The Calendar Effects of the Idiosyncratic-Volatility Puzzle: A Tale of Two Days?*

by

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Abstract

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Keywords: Idiosyncratic volatility; calendar effects; option expiration

JEL Classification: G11; G12; G41

1. Introduction

Over the last ten years, "Low Volatility" trading strategies have gained popularity among investors.[1] These trading strategies exploit the inverse relation between stock return volatility and future stock returns. Among various return volatility measures, idiosyncratic volatility (IVOL) is particularly puzzling[2] (see e.g., Ang, Hodrick, Xing, and Zhang 2006; Bali and Cakici 2008; Huang, Liu, Rhee, and Zhang 2010; Stambaugh, Yu, and Yuan, 2015; Hou and Loh 2016; Cao and Han 2016). Although traditional asset pricing models predict that for sufficiently diversified portfolios, idiosyncratic volatility is unrelated to future stock return, empirical studies find that high IVOL portfolios underperform low IVOL portfolios at the monthly frequency. This paper provides the first piece of evidence that the IVOL puzzle could be related to the exercise of in-the-money equity options upon maturity and removing just the two trading days around the option expiration date reduces the economic significance of the monthly IVOL effect by over 40%.

Using common stocks over the sample period July 1963 to December 2016, we first confirm the IVOL effect for raw and risk-adjusted, equal- and value-weighted quintile portfolio returns. Consistent with the literature, the return pattern for low IVOL and middle IVOL groups is flat and there is a sharp drop in returns of the highest IVOL group. Upon decomposing the monthly return into four 5-day trading intervals, we find a significant underperformance for high IVOL stocks in only the third week of the month. The negative relation between IVOL and stock returns is largely absent in other weeks. The third, 5-day buy-and-hold return as well as the Carhart (1997) four-factor alpha decreases almost monotonically in idiosyncratic volatility. Further, the IVOL effect is strongly negative on Mondays and turns positive on Fridays. Relative to low IVOL stocks,

[1] Since 2007, assets under management in low-volatility equity funds have increased tenfold. Also, a growing number of investors are choosing passive ETFs (Morningstar).

[2] The average cross-sectional correlation between total volatility measure and idiosyncratic volatility measure in Ang et al. (2006) is as high as 0.98 and trading strategies based on low volatility are essentially low idiosyncratic volatility strategies.

high IVOL stocks tend to experience low returns on Mondays and high returns on Fridays. Birru (2018) attributes this day of the week pattern to findings from the psychological literature that investor mood varies over the course of the week, being low on Mondays and high on Fridays. We further find that the negative IVOL effect on Mondays is robust across different weeks in a month with magnitudes that are larger and more significant in the third and the fourth calendar week. More interestingly, the positive IVOL effect obtains on all Fridays except for the third Friday. Thus, the more negative IVOL effect on Monday cannot be offset by a positive IVOL effect on the third Friday, leading to a strong IVOL effect in the third trading week of the month.

What is special about the third Friday? The third Friday of every month is the last trading day before equity options expire. Any unexercised in-the-money (ITM) options are automatically exercised with physical delivery of the underlying stocks. Thus, on the third Friday, ITM call option holders and ITM put option writers receive stocks from call option writers and put option holders, respectively. If the delivered stocks move investors away from their optimal portfolios, then these stocks are more likely be sold. Also, ITM call option holders may sell to realize the gain and ITM put option writers may sell to stop further losses. This selling of the delivered stocks will lead to price pressure on the third Friday and on the subsequent Monday (if there is any delay in selling). More importantly, such selling pressure would increase with IVOL because high IVOL stocks are likely to have more ITM call or ITM put options and risk averse investors may be unwilling to hold these riskier, more volatile stocks.

Option exercise induced stock selling pressure, not only offsets the mood-induced positive IVOL effect on the third Friday, but also enhances the negative IVOL effect on the following Monday. To identify the source of this selling pressure, we obtain the small- and large-order imbalances over the period January 1983 to December 2000 from the transaction databases. The

results show that compared to the large order imbalance, it is the differences in small order imbalance across the IVOL portfolios that are larger on the third Friday and on the following Monday, suggesting that it is retail traders who drive the IVOL related selling pressure. In addition, we also examine the return impact across dual-sorted IVOL and institutional ownership (IO) portfolios. It is in the low IO portfolios that the difference in return across the IVOL portfolios is larger than in the high IO portfolios. Once again, this suggests that it is the retail traders that drive the IVOL related selling pressure.

Since equity options started trading in 1973, we examine the 1973-2016 sample period and find that the third Friday and the subsequent Monday return as well as the Carhart (1997) four-factor alpha differential across the IVOL portfolios can explain at least 40% of the monthly return and alpha differential between the high IVOL and the low IVOL groups, for both, equal- and value-weighted IVOL portfolios. The OptionMetrics data, over the sample period 1996-2016, confirms that the high IVOL stocks have more ITM option positions prior to expiration and, thus, there will be more deliveries of the underlying stocks in the high IVOL portfolios. Using a market capitalization matched sample of stocks with and without options, we find that the IVOL effect is much stronger in stocks with options than in those without options. Moreover, the strong IVOL effect in stocks with options is more pronounced in stocks with high ITM option positions.

The relationship between idiosyncratic risk and the cross-section of future stock returns has been studied ever since the emergence of classic asset pricing theories. Fama and MacBeth (1973) find that in an efficient market, risk as measured by market betas is compensated, but because it can be diversified away, idiosyncratic risk is not compensated. Merton (1987) provides a theoretical rationale for a positive IVOL-return relation based on investors' insufficiently

diversified portfolios. However, most recent studies,[3] find a surprising negative IVOL-return relation. Current explanations for the negative relation are mostly based on two ideas – skewness preferences of investors and limits to arbitrage. Bali, Cakici, and Whitelaw (2011) were the first to provide a skewness-preference based explanation of the IVOL puzzle. Baker, Bradley, and Wurgler (2011) also point out that there is an irrationally high demand for high volatility stocks. High volatility stocks are perceived as having a potential for windfall returns, though the probability might be low. Combined with other behavioral biases like overconfidence, this lottery like preference based trading behavior of investors pushes the stock prices away from the fundamental values causing the high volatility stocks to be overvalued. [4] The second explanation posits that idiosyncratic volatility is a proxy for arbitrage costs (see e.g., Shleifer and Vishny 1997; Pontiff 2006; Stambaugh et al. 2015; Cao and Han 2016). High IVOL stocks underperform since arbitrage costs including short-sale constraints prevent a quick correction of the overvaluation.

This paper adds nuance to the mood-based explanation for the IVOL effect. We document a strong calendar effect in the IVOL returns and offer a new perspective that the IVOL puzzle is partially explained by the selling behavior of delivered stocks after in-the-money options are exercised.

2. Data and IVOL Puzzle

We obtain data for this study as follows: stock returns, prices, and trading volume are obtained from the Center for Research on Security Prices (CRSP) from 1963 to 2016. Following Shumway (1997), stock returns are adjusted for delisting. Option data on individual stocks are from the OptionMetrics Ivy DB database. The database contains information on the entire U.S. equity

[3] See e.g., Ang, Hodrick, Xing, and Zhang (2006, 2009) and Stambaugh, Yu, and Yuan (2015).
[4] See e.g., Barberis and Huang (2008), Boyer, Mitton, and Vorkink (2010), and Bali, Cakici, and Whitelaw (2011).

option market, including daily closing bid and ask quotes, open interest, volume, etc., from 1996 to 2016. Trade level transactions data is obtained from both the Institute for the Study of Securities Markets (ISSM) (1983-1992) and NYSE's Trade and Quote (TAQ) database (1993-2000). The institutional holding data is obtained from the 13f filings in the Thomson Reuters database.

We first replicate the IVOL puzzle using monthly common stock (share code 10, 11) return data from July 1963 to December 2016. Sample stocks are sorted into quintiles based on IVOL. IVOL is estimated as the standard deviation of daily return residuals from the Fama-French 3-factor model for each firm, each month as per the following regression, with a minimum of 17 daily observations each month although the results are robust to using a minimum of 15 daily observations.

$$R_{it} - r_t = \alpha_i + \beta_i (R_{mt} - r_t) + s_i SMB_t + h_i HML_t + \varepsilon_{it}.$$

Table 1 presents the portfolio returns, sorted according to IVOL quintiles. To document the robustness of the IVOL effect, we use different filtering and weighting schemes, and adjust for various common risk factors and stock characteristics. In Panels A and B, we require the last month-end stock price to be higher than $5. Equal- and value-weighted, portfolio returns, both raw and risk-adjusted, are reported across the different panels, respectively. In Panels C and D, we require the last month-end stock price to be higher than $1.

[Table 1 here]

Consistent with the prior literature, Panels A and B with stock prices over $5 and Panels C and D with stock prices over $1 (at the previous month-end) provide strong evidence that the differential[5] return between the high IVOL portfolio and the low IVOL portfolio is economically

[5] We will often use the term differential to denote the difference between the high and low IVOL portfolios.

and statistically significant. The raw return differential, the differential CAPM alpha, the Fama-French (1993) three factor alpha, the Carhart (1997) four factor alpha, the Fama-French (2015) five factor alpha, and the DGTW characteristic adjusted returns are almost all significant at the 1% level. The lowest differential is 40 basis points per month or about 4.8% per year for the Fama-French (2015) five factor-adjusted, value-weighted return with stock prices >$5. The highest differential is 122 basis points per month for the three factor alpha for the value-weighted portfolios with stock prices >$1. The return differential is largely driven by the significantly lower returns of the high IVOL portfolio and most of the alpha differential between the high and the low IVOL portfolio, obtains from the low alphas of the high IVOL portfolio. Panels E and F use all CRSP common stocks without filtering as in Ang et al. (2006). The differential returns and alphas are all economically and statistically significant in Panel F for the value-weighted portfolios but not in Panel E for the equal-weighted portfolios, as shown by Bali and Cakici (2008). Consistent with Bhootra and Hur (2015), this is a small, low priced stock phenomenon because there is a strong IVOL effect in Panels A and C where we eliminate the low priced stocks. Panels G and H use NYSE break points and except for the raw return differential between the high and low IVOL portfolios, all the alphas and the characteristic-adjusted return differentials are economically and statistically significant. Given that transaction costs, illiquidity, short sale constraints, and microstructure biases are likely to be higher in low priced stocks, in the rest of this paper, we require the stock price to be over $5 and report both the value- and equal-weighted portfolio returns. Excluding the low-priced stocks avoids the well-known interaction between size/illiquidity and IVOL as shown in Bali et al. (2005, 2008).

3. The Calendar Effects of the IVOL Puzzle

3.1. IVOL puzzle: A week of the month effect?

To explore potential calendar effects of the IVOL puzzle, we decompose a month into four 5-day trading intervals and examine the weekly IVOL effect over the month. Panel A.1 (A.2) of Table 2 reports the 5-day trading portfolio raw returns (four factor alphas) sorted on last month IVOL for value-weighted portfolios and Panel B.1 (B.2) does the same for the equal-weighted portfolios. Surprisingly, the high IVOL portfolio underperforms significantly in the third 5-day trading interval. For value-weighted portfolios there is no significant return or alpha differential in the other trading intervals. In Panel A.1, for the first 5-day trading interval of the month, the high IVOL portfolio has a return of 0.28% and the low IVOL portfolio has a return of 0.36%. The return differential between the low IVOL and the high IVOL portfolio is an insignificant 8 basis points. However, in the third 5-day trading interval, the high IVOL portfolio has a raw return of -0.18% and low IVOL portfolio has a raw return of 0.14%, generating a differential return of 32 basis points, which is significant at the 1% level. The four-factor alpha differential in Panel A.2 in the third 5-day trading interval is even higher at 36 basis points. For the equal-weighted portfolios, the return (alpha) differential in the third 5-day trading interval is 0.31% (0.37%). Also, in general, in the third 5-day trading interval, the returns and the alphas decrease monotonically across the IVOL sorted portfolios.

[Table 2 here]

How important is the third 5-day trading interval of the month for the IVOL puzzle? We answer this question by compounding the four 5-day trading returns (first 20 trading-days) and compounding the first, second, and fourth 5-day trading returns. For the value-weighted portfolios in Panels A.1 and A.2, the return (alpha) differential over the first twenty trading days of 63 (81)

basis points reduces by more than half to 25 (38) basis points when the third 5-day trading interval is excluded. For the equal-weighted portfolios, the return (alpha) differential reduces from 74 (97) basis points to 36 (52) basis points, suggesting that the third 5-day trading interval does have a large impact on the overall IVOL effect.

Recall the results in Table 1 that the alpha differential across the quintile IVOL portfolios obtains mainly due to the decline in the highest IVOL portfolio alpha. Similarly, the decline in the first 20 trading day alphas, when subtracting the third five-day return, also obtains mainly due to the (absolute) decline in the high IVOL portfolio alpha from -0.87% (-0.80%) in Panel A.2 (B.2) to -0.35% (-0.32%). In other words, since the IVOL effect (especially when measured using alphas) mainly obtains from the low alphas of the high IVOL stocks, the reduction in the IVOL effect also obtains mainly from the high IVOL stocks.

Overall, the return pattern in the third week drives a strong calendar (week-of-the-month) effect.

3.2. IVOL puzzle: The weekday effect?

Given that we have narrowed down the IVOL puzzle from one month to the third trading week, we now investigate the impact of IVOL across different days of the week.[6] The psychology literature has documented that the variation in investor mood over the course of the week impacts trading.[7] In a recent study, Birru (2018) shows that the IVOL effect is also related to the weekday

[6] A number of papers document the low Monday return on the U.S. stock market including Cross (1973), French (1980), and Gibbons and Hess (1981).

[7] Rossi and Rossi (1977) examine the daily mood in 82 college students and find that mood is higher on Friday, Saturday, and Sunday than on other days. Golder and Macy (2011) assess variation in mood by using a sample of 2.4 million individuals making over 500 million tweets from February 2008 through January 2010. They confirm that mood is higher on Friday than it is on Monday through Thursday.

effects. Specifically, stock returns decrease with IVOL on Monday but increase with IVOL on Friday.

