et al. (2020)). For each trading day, we first calculate the cross-sectional mean net selling by market makers. We then report the time-series averages of these means in periods with four and five weeks between expiration days.

Insert Table 8 here

The results show that market makers over-sell options during four-week expiration cycles (relative to five-week cycles) in most subsamples, using both trading volume and number of trades, and the differences are statistically significant in most cases. [12] As expected, the effect is stronger for position-opening trades. This is consistent with the view that the market makers indeed act as informed traders with respect to the maturity driven mispricing we document in this study. Note, in principle, it is hard to determine whether equilibrium prices are driven primarily by inattentive investors or sophisticated quote-posting market makers—both act simultaneously. Indeed, the results of the paper provide evidence consistent with both investors and market makers facilitating mispricing.

Table 9 addresses the second hypothesis of whether the observed mispricing is more prevalent in options that market makers over-trade. For this test, we use the main regression framework adapted in the paper (Table 3) while interacting the 5-week dummy with a new dummy variable that indicates "mispricing trading", which is based on market makers net selling. The mispricing-trading variable equals one for all options traded during four-week expiration cycles with net selling higher than the daily median, as well as all options traded

[12] An interesting extension would be to examine how the strength of this effect varies with the degree of competition among market makers. Unfortunately, the ISE data do not provide a way to construct competition measures.

during five-week cycles with net selling lower than the daily median. The mispricing-trading variable essentially seeks to capture informed market-maker trading activity.

Insert Table 9 here

The interaction of the 5-week dummy with mispricing-trading is positive for all models, and generally statistically significant, which suggests that mispricing is stronger for options that exhibit high mispricing trading by market makers. Collectively, the results in Tables 8 and 9 suggest that market makers are aware of the option maturity mispricing, while less sophisticated investors are inattentive to the exact expiration dates.

V. Implications for option pricing literature

The evidence reported in this paper suggests that there is a "mispricing" factor for short-term options, generated by the fact that there are either four or five weeks between two consecutive expiration dates. This finding has potentially important implications for the pricing of options, testing the performance of option pricing models, as well as using option prices to predict future variables like stock returns or return volatility.

On the one hand, option pricing models that do not account for the effect of the number of weeks between expiration dates (and to the best of our knowledge, there are no existing option pricing models that would incorporate this effect), but are rather calibrated on the pool of options that includes both four- and five-week ones, are likely to result in pricing errors. This applies to the whole spectrum of option pricing models, from that of Black and Scholes (1973) to more advanced ones like Heston (1993), Pan (2002), Bakshi, Kapadia, and Madan (2003), Christoffersen, Heston, and Jacobs (2013), and Geske, Subrahmanyam, and Zhou (2016), among others.

On the other hand, if option prices are used to predict some forward-looking information, the accuracy of such forecasts is likely to depend on whether they are obtained during four- versus five-week expiration cycles. A large body of literature argues that information in option prices can be used for forecasting. For example, An, Ang, Bali, and Cakici (2014) document a relation between changes in option implied volatilities and subsequent stock returns; Bali and Hovakimian (2009) examine the predictive ability of the difference between implied and realized volatilities; Xing, Zhang, and Zhao (2010) study the effect of risk-neutral skewness; and Chang, Christoffersen, Jacobs, and Vainberg (2012) use option prices to extract forward-looking equity betas. Our findings suggest that the prices of options and hence their implied volatilities might be sensitive to the calendar month effect that we document. Furthermore, as five-week maturity periods tend to alternate with four-week ones, this might give rise to a certain autocorrelation process in implied volatilities. It is potentially interesting to examine how the results in the above studies vary with the choice of options traded during four- versus five-week expiration cycles.

VI. Conclusions

We document a strong mispricing effect in options markets. Short-term options achieve significantly lower weekly adjusted returns when there are four weeks between expiration dates than when there are five weeks. The gap is larger if option portfolios are formed around earnings announcement dates and for options written on stocks with lower institutional ownership. The mispricing is stronger for options that are over-traded by informed market makers against less sophisticated investors. The results remain highly significant controlling for a large set of option and stock characteristics, and are robust to various subsamples and estimation procedures. We find a similar effect using an alternative mispricing measure based on the difference between market and theoretical Black-Scholes option values. We find no evidence that would support a risk-based explanation, and our results prevail when we compare option portfolios with the same maturities.

All this evidence strongly suggests that the effect we identify in the data is driven primarily by investor inattention to the exact number of days to expiration and by a tendency to treat options maturing in the next month as having similar "next month" maturity. Our results are strikingly puzzling for two reasons. First, option traders are assumed to be relatively sophisticated and more knowledgeable than retail stock traders (trading options entails more restrictions than trading stocks, and most retail brokers require some trading experience before granting option trading permission). Second, while firm-specific information embedded in financial statements or in news releases requires some time and effort to process, the number of days to an option's expiration is very easy to obtain; it requires attention alone. The evidence that this information is not fully captured by option prices is indicative of a strong degree of behavioral investment in the options markets.

