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Do option open-interest changes foreshadow future equity returns?

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Abstract Recent work considers whether information is simultaneously reflected in both option and equity markets. We provide new evidence supporting Black's (Financ. Anal. J. 31:36–72, 1975) conjecture that information is first revealed in option markets. Specifically, changes in call and put open-interest levels have predictive power for future equity returns. Large increases in call open interest are followed by significantly increased equity returns. Put open-interest increases precede weaker future returns, but the relationship is considerably less pronounced in the presence of certain controls. The recent change in the call-to-put open-interest ratio has predictive power as to equity returns over the following week, even after controlling for numerous factors.

Keywords Options · Open interest · Market efficiency · Investor sentiment

JEL Classification G11 · G12 · G14

1 Introduction

The information flow between equity and option markets has received increased attention in recent years. Findings by Bali (2008), Cremers and Weinbaum (2010), and

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Doran and Krieger (2010) show that information flows from option markets to equity markets, reflected first by volatility or option price movements. These changes can forecast the direction of underlying equity price movements, depending on the location and degree of option information gathered from across the volatility skew. Other work, including Damodaran (1990), Bruand (1996), and Gibson and Zimmermann (1996), demonstrates the general connectedness of stock and option markets with respect to pricing efficiency and risk. Despite progress in this area of research, questions remain. What mechanisms drive changes in option markets and what subsequent changes are visible in equity markets? What characteristics are manifested by these mechanisms?

The literature relating the forecastability of equity returns to the trading characteristics of markets has developed along multiple fronts, both theoretical and empirical. Equity volume was initially investigated as a potential precursor to the movement of equity prices, but the potential leverage provided by option markets, as first noted by Black (1975), allowed researchers an additional avenue to consider. Additional trading properties, including adjusted volumes, open interest, and put/call differentials have become more visible recently, and numerous researchers have utilized special data sets and investigated trading characteristics surrounding specific events.

Easley and O'Hara (1988) develop a theoretical model that demonstrates the importance of equity trade size in suggesting further movements in equity markets. Trade size is correlated with private information and thus those with superior information desire to execute notably larger trades. The model determines that transaction prices rise after block buys and decline after block sales as market makers anticipate large trades to be indicative of superior information.

Along with Black's (1975) leverage argument for the sustainability of option markets, other authors note advantages to derivative trading. Cox and Rubenstein (1985), for example, describe potential savings in trading costs, and Diamond and Verrecchia (1987) show the ability of option trading to overcome short-sale restrictions. Such developments encouraged Easley et al. (1998) to further extend a model that describes the importance of option volume in forecasting equity prices. This model considers the impact of increased volume to be reflective of "good news" or "bad news," and considers both calls and puts; thus, it is viewed as an improvement on the initial work of Stephan and Whaley (1990). If option markets provide a more favorable environment for trading, investors may first reveal their preferences there, and Easley et al. (1998) conclude that option volumes do, in fact, portend information about future stock prices. Informed traders who buy (sell) calls or sell (buy) puts appear to have positive (negative) information about future stock prices. In their empirical work, Easley et al. (1998) reject the hypothesis that option volumes carry no information about future stock price changes when they consider the aggregate of "good news" versus "bad news" option trades. They do not expect overall option volume to be indicative of stock price movements, as there are many motivations for option trades, but when they classify trades executing below (above) the halfway point in the bid-ask spread as sells (buys), the aggregate volume significantly Granger causes (see Granger 1969; Granger and Newbold 1977) movements of stock prices over the intraday periods from October and November 1990.

Black (1975) and Manaster and Rendleman (1982) initially theorized and demonstrated the use of option markets as a superior location for information trading, based on increased available leverage. Using Hasbrouck's (1995) methodology for determining "information share," Chakravarty et al. (2004) determine that option markets provide an average of 17% of information discovery in equity prices, based on volume and various spreads. To do so, they describe the importance of focusing on the permanent component of stock price changes as this movement is indicative of the impact of real information.

Findings regarding the importance of option volume for future equity prices do not uniformly support a linkage, even over very short intervals. Chan et al. (2002), for example, find no lead effect of option volume for stock returns (though they do document a strong link of returns to stock-net-trade volume). Vijh (1990) determines that large option trades have a very small effect on equity prices, though Srinivas (1993) describes a considerably stronger link after taking exception to Vijh's sample selection.