[Table 3 here]

We first replicate these results. Table 3 confirms that the IVOL effect is most negative on Mondays and most positive on Fridays. Panel A (B) reports the monthly average of value-weighted (equal-weighted) portfolio returns on each weekday. On Monday, the average portfolio return decreases from the low IVOL portfolio to the high IVOL portfolio, leaving a high-minus-low return (alpha) differential of -21 (-21) basis points for the value-weighted portfolios and a return (alpha) differential of -19 (-20) basis points for the equal-weighted portfolios. However, on Fridays, the average portfolio return increases from the low IVOL portfolio to the high IVOL portfolio, leaving a high-minus-low return (alpha) differential of 10 (9) basis point for value-weighted portfolios and a return (alpha) differential of 12 (11) basis points for the equal-weighted portfolios. The high-minus-low differential increases from Monday to Friday possibly because investors' mood improves gradually from Monday to Friday. This is consistent with the Birru (2018) argument that relative to non-speculative or low IVOL stocks, the speculative or high IVOL stocks will experience low returns on Mondays and high returns on Fridays. The negative overall IVOL effect for monthly returns can be regarded as an imbalance between the Monday and Friday returns. The "blue" Monday effect is stronger than "happy" Friday effect giving rise to the overall IVOL effect. We next investigate the Monday and Friday effect of IVOL in each calendar week of the month.

Panels A.1 and B.1 (A.2 and B.2) of Table 4 present the IVOL sorted value-weighted (equal-weighted) portfolio returns on Mondays and Fridays of each calendar week. The negative IVOL effect is quite robust on Monday of each calendar week. However, the magnitude of the

IVOL effect as measured by the differential return and alpha across the high-minus-low IVOL portfolio is much larger for the third and fourth Mondays. For value-weighted portfolios in Panel A.1, the first (second) Monday, the return differential is -0.18% (-0.15%), and the alpha differential is -0.18% (-0.20%). The third and fourth Mondays have a return and alpha differential of -0.25% and -0.28%, respectively. For equal weighted portfolios in Panel B.1 the alpha differential on the first four Mondays is -0.19%, -0.16%, -0.22%, and -0.26%.[8]

[Table 4 here]

Panels A.2 and B.2 show that on Fridays the high-minus-low return and alpha differentials are significantly positive, except in the third week. In contrast to other Fridays of a month, the return and alpha differentials on the third Friday are -0.01% (0.01%) across the value-weighted (equal-weighted) portfolios. In sharp contrast to the other Fridays, the raw returns of the value-weighted quintile portfolios are negative (albeit insignificant) for the third Fridays which is opposite of the "happy" Friday effect.[9] Recall from Table 2 that the IVOL effect is driven by the third trading week of the month. The evidence in Table 4, points to an imbalance between the Friday and Monday IVOL effect, which leads to a general negative IVOL effect in the third trading week of the month. The positive IVOL effect on Friday is absent in the third calendar week, while the negative IVOL effect on Monday is strongest in the third and the fourth calendar weeks. The third trading week is very likely to contain such an imbalanced combination of Monday and Friday, leading to an overall negative IVOL effect in that trading week.[10]

[8] Wang et al. (1997) also show that returns are significantly more negative on the last two Mondays of the month.
[9] Abraham and Ikenberry (1994) document a positive correlation between the returns on Monday and the preceding Friday. Thus, a negative return on a Friday is more likely to result in a negative return on the following Monday.
[10] In order to eliminate the possibility that this third Friday effect is due to macroeconomic (macro) announcements or clustering of earnings announcement, we have examined the macro announcements (data from Chordia, Green, and Kottimukkalur (2018)) and earnings announcement dates. We confirm that the macro announcements and earnings announcements do not cluster on the third Friday of the month, and thus are unlikely to be the main driver of the IVOL calendar effect.

4. IVOL Puzzle: The Third Friday and Option Exercise

What is special about the third Friday and how is it related to the IVOL effect? We now explore one possible explanation - equity option exercise.[11]

4.1. Equity option exercise induced stock selling pressure

Equity options and index options expired on the Saturday following the third Friday before February 15, 2015. After February 15, 2015, the expiration date was changed to the third Friday of the expiration month. Any unexercised in-the-money options are automatically exercised by brokerage firms with notice to Options Clearing Corporation (OCC), on the third Friday.[12] While index option exercise can be settled with cash delivery, single-name equity option exercise requires physical delivery of the underlying stocks. For in-the-money (ITM) call options, option writers will be forced to sell the underlying stocks to the call option holders at the strike price, which is lower than current stock price. Similarly, ITM put option holders will sell the underlying stocks to the put option writers at strike price, which is higher than the current stock price.

After the underlying stocks are delivered, investors have an incentive to close their positions for the following reasons. These delivered stocks may move investors away from their optimal portfolios and thus may be sold. Also, call option holders may sell the delivered stocks to realize the gain and put option writers who receive the underlying stocks may sell to stop further potential losses.[13] Therefore, one can expect selling pressure on the third Friday and the subsequent Monday.

[11] Chiang (2014) documents negative stock returns on option expiration days.
[12] http://www.cboe.com/education/getting-started/quick-facts/expiration-exercise-assignment
[13] It could be argued that the disposition effect would cause the put option writers to hold on to their losing positions. However, the put option writers did not originally hold the delivered stocks in their portfolio and thus do not have any basis price for the stock.

How is the selling behavior related to IVOL? Higher IVOL indicates larger price movements, and therefore a higher probability that the option will end up in-the-money. At the same time, high IVOL is also related to the selling pressure afterwards, because higher volatility pushes risk-averse investors to close their position to lock-in the profits or limit their losses. Therefore, one can also expect the selling pressure to increase with IVOL. We next examine the IVOL driven selling pressure.

To measure the selling pressure, we obtain data from ISSM and the TAQ datasets. Both datasets report intraday quotes and prices and quantity of each trade. We use the filtering rules in Chordia, Roll, and Subrahmanyam (2001) to eliminate obvious data errors in the TAQ dataset. We then use the Lee and Ready (1991) algorithm to classify transactions as either a buy or a sell. Briefly, we implement the Lee and Ready algorithm as follows: if a trade is executed at a price above (below) the quote midpoint, we classify it as a buy (sell); if a trade occurs exactly at the quote mid-point, we sign it using the previous transaction price according to the tick test (i.e., a buy if the sign of the last nonzero price change is positive and vice versa). The Lee and Ready algorithm uses the fact that seller-initiated trades tend to execute at a lower price than buyer-initiated trades. We apply the tick test up to the past five price changes. If the past five price changes are zero then we do not use it in the computation of buys or sells. As Lee and Ready (1991) note, the timestamps on quotes are not always correctly synchronized with those for trades and hence they recommend that the quotes be matched to trades with a five-second delay. We follow this five-second delay rule until 1998. Since such recording errors are not observed in the more recent data (see, for example, Madhavan, Ming, Strasser, and Wang, 2002 as well as Chordia, Roll, and Subrahmanayam, 2005) we do not impose any delays after 1998.

One concern with the Lee and Ready (1991) algorithm is that it may misclassify the side

that initiated a particular trade, even if the trade initiator places a market order. Lee and Radhakrishna (2000) and Odders-White (2000) examine the trade-level accuracy of the Lee and Ready algorithm for NYSE traded stocks and report accuracy rates of 93% and 85%, respectively. Chakrabarty, Moulton, and Shkilko (2012) document a lower accuracy rate of 68% for Nasdaq stocks. We use only NYSE stocks.

Further, we measure selling pressure from retail traders (with trades less than $10,000 in size) and from institutional investors (with trades over $10,000).[14] Our sample period is from 1983 through 2000. The start of our sample in 1983 coincides with the availability of transactions level data and we end the sample in 2000 because after decimalization in January 2001, large institutional trades started to be broken up into smaller trades so as to limit the price impact, and this breaking up of trades makes it difficult to identify retail versus institutional trades.

Selling pressure is measured as daily order imbalance (OIB), which is defined as buy orders less sell orders divided by the sum of buy and sell orders on a given day. A positive OIB signifies an excess of buy originated trades over sell originated trades. The buy and sell orders are measured in terms of (i) number of trades, (ii) number of shares traded, and (iii) dollars traded. Table 5 presents the results for the number of trades. The results for the number of shares traded and dollars traded are presented in the internet appendix Table IA.1.

Panel A of Table 5 shows the difference in the small and big OIB (SOIB and BOIB) on the third Fridays (relative to other Fridays) and on Mondays following the third Fridays (relative to other Mondays).[15] The relative SOIB on Fridays for the low IVOL portfolio is -0.26% and for the high IVOL portfolio it is -1.34% giving a differential relative SOIB of -1.08%. The differential

[14] We follow Lee (1992) who uses a cutoff of $10,000 to separate large and small traders. Barber and Odean (2000) report median trade sizes of about $5,000 for individual investors.

[15] There are four Fridays during 1983-2000 that were holidays and the option expiration date was the prior Thursday. In these cases, we replaced the third Fridays with the prior Thursdays.

relative BOIB is only -0.72%. The difference (which is actually a difference-in-difference-in-difference) between the two, relative SOIB and relative BOIB, is -0.36% (t-statistic = -1.69). In other words, on the third Fridays of the month (compared to other Fridays), there is more differential selling pressure, across the IVOL portfolios, from retail traders as compared to the institutional investors. The same result obtains for the Mondays following the third Friday of the month. The differential relative SOIB for the Mondays following the third Friday is -0.97% while the differential relative BOIB is -0.33% giving a difference-in-difference-in-difference of -0.64% (t-statistic = -3.59). Thus, once again it is the selling pressure from retail traders that drives the IVOL related negative returns on the Mondays following the third Friday of the month.[16] Table IA.1 shows that the results for the OIB measured using shares traded and dollars traded are robust and even stronger for the Mondays after the third Friday of the month. For the third Friday, the differential relative SOIBs are indeed larger (in absolute terms) than the BOIBs but the difference-in-difference-in-difference is not statistically significant.

[Table 5 here]

Next, we independently double sort on quarterly institutional holdings (available from the 13f filings) and IVOL over the sample period 1980-2016. Panel B.1 (B.2) of Table 5 presents the value-weighted (equal-weighted) results. For the value-weighted (equal-weighted) portfolios the third, 5-day return differential across the high and low IVOL portfolios is -0.57% (-0.39%) with a t-statistic of -2.94 (-3.53) for the low institutional holdings, IO, portfolio and for the high IO portfolio it is lower at -0.23% (-0.24%) with a t-statistic of -1.45 (-1.96). While the IVOL differential across the low IO portfolios is larger than that across the high IVOL portfolios, the

[16] It is possible that investors start exercising their American options prior to expiry. This will lead to selling pressure prior to expiry. It is also possible that there is spillover of selling beyond the Monday following the third Friday. We have examined the order imbalance on the Thursday before and the Tuesday following the third Friday. There is no significant difference-in-difference-in-difference between the small and big order imbalances.

difference-in-difference between the IO portfolios is significant at the 10% level only for the value-weighted portfolios.

For the value-weighted (equal-weighted) portfolios the third Friday and the subsequent Monday return differential across the high and low IVOL portfolios is -0.32% (-0.36%) with a t-statistic of -2.85 (-5.06) for the low IO portfolio and for the high IO portfolio it is lower at -0.19% (-0.23%) with a t-statistic of -1.99 (-3.31).[17] The difference-in-difference between the IO portfolios is significant at the 10% level only for the equal-weighted portfolios.

The larger price impact for the low IO portfolio suggests that it is trading by the retail investors that impacts the IVOL return differentials in the third 5-day period as well as on the third Friday and subsequent Monday. The caveat here is that we are assuming more (less) retail trading in the low (high) IO portfolios.

Panels C.1 (C.2) of Table 5 present the value-weighted (equal-weighted) return and the four-factor alpha differentials across the IVOL portfolios for third Friday and the subsequent Monday relative to other Fridays and subsequent Mondays over the sample periods 1983-2000 and 1963-2016. For the value-weighted portfolios in Panel C.1, the relative differential (difference-in-difference) return and alpha over the sample period 1983-2000 is -0.28% (t-statistic = -1.94) and over the sample period 1963-2016 it is -0.14% (t-statistic = -1.67). For the equal-weighted portfolios in Panel C.2, the difference-in-difference return and alpha over the sample period 1983-2000 is -0.31% (t-statistic = -3.18) and over the sample period 1963-2016 it is -0.20% (t-statistic = -3.39). Thus, the third Friday and the following Monday return and alpha differential is indeed negative over the 1983-2000 sample period, suggesting that the option expiration related retail selling pressure does indeed have an impact on the IVOL effect.

[17] The alpha differentials are essentially the same.

4.2. IVOL puzzle: A story of two trading days?

Option exercise induced selling pressure which emanates mainly from retail investors not only offsets the mood-induced positive IVOL effect on the third Friday, but also enhances the negative IVOL effect on the following Monday. We now assess the impact of these two days on the negative cross-sectional relation between IVOL and the next month return.

[Table 6 here]

Since equity options started trading on the CBOE in 1973, we examine the 1973-2016 sample period. The importance of the third Friday and the following Monday for the IVOL effect can be easily identified in Panels A and B of Table 6 which present results for the value-weighted and equal-weighted portfolios, respectively. In Panel A, the first row shows the monthly IVOL effect, with a high-minus-low IVOL return (alpha) differential of -59 (-73) basis points. However, once we remove the third Friday and the following Monday, the return (alpha) differential reduces to -27 (-42) basis points and is at best marginally significant and that too only for the four-factor alpha. Removing just these two days reduces the monthly IVOL return (alpha) differential by about 40% (46%). If we only remove the Monday after the third Friday, which can be the third or the fourth calendar Monday of a month, we obtain a high-minus-low IVOL return (alpha) differential of -34 (-49) basis points with a t-statistic = -1.21 (-1.85). For the equal-weighted portfolios, removing just the third Friday and the following Monday reduces the monthly IVOL return (alpha) differential by about 54% (41%).

Just removing two days, the third Friday and the following Monday, has a large impact, of at least a 40% reduction, on the IVOL effect. While the positive Friday effect and negative Monday effect in other weeks largely cancel each other, this cancelling-effect is absent in the combination

of the third Friday and the subsequent Monday because of the selling pressure due to the exercise of ITM equity options.

Once again, we see that the reduction in the differential IVOL return obtains mainly from the high IVOL portfolio. In Panel A (B) of Table 6 the monthly return of the high IVOL portfolio increases from 35 (47) basis points to 76 (91) basis points when the return on the third Friday and the following Monday is excluded. In comparison, the monthly return of the low IVOL portfolio increases from 94 (117) basis points to only 102 (124) basis points.