Our findings also have important implications for the option pricing literature. Our evidence suggests that calibrating option pricing models without accounting for the calendar month effect that we document is likely to result in pricing errors. Moreover, using option prices to make predictions about future stock returns, return volatility, or equity betas, is subject to potential behavioral biases due to the relative mispricing of options traded during four- versus five-week expiration cycles.

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Table 1. Summary statistics

The data on options are from the OptionMetrics Ivy DB database over the period 1996 to 2017. Data on the underlying stocks are obtained from CRSP/Compustat. The sample includes data on all options as of the option expiration day in each month, i.e., the third Friday of the month. The selected options are those that expire in the following month. For every underlying security in each month, we pick the call and the put options that are closest to at-the-money as of five weeks before their expiration. We include only options with moneyness (ratio of stock price to strike price) between 0.7 and 1.3, and we exclude options with zero open interest or trading volume. The table reports statistics of the characteristics of the options, as well as their underlying stocks, separately for periods with four and five weeks between option expiration days. All variables are winsorized at the 1st and 99th percentiles. Volume/open interest is the ratio of the daily trading volume to open interest of the option. Option bid-ask spread is the difference between the ask and bid quotes of the option over the midpoint of bid and ask quotes at the end of the day. Implied volatilities are provided by OptionMetrics. IV-HV is the difference between the option's implied volatility and historical volatility, based on daily returns over the past year. Log(SIZE) is the log of equity value of the underlying stock (in millions of dollars). Log(MARKET-TO-BOOK) of the underlying stock is the ratio of current equity market value to equity book value as of the previous quarter. PAST RETURN of the underlying stock is cumulative return over the past six months. ILLIQUIDITY of the underlying stock is the Amihud's (2002) measure, calculated by the monthly average of daily ratios of absolute return to dollar trading volume (in millions). SKEWNESS and KURTOSIS are based on the daily returns of the underlying stock over the previous month. IDIOSYNCRATIC VOLATILITY is the standard deviation of the residuals of regression of daily stock returns on the daily Fama and French (1993) three factors over the previous month. GAMMA and VEGA are Black-Scholes option derivatives, where we normalize both to capture the percentage change in option price; GAMMA is multiplied by the ratio of the stock price to the absolute value of the option delta, and VEGA is scaled by the option price. INSTITUTIONAL OWNERSHIP is the sum of all shares held by institutions divided by total shares outstanding.

	Calls						Puts					
	4-week cycle # obs = 185,706			5-week cycle # obs = 117,125			4-week cycle # obs = 148,932			5-week cycle # obs = 91,182		
	Mean	Median	Stdev	Mean	Median	Stdev	Mean	Median	Stdev	Mean	Median	Stdev
VOLUME/OPEN INTEREST	0.502	0.117	1.360	0.509	0.131	1.350	0.600	0.134	1.532	0.587	0.149	1.466
OPTION BID-ASK SPREAD	0.236	0.143	0.299	0.196	0.128	0.241	0.212	0.133	0.270	0.168	0.113	0.204
IMPLIED VOLATILITY	0.460	0.402	0.249	0.432	0.377	0.234	0.464	0.404	0.253	0.438	0.381	0.239
IV-HV	0.034	0.038	0.158	0.014	0.024	0.148	0.042	0.043	0.157	0.023	0.030	0.148
Log(SIZE)	14.896	14.780	1.631	14.900	14.786	1.629	15.106	15.001	1.630	15.118	15.019	1.629
Log(MARKET-TO-BOOK)	1.114	1.047	0.888	1.097	1.032	0.878	1.118	1.054	0.898	1.107	1.042	0.893
PAST STOCK RETURN	0.107	0.066	0.408	0.102	0.062	0.389	0.095	0.055	0.401	0.093	0.053	0.386
STOCK ILLIQUIDITY	0.327	0.061	0.918	0.319	0.059	0.903	0.236	0.046	0.708	0.229	0.044	0.687
SKEWNESS	0.155	0.143	0.954	0.123	0.105	0.979	0.125	0.123	0.961	0.092	0.083	0.980
KURTOSIS	1.224	0.356	2.767	1.327	0.412	2.881	1.226	0.348	2.786	1.318	0.397	2.886
IDIOSYNCRATIC VOLATILITY	0.020	0.016	0.015	0.020	0.016	0.014	0.020	0.016	0.014	0.019	0.016	0.014
GAMMA	8.473	6.627	7.447	7.949	6.505	6.006	8.983	7.390	6.448	8.157	7.010	5.165
VEGA	0.035	0.024	0.040	0.035	0.027	0.031	0.034	0.025	0.027	0.032	0.026	0.026
INSTITUTIONAL OWNERSHIP	0.725	0.762	0.235	0.730	0.768	0.234	0.738	0.773	0.230	0.739	0.775	0.229