In an effort to reconcile previous work, Pan and Poteshman (2006) utilize data from 1990 through 2001 and consider long-minus-short stock portfolios formed based on put-call volume ratio. Investing in firms with low put-to-call ratios while shorting firms with high ratios results in highly statistically significant adjusted returns. These results, however, are based on a unique data set that notes whether the initiator of a trade is the buyer or seller and, furthermore, whether he or she is opening or closing a position. Given the private nature of the data, no market inefficiency need exist. Pan and Poteshman (2006) find that full-service brokerage houses provide considerably stronger option signals than discount brokerage houses, which they find plausible given the concentration of hedge funds under the full-service umbrella. Alternatively, publicly visible option volume data, based on an algorithm similar to Easley et al. (1998), also has predictive power for stock returns, but only for a day. Furthermore, in regressions of future equity returns on both forms of information, the public portion of the information is subsumed by the impact of the private portion.

Another branch of the literature detailing the link between option market characteristics and equity returns considers the market characteristics surrounding certain events. Cao and Yang (2009) develop a theoretical model that demonstrates increased utility for investors when options are introduced. They hypothesize that option trading volume should increase near public events, like mergers and acquisitions, earnings announcements, and credit rating changes. Furthermore, trading volume should be higher for optionable stocks as investors may use the equity to hedge their positions in options markets.

A number of empirical papers seek to explain the interaction of option market characteristics and equity returns surrounding notable events. Amin and Lee (1997) find that more long (short) positions are undertaken in the options market immediately before positive (negative) earnings reports. Cao et al. (2005) find that higher preannouncement volume of call options portends increased takeover premiums for M&A targets, but they do not detect much information in option volumes at nonevent times. Arnold et al. (2006) describe how, in the absence of an option market for an underlying stock, abnormal stock volume exists for target firms prior to cash tender offer announcements. However, when option markets are present for a firm, the volume effect of stock markets dissipates and the increased option volume emerges at an earlier point than the would-be uptick in stock volume (13 days prior to the tender offer, rather than 10 days in stock markets when no option markets exist).

The lead-volume effect of option markets has been linked to other informational events as well, including the terrorist attacks of September 11, 2001. Poteshman (2006) documents an abnormally high level of put buying in the days preceding the attacks, consistent with informed trading. Put-call ratios greater than 6, in the case of American Airlines, and over 25, in the case of United Airlines, were present on September 6, 2001. These ratios are shown to be statistically significant and indicative of early trading in options markets.

The importance of both option and equity volume as lead indicators of equity prices is discussed throughout the literature, but the impact of open interest is a more recent and less developed topic. In their study of takeover announcements, Launois and Van Oppens (2003) note the advantages of utilizing open interest as representative of market activity, rather than volume. Open interest is less volatile than volume and, moreover, open interest is not affected by very short-term, intraday speculation. Lakonishok et al. (2007) describe the distribution of option open interest among investors by utilizing a unique data set to describe the open-interest characteristics of contracts by investor class. They obtain classifications for firm proprietary traders, public customers of full-service brokers, public customers of discount brokers, and other public customers, and analyze daily open-interest levels from 1990 through 2001. They determine that full-service customers, who provide the majority of non-market-maker transactions, have more written than purchased open interest. Firm proprietary traders, discount customers, and other public customers have greater purchased than written open interest. Finally, non-market-maker investors have four times as much purchased call as purchased put open interest.

Early efforts to specifically link option open interest to equity returns centered on the dynamics surrounding certain events. Results are varied. Schachter (1988) believes option open interest might provide insight into equity returns and finds a significant drop in abnormal option open interest prior to earnings announcements. This effect is particularly prevalent in options with short time to maturity and those most sensitive to volatility changes.

In studying merger announcements, Jayaraman et al. (2001) find an increase in trading activity of both calls and puts for firms before public announcements or publicized rumors. This activity precedes abnormal trading activity in equity markets. Studying a sample of 33 announcements, the authors note increased abnormal open interest and volume preceding the announcements.

Chesney et al. (2009) focus on puts and stock market crashes. Looking at the period 1996–2006, the authors consider 14 companies and study the importance of increased daily open interest. The results are verified with a sample of European firms. The authors concentrate on put open interest and find that when large, day-to-day increases occur, not indicative of hedging activity, most significantly positive subsequent equity returns are due to the announcement effects of M&A announcements, earnings announcements, quarterly financial statements, and the September 11, 2001 terrorist attacks.

Other recent work explores the connection between option open interest and equity markets outside the periods surrounding major corporate events. Bhuyan and

Chaudhury (2005) study 30 firms from February to July 1999. They use open interest of near-maturity equity options to create a number of portfolios based on call and put characteristics and, in so doing, outperform the S&P 500, passive covered call, and buy-and-hold strategies based on the underlying stocks. However, the period of measured performance is notably short, and the impact of option open-interest characteristics on equity returns is not directly tested.