Thus far we have presented univariate results for the monthly IVOL effect as well as the returns on the third Friday and the following Monday. Table 7 presents the coefficient estimates from individual stock Fama-MacBeth (1973) regressions of monthly returns on lagged IVOL and other firm-level characteristics over the sample period 1973-2016. The characteristics include firm size, the book-to-market ratio, the past one-month return, and the past eleven-month return that does not include the past one-month return. The main takeaways from this table are that (i) the IVOL effect is robust to the inclusion of the firm characteristics, including the size, value, reversal, and momentum effects, and (ii) upon excluding the return on the third Friday of the month and that of the following Monday, the coefficient estimate on IVOL declines by 30%. In economic terms, a one standard deviation (cross-sectional) change in IVOL results in a decline in the monthly return of 0.36% and this decline reduces to 0.22% when the return on the third Friday and the following Monday is excluded from the monthly return.

[Table 7 here]

The internet appendix Table IA.2 presents sub-period results. Panel A (B) presents the value-weighted (equal-weighted) results for the sub-periods 1973-1983, 1984-1994, 1995-2005, 2006-2016. In both panels we see that the IVOL effect is strongest over the sub-period 1984-1994.

In the 1970s there were very few stocks with options. As the number of stocks with options increased, the price pressure due to delivery upon options expiration may be the cause of the increase in the IVOL effect. The IVOL effect has decreased in recent years due to the publication effect and the activities of sophisticated investors such as hedge funds as shown by Chordia, Subrahmanyam, and Tong (2014) and McLean and Pontiff (2016).

4.3. IVOL puzzle: Equity options

Given that the return of two trading days related to option expiration can explain more than 40% of the monthly IVOL effect, we expect the IVOL effect to be more pronounced for stocks with equity options than for stocks without equity options. In this subsection, we show that the IVOL effect is indeed more pronounced for stocks with options.

The options data is obtained from OptionMetrics over the sample period 1996-2016. In Panel A of the internet appendix Table IA.3, for the unmatched sample, we find no difference in the IVOL effect for stocks with and without options. Note that the stocks with options are on average larger than those without. Further, the differential in Ln(market capitalization) across the Low and High IVOL portfolios is also larger in stocks with options, with the Low IVOL stocks being larger. The difference in the Ln(market capitalization) between the High IVOL and the Low IVOL portfolio is -1.94 (-0.77) for stocks with (without) options. The difference in these differentials is a significant -1.16. Thus, the High IVOL stocks are significantly smaller than the low IVOL stocks and this difference is larger for stocks with options than without. The IVOL effect results in High IVOL stocks having lower returns than the Low IVOL stocks while the size effect results in the High IVOL stocks having higher returns than the Low IVOL stocks. With the

IVOL and the size effects working against each other, it is not surprising that for the unmatched sample we find no IVOL related difference between the stocks with and without options.

To mitigate the impact of firm size, when comparing the IVOL effect across firms with and without options, we now match on market capitalization. Specifically, for each month, we require stocks with and without options to belong to the same CRSP 100 size group. If a stock with options is matched to multiple stocks without options, we retain the one with the closest market capitalization. If an optionable stock is not matched with any non-optionable stocks, it will be excluded from the matched sample. The matching procedure effectively reduces the size gap between stocks with and without options. The difference in the differential (across the High and Low IVOL portfolios) size gap between stocks with and without options decreases from -1.16 in Table IA.3 to a still significant -0.76 in Table 8. Note that this difference in the differential firm size will bias against finding a significant difference in the IVOL effect across the stocks with and without options.

[Table 8 here]

The monthly value-weighted return across the quintile IVOL portfolios decreases with IVOL from 0.82% to -1.70%, resulting in a return differential of -2.53% (t-statistic=-4.71). The return differential for stocks without options is -0.40% (t-statistic=-0.63). The difference in the return differential across stocks with and without options is -2.13% (t-statistic=-6.54) and the difference in the alpha differential is -1.98% (-6.31). The difference in the return (alpha) differentials using equal-weighted portfolios is a significant -0.80% (-2.13%). Thus, the IVOL effect is larger in stocks with options than in stocks without options.

We find similar results in Panels B and C of the internet appendix Table IA.3 when matching on firm size and the 12 Fama-French industries and when matching on firm size, stock

liquidity (using the Amihud (2002) measure), and industry. Overall, these results are consistent with our hypothesis that IVOL effect, largely driven by the two days related to option expiration, is much more pronounced in stocks with options than in stocks without options.

4.4. IVOL puzzle: In-the-money options

In this subsection we test the following: (i) Do high IVOL stocks have more ITM option open positions just prior to expiration for both calls and puts? and (ii) Is the IVOL effect stronger in stocks with more ITM positions? We focus on the matched sample, as described in previous subsection.

[Table 9 here]

Panel A of Table 9 confirms that, for the high IVOL stocks, there are more ITM option positions prior to the third Friday. In fact, high IVOL stocks have more open interest for both ITM and out-of-the-money (OTM) options relative to low IVOL stocks which is not surprising given the higher volatility of the underlying stock returns. Note that an ITM call implies an OTM put and an ITM put implies an OTM call. Since we are dealing with American options, they could be exercised prior to expiration. To offset the possible delivery on expiration, the option writers can buy back the same option contract before expiration, which reduces the outstanding option open interest. So, for each stock, we sum up the open interest of all ITM call and put options for each of three trading days before the third Friday.[18] Then we divide the three-day average of total open interest by total shares outstanding of the underlying stock. We tabulate the daily average ITM open interest for each IVOL sorted portfolio. This measure is a proxy for the magnitude of potential selling activity, after the exercise of the ITM options. Indeed, open interest increases

[18] Our results are robust to using open interest data within two or within four trading days before the third Friday.

monotonically with IVOL, for both ITM calls and ITM puts. The differential in open interest between the high IVOL and the low IVOL portfolio amounts to 0.18% and 0.15% for call and put options, respectively. There will be more delivery of the underlying stocks in the high IVOL portfolio and, thus, the higher post-delivery selling pressure that was documented in Table 5.[19]

Panels B and C of Table 9 present the impact of moneyness on the IVOL effect for the value-weighted and equal-weighted portfolios, respectively. Stocks with low ITM open interest have a differential return (alpha) across the IVOL portfolios of -1.64% (-1.96%) while stocks with high ITM open interest have a differential return (alpha) of -2.98% (-3.28%). The difference, across the High and Low ITM portfolios, in the differential returns and differential alphas (difference-in-difference in returns and alphas) is highly significant at -1.34% (t-statistic = -4.84) and -1.32% (t-statistic = -4.91), respectively. Stocks with a high ITM open interest have a return differential (alpha differential) that is 82% (67%) higher than that for stocks with a low ITM open interest. We also examine the impact of moneyness on the IVOL effect separately for calls and puts. The difference-in-difference in the returns and alphas between the high ITM open interest and the low ITM open interest for calls is -1.35% (t-statistic = -5.29) and -1.38% (t-statistic = -5.33), respectively. For put options the difference-in-difference in the returns and alphas are both highly significant at -1.91%. Similar results obtain for the equal-weighted portfolios in Panel C of Table 9.

In sum, the IVOL effect is stronger in stocks with a higher ITM open position, close to the time of option expiration.

[19] It could be argued that covered call and protective put positions could lead to selling pressure in the underlying stocks even when the options expire OTM. However, the option writer can open another position upon the expiry of an OTM position. Moreover, even if the option writer were to liquidate the position in the underlying stock, low hedge ratios with OTM positions will result in low selling pressure. Thus, we focus on ITM positions.

Do our findings suggest the possibility of a profitable trading strategy? Panel B of Table 9 documents a monthly value-weighted four factor alpha differential between low and high IVOL stocks of 3.28% for stocks with in-the-money options. While this does seem to be highly profitable we have to be cognizant of trading costs which are likely to be high in these small, illiquid, high IVOL stocks. We leave an analysis of trading costs for future research.

4.5. Return pattern after the 3rd 5-day trading period

Given that the selling pressure related to the delivery of shares at the expiration of ITM option positions drives a substantial fraction of the IVOL effect, we should observe a reversal in the 4th 5-day trading period, i.e., after the 3rd 5-day period which includes the third Friday and the subsequent Monday. The results in Table 2 provide some evidence. The IVOL effect in the 4th 5-day trading interval is the weakest compared with other 5-day trading intervals, indicating that a price reversal after option expiration may be possibly mitigating the usual IVOL effect. Table IA.4 presents the return pattern after the 3rd 5-day trading period for the matched sample of Table 8.

We first report the return pattern of the IVOL effect in the 4th 5-day trading interval (i.e., following the third 5-day period of the month which includes the Friday of the options expiration as well as the following Monday) in Panel A of Table IA.4. We compare the differential High-Low value-weighted return differences in the 4th 5-day trading period and the average of other 5-day trading periods. The return differential in the 4th 5-day trading period is -0.14 (t-statistic = -0.69) and the average return differential of the other 5-day trading periods is -0.63% (t-statistic = -4.03). The difference-in-difference of the return spreads is 0.48% (t-statistic=1.93), suggesting that, relative to the other 5-day trading intervals, there is a reversal of IVOL effect in the 4th 5-day trading interval.

In Panel B, we focus on the sample of stocks with options and expect a stronger relative reversal of IVOL effect in the 4th 5-day trading period. The difference in the return differential between the 4th 5-day trading interval and the other 5-day trading intervals is 0.55% (t-statistic=2.13) in the sample of stocks with options. Panel C shows that the reversal in the 4th 5-day trading interval, relative to the other 5-day trading intervals, is absent in the sample of stock without options.

Finally, in Panel D we report the difference-in-difference-in-difference in returns across the High and Low IVOL portfolios, across the 4th 5-day trading period and the other 5-day trading periods, and across stocks with and without options. This difference-in-difference-in-difference in returns is 0.56%. Thus, consistent with the option induced selling pressure evidence, the relative price reversal after the option expiration is more pronounced in stocks with options than in those without.

4.6. Revisiting short-sale constraints and costly arbitrage

Stambaugh, Yu, and Yuan (2015) and Cao and Han (2016) argue that high IVOL stocks are subject to high arbitrage risk. The IVOL effect is positive in underpriced stocks and negative for overpriced stocks. We first replicate the empirical results of these studies using our longer sample period from 1973 to 2016. Based on the Stambaugh et al. (2015) mispricing measure and IVOL, we independently sort the sample stocks into 25 (5x5) value-weighted and equal-weighted portfolios in Panels A and B of Table 10. Consistent with the costly arbitrage argument, Panel A.1 of Table 10 shows that, for most underpriced stocks, the return (alpha) differential across the high and low IVOL portfolios in the next month is 0.43% (0.31%). For most overpriced stocks, the high IVOL portfolio has a return (alpha) that is lower than that of the low IVOL portfolio in the next

month by 1.60% (1.68%). In Panel B.1 for equal-weighted portfolios the return (alpha) differential across the high and low IVOL portfolios in the next month is 0.21% (-0.01%) for the most underpriced stocks and for the most overpriced stocks the return (alpha) differential is -1.49% (-1.46%). There is a large asymmetry between the impact of IVOL in overpriced and in underpriced stocks. Stambaugh et al. (2015) argue that this is due to short sale constraints.

Can our newly discovered calendar effect add anything new to this empirical finding? Recall that we find that a large fraction of the negative IVOL effect obtains due to the selling pressure in the delivered underlying stocks on the third Friday and the subsequent Monday after the expiry of equity options. The selling pressure should reduce the positive IVOL effect for underpriced stocks while enhancing the negative IVOL effect for the overpriced stocks. Thus, unrelated to short-sale constraints, the option expiration driven selling pressure should enhance the asymmetry between the IVOL effect for overpriced and underpriced stocks.

In order to disentangle the impact of mispricing from selling pressure, we conduct two additional tests. First, we re-examine the IVOL effect for overpriced and underpriced stocks on the Monday after the third Friday of the month. Second, we skip that Monday and re-examine the IVOL effect for overpriced and underpriced stocks. These tests will provide an indication of the impact of the option expiration induced selling pressure.

[Table 10 here]

Panels A.2 and B.2 of Table 10 demonstrate that regardless of overpricing or underpricing, the IVOL effect, as measured by the return or alpha differential across the high and low IVOL portfolios, is negative on the Monday after the third Friday, although the IVOL effect is more negative for the overpriced stocks. This is consistent with the option expiration induced selling pressure. In Panels A.3 and B.3, we remove the return of the Monday after the third Friday when

calculating the monthly returns and find a much weaker (absolute) asymmetry in the IVOL effect between underpriced stocks and overpriced stocks. After removing that Monday, in Panel A.3 for the value-weighted portfolios, the return (alpha) differential across the IVOL portfolios in the underpriced stocks is 0.60% (0.42%) and in the overpriced stocks the return (alpha) differential is -1.07% (-1.40%). In other words, upon removing the negative returns on the Monday following the third Friday the return (alpha) differential across the IVOL portfolio is higher by 40% (35%) for the underpriced stocks and lower (in absolute terms) for the overpriced stocks by 33% (17%). Similar results obtain for the equal-weighted portfolios in Panel B.3.

Since mispricing is not restricted to the third Friday of the month and the subsequent Monday, the above results suggest that option expiration induced selling pressure has an important role in the IVOL effect. Selling pressure caused by option expiration can explain part of the asymmetry of IVOL effect. The impact of short-sale constraints while significant, is smaller than that previously documented.

5. Conclusions

The negative association between idiosyncratic volatility and the next month stock return is particularly puzzling and incompatible with the classical asset pricing paradigm. The literature largely takes a behavioral approach to explain the puzzle. Prior research has suggested that investor mood leads to positive returns on Fridays and negative returns on Mondays. IVOL sorted long-short portfolio returns also have positive returns on Fridays and negative returns on Mondays. The positive Friday and the negative Monday returns offset each other in all weeks of the month, except for the third week when option-induced selling pressure (due to the automatic exercise of in-the-money options on the third Friday of each month) eliminates the positive Friday return. This gives

rise to a negative IVOL-return relation in the third week of the month. We also find that this option expiration induced selling pressure increases with IVOL, since more volatile stocks are more likely to have in-the-money call or put options upon expiration and (mainly retail) investors are more likely to liquidate the option-exercise created positions in the more risky and volatile stocks.