Table 2. Option portfolio returns for 4- and 5-week expiration cycles

The sample contains all options as of the option expiration day in each month, i.e., the third Friday of the month, as described in Table 1. For each option in the sample, we step either one week back or one week forward from expiration day to form two sets of returns with equal time to maturity. 'Four-week returns' includes the returns of all options with four weeks to maturity, i.e., those options are purchased either on expiration days or one week after. 'Five-week returns' includes the returns of all options with five weeks to maturity, i.e., those options are purchased either on expiration days or one week before. We also form 'Expiration-to-expiration returns' set, which includes the returns of all options from expiration day in a given month until their maturity in the next month. For each set of returns, we form monthly equal-weighted portfolios, and compute the time-series averages of the monthly portfolio returns (in weekly terms) separately over four- and five-week expiration cycles. The table reports average weekly returns on three option positions: straddles, delta-hedged calls, and delta-hedged puts. Returns on all positions are based on current market prices and the position's payoff at the option maturity day in the next month. See Section II for return definitions. The sample period is 1996-2017.

	Four-week returns			Five-week returns			Expiration-to-expiration returns		
	Straddles	DH Calls	DH Puts	Straddles	DH Calls	DH Puts	Straddles	DH Calls	DH Puts
4 WEEKS BETWEEN EXPIRATION DAYS	-1.88%	-0.33%	-0.23%	-2.73%	-0.41%	-0.29%	-1.88%	-0.33%	-0.23%
5 WEEKS BETWEEN EXPIRATION DAYS	-0.08%	-0.06%	0.00%	-0.86%	-0.12%	-0.07%	-0.86%	-0.12%	-0.07%
Difference	-1.80%	-0.26%	-0.23%	-1.87%	-0.29%	-0.22%	-1.01%	-0.21%	-0.16%
t-statistic	(-2.96)	(-2.90)	(-2.64)	(-2.99)	(-3.14)	(-2.72)	(-1.70)	(-2.29)	(-1.95)

Table 3. Regression of option returns on 4-5 week expiration cycle

The sample contains all options that mature in four weeks and five weeks during the period 1996-2017, divided into three sets of returns as described in Table 2. The dependent variables are the average weekly returns of three option positions: straddles, and delta-hedged calls and puts (see Section II for return definitions). The first independent variable is a dummy variable that equals one if the option expires on a day that is five weeks after the prior expiration day, and zero for four weeks after the prior expiration day. The control variables include both option characteristics (VOLUME/OPEN INTEREST, BID-ASK SPREAD, IV-HV, GAMMA, and VEGA) and stock characteristics (log(SIZE), log(MARKET-TO-BOOK), PAST STOCK RETURN, STOCK ILLIQUIDITY, RETURN SKEWNESS, RETURN KURTOSIS, and IDIOSYNCRATIC VOLATILITY) as described in Table 1. The upper and lower panels show the regression results without and with the control variables, respectively. All coefficients are multiplied by 100, and *t*-statistics are in parentheses, where standard errors are clustered by date.