Bhuyan and Yan (2002) develop stock price predictors based on option open interest and volume characteristics. Srivastava (2004) verifies these findings in the context of the Indian stock and option markets and notes that option open interest is superior to option volume in predicting equity prices while utilizing logarithmic regressions; however, these studies' sample sizes are small and cover only brief periods while failing to control for typical factors believed to affect asset prices.

We hypothesize that option traders will demand relatively more (fewer) call (put) options when they believe the underlying asset will perform well in the near future and, conversely, that option traders demand relatively more (fewer) put (call) options when they believe the underlying asset will perform poorly in the near future. We hypothesize that these demand changes will lead to changes in aggregate open interest for call and put options that will have predictive power for future equity returns. The leverage argument first described by Black (1975) suggests that the long side of option contracts denotes the holdings of informed investors.

In this paper we demonstrate the informational content of option open-interest changes for near-term equity price movements. Those firms in the highest quintile of recent change in call open interest outperform those firms in the lowest quintile by a highly significant 1.6 basis points per day in the week following open-interest change measurement. The predictive impact of changes in put open interest is less demonstrable after control measures are included, though there is some evidence of inferior performance for equities with increased recent put open interest. When the effects are combined, we find those firms in the highest ΔCall/ΔPut open-interest quintile significantly outperform those firms in the lowest quintile. The underlying results are robust to numerous controls and methodological approaches. Utilizing monthly changes in open interest and analyzing returns over the subsequent month yields results similar to those of the weekly case.

The remainder of the paper develops as follows. Section 2 describes the data sources and empirical methodology. Section 3 presents results. Section 4 concludes.

2 Data and methodology

Our sample consists of all firms in the CRSP database with options data available from Optionmetrics. Returns data are taken from CRSP. Our sample period is January 1996 through September 2009. Firms must have CRSP share codes of either 10 or 11 and be traded on the NYSE, NASDAQ, or AMEX to be included in the sample. Data for calculating size and momentum are from CRSP. Size is calculated as the number of shares outstanding multiplied by price on the day before the beginning of the open-interest measurement period. Momentum is a short-term measure, calculated as the buy-and-hold return over the week prior to the beginning of the measurement period.

Table 1 Descriptive statistics. This table presents descriptive statistics for open interest, open-interest change, and control measures. Call, put, and total open interest are measured as the total end of day open interest for all call options, all put options, and all options with between 30 and 365 days to expiration on the initial measurement day for the firm/week. Firm/weeks with beginning call or put open interest less than 50 contracts are excluded from the sample. ΔCall and ΔPut are measured as the change in open interest measured from each Wednesday, day $t-7$, to the following Tuesday, day $t-1$. ΔC/P is the change in the ratio of call open interest to put open interest. Open-interest changes are calculated on a percentage basis. ME is the market equity of firms on day t. BM is the book-to-market ratio, calculated using the market equity value on day t and the most recent book value of equity from Compustat. PrevYearRet is the buy-and-hold return of the firm in the prior year. IV is moneyness-weighted implied volatility, measured at the end of the open-interest change measurement week, where options nearest at-the-money are given the most weight. The sample period is from January 1996 through September 2009

	Mean	Std Dev	Median	25th Pct.	75th Pct.
ΔCall	0.1135	0.6453	0.0420	0.0118	0.1096
ΔPut	0.1336	0.8930	0.0362	0.0063	0.1111
ΔC/P	0.0240	0.6041	0.0031	−0.0435	0.0507
Call OI	22939	95888	3474	1179	12831
Put OI	17899	99076	1817	541	8192
Total OI	40837	189118	5551	1895	21573
ME	7.04E+09	2.2E+10	1.56E+09	5.72E+08	4.76E+09
BM	0.9589	14.5679	0.4018	0.2309	0.6537
PrevYearRet	0.1900	1.2820	0.0552	−0.2280	0.3639
IV	0.5230	0.2583	0.4652	0.3373	0.6521

Option open-interest levels, option volumes, and implied volatilities are taken from Optionmetrics. Data used to calculate book value of equity are taken from Compustat. Book-to-market is calculated as the ratio of the most recently available book value of equity to the market value of equity in that month. Table 1 presents descriptive statistics of our sample.