We decompose the monthly IVOL effect to a weekly IVOL effect and, in the end, trace the driving force to selling pressure on the two days in a month that are most relevant to option exercise, the third Friday of the month and the subsequent Monday. Removing just these two days from the sample, reduces the monthly IVOL effect by at least 40%.

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Table 1. Monthly Returns by IVOL Sorted Portfolios

In each month from July 1963 to December 2016, we form quintile portfolios sorted on last month's idiosyncratic volatility (IVOL). IVOL is estimated as the standard deviation of daily return residuals from the Fama-French 3-factor model for each firm each month, with a minimum of 17 daily observations. In Panels A and B, the sample consists of only common stocks and excludes stocks with a price less than $5 at the end of last month. In Panels C and D the sample consists of only common stocks and excludes stocks with a price less than $1 at the end of last month. In Panels E and F, we do not filter the sample and use all CRSP stocks as in Ang et al. (2006). In Panels G and H, we use the same sample as in Panels A and B but use NYSE breakpoints to form the IVOL sorted quintile portfolios. Panels A, C, E, and G present results for equal-weighted portfolios and Panels B, D, F, and H report results for value-weighted (capitalization-weighted) portfolios. This table presents several measures of stock performance, including raw return, risk-adjusted return, and characteristics-adjusted return. Specifically, we use CAPM, Fama-French (1993) 3-factor model, Carhart (1997) 4-factor model, and Fama-French (2015) 5-factor model to account for various common risk factors. We also present results of the DGTW (1997) adjusted returns to account for difference in characteristics. Robust Newey and West (1987) t-statistics are reported in brackets. The symbols $*$, $**$, $***$ denote significance at the 10%, 5% and 1% levels, respectively.

Common Stocks and Price>$5

	Panel A: Equal-weighted portfolio return						Panel B: Value-weighted portfolio return					
IVOL Quintile:	Low	2	3	4	High	H-L	Low	2	3	4	High	H-L
Raw Return	1.13	1.29	1.35	1.19	0.48	-0.65***	0.91	0.95	0.99	0.92	0.37	-0.55**
	(6.88)	(6.20)	(5.66)	(4.26)	(1.49)	(-2.94)	(6.04)	(5.16)	(4.40)	(3.28)	(1.09)	(-2.15)
CAPM Alpha	0.38	0.42	0.40	0.16	-0.61	-0.99***	0.12	0.05	0.01	-0.16	-0.79	-0.92***
	(4.13)	(4.21)	(3.70)	(1.23)	(-3.58)	(-5.47)	(2.15)	(1.31)	(0.09)	(-1.56)	(-4.81)	(-4.34)
3-factor Alpha	0.20	0.21	0.21	0.00	-0.72	-0.91***	0.09	0.03	-0.01	-0.15	-0.76	-0.85***
	(2.95)	(3.66)	(4.15)	(0.00)	(-9.66)	(-7.52)	(1.94)	(0.73)	(-0.18)	(-1.93)	(-6.14)	(-5.45)
4-factor Alpha	0.20	0.24	0.24	0.04	-0.64	-0.83***	0.05	0.01	0.02	-0.12	-0.64	-0.70***
	(3.13)	(4.30)	(5.09)	(0.97)	(-7.95)	(-6.84)	(1.11)	(0.23)	(0.36)	(-1.60)	(-5.00)	(-4.26)
5-factor Alpha	0.06	0.09	0.13	0.02	-0.49	-0.55***	-0.01	-0.04	0.02	-0.01	-0.42	-0.40***
	(0.97)	(1.73)	(2.53)	(0.47)	(-7.32)	(-5.92)	(-0.32)	(-0.83)	(0.26)	(-0.14)	(-4.12)	(-3.14)
DGTW adj. Return	0.01	0.15	0.21	0.06	-0.53	-0.55***	0.02	0.02	0.03	-0.09	-0.54	-0.56***
	(0.22)	(3.42)	(6.24)	(1.47)	(-7.72)	(-4.61)	(0.67)	(0.53)	(0.75)	(-1.25)	(-5.23)	(-4.48)

Common Stocks and Price>$1

	Panel C: Equal-weighted portfolio return						Panel D: Value-weighted portfolio return					
IVOL Quintile:	Low	2	3	4	High	H-L	Low	2	3	4	High	H-L
Raw Return	1.11	1.32	1.34	1.20	0.49	-0.62**	0.91	0.97	1.03	0.78	0.12	-0.79***
	(6.49)	(6.00)	(5.12)	(3.83)	(1.31)	(-2.31)	(5.92)	(4.91)	(4.14)	(2.49)	(0.32)	(-2.80)
CAPM Alpha	0.35	0.42	0.36	0.14	-0.60	-0.95***	0.11	0.04	-0.00	-0.35	-1.07	-1.17***
	(3.71)	(4.14)	(2.97)	(0.92)	(-2.62)	(-4.21)	(2.09)	(1.03)	(-0.02)	(-2.56)	(-5.47)	(-4.98)
3-factor Alpha	0.16	0.21	0.16	-0.05	-0.83	-0.99***	0.08	0.02	-0.02	-0.33	-1.14	-1.22***
	(2.38)	(3.76)	(3.43)	(-0.74)	(-6.75)	(-6.31)	(1.91)	(0.48)	(-0.27)	(-3.42)	(-8.07)	(-7.23)
4-factor Alpha	0.17	0.26	0.25	0.12	-0.59	-0.76***	0.04	0.05	0.03	-0.21	-0.92	-0.96***
	(2.69)	(4.92)	(5.20)	(1.69)	(-4.26)	(-4.63)	(1.03)	(1.20)	(0.56)	(-2.09)	(-6.11)	(-5.33)
5-factor Alpha	0.03	0.11	0.15	0.09	-0.54	-0.56***	-0.02	0.00	0.08	-0.09	-0.69	-0.67***
	(0.44)	(2.09)	(2.61)	(1.13)	(-4.19)	(-4.07)	(-0.56)	(0.10)	(1.51)	(-1.11)	(-5.69)	(-4.64)
DGTW adj. Return	-0.00	0.18	0.17	0.10	-0.47	-0.46***	0.01	0.04	0.05	-0.18	-0.82	-0.83***
	(-0.04)	(4.77)	(6.52)	(2.16)	(-4.99)	(-3.23)	(0.43)	(1.20)	(0.89)	(-1.93)	(-6.69)	(-5.86)

All CRSP stocks

	Panel E: Equal-weighted portfolio return						Panel F: Value-weighted portfolio return					
IVOL Quintile:	Low	2	3	4	High	H-L	Low	2	3	4	High	H-L
Raw Return	1.00	1.25	1.31	1.18	1.01	0.01	0.91	0.97	1.04	0.73	0.12	-0.79***
	(6.12)	(6.04)	(5.17)	(3.75)	(2.51)	(0.03)	(5.98)	(5.26)	(4.35)	(2.45)	(0.33)	(-2.73)
CAPM Alpha	0.27	0.39	0.35	0.13	-0.09	-0.37	0.12	0.07	0.03	-0.37	-1.05	-1.17***
	(3.00)	(3.98)	(2.98)	(0.81)	(-0.36)	(-1.50)	(2.27)	(1.92)	(0.46)	(-2.75)	(-5.12)	(-4.78)
3-factor Alpha	0.11	0.20	0.16	-0.06	-0.36	-0.47**	0.09	0.05	0.01	-0.37	-1.12	-1.22***
	(1.55)	(3.24)	(2.92)	(-0.75)	(-2.15)	(-2.54)	(2.26)	(1.31)	(0.25)	(-3.69)	(-7.43)	(-6.87)
4-factor Alpha	0.13	0.26	0.26	0.14	0.00	-0.12	0.06	0.05	0.08	-0.23	-0.87	-0.93***
	(1.78)	(4.36)	(4.60)	(1.59)	(0.02)	(-0.56)	(1.38)	(1.40)	(1.51)	(-2.35)	(-5.38)	(-4.92)
5-factor Alpha	-0.00	0.11	0.14	0.08	0.00	0.00	-0.00	-0.01	0.10	-0.12	-0.66	-0.66***
	(-0.01)	(1.76)	(2.20)	(0.86)	(0.01)	(0.01)	(-0.09)	(-0.36)	(1.74)	(-1.37)	(-4.79)	(-4.20)
DGTW adj. Return	-0.01	0.18	0.19	0.11	-0.01	0.00	0.01	0.05	0.03	-0.21	-0.79	-0.80***
	(-0.14)	(4.30)	(6.84)	(2.41)	(-0.08)	(0.01)	(0.18)	(1.83)	(0.69)	(-2.51)	(-6.21)	(-5.35)

Common Stocks and Price>$5, NYSE breakpoints

	Panel G: Equal-weighted portfolio return						Panel H: Value-weighted portfolio return, stock price>$5					
IVOL Quintile:	Low	2	3	4	High	H-L	Low	2	3	4	High	H-L
Raw Return	1.11	1.31	1.34	1.34	0.80	-0.31	0.93	1.01	0.96	1.05	0.70	-0.23
	(6.74)	(6.58)	(6.00)	(5.35)	(2.64)	(-1.61)	(6.12)	(5.79)	(4.70)	(4.42)	(2.29)	(-1.04)
CAPM Alpha	0.36	0.46	0.42	0.37	-0.27	-0.63***	0.15	0.14	0.02	0.04	-0.42	-0.57***
	(3.87)	(4.69)	(4.00)	(3.15)	(-1.85)	(-4.28)	(2.41)	(2.70)	(0.38)	(0.62)	(-3.44)	(-3.30)
3-factor Alpha	0.18	0.26	0.21	0.16	-0.41	-0.59***	0.11	0.11	-0.02	0.01	-0.42	-0.54***
	(2.52)	(4.02)	(3.38)	(2.82)	(-7.53)	(-5.97)	(2.42)	(2.33)	(-0.39)	(0.20)	(-4.67)	(-4.28)
4-factor Alpha	0.18	0.28	0.25	0.22	-0.34	-0.52***	0.08	0.07	-0.01	0.06	-0.33	-0.41***
	(2.69)	(4.60)	(4.16)	(3.81)	(-5.85)	(-5.34)	(1.65)	(1.26)	(-0.13)	(0.95)	(-3.58)	(-3.20)
5-factor Alpha	0.02	0.10	0.07	0.06	-0.30	-0.33***	-0.01	-0.00	-0.08	0.02	-0.23	-0.22**
	(0.38)	(1.86)	(1.25)	(0.96)	(-5.21)	(-4.05)	(-0.33)	(-0.08)	(-1.36)	(0.31)	(-2.78)	(-2.00)
DGTW adj. Return	0.01	0.14	0.21	0.06	-0.52	-0.54***	0.02	0.01	0.03	-0.09	-0.52	-0.55***
	(0.21)	(3.40)	(6.21)	(1.50)	(-7.66)	(-4.60)	(0.66)	(0.54)	(0.71)	(-1.23)	(-5.21)	(-4.48)

Table 2. IVOL Puzzle: Week-in-Month Effects

In each month from July 1963 to December 2016, we form quintile portfolios sorted on last month's idiosyncratic volatility. We focus on common stocks and exclude stocks with a price less than $5 at the end of last month. In each month, we partition the trading days into four five-day trading intervals. For each interval, we calculate the buy-and-hold return and the Carhart (1997) 4-factor alpha for each stock and report the average portfolio return. In row 5, we calculate the buy-and-hold return for 20 trading days. In row 6, we cumulate the return from 1st, 2nd, and 4th trading intervals. Panels A.1 and A.2 (B.1 and B.2) report the value-weighted (equal-weighted) portfolio returns and alphas. Robust Newey and West (1987) t-statistics are reported in brackets. The symbols ∗, ∗∗, ∗∗∗ denote significance at the 10%, 5% and 1% levels, respectively.

Panel A.1: Value-weighted raw return

	Low-IVOL	2	3	4	High-IVOL	H-L
1st 5-day trading return	0.36	0.42	0.39	0.43	0.28	-0.08
	(4.51)	(4.29)	(3.37)	(3.11)	(1.84)	(-0.73)
2nd 5-day trading return	0.19	0.18	0.20	0.18	0.05	-0.14
	(2.50)	(1.86)	(1.75)	(1.36)	(0.31)	(-1.21)
3rd 5-day trading return	0.14	0.06	0.07	-0.02	-0.18	-0.32***
	(1.66)	(0.67)	(0.58)	(-0.14)	(-1.19)	(-2.75)
4th 5-day trading return	0.16	0.18	0.21	0.19	0.15	-0.00
	(2.09)	(2.07)	(2.08)	(1.58)	(1.12)	(-0.04)
1st 20-trading day return	0.82	0.82	0.83	0.74	0.19	-0.63**
	(5.06)	(4.07)	(3.40)	(2.48)	(0.55)	(-2.46)
1st 20-trading day & skip 3rd 5-day trading return	0.69	0.77	0.78	0.79	0.44	-0.25
	(5.11)	(4.48)	(3.73)	(3.07)	(1.49)	(-1.18)

Panel A.2: Value-weighted 4-factor alpha

	Low-IVOL	2	3	4	High-IVOL	H-L
1st 5-day trading return	0.14	0.18	0.15	0.17	0.02	-0.12
	(1.82)	(1.85)	(1.28)	(1.28)	(0.10)	(-1.17)
2nd 5-day trading return	-0.03	-0.06	-0.05	-0.08	-0.21	-0.18
	(-0.38)	(-0.58)	(-0.41)	(-0.55)	(-1.30)	(-1.56)
3rd 5-day trading return	-0.08	-0.18	-0.18	-0.27	-0.45	-0.36***
	(-1.06)	(-1.94)	(-1.62)	(-2.20)	(-2.97)	(-3.20)
4th 5-day trading return	-0.06	-0.06	-0.04	-0.06	-0.11	-0.05
	(-0.83)	(-0.68)	(-0.41)	(-0.51)	(-0.75)	(-0.43)
1st 20-trading day return	-0.06	-0.15	-0.17	-0.31	-0.87	-0.81***
	(-0.39)	(-0.74)	(-0.71)	(-1.01)	(-2.40)	(-3.03)
1st 20-trading day & skip 3rd 5-day trading return	0.03	0.05	0.03	0.00	-0.35	-0.38*
	(0.24)	(0.26)	(0.15)	(0.02)	(-1.13)	(-1.70)