	Four-week returns			Five-week returns			Expiration-to-expiration returns		
	Straddles	DH Calls	DH Puts	Straddles	DH Calls	DH Puts	Straddles	DH Calls	DH Puts
INTERCEPT	-1.849	-0.304	-0.220	-2.717	-0.374	-0.265	-1.849	-0.304	-0.220
	(-4.68)	(-5.45)	(-4.34)	(-6.28)	(-6.08)	(-4.52)	(-4.68)	(-5.45)	(-4.34)
5 WEEKS BETWEEN EXPIRATION DAYS DUMMY	1.511	0.233	0.202	1.689	0.255	0.175	0.821	0.185	0.130
	(2.43)	(2.79)	(2.24)	(2.60)	(2.86)	(2.14)	(1.31)	(2.16)	(1.71)
INTERCEPT	-0.414	0.171	0.139	-3.231	-0.100	0.051	-1.129	0.085	0.152
	(-0.23)	(0.85)	(0.80)	(-1.87)	(-0.45)	(0.26)	(-0.69)	(0.43)	(0.94)
5 WEEKS BETWEEN EXPIRATION DAYS DUMMY	1.553	0.245	0.200	1.271	0.260	0.175	0.820	0.194	0.132
	(2.45)	(2.90)	(2.16)	(1.88)	(2.91)	(2.08)	(1.29)	(2.26)	(1.71)
VOLUME/OPEN INTEREST	0.104	0.005	-0.002	0.044	-0.003	0.002	0.055	0.005	-0.003
	(1.44)	(0.72)	(-0.31)	(0.65)	(-0.41)	(0.29)	(0.94)	(0.71)	(-0.44)
OPTION BID-ASK SPREAD	0.770	-0.171	-0.159	0.482	-0.051	-0.169	0.708	-0.153	-0.167
	(0.52)	(-1.80)	(-1.56)	(0.39)	(-0.57)	(-1.95)	(0.59)	(-1.85)	(-1.90)
IV-HV	0.733	-0.457	-0.216	1.429	-0.400	-0.179	0.497	-0.562	-0.298
	(0.60)	(-2.13)	(-1.40)	(1.25)	(-1.73)	(-0.99)	(0.46)	(-2.77)	(-2.05)
Log(SIZE)	-0.107	-0.025	-0.021	0.094	0.003	-0.007	-0.044	-0.019	-0.021
	(-0.75)	(-1.88)	(-1.66)	(0.72)	(0.19)	(-0.55)	(-0.34)	(-1.48)	(-1.85)
Log(MARKET-TO-BOOK)	-0.077	-0.023	-0.018	-0.170	-0.032	-0.025	-0.130	-0.030	-0.024
	(-0.56)	(-1.21)	(-0.90)	(-1.23)	(-1.57)	(-1.18)	(-1.02)	(-1.63)	(-1.24)
PAST STOCK RETURN	-0.386	-0.022	0.006	-0.320	0.010	-0.029	-0.380	0.004	0.009
	(-0.93)	(-0.37)	(0.10)	(-0.81)	(0.16)	(-0.46)	(-1.01)	(0.07)	(0.16)
STOCK ILLIQUIDITY	-60.661	-10.361	-9.278	-44.910	-13.782	-8.251	-51.469	-9.394	-8.760
	(-3.23)	(-6.51)	(-5.40)	(-2.52)	(-5.88)	(-3.62)	(-3.55)	(-6.14)	(-5.54)
SKEWNESS	-0.155	-0.003	0.005	-0.166	0.004	0.000	-0.137	-0.001	0.008
	(-2.13)	(-0.33)	(0.63)	(-2.18)	(0.42)	(0.04)	(-2.06)	(-0.20)	(1.06)
KURTOSIS	-0.096	-0.002	-0.004	-0.055	0.007	0.004	-0.086	-0.002	-0.003
	(-2.32)	(-0.40)	(-0.70)	(-1.41)	(0.98)	(0.63)	(-2.31)	(-0.37)	(-0.58)
IDIOSYNCRATIC VOLATILITY	-6.168	-7.680	-5.090	-11.007	-12.771	-7.935	-7.786	-7.829	-5.068
	(-0.46)	(-3.22)	(-2.15)	(-0.71)	(-4.64)	(-3.15)	(-0.59)	(-3.35)	(-2.34)
GAMMA	0.177	0.071	0.060	-0.997	-0.003	-0.022	0.149	0.068	0.059
	(1.49)	(5.28)	(4.69)	(-6.79)	(-0.17)	(-1.24)	(1.33)	(5.20)	(4.75)
VEGA	-29.652	-12.474	-11.478	247.116	0.671	6.193	-27.310	-11.826	-11.094
	(-1.20)	(-6.28)	(-6.21)	(7.55)	(0.28)	(2.13)	(-1.19)	(-6.10)	(-6.06)

Table 4. Robustness checks to the regression results

We replicate the full regression models in Table 3 (referred to as "Base results") for different subsamples, and when controlling for calendar month and firm fixed effects. The first subsample excludes all months with large changes in implied volatilities, defined by differences in the VIX index of more than 5% in absolute value between expiration days (about 20% of the sample). The second subsample excludes months during recessions, which according to NBER definition are March 2001 to November 2001 and December 2007 to June 2009. The third subsample includes only options with moneyness between 0.95 and 1.05. The fourth subsample excludes all stocks on which options have started to trade during the past year. The fifth subsample excludes all stocks on which an investor can trade weekly options (options that are introduced each Thursday and expire eight days later on Friday). The sixth and seventh subsamples exclude stocks with earnings and merger announcements during the maturity of the option. The bottom two regressions include fixed effects for calendar months, and firm fixed effects. The table reports only the coefficients (multiplied by 100) and *t*-statistics of the 5-week cycle dummy variable, where standard errors are clustered by date. The sample period is 1996 to 2017.