Weekly open-interest measures are based on the change in call open interest, put open interest, and the change in the ratio of call-to-put open interest from Wednesday (day $d-7$) to the following Tuesday (day $d-1$). The firm returns are then observed from Thursday (day $d+1$) through the following Wednesday (day $d+7$). Due to nonsynchronous trading between equity and option markets, we skip the Wednesday (day d) separating the measurement and return periods. Firms with beginning aggregate open-interest levels of less than 50 call or put contracts are excluded from the sample.[1] All changes are measured in percentages.

Each week, we sort firms into quintiles based on call and put open-interest changes, call-to-put open-interest ratio changes, and the current call-to-put open-interest ratio. We then calculate the mean buy-and-hold equity return for all firms, in each quintile, over the next period and test for differences in returns across quintiles. We also track the buy-and-hold performance of high and low quintile portfolios through time, rebalancing after each option expiration date. Additionally, we evalu-

[1] This eliminates approximately the lowest 1% of open-interest firms from the sample.

ate the high-minus-low portfolio returns for the open-interest characteristic quintiles after first sorting by a number of controls.

We next implement the Fama and Macbeth (1973) regression procedure to further test the ability of open-interest change measures to predict future equity returns in a framework allowing for the easy inclusion of additional control measures. Fama–Macbeth regressions are performed with the subsequent week returns as the dependent variable and open-interest measures as predictors. Additionally, size, book-to-market, momentum, implied volatility, and option volume serve as control variables.

We lastly utilize a four-factor calendar-time regression approach to evaluate quintile portfolio returns while controlling for common factors shown to have predictive power for equity returns. At the end of each open-interest change period, firms are placed into quintiles based on open-interest measures over the previous week. These rankings remain in place for the following week. The daily high-minus-low open-interest quintile returns are then regressed on the three daily Fama and French (1992) factors and the momentum factor from Ken French's website.[2] The intercepts of these regressions are interpreted as abnormal returns associated with the high-minus-low portfolios.

3 Results

3.1 Sorting procedures

For our initial analysis, we consider the change of open interest in firm options over a week-long period from each Wednesday (day $d-7$) through the following Tuesday (day $d-1$). We separately consider the percentage changes in aggregate call open interest and aggregate put open interest. These measures are denoted ΔCall and ΔPut, respectively. The change in the ratio of call open interest to put open interest over the measurement week is denoted ΔC/P. The average daily stock returns over the following week, from Thursday (day $d+1$) through the following Wednesday (day $d+7$), are reported based on the various open-interest change levels.

Table 2 presents average daily stock returns of firms in the week following measurement of the open-interest changes of their options. Those firms with the greatest increases in call open interest in the previous week outperform firms with the smallest increases (or, more frequently, greatest decreases) in call open interest by an average of 1.6 basis points per day in the following week. This result is statistically significant at the 1% level. Analogously, we find that those firms in the lowest quintile of put open-interest change experience stock returns outperforming those firms in the highest quintile of put open interest by a highly significant (again, at the 1% significance level) 1.4 average basis points per day. Combined utilization of call and put open-interest change information via the change in call-to-put open-interest ratio also

[2] http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html. Our returns are calculated weekly from Wednesday until the following Tuesday, whereas weekly factor returns provided by Ken French are calculated over calendar weeks. Therefore, we use provided daily factor returns to calculate weekly factor returns from Wednesday until the following Tuesday for each period, such that timing of quintile portfolio returns and weekly factor returns are consistent.

Table 2 Average daily stock returns by open-interest changes. This table presents average daily stock returns for quintile portfolios created based on changes in the call open interest, put open interest, and call/put open-interest ratios. Call and put open interest are measured as the total end-of-day open interest for all call and all put options with between 30 and 365 days to expiration on the initial measurement day for the firm/week. Firm/weeks with beginning call or put open interest less than 50 contracts are excluded from the sample. Ratio changes, as a percentage of the beginning ratio for the period, are measured from each Wednesday, day $t-7$, to the following Tuesday, day $t-1$. ΔCall, ΔPut, and ΔC/P are call, put, and call/put open interest, respectively. Firms are sorted into quintiles and placed in portfolios weekly based on these changes. Means of these average daily returns across weeks are reported for each portfolio. Differences between high and low quintile mean returns are also presented, with t-statistics in parentheses. The sample period is from January 1996 through September 2009

	Call OI change	ΔCall	Put OI change	ΔPut	C/P OI change	ΔC/P
All	0.1135	0.041	0.1337	0.041	0.0240	0.041
Quintile						
Low	−0.0164	0.030	−0.0298	0.053	−0.1987	0.037
2	0.0189	0.044	0.0127	0.041	−0.0329	0.035
3	0.0453	0.042	0.0395	0.035	0.0038	0.037
4	0.0941	0.042	0.0942	0.036	0.0404	0.042
High	0.4255	0.046	0.5519	0.039	0.3076	0.053
High–Low		0.016		−0.014		0.016
t-stat		3.41		−2.91		3.54

results in a strongly significant result. Those firms in the highest quintile experience average daily stock returns in the week following the measurement period that are 1.6 basis points greater than those of the lowest ΔC/P quintile.