Panel B.1: Equal-weighted raw return

	Low-IVOL	2	3	4	High-IVOL	H-L
1st 5-day trading return	0.35	0.45	0.49	0.47	0.26	-0.09
	(5.31)	(4.92)	(4.58)	(3.91)	(1.92)	(-0.99)
2nd 5-day trading return	0.24	0.28	0.29	0.23	0.08	-0.16*
	(3.65)	(3.25)	(2.85)	(1.95)	(0.58)	(-1.67)
3rd 5-day trading return	0.17	0.13	0.11	0.04	-0.14	-0.31***
	(2.65)	(1.61)	(1.22)	(0.35)	(-1.12)	(-3.52)
4th 5-day trading return	0.22	0.23	0.26	0.24	0.16	-0.07
	(3.68)	(2.95)	(2.85)	(2.23)	(1.26)	(-0.83)
1st 20-trading day return	0.99	1.10	1.14	0.95	0.25	-0.74***
	(5.71)	(4.98)	(4.53)	(3.25)	(0.75)	(-3.34)
1st 20-trading day & skip 3rd 5-day trading return	0.82	0.97	1.04	0.94	0.46	-0.36**
	(5.82)	(5.28)	(4.88)	(3.85)	(1.70)	(-2.01)

Panel B.2: Equal-weighted 4-factor alpha

	Low-IVOL	2	3	4	High-IVOL	H-L
1st 5-day trading return	0.15	0.22	0.25	0.22	-0.00	-0.15*
	(2.33)	(2.48)	(2.34)	(1.81)	(-0.02)	(-1.69)
2nd 5-day trading return	0.03	0.05	0.04	-0.02	-0.18	-0.21**
	(0.55)	(0.60)	(0.45)	(-0.21)	(-1.33)	(-2.28)
3rd 5-day trading return	-0.03	-0.09	-0.13	-0.21	-0.40	-0.37***
	(-0.48)	(-1.15)	(-1.40)	(-1.96)	(-3.18)	(-4.24)
4th 5-day trading return	0.02	0.00	0.02	-0.02	-0.10	-0.12
	(0.33)	(0.05)	(0.22)	(-0.16)	(-0.79)	(-1.38)
1st 20-day trading return	0.17	0.18	0.16	-0.09	-0.80	-0.97***
	(1.04)	(0.82)	(0.63)	(-0.30)	(-2.38)	(-4.24)
1st 20-trading day & skip 3rd 5-day trading return	0.20	0.28	0.30	0.16	-0.32	-0.52***
	(1.49)	(1.54)	(1.45)	(0.66)	(-1.18)	(-2.87)

Table 3. IVOL Puzzle: Weekday Effects

In each month from July 1963 to December 2016, we form quintile portfolios sorted on last month's idiosyncratic volatility. We focus on common stocks and exclude stocks with a price less than $5 at the end of last month. Panels A and Panel B report the value-weighted and equal-weighted portfolio return on each weekday, respectively. The Carhart (1997) 4-factor alpha of long-short return differential is calculated from the pre-estimated factor loadings and the average daily common factors using daily returns over the past 12 months. Robust Newey and West (1987) t-statistics are reported in brackets. The symbols ∗, ∗∗, ∗∗∗ denote significance at the 10%, 5% and 1% levels, respectively.

Panel A: Value-weighted return

	Low-IVOL	2	3	4	High-IVOL	H-L	4-factor alpha
Monday	-0.00	-0.03	-0.08	-0.13	-0.21	-0.21***	-0.21***
	(-0.04)	(-1.47)	(-3.18)	(-4.18)	(-5.61)	(-7.89)	(-8.10)
Tuesday	0.07	0.06	0.06	0.03	-0.03	-0.10***	-0.11***
	(4.13)	(3.14)	(2.55)	(1.22)	(-1.01)	(-4.73)	(-5.34)
Wednesday	0.07	0.09	0.12	0.13	0.14	0.07***	0.06***
	(4.36)	(4.62)	(4.99)	(4.85)	(4.42)	(3.11)	(2.89)
Thursday	0.03	0.05	0.06	0.08	0.08	0.04*	0.04
	(2.21)	(2.37)	(2.52)	(2.97)	(2.18)	(1.70)	(1.44)
Friday	0.05	0.06	0.09	0.12	0.15	0.10***	0.09***
	(3.04)	(3.58)	(4.39)	(5.14)	(5.34)	(4.71)	(4.48)

Panel B: Equal-weighted return

	Low-IVOL	2	3	4	High-IVOL	H-L	4-factor alpha
Monday	-0.00	-0.04	-0.07	-0.12	-0.20	-0.19***	-0.20***
	(-0.19)	(-1.70)	(-3.07)	(-4.54)	(-6.45)	(-9.48)	(-9.91)
Tuesday	0.05	0.05	0.04	0.02	-0.04	-0.09***	-0.10***
	(3.86)	(3.18)	(2.37)	(1.06)	(-1.40)	(-5.29)	(-5.81)
Wednesday	0.07	0.10	0.11	0.12	0.11	0.04**	0.04**
	(5.94)	(5.80)	(6.05)	(5.64)	(4.55)	(2.24)	(2.02)
Thursday	0.07	0.08	0.10	0.11	0.10	0.03*	0.02
	(5.05)	(4.81)	(5.06)	(4.59)	(3.66)	(1.85)	(1.30)
Friday	0.08	0.11	0.14	0.17	0.20	0.12***	0.11***
	(7.57)	(7.58)	(8.48)	(9.40)	(9.23)	(7.79)	(7.56)

Table 4. Monday and Friday IVOL Effects across Different Calendar Weeks

In each month from July 1963 to December 2016, we form quintile portfolios sorted on last month's idiosyncratic volatility. We focus on common stocks and exclude stocks with a price less than $5 at the end of last month. Panel A.1 (A.2) reports the value-weighted portfolio return on each Monday (Friday) of the month. Panel B.1 (B.2) reports the equal-weighted portfolio return on each Monday (Friday) of the month. The Carhart (1997) 4-factor alpha of long-short return differential is calculated from the pre-estimated factor loadings and the average daily common factors using daily returns over the past 12 months. Robust Newey and West (1987) t-statistics are reported in brackets. The symbols ∗, ∗∗, ∗∗∗ denote significance at the 10%, 5% and 1% levels, respectively.

Panel A.1: Value-weighted portfolio return on Mondays

	Low-IVOL	2	3	4	High-IVOL	H-L	4-factor alpha
1st Monday	0.04	0.03	-0.03	-0.05	-0.14	-0.18***	-0.18***
	(0.84)	(0.57)	(-0.41)	(-0.76)	(-1.82)	(-3.46)	(-3.83)
2nd Monday	0.08	0.06	0.01	-0.01	-0.07	-0.15***	-0.20***
	(2.09)	(1.29)	(0.29)	(-0.17)	(-1.05)	(-3.10)	(-4.09)
3rd Monday	-0.02	-0.06	-0.11	-0.21	-0.28	-0.25***	-0.25***
	(-0.50)	(-1.31)	(-2.05)	(-3.18)	(-3.79)	(-5.32)	(-5.39)
4th Monday	-0.08	-0.15	-0.20	-0.25	-0.36	-0.28***	-0.28***
	(-2.20)	(-3.30)	(-3.60)	(-4.37)	(-5.37)	(-6.43)	(-5.65)
5th Monday	-0.09	-0.12	-0.17	-0.22	-0.27	-0.18**	-0.14**
	(-1.21)	(-1.38)	(-1.58)	(-1.77)	(-2.03)	(-2.30)	(-2.20)

Panel A.2: Value-weighted portfolio return on Fridays

	Low-IVOL	2	3	4	High-IVOL	H-L	4-factor alpha
1st Friday	0.12	0.14	0.16	0.23	0.25	0.13**	0.12**
	(3.38)	(3.41)	(3.22)	(3.86)	(3.40)	(2.45)	(2.41)
2nd Friday	0.05	0.08	0.11	0.15	0.18	0.12***	0.10***
	(1.53)	(2.04)	(2.45)	(3.09)	(3.26)	(3.43)	(3.08)
3rd Friday	-0.00	-0.02	-0.04	-0.04	-0.01	-0.01	-0.01
	(-0.01)	(-0.55)	(-0.91)	(-0.80)	(-0.20)	(-0.29)	(-0.15)
4th Friday	-0.00	0.03	0.08	0.09	0.13	0.13***	0.13***
	(-0.10)	(0.88)	(2.16)	(1.98)	(2.05)	(2.69)	(2.59)
5th Friday	0.12	0.16	0.26	0.32	0.39	0.27***	0.28***
	(2.16)	(2.50)	(3.65)	(4.58)	(4.74)	(4.72)	(4.25)

Panel B.1: Equal-weighted portfolio return on Mondays

	Low-IVOL	2	3	4	High-IVOL	H-L	4-factor alpha
1st Monday	0.03	0.01	-0.02	-0.06	-0.16	-0.19***	-0.19***
	(0.76)	(0.23)	(-0.32)	(-1.08)	(-2.43)	(-4.43)	(-5.20)
2nd Monday	0.06	0.05	0.02	-0.01	-0.08	-0.14***	-0.16***
	(2.16)	(1.51)	(0.53)	(-0.30)	(-1.50)	(-3.85)	(-4.78)
3rd Monday	-0.03	-0.08	-0.12	-0.18	-0.26	-0.23***	-0.22***
	(-1.09)	(-2.03)	(-2.88)	(-3.71)	(-4.87)	(-6.87)	(-7.14)
4th Monday	-0.07	-0.14	-0.18	-0.24	-0.33	-0.25***	-0.26***
	(-2.54)	(-3.53)	(-4.04)	(-4.83)	(-5.78)	(-7.38)	(-6.48)
5th Monday	-0.02	-0.06	-0.11	-0.16	-0.19	-0.17***	-0.17***
	(-0.41)	(-0.83)	(-1.19)	(-1.65)	(-1.80)	(-2.94)	(-2.99)

Panel B.2: Equal-weighted portfolio return on Fridays

	Low-IVOL	2	3	4	High-IVOL	H-L	4-factor alpha
1st Friday	0.10	0.14	0.18	0.23	0.25	0.15***	0.15***
	(4.19)	(4.24)	(4.67)	(5.34)	(5.21)	(4.58)	(5.08)
2nd Friday	0.08	0.12	0.16	0.20	0.23	0.14***	0.12***
	(3.73)	(3.89)	(4.71)	(5.17)	(5.22)	(4.87)	(4.10)
3rd Friday	0.05	0.05	0.05	0.06	0.06	0.01	0.01
	(2.40)	(1.84)	(1.72)	(1.63)	(1.63)	(0.38)	(0.47)
4th Friday	0.07	0.09	0.13	0.16	0.19	0.12***	0.14***
	(3.37)	(3.21)	(3.84)	(4.02)	(4.15)	(3.74)	(3.96)
5th Friday	0.16	0.25	0.32	0.43	0.52	0.37***	0.37***
	(3.60)	(4.44)	(5.07)	(5.83)	(6.57)	(7.15)	(6.15)

Table 5: Selling Pressure and IVOL Effect on the third Friday and the following Monday

In each month from July 1963 to December 2016, we form quintile portfolios sorted on last month's idiosyncratic volatility (IVOL). We focus on common stocks and exclude stocks with a price less than $5 at the end of last month. For the 1983-2000 sample period, selling pressure is measured as daily order imbalance (OIB), which is defined as buy orders less sell orders divided by the sum of buy and sell orders on a given day. Small (big) OIB is measured using trades that are less (greater) than $10,000. The buy and sell orders are measured in terms of number of trades. In Panel A, we examine the relation between IVOL and the abnormal order imbalance on 3rd Friday (relative to other Fridays) and the Monday following the 3rd Friday (relative to other Mondays). The differences in order imbalance are multiplied by 100. For the 1980-2016 sample period, Panel B.1 (B.2) reports the valued-weighted (equal-weighted) return for portfolios sorted on institutional ownership (3 groups) and IVOL (5 groups), including the 3rd 5-day trading return within a month as well as the buy-and-hold portfolio return for the 3rd Friday and the following Monday. Panel C.1 (C.2) compares the IVOL effects using the valued-weighted (equal-weighed) buy-and-hold portfolio returns for the 3rd Friday and the following Monday, with other Fridays and the following Mondays. The Carhart (1997) 4-factor alphas of long-short returns across the IVOL portfolios are also reported. Robust Newey and West (1987) t-statistics are reported in brackets. The symbols ∗, ∗∗, ∗∗∗ denote significance at the 10%, 5% and 1% levels, respectively.