	Four-week returns			Five-week returns			Expiration-to-expiration returns		
	Straddles	DH Calls	DH Puts	Straddles	DH Calls	DH Puts	Straddles	DH Calls	DH Puts
Base results	1.553	0.245	0.200	1.271	0.260	0.175	0.820	0.194	0.132
	(2.45)	(2.90)	(2.16)	(1.88)	(2.91)	(2.08)	(1.29)	(2.26)	(1.71)
Excluding large changes in IV	1.420	0.219	0.176	1.089	0.246	0.184	0.591	0.149	0.145
	(3.00)	(4.52)	(4.09)	(2.16)	(4.10)	(3.16)	(1.31)	(2.89)	(3.00)
Excluding recessions	1.614	0.239	0.205	1.433	0.258	0.171	0.926	0.192	0.139
	(2.72)	(3.40)	(2.49)	(2.28)	(3.56)	(2.56)	(1.53)	(2.70)	(2.22)
5% moneyness	1.440	0.220	0.184	1.302	0.255	0.182	0.710	0.169	0.124
	(2.27)	(2.69)	(2.02)	(1.90)	(2.94)	(2.21)	(1.08)	(2.11)	(1.69)
Excluding newly optionable stocks	1.625	0.245	0.202	1.322	0.260	0.176	0.898	0.203	0.132
	(2.42)	(2.70)	(2.06)	(1.87)	(2.72)	(2.00)	(1.33)	(2.20)	(1.63)
Excluding stocks with weekly options	1.631	0.264	0.215	1.209	0.270	0.182	0.814	0.203	0.137
	(2.50)	(2.94)	(2.17)	(1.73)	(2.86)	(2.03)	(1.26)	(2.26)	(1.68)
Excluding earnings announcements	1.430	0.230	0.182	0.991	0.233	0.146	0.491	0.162	0.098
	(2.24)	(2.69)	(2.14)	(1.49)	(2.55)	(1.69)	(0.79)	(1.87)	(1.26)
Excluding merger announcements	1.539	0.244	0.196	1.249	0.256	0.170	0.790	0.192	0.126
	(2.43)	(2.86)	(2.12)	(1.86)	(2.85)	(2.02)	(1.24)	(2.22)	(1.63)
Calendar month effects	1.582	0.258	0.209	1.065	0.253	0.166	0.779	0.197	0.134
	(2.50)	(3.08)	(2.31)	(1.64)	(2.89)	(2.04)	(1.26)	(2.35)	(1.78)
Firm fixed effects	1.723	0.267	0.220	1.354	0.258	0.175	0.976	0.209	0.144
	(2.74)	(3.16)	(2.41)	(2.04)	(2.86)	(2.06)	(1.54)	(2.43)	(1.88)

Table 5. Alternative measure of mispricing

We run a pooled regression of the log of the ratio of the theoretical Black-Scholes option value to the actual option value. The Black-Scholes values are based on both historical volatility of the underlying stock return and conditional expected volatility derived from the GARCH(1,1) model applied to monthly returns. The sample includes all options as of the option expiration day in each month, i.e., the third Friday of the month, as described in Table 1. The independent variable is a dummy variable that equals one if there are five weeks until the next expiration day, and zero if there are four weeks. The control variables include option and stock characteristics, as described in Table 1. All coefficients are multiplied by 100, and *t*-statistics are in parentheses, where standard errors are clustered by date and firm. The sample period is 1996 to 2017.

	Black-Scholes using historical volatility				Black-Scholes using GARCH(1,1) volatility			
	Calls		Puts		Calls		Puts	
5 WEEKS BETWEEN EXPIRATION DAYS DUMMY	3.747	3.361	3.986	3.454	3.660	3.632	3.723	3.885
	(1.95)	(1.99)	(1.93)	(2.05)	(1.71)	(2.20)	(1.66)	(2.21)
VOLUME/OPEN INTEREST		0.161		0.516		-0.867		0.022
		(1.36)		(4.39)		(-5.26)		(0.24)
OPTION BID-ASK SPREAD		-8.216		-44.107		5.112		-10.668
		(-3.55)		(-12.64)		(2.41)		(-4.90)
Log(SIZE)		3.856		2.465		-2.841		-3.688
		(15.80)		(8.56)		(-7.45)		(-9.70)
Log(MARKET-TO-BOOK)		-2.050		-0.692		3.036		4.627
		(-6.46)		(-1.94)		(6.92)		(8.56)
PAST STOCK RETURN		-2.168		-3.453		14.390		16.077
		(-2.10)		(-3.17)		(14.44)		(14.41)
STOCK ILLIQUIDITY		-295.757		-178.162		-394.292		-417.236
		(-9.02)		(-4.54)		(-11.84)		(-9.20)
SKEWNESS		-1.409		-1.823		0.258		0.560
		(-5.37)		(-6.48)		(1.19)		(2.46)
KURTOSIS		0.569		0.316		1.491		1.575
		(3.47)		(1.77)		(13.08)		(12.40)
IDIOSYNCRATIC VOLATILITY		760.809		900.295		-156.551		-103.016
		(20.29)		(20.55)		(-3.20)		(-1.90)
GAMMA		28.646		54.690		85.980		98.181
		(8.15)		(11.75)		(13.03)		(12.88)
VEGA		42.377		69.578		102.552		108.201
		(3.98)		(5.20)		(6.73)		(6.90)

Table 6. Risk characteristics during periods of 4 and 5 weeks between expiration days

Panel A reports risk-related characteristics of call and put options and their underlying securities separately for periods of four and five weeks between option expiration days. Realized volatility is the annualized standard deviation of the underlying stock daily returns between expiration days. The table shows the weekly-adjusted percentage of options on firms that have reported earnings during the time to expiration, and the weekly-adjusted percentage of options on stocks with at least one daily "return jump" during the time to expiration; a daily return jump is defined as return that is higher in absolute value than three standard deviations of the stock daily returns during the past year. Panel B reports the realized volatility (standard deviation) and skewness of the option positions' daily returns from purchase day until expiration day. The *t*-statistics of the differences are adjusted for time and firm clustering. The sample period is 1996 to 2017.

Panel A. Stock characteristics

	Calls		Puts	
	4-week	5-week	4-week	5-week
MEAN REALIZED VOLATILITY	0.392	0.388	0.388	0.385
Difference (*t*-statistic)	-0.004	(-0.15)	-0.003	(-0.12)
% OF EARNINGS ANNOUNCEMENTS	3.39%	3.68%	3.37%	3.70%
Difference (*t*-statistic)	0.29%	(0.58)	0.33%	(0.67)
% OF DAILY RETURN JUMPS	7.29%	6.26%	7.07%	6.06%
Difference (*t*-statistic)	-1.04%	(-2.33)	-1.01%	(-2.29)

Panel B. Option position returns

	Straddles		Delta-hedged calls		Delta-hedged puts	
	4-week	5-week	4-week	5-week	4-week	5-week
MEAN OPTION POSITION'S REALIZED VOLATILITY	0.205	0.194	0.021	0.023	0.017	0.018
Difference (*t*-statistic)	-0.011	(-3.97)	0.001	(0.76)	0.000	(0.51)
MEAN OPTION POSITION'S REALIZED SKEWNESS	0.496	0.526	0.118	0.124	0.196	0.218
Difference (*t*-statistic)	0.030	(2.18)	0.006	(0.43)	0.021	(1.74)

Table 7. Regression of option returns on interaction between 4-5 week expiration cycle and institutional ownership and earnings announcements

We add to the pooled regressions in Table 3 interaction terms between the 5-week expiration cycle dummy variable and two variables: Institutional Own is the sum of all shares held by institutions divided by total shares outstanding. EARNINGS ANN is a dummy variable that indicates if the company has reported its financial statements during the window of three days around the option position formation day (earnings announcements are obtained from IBES). The regressions include the same set of control variables as in Table 3, where for brevity we do not report their coefficients. All coefficients are multiplied by 100, and *t*-statistics are in parentheses, where standard errors are clustered by date. The sample period is 1996 to 2017.

	Four-week returns			Five-week returns			Expiration-to-expiration returns		
	Straddles	DH Calls	DH Puts	Straddles	DH Calls	DH Puts	Straddles	DH Calls	DH Puts
INTERCEPT	-1.483	0.011	0.052	-4.858	-0.307	-0.200	-1.870	-0.066	0.089
	(-0.68)	(0.04)	(0.25)	(-2.32)	(-1.12)	(-0.79)	(-0.94)	(-0.28)	(0.45)
5 WEEKS BETWEEN	3.095	0.542	0.382	3.528	0.633	0.512	2.503	0.443	0.303
EXPIRATION DAYS DUMMY	(3.65)	(4.23)	(3.26)	(3.95)	(4.31)	(4.31)	(3.02)	(3.23)	(2.78)
INSTITUTIONAL OWN	1.027	0.182	0.107	1.831	0.248	0.285	1.018	0.184	0.102
	(1.38)	(1.73)	(1.16)	(2.29)	(2.01)	(2.52)	(1.38)	(1.75)	(1.11)
5-WEEK*INSTITUTIONAL OWN	-2.132	-0.415	-0.260	-3.112	-0.520	-0.461	-2.365	-0.357	-0.252
	(-2.12)	(-2.94)	(-2.06)	(-3.01)	(-3.05)	(-3.31)	(-2.36)	(-2.24)	(-1.99)
EARNINGS ANN	-0.968	-0.197	-0.184	-0.780	-0.048	-0.043	-0.960	-0.201	-0.186
	(-1.92)	(-3.06)	(-3.14)	(-1.27)	(-0.60)	(-0.60)	(-1.91)	(-3.13)	(-3.18)
5-WEEK*EARNINGS ANN	1.086	0.184	0.151	1.191	0.141	0.097	1.381	0.295	0.240
	(1.37)	(2.08)	(1.96)	(1.37)	(1.30)	(0.96)	(1.74)	(3.00)	(2.59)