Panel A: Selling pressure and IVOL (1983-2000)

	3rd Friday – Other Fridays					
	Low-IVOL	2	3	4	High-IVOL	H-L
Difference in	-0.26	-0.76	-0.52	-0.68	-1.34	-1.08***
Small Order Imbalance	(-0.47)	(-1.37)	(-0.85)	(-1.17)	(-2.47)	(-2.93)
Difference in	-0.63	-1.03	-0.94	-1.12	-1.34	-0.72**
Big Order Imbalance	(-1.01)	(-1.77)	(-1.41)	(-1.85)	(-2.49)	(-2.02)
						-0.36*
						(-1.69)
	Monday after 3rd Friday – Other Mondays					
	Low-IVOL	2	3	4	High-IVOL	H-L
Difference in	-0.85	-0.51	-0.85	-1.25	-1.82	-0.97**
Small Order Imbalance	(-1.60)	(-0.99)	(-1.60)	(-2.56)	(-3.88)	(-2.51)
Difference in	-1.74	-1.53	-1.47	-1.74	-2.07	-0.33
Big Order Imbalance	(-2.67)	(-2.39)	(-2.31)	(-2.99)	(-3.90)	(-0.85)
						-0.64***
						(-3.59)

Panel B: Independent double portfolio sorts based on intuitional ownership and IVOL (1980-2016)

	Low-IVOL	2	3	4	High-IVOL	H-L	4-factor alpha
Panel B.1: Value-weighted return							
IO	3rd 5-day trading return						
1	0.27	0.06	0.13	0.01	-0.21	-0.47**	-0.57***
	(2.81)	(0.55)	(0.94)	(0.03)	(-0.97)	(-2.47)	(-2.94)
2	0.31	0.17	0.23	0.02	-0.10	-0.41**	-0.40**
	(3.07)	(1.37)	(1.43)	(0.13)	(-0.48)	(-2.48)	(-2.41)
3	0.28	0.15	0.15	0.13	0.03	-0.24	-0.23
	(2.43)	(1.15)	(0.97)	(0.79)	(0.15)	(-1.59)	(-1.45)
	Return on 3rd Friday and the following Monday						
1	-0.07	-0.13	-0.16	-0.24	-0.34	-0.26**	-0.32***
	(-1.20)	(-1.80)	(-1.71)	(-2.16)	(-2.55)	(-2.38)	(-2.85)
2	-0.07	-0.11	-0.07	-0.23	-0.33	-0.25**	-0.25**
	(-1.28)	(-1.32)	(-0.71)	(-1.97)	(-2.39)	(-2.30)	(-2.30)
3	-0.05	-0.08	-0.09	-0.19	-0.25	-0.20**	-0.19**
	(-0.71)	(-1.04)	(-0.94)	(-1.70)	(-1.90)	(-2.00)	(-1.99)
Panel B.2: Equal-weighted return							
IO	3rd 5-day trading return						
1	0.27	0.23	0.22	0.12	-0.08	-0.35***	-0.39***
	(3.90)	(2.65)	(2.30)	(1.02)	(-0.57)	(-3.15)	(-3.53)
2	0.25	0.22	0.18	0.09	-0.11	-0.36***	-0.39***
	(3.00)	(2.07)	(1.50)	(0.61)	(-0.66)	(-2.92)	(-3.10)
3	0.21	0.14	0.14	0.06	-0.02	-0.23**	-0.24*
	(2.02)	(1.16)	(0.99)	(0.40)	(-0.09)	(-1.97)	(-1.96)
	Return on 3rd Friday and the following Monday						
1	0.00	-0.05	-0.10	-0.20	-0.33	-0.33***	-0.36***
	(0.04)	(-0.83)	(-1.52)	(-2.60)	(-3.57)	(-4.77)	(-5.06)
2	-0.05	-0.10	-0.15	-0.25	-0.35	-0.30***	-0.31***
	(-0.99)	(-1.41)	(-1.94)	(-2.66)	(-3.39)	(-4.08)	(-4.13)
3	-0.09	-0.13	-0.14	-0.23	-0.32	-0.23***	-0.23***
	(-1.34)	(-1.63)	(-1.63)	(-2.30)	(-2.87)	(-3.30)	(-3.31)

Panel C: Return and IVOL

	Low-IVOL	2	3	4	High-IVOL	H-L	4-factor alpha
Panel C.1: Value-weighted return							
				1983-2000			
3rd Friday & the Monday after	-0.15	-0.24	-0.39	-0.52	-0.54	-0.39***	-0.40***
	(-1.17)	(-1.80)	(-2.61)	(-3.10)	(-2.89)	(-3.44)	(-3.31)
Other Friday & Monday after	0.26	0.20	0.17	0.19	0.15	-0.11	-0.12*
	(4.80)	(3.45)	(2.65)	(2.25)	(1.56)	(-1.45)	(-1.72)
Difference	-0.41***	-0.44***	-0.56***	-0.71***	-0.69***	-0.28*	-0.28*
	(-3.08)	(-3.39)	(-3.71)	(-3.90)	(-3.25)	(-1.94)	(-1.94)
				1963-2016			
3rd Friday & the Monday after	-0.11	-0.16	-0.20	-0.27	-0.31	-0.20***	-0.22***
	(-1.79)	(-2.26)	(-2.48)	(-2.79)	(-2.88)	(-2.98)	(-3.21)
Other Friday & Monday after	0.12	0.11	0.08	0.11	0.06	-0.06	-0.08*
	(3.49)	(2.80)	(1.86)	(1.96)	(0.84)	(-1.26)	(-1.82)
Difference	-0.23***	-0.27***	-0.29***	-0.37***	-0.37***	-0.14*	-0.14*
	(-3.16)	(-3.29)	(-2.95)	(-3.20)	(-2.78)	(-1.67)	(-1.67)
Panel C.2: Equal-weighted return							
				1983-2000			
3rd Friday & the Monday after	-0.08	-0.18	-0.24	-0.32	-0.41	-0.33***	-0.35***
	(-1.13)	(-1.88)	(-2.41)	(-2.82)	(-3.29)	(-4.05)	(-4.05)
Other Friday & Monday after	0.15	0.14	0.14	0.15	0.13	-0.01	-0.04
	(4.00)	(2.96)	(2.69)	(2.37)	(1.85)	(-0.27)	(-0.70)
Difference	-0.23***	-0.32***	-0.38***	-0.47***	-0.54***	-0.31***	-0.31***
	(-3.28)	(-3.48)	(-3.82)	(-4.01)	(-3.92)	(-3.18)	(-3.18)
				1963-2016			
3rd Friday & the Monday after	-0.02	-0.07	-0.11	-0.16	-0.24	-0.23***	-0.24***
	(-0.44)	(-1.35)	(-1.87)	(-2.29)	(-3.17)	(-4.70)	(-4.75)
Other Friday & Monday after	0.12	0.12	0.13	0.13	0.09	-0.02	-0.04
	(4.44)	(3.62)	(3.19)	(2.83)	(1.73)	(-0.65)	(-1.12)
Difference	-0.13***	-0.20***	-0.24***	-0.29***	-0.34***	-0.20***	-0.20***
	(-2.90)	(-3.16)	(-3.34)	(-3.45)	(-3.57)	(-3.39)	(-3.39)

Table 6. IVOL Puzzle: Excluding the Selling Pressure Induced by Option Expiration

Panel A (B) reports the value-weighted (equal-weighted) portfolio return for 1973-2016 period. For each month, we form quintile portfolios sorted on last month's idiosyncratic volatility. We focus on common stocks and exclude stocks with a price less than $5 at the end of last month. In Row 1, we report the monthly portfolio return. Row 2 reports the portfolio return on the Monday after the 3rd Friday. Row 3 excludes the Monday following the 3rd Friday of the month when calculating the monthly return and reports the buy-and-hold portfolio return. In Row 4, we report the buy-and-hold portfolio return for the 3rd Friday and the following Monday. Row 5 excludes the 3rd Friday and the following Monday from calculating the monthly return and report the buy-and-hold portfolio return. The Carhart (1997) 4-factor alphas of long-short returns across the IVOL portfolios are also reported. Robust Newey and West (1987) t-statistics are reported in brackets. The symbols ∗, ∗∗, ∗∗∗ denote significance at the 10%, 5% and 1% levels, respectively.

Panel A: Value-weighted return (1973-2016)

	Low-IVOL	2	3	4	High-IVOL	H-L	4-factor alpha
Monthly return	0.94	0.97	0.98	0.94	0.35	-0.59**	-0.73***
	(5.45)	(4.63)	(3.85)	(2.97)	(0.95)	(-2.08)	(-6.48)
The Monday after 3rd Friday	-0.12	-0.15	-0.19	-0.26	-0.34	-0.22***	-0.23***
	(-2.18)	(-2.57)	(-2.90)	(-3.42)	(-3.98)	(-3.89)	(-4.76)
Exclude the Monday after 3rd Friday	1.06	1.13	1.18	1.22	0.72	-0.34	-0.49*
	(6.49)	(5.69)	(4.77)	(3.97)	(1.97)	(-1.21)	(-1.85)
3rd Friday and the Monday after	-0.08	-0.12	-0.13	-0.24	-0.35	-0.27***	-0.29***
	(-1.37)	(-1.71)	(-1.56)	(-2.48)	(-3.04)	(-3.15)	(-3.93)
Exclude the 3rd Friday and the Monday after	1.02	1.10	1.12	1.20	0.76	-0.27	-0.42*
	(6.38)	(5.61)	(4.60)	(4.07)	(2.16)	(-1.02)	(-1.66)

Panel B: Equal-weighted return (1973-2016)

	Low-IVOL	2	3	4	High-IVOL	H-L	4-factor alpha
Monthly return	1.17	1.29	1.34	1.18	0.47	-0.71***	-0.86***
	(6.44)	(5.57)	(5.17)	(3.91)	(1.35)	(-2.93)	(-8.18)
The Monday after 3rd Friday	-0.08	-0.14	-0.18	-0.24	-0.32	-0.25***	-0.26***
	(-2.36)	(-3.19)	(-3.70)	(-4.22)	(-5.22)	(-5.92)	(-7.10)
Exclude the Monday after 3rd Friday	1.25	1.43	1.53	1.43	0.83	-0.42*	-0.62***
	(7.25)	(6.46)	(6.12)	(4.91)	(2.48)	(-1.81)	(-2.74)
3rd Friday and the Monday after	-0.07	-0.13	-0.17	-0.27	-0.39	-0.33***	-0.35***
	(-1.46)	(-2.21)	(-2.53)	(-3.47)	(-4.50)	(-5.51)	(-6.67)
Exclude the 3rd Friday and the Monday after	1.24	1.43	1.53	1.47	0.91	-0.33	-0.51**
	(7.46)	(6.63)	(6.27)	(5.23)	(2.85)	(-1.48)	(-2.37)

Table 7. Fama-MacBeth Regressions

This table reports the average coefficients from monthly Fama-MacBeth regressions for 1973-2016 period. We focus on common stocks and exclude stocks with a price less than $5 at the end of last month. In column (i), the dependent variable is the monthly portfolio return. In column (ii) the dependent variable is the portfolio return on the Monday after the 3rd Friday. Column (iii) excludes the Monday following the 3rd Friday of the month when calculating the monthly return. In column (iv), the dependent variable is the buy-and-hold portfolio return for the 3rd Friday and the following Monday. Column (v) excludes the 3rd Friday and the subsequent Monday when calculating the monthly return. IVOL is the last month's idiosyncratic volatility. Ln(ME) represents the logarithm of market capitalization. Ln(BM) is the logarithm of the book-to-market ratio. $RET_{(-1,0)}$ is the lagged one month return. $RET_{(-12,-2)}$ is the cumulative returns over the second through twelfth months prior to the current month. Robust Newey and West (1987) t-statistics are reported in brackets. The symbols $*$, $**$, $***$ denote significance at the 10%, 5% and 1% levels, respectively.

	Monthly Return	The Monday after 3rd Friday	Exclude the Monday after 3rd Friday	3rd Friday and the following Monday	Exclude the 3rd Friday and the following Monday
	(i)	(ii)	(iii)	(iv)	(v)
Intercept	1.765***	-0.009	1.722***	0.047	1.685***
	(6.66)	(-0.16)	(7.26)	(1.42)	(6.68)
IVOL	-5.107***	-1.694***	-3.161***	-1.318***	-3.590***
	(-5.90)	(-7.31)	(-3.80)	(-7.39)	(-4.19)
Ln(ME)	-0.052*	-0.002	-0.043*	-0.017**	-0.032
	(-1.85)	(-0.25)	(-1.67)	(-2.31)	(-1.16)
Ln(BM)	0.227***	0.072***	0.159**	0.042***	0.191***
	(2.93)	(4.82)	(2.29)	(4.12)	(2.64)
$RET_{(-1,0)}$	-3.417***	0.025	-3.432***	0.025	-3.426***
	(-8.10)	(0.27)	(-8.68)	(0.38)	(-8.53)
$RET_{(-12,-2)}$	0.785***	0.100***	0.679***	0.048*	0.724***
	(4.75)	(3.18)	(4.26)	(1.90)	(4.19)
Avg. Adj R^2	0.051	0.035	0.047	0.036	0.048

Table 8. IVOL Effect and Equity Options

In each month from January 1996 to December 2016, we form quintile portfolios sorted on last month's idiosyncratic volatility (IVOL). We focus on common stocks and exclude stocks with a price less than $5 at the end of last month. Each month, we match stocks with options and stocks without options according to market capitalization. Specifically, we require the stocks with and without options to be in the same CRSP 100 size group. If a stock with options is matched with multiple stocks without options, we keep the one with the closest market capitalization. We report the IVOL sorted value-weighted and equal-weighted monthly portfolio return and the Carhart (1997) 4-factor alpha as well as the difference in returns and alphas across the matched stocks with and without options. Column (5)-(6) report the average IVOL sorted market capitalization of the matched stocks with and without options. Robust Newey and West (1987) t-statistics are reported in brackets. The symbols ∗, ∗∗, ∗∗∗ denote significance at the 10%, 5% and 1% levels, respectively.

	Value-weighted Return			Equal-weighted Return			Ln(market cap)		
	Stocks without options	Stocks with options	Difference	Stocks without options	Stocks with options	Difference	Stocks without options	Stocks with options	Difference
IVOL	(1)	(2)	(2) – (1)	(3)	(4)	(4) – (3)	(5)	(6)	(6) – (5)
Low	0.98	0.82		1.16	0.95		6.87	7.97	
	(3.90)	(3.08)		(5.41)	(3.27)		(190.41)	(161.00)	
2	0.82	0.51		0.97	0.72		6.34	6.97	
	(2.75)	(1.46)		(3.13)	(1.89)		(207.93)	(235.81)	
3	1.15	0.15		0.86	0.51		6.00	6.48	
	(3.31)	(0.37)		(2.41)	(1.21)		(221.18)	(257.18)	
4	1.14	-0.78		0.91	0.09		5.76	6.17	
	(2.47)	(-1.45)		(2.11)	(0.18)		(218.95)	(222.26)	
High	0.58	-1.70		0.31	-0.70		5.60	5.94	
	(0.91)	(-2.50)		(0.55)	(-1.10)		(188.22)	(187.06)	
H-L	-0.40	-2.53^{***}	-2.13^{***}	-0.85^{*}	-1.65^{***}	-0.80^{***}	-1.27^{***}	-2.03^{***}	-0.76^{***}
	(-0.63)	(-4.71)	(-6.54)	(-1.69)	(-3.31)	(-4.53)	(-31.21)	(-36.37)	(-16.29)
4-factor alpha	-0.90^{**}	-2.89^{***}	-1.98^{***}	-0.40	-2.53^{***}	-2.13^{***}			
	(-2.51)	(-9.64)	(-6.31)	(-0.63)	(-4.71)	(-6.54)			

Table 9. IVOL Effect and In-the-Money Equity Options

In each month from January 1996 to December 2016, we form quintile portfolios sorted on last month's idiosyncratic volatility (IVOL). The sample is the same as in Table 8. Panel A reports the average open interest of in-the-money (ITM) call and put options for each portfolio. Open interest is the daily average of total open interests covering all ITM options over three trading days prior to options expiry and is scaled by the total outstanding shares of the underlying stocks. Panel B (C) reports the IVOL sorted value-weighted (equal-weighted) monthly portfolio return and the Carhart (1997) 4-factor alpha for (1) stocks with low ITM open interest of both call and put options, (3) stocks with high ITM open interest of both call and put options, (3) stocks with low ITM open interest of call options, (4) stocks with high ITM open interest of call options, (5) stocks with low ITM open interest of put options, and (6) stocks with high ITM open interest of put options. Robust Newey and West (1987) t-statistics are reported in brackets. The symbols *, **, *** denote significance at the 10%, 5% and 1% levels, respectively.

Panel A: In-the-money option positions

	Low-IVOL	2	3	4	High-IVOL	H-L	t-stat
ITM Call Option Open Interest / Total Stock Shares (%)	0.07	0.08	0.11	0.14	0.24	0.18***	(9.07)
ITM Put Option Open Interest / Total Stock Shares (%)	0.03	0.05	0.08	0.11	0.19	0.15***	(13.85)

Panel B: IVOL, moneyness, and the open interest of equity options (value-weighted return)

	Call and Put options			Call options only			Put options only		
	Stocks with **Low** ITM open interest	Stocks with **High** ITM open interest	Difference High vs. Low ITM open interest	Stocks with **Low** ITM open interest	Stocks with **High** ITM open interest	Difference High vs. Low ITM open interest	Stocks with **Low** ITM open interest	Stocks with **High** ITM open interest	Difference High vs. Low ITM open interest
IVOL	(1)	(2)	(2) – (1)	(3)	(4)	(4) – (3)	(5)	(6)	(6) – (5)
Low	0.77	0.89		0.88	0.76		0.68	0.93	
	(2.95)	(2.85)		(3.42)	(2.59)		(2.37)	(3.21)	
2	0.60	0.28		0.74	0.29		0.54	0.36	
	(1.70)	(0.74)		(2.13)	(0.80)		(1.53)	(0.93)	
3	0.37	-0.07		0.33	-0.02		0.21	0.06	
	(0.97)	(-0.15)		(0.83)	(-0.04)		(0.56)	(0.15)	
4	-0.13	-1.23		-0.09	-1.24		-0.28	-1.10	
	(-0.28)	(-2.09)		(-0.18)	(-2.14)		(-0.62)	(-1.84)	
High	-0.87	-2.09		-0.69	-2.16		-0.56	-2.22	
	(-1.41)	(-2.89)		(-1.06)	(-3.04)		(-0.96)	(-3.01)	
H-L	-1.64***	-2.98***	-1.34***	-1.57***	-2.91***	-1.35***	-1.23**	-3.15***	-1.91***
	(-3.27)	(-5.52)	(-4.84)	(-2.91)	(-5.57)	(-5.29)	(-2.53)	(-5.53)	(-6.60)
4-factor alpha	-1.96***	-3.28***	-1.32***	-1.89***	-3.27***	-1.38***	-1.56***	-3.47***	-1.91***
	(-6.57)	(-9.76)	(-4.91)	(-6.61)	(-10.24)	(-5.33)	(-5.65)	(-10.29)	(-6.97)

Panel C: IVOL, moneyness, and the open interest of equity options (equal-weighted return)

	Call and Put options			Call options only			Put options only		
	Stocks with **Low** ITM open interest	Stocks with **High** ITM open interest	Difference High vs. Low ITM open interest	Stocks with **Low** ITM open interest	Stocks with **High** ITM open interest	Difference High vs. Low ITM open interest	Stocks with **Low** ITM open interest	Stocks with **High** ITM open interest	Difference High vs. Low ITM open interest
IVOL	(1)	(2)	(2) − (1)	(3)	(4)	(4) − (3)	(5)	(6)	(6) − (5)
Low	0.97	0.92		0.96	0.93		0.95	0.96	
	(3.38)	(3.04)		(3.26)	(3.17)		(3.30)	(3.10)	
2	0.87	0.52		0.86	0.52		0.83	0.57	
	(2.32)	(1.29)		(2.26)	(1.33)		(2.28)	(1.38)	
3	0.69	0.31		0.65	0.34		0.62	0.41	
	(1.60)	(0.68)		(1.54)	(0.76)		(1.49)	(0.91)	
4	0.60	-0.36		0.53	-0.34		0.49	-0.23	
	(1.26)	(-0.66)		(1.08)	(-0.64)		(1.05)	(-0.42)	
High	-0.15	-1.03		-0.06	-1.11		0.01	-1.12	
	(-0.25)	(-1.54)		(-0.11)	(-1.68)		(0.01)	(-1.65)	
H-L	-1.12**	-1.96***	-0.83***	-1.03**	-2.04***	-1.01***	-0.94**	-2.08***	-1.14***
	(-2.43)	(-3.91)	(-4.17)	(-2.24)	(-4.07)	(-5.28)	(-2.00)	(-4.09)	(-5.66)
4-factor alpha	-1.35***	-2.22***	-0.86***	-1.20***	-2.34***	-1.14***	-1.21***	-2.34***	-1.13***
	(-5.30)	(-8.58)	(-4.15)	(-5.09)	(-9.25)	(-6.69)	(-4.90)	(-8.63)	(-5.65)

Table 10. Arbitrage Asymmetry and IVOL Puzzle

In each month from January 1973 to December 2016, we form 5x5 portfolios, by independently sorting on the last month's idiosyncratic volatility (IVOL) and the mispricing score. The mispricing score is from Stambaugh, Yu, and Yuan (2015). We focus on common stocks and exclude stocks with a price less than $5 at the end of last month. The value-weighted portfolio return for each idiosyncratic volatility group is reported for the most underpriced and most overpriced stocks in Panels A.1-A3. Panel A.1 reports the monthly returns; Panel A.2 reports returns on the Monday following the 3rd Friday; and Panel A.3 excludes returns from the Monday following the 3rd Friday when calculating the monthly returns. Panel B.1-B.3 report the corresponding results for equal-weighted portfolios. The Carhart (1997) 4-factor alphas of long-short returns across the IVOL portfolios are also reported. Robust Newey and West (1987) t-statistics are reported in brackets. The symbols ∗, ∗∗, ∗∗∗ denote significance at the 10%, 5% and 1% levels, respectively.

Panel A.1: Value-weighted monthly portfolio return

	Low-IVOL	2	3	4	High-IVOL	H-L	4-factor alpha
Most Underpriced	0.97	1.20	1.39	1.58	1.40	0.43*	0.31
	(5.41)	(6.02)	(6.17)	(5.54)	(4.41)	(1.71)	(1.52)
Most Overpriced	0.77	0.64	0.56	0.19	-0.82	-1.60***	-1.68***
	(3.84)	(2.43)	(1.73)	(0.52)	(-1.81)	(-4.52)	(-6.85)

Panel A.2: Value-weighted portfolio return on the Monday following the 3rd Friday

	Low-IVOL	2	3	4	High-IVOL	H-L	4-factor alpha
Most Underpriced	-0.09	-0.08	-0.13	-0.13	-0.19	-0.10**	-0.13**
	(-1.48)	(-1.43)	(-2.01)	(-1.78)	(-2.37)	(-1.99)	(-2.32)
Most Overpriced	-0.17	-0.22	-0.25	-0.40	-0.47	-0.30***	-0.29***
	(-3.37)	(-3.34)	(-3.00)	(-4.95)	(-5.51)	(-4.62)	(-4.53)

Panel A.3: Value-weighted monthly portfolio return & skip the Monday following the 3rd Friday

	Low-IVOL	2	3	4	High-IVOL	H-L	4-factor alpha
Most Underpriced	1.06	1.26	1.53	1.74	1.66	0.60**	0.42*
	(6.36)	(6.63)	(6.73)	(6.37)	(5.38)	(2.48)	(2.05)
Most Overpriced	1.02	0.78	0.87	0.74	-0.05	-1.07***	-1.40***
	(4.91)	(2.86)	(2.75)	(2.08)	(-0.12)	(-3.21)	(-5.67)

Panel B.1: Equal-weighted monthly portfolio return

	Low-IVOL	2	3	4	High-IVOL	H-L	4-factor alpha
Most Underpriced	1.36	1.53	1.73	1.81	1.57	0.21	-0.01
	(7.43)	(7.15)	(7.22)	(6.72)	(5.23)	(1.13)	(-0.08)
Most Overpriced	0.91	0.88	0.83	0.56	-0.58	-1.49***	-1.46***
	(4.58)	(3.42)	(2.78)	(1.67)	(-1.46)	(-5.06)	(-8.20)

Panel B.2: Equal-weighted portfolio return on the Monday following the 3rd Friday

	Low-IVOL	2	3	4	High-IVOL	H-L	4-factor alpha
Most Underpriced	-0.07	-0.10	-0.12	-0.15	-0.22	-0.15***	-0.16***
	(-1.89)	(-2.32)	(-2.47)	(-2.84)	(-3.66)	(-4.08)	(-4.34)
Most Overpriced	-0.11	-0.19	-0.25	-0.34	-0.42	-0.31***	-0.31***
	(-3.18)	(-4.15)	(-4.71)	(-5.28)	(-6.19)	(-6.73)	(-6.65)

Panel B.3: Equal-weighted monthly portfolio return & skip the Monday following the 3rd Friday

	Low-IVOL	2	3	4	High-IVOL	H-L	4-factor alpha
Most Underpriced	1.45	1.64	1.84	2.03	1.93	0.47**	0.21
	(8.26)	(7.98)	(7.98)	(7.76)	(6.41)	(2.44)	(1.00)
Most Overpriced	0.99	1.01	1.07	0.97	0.15	-0.84***	-0.85***
	(5.13)	(4.00)	(3.70)	(3.06)	(0.42)	(-3.22)	(-3.01)

Internet Appendix Table IA.1
Selling Pressure and IVOL: Alternative Measures

During the 1983-2000 sample period, we form quintile portfolios sorted on last month's idiosyncratic volatility (IVOL). We focus on common stocks and exclude stocks with a price less than $5 at the end of last month. For the 1983-2000 sample period, selling pressure is measured as daily order imbalance (OIB), which is defined as buy orders less sell orders divided by the sum of buy and sell orders on a given day. Small (big) OIB is measured using trades that are less (greater) than $10,000. Panel A (B) reports the results for the buy and sell orders measured as number of shares traded (dollars traded). The differences in order imbalance are multiplied by 100. We examine the relation between IVOL and the abnormal order imbalance on 3rd Friday (relative to other Fridays) and the Monday after 3rd Friday (relative to other Mondays). The differences in order imbalance are multiplied by 100. Robust Newey and West (1987) t-statistics are reported in brackets. The symbols ∗, ∗∗, ∗∗∗ denote significance at the 10%, 5% and 1% levels, respectively.

Panel A: Buy and sell orders measured as number of shares traded

	3rd Friday – Other Fridays					
	Low-IVOL	2	3	4	High-IVOL	H-L
Difference in	-0.31	-0.80	-0.43	-0.59	-1.33	-1.02***
Small Order Imbalance	(-0.54)	(-1.35)	(-0.65)	(-0.92)	(-2.34)	(-2.70)
Difference in	-0.44	-0.69	-0.57	-1.17	-1.30	-0.86*
Big Order Imbalance	(-0.59)	(-1.02)	(-0.74)	(-1.68)	(-2.01)	(-1.94)
						-0.16
						(-0.38)
	Monday after 3rd Friday – Other Mondays					
	Low-IVOL	2	3	4	High-IVOL	H-L
Difference in	-0.91	-0.65	-1.11	-1.59	-1.98	-1.07**
Small Order Imbalance	(-1.61)	(-1.19)	(-1.99)	(-2.92)	(-3.78)	(-2.55)
Difference in	-2.84	-2.27	-2.45	-2.37	-2.75	0.10
Big Order Imbalance	(-3.67)	(-3.09)	(-3.18)	(-3.36)	(-3.97)	(0.23)
						-1.17***
						(-3.28)

Panel B: Buy and sell orders measured as dollar traded

	3rd Friday – Other Fridays					
	Low-IVOL	2	3	4	High-IVOL	H-L
Difference in	-0.31	-0.80	-0.43	-0.59	-1.33	-1.02***
Small Order Imbalance	(-0.55)	(-1.35)	(-0.65)	(-0.92)	(-2.33)	(-2.70)
Difference in	-0.44	-0.69	-0.57	-1.17	-1.30	-0.86*
Big Order Imbalance	(-0.59)	(-1.02)	(-0.74)	(-1.67)	(-2.00)	(-1.94)
						-0.16
						(-0.37)
	Monday after 3rd Friday – Other Mondays					
	Low-IVOL	2	3	4	High-IVOL	H-L
Difference in	-0.91	-0.66	-1.11	-1.59	-1.98	-1.07**
Small Order Imbalance	(-1.61)	(-1.20)	(-1.99)	(-2.92)	(-3.78)	(-2.55)
Difference in	-2.84	-2.27	-2.45	-2.37	-2.75	0.10
Big Order Imbalance	(-3.67)	(-3.09)	(-3.19)	(-3.36)	(-3.97)	(0.23)
						-1.17***
						(-3.28)

Internet Appendix Table IA.2
Subperiod Results

Panel A (B) reports the value-weighted (equal-weighted) portfolio return for the 1973-1983, 1984-1994, 1995-2005, and 2006-2016 subperiods. In each month, we form quintile portfolios sorted on last month's idiosyncratic volatility. We focus on common stocks and exclude stocks with a price less than $5 at the end of last month. We report the monthly portfolio return, the buy-and-hold portfolio return for the 3rd Friday and the Monday after, and the monthly buy-and-hold portfolio return excluding the 3rd Friday and the following Monday. Robust Newey and West (1987) t-statistics are reported in brackets. The symbols ∗, ∗∗, ∗∗∗ denote significance at the 10%, 5% and 1% levels, respectively.