Table 8. Market makers net selling in 4-5 weeks expiration cycles

The table reports the average net selling by market makers during periods with four and five weeks between expiration days. Because options are in zero net supply, we estimate the net selling of option trades made by market makers as the difference between the daily buy and sell trade positions (measured by both quantity of trades and trading volume), divided by the total daily trade positions. For each trading day, we first calculate the cross-sectional mean net selling by market makers. We then report the time-series averages of these means in periods with four and five weeks between expiration days, as well as the differences and their *t*-statistics. The sample includes all call and put options traded in the two-week window around option expiration dates and that mature in the next month. Panel A includes all trade positions and Panel B includes only opening positions, in each we report the results for all options and for only at-the-money options. The sample period is 2005-2017.

Panel A. All positions

	All moneyness				At-the-money			
	Quantity of trades		Trading volume		Quantity of trades		Trading volume	
	Calls	Puts	Calls	Puts	Calls	Puts	Calls	Puts
4 WEEKS	-4.51	-2.71	-3.03	-2.31	-7.77	-3.77	-5.55	-3.17
5 WEEKS	-5.52	-3.56	-3.70	-2.90	-8.39	-4.18	-5.74	-3.05
Difference	1.01	0.86	0.67	0.59	0.62	0.42	0.19	-0.12
t-statistic	(4.71)	(5.22)	(3.78)	(3.66)	(1.65)	(1.28)	(0.54)	(-0.32)

Panel B. Opening positions

	All moneyness				At-the-money			
	Quantity of trades		Trading volume		Quantity of trades		Trading volume	
	Calls	Puts	Calls	Puts	Calls	Puts	Calls	Puts
4 WEEKS	-1.30	-0.49	1.40	-0.03	-4.18	-0.31	-0.58	0.59
5 WEEKS	-3.17	-2.06	-0.13	-1.33	-5.19	-1.35	-1.08	-0.02
Difference	1.87	1.57	1.53	1.30	1.00	1.04	0.50	0.61
t-statistic	(6.13)	(6.90)	(5.32)	(6.02)	(2.23)	(2.32)	(1.18)	(1.27)

Table 9. Regression of option returns on interaction between 4-5 week expiration cycle and mispricing trading

We add to the pooled regressions in Table 3 interaction terms between the 5-week expiration cycle dummy variable and a dummy variable that indicates 'mispricing trading', which is defined as follows. We estimate the option's net selling trades made by market makers as the difference between the daily buy and sell trade positions (by quantity of trades), divided by the total daily trade positions. The MISPRICING-TRADING variable equals one for all options during 4-week expiration cycles with net selling higher than the daily median, and all options during 5-weeks expiration cycles with net selling lower than the daily median. The control variables include both option characteristics (VOLUME/OPEN INTEREST, BID-ASK SPREAD, IV-HV, GAMMA, AND VEGA) and stock characteristics (log(SIZE), log(MARKET-TO-BOOK), PAST STOCK RETURN, STOCK ILLIQUIDITY, RETURN SKEWNESS, RETURN KURTOSIS, and IDIOSYNCRATIC VOLATILITY) as described in Table 1. All coefficients are multiplied by 100, and *t*-statistics are in parentheses, where standard errors are clustered by date. The sample period is 2005 to 2017.