Panel A: Value-weighted return	Low-IVOL	2	3	4	High-IVOL	H-L	4-factor alpha
			1973-1983				
Monthly return	0.59	0.97	1.15	1.14	0.47	-0.12	-0.65**
	(1.60)	(2.14)	(2.16)	(1.81)	(0.68)	(-0.26)	(-2.06)
3rd Friday and the Monday after	-0.06	-0.12	-0.18	-0.27	-0.48	-0.42***	-0.46***
	(-0.57)	(-1.05)	(-1.50)	(-2.04)	(-3.00)	(-4.61)	(-5.29)
Exclude the 3rd Friday and the Monday after	0.64	1.09	1.33	1.41	0.95	0.31	-0.09
	(1.86)	(2.45)	(2.55)	(2.36)	(1.44)	(0.69)	(-0.18)
			1984-1994				
Monthly return	1.19	1.16	1.23	1.03	0.22	-0.96***	-0.67***
	(3.80)	(3.11)	(2.80)	(2.04)	(0.43)	(-3.09)	(-3.73)
3rd Friday and the Monday after	-0.30	-0.42	-0.50	-0.62	-0.73	-0.42***	-0.40***
	(-2.44)	(-2.87)	(-3.12)	(-3.11)	(-3.76)	(-3.88)	(-3.52)
Exclude the 3rd Friday and the Monday after	1.49	1.59	1.73	1.67	0.97	-0.52*	-0.29
	(5.45)	(5.02)	(4.65)	(3.88)	(2.32)	(-1.89)	(-0.92)
			1995-2005				
Monthly return	1.21	0.99	0.95	0.86	0.35	-0.85	-0.81*
	(3.87)	(2.76)	(1.98)	(1.26)	(0.39)	(-1.06)	(-1.81)
3rd Friday and the Monday after	0.02	0.02	0.01	-0.20	-0.41	-0.43*	-0.40
	(0.16)	(0.10)	(0.04)	(-0.89)	(-1.36)	(-1.70)	(-1.62)
Exclude the 3rd Friday and the Monday after	1.20	0.98	0.96	1.06	0.76	-0.44	-0.34
	(4.64)	(3.16)	(2.30)	(1.81)	(0.95)	(-0.64)	(-0.43)
			2006-2016				
Monthly return	0.76	0.74	0.54	0.74	0.41	-0.35	-0.73**
	(2.02)	(1.50)	(0.92)	(1.03)	(0.48)	(-0.64)	(-2.22)
3rd Friday and the Monday after	0.03	0.06	0.20	0.18	0.25	0.22	0.18
	(0.37)	(0.49)	(1.45)	(1.15)	(1.16)	(1.31)	(1.06)
Exclude the 3rd Friday and the Monday after	0.73	0.72	0.41	0.62	0.30	-0.43	-0.72
	(1.96)	(1.51)	(0.68)	(0.86)	(0.35)	(-0.75)	(-1.29)

Panel B: Equal-weighted return	Low-IVOL	2	3	4	High-IVOL	H-L	4-factor alpha
				1973-1983			
Monthly return	1.20	1.56	1.76	1.71	0.81	-0.38	-0.80***
	(2.79)	(2.93)	(2.90)	(2.46)	(1.10)	(-0.93)	(-2.96)
3rd Friday and the Monday after	-0.06	-0.16	-0.21	-0.34	-0.53	-0.48***	-0.51***
	(-0.86)	(-1.63)	(-1.77)	(-2.51)	(-3.64)	(-5.40)	(-5.85)
Exclude the 3rd Friday and the Monday after	1.23	1.72	1.97	2.04	1.36	0.12	-0.21
	(3.17)	(3.47)	(3.45)	(3.16)	(1.96)	(0.32)	(-0.42)
				1984-1994			
Monthly return	1.17	1.26	1.29	1.02	0.21	-0.97***	-0.74***
	(3.57)	(2.97)	(2.75)	(1.97)	(0.41)	(-3.94)	(-6.11)
3rd Friday and the Monday after	-0.28	-0.44	-0.51	-0.60	-0.66	-0.38***	-0.38***
	(-2.57)	(-3.05)	(-3.36)	(-3.48)	(-4.03)	(-5.68)	(-5.37)
Exclude the 3rd Friday and the Monday after	1.44	1.69	1.80	1.63	0.93	-0.51**	-0.45*
	(5.43)	(4.85)	(4.56)	(3.80)	(2.17)	(-2.29)	(-1.78)
				1995-2005			
Monthly return	1.39	1.45	1.46	1.27	0.63	-0.76	-0.80***
	(4.61)	(4.24)	(3.76)	(2.35)	(0.80)	(-1.02)	(-2.97)
3rd Friday and the Monday after	0.03	0.02	-0.04	-0.18	-0.38	-0.41**	-0.39**
	(0.43)	(0.17)	(-0.32)	(-1.15)	(-1.81)	(-2.33)	(-2.08)
Exclude the 3rd Friday and the Monday after	1.36	1.44	1.52	1.46	1.03	-0.32	-0.15
	(5.04)	(4.61)	(4.26)	(2.96)	(1.46)	(-0.49)	(-0.20)
				2006-2016			
Monthly return	0.91	0.84	0.81	0.69	0.19	-0.72**	-0.93***
	(2.35)	(1.59)	(1.40)	(1.08)	(0.28)	(-2.17)	(-5.75)
3rd Friday and the Monday after	0.05	0.07	0.10	0.07	0.04	-0.01	-0.03
	(0.60)	(0.61)	(0.83)	(0.53)	(0.30)	(-0.11)	(-0.35)
Exclude the 3rd Friday and the Monday after	0.88	0.80	0.76	0.68	0.25	-0.63*	-0.74**
	(2.29)	(1.53)	(1.32)	(1.07)	(0.38)	(-1.90)	(-2.28)

Internet Appendix Table IA.3
IVOL Effect and Equity Options: Unmatched Results and Alternative Matching Methods

In each month from January 1996 to December 2016, we form quintile portfolios sorted on last month's idiosyncratic volatility (IVOL). We focus on common stocks and exclude stocks with a price less than $5 at the end of last month. Panel A reports the IVOL effect for stocks with and without options. Panel A also reports the IVOL sorted market capitalization of the stocks with and without options. In Panel B, each month, we match stocks with options and stocks without options according to market capitalization and industry using Fama-French 12 industry classification. Specifically, we require the stocks with and without options to be in the same CRSP 100 size group and the same industry. If a stock with options is matched with multiple stocks without options, we keep the one with the closest market capitalization. In Panel C the matching is done on the basis of size (10 groups), liquidity (10 groups) and industry. We report the IVOL sorted value-weighted and equal-weighted monthly portfolio return and the Carhart (1997) 4-factor alpha as well as the difference in returns and alphas across the matched stocks with and without options. Robust Newey and West (1987) t-statistics are reported in brackets. The symbols ∗, ∗∗, ∗∗∗ denote significance at the 10%, 5% and 1% levels, respectively.

Panel A: Unmatched sample

	Value-weighted return			Equal-weighted return			Ln(market cap)		
	Stocks without options	Stocks with options	Difference	Stocks without options	Stocks with options	Difference	Stocks without options	Stocks with options	Difference
IVOL	(1)	(2)	(2) – (1)	(3)	(4)	(4) – (3)	(5)	(6)	(6) – (5)
Low	0.99	0.89		1.15	1.04		5.37	8.37	
	(4.25)	(3.52)		(5.14)	(3.74)		(124.27)	(238.71)	
2	0.90	0.78		1.17	0.98		5.20	7.77	
	(3.16)	(2.47)		(3.98)	(2.80)		(141.45)	(255.86)	
3	1.12	0.64		1.18	0.97		4.99	7.25	
	(3.48)	(1.61)		(3.68)	(2.37)		(149.76)	(218.39)	
4	1.04	0.69		1.02	0.77		4.81	6.83	
	(2.38)	(1.32)		(2.67)	(1.54)		(157.19)	(192.48)	
High	0.53	0.27		0.47	0.21		4.59	6.43	
	(0.86)	(0.41)		(0.92)	(0.33)		(126.57)	(169.96)	
H-L	-0.46	-0.62	-0.16	-0.68	-0.83*	-0.15	-0.77***	-1.94***	-1.16***
	(-0.78)	(-1.20)	(-0.43)	(-1.55)	(-1.65)	(-0.59)	(-13.52)	(-54.42)	(-21.28)
4-factor alpha	-0.98***	-0.89***	0.08	-1.04***	-1.08***	-0.05			
	(-2.98)	(-3.05)	(0.24)	(-4.47)	(-4.79)	(-0.22)			

Panel B: Matched (by size and industry) sample

	Value-weighted Return			Equal-weighted Return		
	Stocks without options	Stocks with options	Difference	Stocks without options	Stocks with options	Difference
IVOL	(1)	(2)	(2) – (1)	(3)	(4)	(4) – (3)
Low	1.12	0.57		1.59	0.86	
	(4.35)	(1.72)		(6.85)	(2.96)	
2	1.04	0.16		1.53	0.47	
	(3.47)	(0.34)		(4.93)	(1.15)	
3	1.64	-0.31		1.93	-0.06	
	(4.68)	(-0.74)		(5.47)	(-0.14)	
4	1.88	-1.24		2.58	-0.54	
	(3.85)	(-2.14)		(5.53)	(-1.03)	
High	1.74	-2.24		2.95	-1.37	
	(2.60)	(-3.06)		(4.50)	(-2.00)	
H-L	0.62	-2.81***	-3.43***	1.36**	-2.24***	-3.60***
	(0.94)	(-4.50)	(-9.30)	(2.19)	(-3.82)	(-12.03)
4-factor alpha	0.08	-3.11***	-3.19***	0.95***	-2.50***	-3.45***
	(0.22)	(-8.81)	(-8.29)	(2.62)	(-8.72)	(-11.72)

Panel C: Matched (by size, liquidity, and industry) sample

	Value-weighted Return			Equal-weighted Return		
	Stocks without options	Stocks with options	Difference	Stocks without options	Stocks with options	Difference
IVOL	(1)	(2)	(2) – (1)	(3)	(4)	(4) – (3)
Low	1.05	1.01		1.19	1.08	
	(4.12)	(3.38)		(5.55)	(3.63)	
2	0.68	0.90		1.05	1.10	
	(2.31)	(2.41)		(3.32)	(2.84)	
3	1.08	0.85		1.01	0.88	
	(3.07)	(2.16)		(2.55)	(2.01)	
4	1.29	0.64		1.36	0.69	
	(2.63)	(1.19)		(2.74)	(1.32)	
High	1.37	0.04		1.18	0.10	
	(1.89)	(0.05)		(1.83)	(0.15)	
H-L	0.33	-0.98	-1.30***	-0.01	-0.98*	-0.97***
	(0.45)	(-1.49)	(-3.30)	(-0.02)	(-1.65)	(-3.03)
4-factor alpha	-0.30	-1.29***	-0.99**	-0.45	-1.18***	-0.74**
	(-0.73)	(-3.16)	(-2.35)	(-1.46)	(-3.39)	(-2.32)

Internet Appendix Table IA.4
IVOL Effect: Return pattern after Option Expiration

In each month from January 1996 to December 2016, we form quintile portfolios sorted on last month's idiosyncratic volatility (IVOL). We focus on common stocks and exclude stocks with a price less than $5 at the end of last month. Each month, within each IVOL quintile, we match stocks with options and stocks without options according to market capitalization. Specifically, we require the optionable and non-optionable stocks to be in the same CRSP 100 size group. If an optionable stock is matched with multiple non-optionable stocks, we keep the one with closest market capitalization. If an optionable stock is not matched with any non-optionable stock, it is excluded from the sample. We focus on this matched sample and examine the reversal after the option expiration. Specifically, we compare the IVOL effect on the 4th 5-day trading return with IVOL effect on the other 5-day trading returns. Panel A present the IVOL sorted value-weighted raw portfolio return of the average other 5-day trading return, the 4th 5-day trading return, and the difference of the full matched sample. Panel B (C) presents the IVOL sorted value-weighted raw portfolio return of the average other 5-day trading return, the 4th 5-day trading return, and the difference of the matched optionable (non-optionable) sample. Panel D presents the reversal in IVOL effects after option expiration for optionable and non-optionable sample and compares the difference. Robust Newey and West (1987) t-statistics are reported in brackets. The symbols $*$, $**$, $***$ denote significance at the 10%, 5% and 1% levels, respectively.

Panel A: Value-weighted raw return (January 1996-December 2016)

	Low-IVOL	2	3	4	High-IVOL	H-L
Average other 5-day trading return	0.23	0.09	0.01	-0.19	-0.40	-0.63***
	(2.53)	(0.72)	(0.07)	(-1.13)	(-1.86)	(-4.03)
4th 5-day trading return	0.06	0.13	0.12	0.05	-0.08	-0.14
	(0.48)	(0.83)	(0.70)	(0.25)	(-0.31)	(-0.69)
Difference	-0.17	0.04	0.11	0.25	0.32	0.48*
	(-1.07)	(0.21)	(0.50)	(0.93)	(0.97)	(1.93)

Panel B: Value-weighted raw return (Optionable sample)

	Low-IVOL	2	3	4	High-IVOL	H-L
Average other 5-day trading return	0.23	0.07	-0.04	-0.28	-0.54	-0.77***
	(2.54)	(0.60)	(-0.25)	(-1.56)	(-2.46)	(-4.89)
4th 5-day trading return	0.04	0.09	0.07	-0.04	-0.18	-0.23
	(0.31)	(0.59)	(0.38)	(-0.18)	(-0.70)	(-1.07)
Difference	-0.19	0.02	0.10	0.24	0.36	0.55**
	(-1.20)	(0.10)	(0.44)	(0.86)	(1.07)	(2.13)

Panel C: Value-weighted raw return (Non-optionable sample)

	Low-IVOL	2	3	4	High-IVOL	H-L
Average other 5-day trading return	0.15	0.12	0.22	0.16	0.10	-0.04
	(1.62)	(1.09)	(1.97)	(1.09)	(0.52)	(-0.22)
4th 5-day trading return	0.35	0.32	0.34	0.43	0.30	-0.05
	(2.63)	(2.39)	(1.92)	(2.06)	(1.10)	(-0.20)
Difference	0.20	0.20	0.12	0.28	0.19	-0.01
	(1.15)	(1.13)	(0.57)	(1.17)	(0.60)	(-0.04)

Panel D: Value-weighted return pattern difference (Optionable vs. Non-optionable sample)

	Low-IVOL	2	3	4	High-IVOL	H-L
Non-option sample	0.20	0.20	0.12	0.28	0.19	-0.01
	(1.15)	(1.13)	(0.57)	(1.17)	(0.60)	(-0.04)
Option Sample	-0.19	0.02	0.10	0.24	0.36	0.55**
	(-1.20)	(0.10)	(0.44)	(0.86)	(1.07)	(2.13)
Difference	-0.40***	-0.18	-0.02	-0.03	0.16	0.56**
	(-2.71)	(-1.62)	(-0.14)	(-0.23)	(1.07)	(2.44)