	Four-week returns			Five-week returns			Expiration-to-expiration returns		
	Straddles	DH Calls	DH Puts	Straddles	DH Calls	DH Puts	Straddles	DH Calls	DH Puts
INTERCEPT	8.158	1.738	1.530	2.049	0.766	1.452	6.678	1.475	1.430
	(1.87)	(2.86)	(3.58)	(0.52)	(1.44)	(2.87)	(1.63)	(2.45)	(3.40)
5 WEEKS BETWEEN EXPIRATION DAYS DUMMY	1.422	0.138	0.070	1.344	0.161	0.050	0.627	0.132	-0.010
	(1.32)	(0.81)	(0.39)	(1.18)	(0.96)	(0.32)	(0.56)	(0.79)	(-0.06)
MISPRICING-TRADING	0.069	-0.063	-0.063	0.609	0.018	-0.003	0.072	-0.065	-0.064
	(0.20)	(-1.46)	(-1.14)	(1.74)	(0.39)	(-0.06)	(0.21)	(-1.50)	(-1.16)
5-WEEK*MISPRICING-TRADING	0.725	0.144	0.149	0.322	0.056	0.114	0.808	0.125	0.160
	(1.45)	(2.37)	(2.01)	(0.63)	(0.86)	(1.56)	(1.59)	(1.93)	(2.17)
VOLUME/OPEN INTEREST	-0.216	-0.035	-0.017	-0.204	-0.002	0.004	-0.235	-0.021	-0.015
	(-1.13)	(-1.85)	(-0.87)	(-1.34)	(-0.16)	(0.27)	(-1.49)	(-1.30)	(-0.88)
OPTION BID-ASK SPREAD	-2.784	-0.416	-0.189	0.663	0.332	0.314	-4.175	-0.289	-0.120
	(-0.45)	(-1.15)	(-0.45)	(0.12)	(0.68)	(0.93)	(-0.75)	(-0.84)	(-0.30)
IV-HV	1.613	0.007	-0.446	2.648	0.172	0.012	1.472	-0.210	-0.349
	(0.42)	(0.01)	(-0.71)	(0.70)	(0.20)	(0.02)	(0.40)	(-0.27)	(-0.55)
Log(SIZE)	-0.538	-0.108	-0.089	-0.202	-0.034	-0.080	-0.432	-0.089	-0.087
	(-1.73)	(-2.85)	(-3.44)	(-0.66)	(-1.02)	(-2.69)	(-1.49)	(-2.40)	(-3.54)
Log(MARKET-TO-BOOK)	-0.294	0.002	-0.029	-0.466	-0.020	-0.041	-0.444	-0.024	-0.037
	(-0.83)	(0.05)	(-0.81)	(-1.47)	(-0.43)	(-1.04)	(-1.33)	(-0.52)	(-0.93)
PAST STOCK RETURN	-1.371	-0.167	-0.043	-0.969	-0.124	-0.132	-1.256	-0.151	-0.112
	(-1.11)	(-0.81)	(-0.22)	(-0.88)	(-0.61)	(-0.73)	(-1.08)	(-0.76)	(-0.60)
STOCK ILLIQUIDITY	-390.394	-25.525	-9.240	-159.946	-23.570	-49.724	-191.812	-14.762	-2.016
	(-2.68)	(-0.83)	(-0.34)	(-0.96)	(-0.69)	(-1.16)	(-1.57)	(-0.60)	(-0.08)
SKEWNESS	-0.198	0.005	0.004	-0.452	-0.018	-0.010	-0.323	-0.003	-0.013
	(-1.08)	(0.25)	(0.17)	(-2.34)	(-0.80)	(-0.38)	(-1.80)	(-0.17)	(-0.51)
KURTOSIS	0.051	0.018	0.007	0.075	0.027	0.027	0.066	0.023	0.012
	(0.56)	(1.35)	(0.41)	(0.88)	(1.79)	(1.84)	(0.76)	(1.65)	(0.77)
IDIOSYNCRATIC VOLATILITY	-32.612	-16.490	-12.548	-33.857	-22.482	-16.627	-31.675	-17.759	-10.324
	(-0.97)	(-2.38)	(-2.19)	(-1.01)	(-3.40)	(-2.41)	(-0.96)	(-2.49)	(-1.74)
GAMMA	0.145	0.055	0.046	-1.033	-0.046	-0.027	0.086	0.048	0.055
	(0.82)	(1.60)	(1.45)	(-4.66)	(-1.26)	(-0.83)	(0.49)	(1.42)	(1.75)
VEGA	-31.694	-9.393	-8.672	257.378	8.262	6.751	-18.286	-8.324	-10.104
	(-0.82)	(-1.85)	(-1.95)	(5.03)	(1.56)	(1.46)	(-0.48)	(-1.68)	(-2.30)

Figure 1. Cumulative returns for 4- and 5-week expiration cycles

The solid lines show the cumulative returns between January 1996 and December 2017 of shorting one-month delta-hedged call and put positions on current-month expiration day when there are four weeks to next expiration day. The dashed lines show the equivalent returns when there are five weeks to next expiration day. Returns on the short positions are based on the returns outlined in Table 2. To allow a fair comparison, the four-week portfolio returns are divided by the ratio of the number of months with four weeks between expiration days to that of five weeks (=1.89).