For demonstration, we separately track the growth, over our sample period, of buy-and-hold equity portfolios that are long firms in the highest and lowest ΔC/P open-interest quintiles. These portfolios are rebalanced every Wednesday (day t) based on the shifts of open interest from the previous Wednesday (day $d-7$) through the day before (Tuesday, day $d-1$). The results reflect the generally superior performance of firms with higher call open-interest changes relative to those with lower call open-interest changes. Over the sample period, the high quintile portfolio grows by nearly 500%; the low quintile portfolio grows by less than 200 percent. Figure 1 presents time series buy-and-hold returns for the high and low quintile portfolios formed based on changes in the call/put open interest ratio. The longstanding superior performance of equities with greater shifts in call/put open interest is readily evident.

Next, our open-interest change quintile sorts are preceded by initial sorts of various control variables.

Market equity is utilized in Panel A of Table 3; firm book-to-market value is utilized in Panel B; the prior return period's buy-and-hold return (momentum) is utilized in Panel C; implied volatility level is utilized in Panel D; the trading volume of options is utilized in Panel E. After the initial sorts by control variable, each control quintile is sorted again into quintiles based on the recent change levels of option open interest. The average stock returns by open-interest change quintile are presented in Table 3. After the double sorting procedure, the results utilizing the change in call open interest are markedly *stronger* for the ΔCall sorts. The put open-interest results

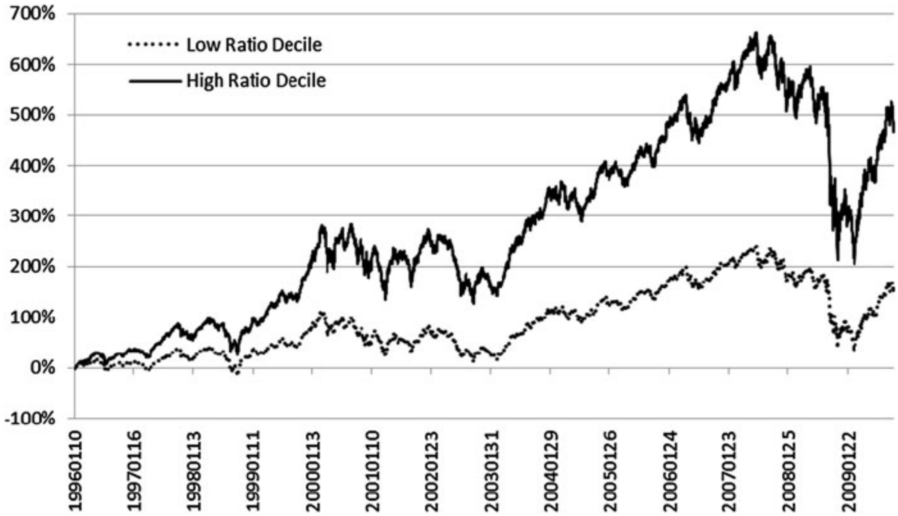

Fig. 1 Time series buy-and-hold returns by ΔCall/Put open-interest quintile. This figure presents time series buy-and hold returns for high and low quintile portfolios formed based on changes in the call/put open interest ratio. Call and put open interest are measured as the total end of day open interest for all call and all put options with between 30 and 365 days to expiration on the initial measurement day for the firm/period. Firms with beginning call or put open interest less than 50 contracts are excluded from the sample. Ratio changes, as a percentage of the beginning ratio for the period, are measured from each Wednesday, day $t-7$ to the following Tuesday, day $t-1$. Firms are then sorted into quintiles and placed in portfolios weekly. The following Thursday, day $t+1$, the portfolio takes a long (short) position in those firms in the highest (lowes) call/put open interest change quintile and maintains this position until the following Wednesday. Each day, mean portfolio returns are calculated for high and low quintiles. These mean returns are used to calculate the buy-and-hold returns presented in the figure. The sample period is from January 1996 through September 2009

decrease to the 5% significance level in the case of the momentum double sort, and reduce to statistical insignificance in the case of the volume double sort; however, the use of ΔC/P maintains strong statistical significance after the implementation of control measures, with all high-minus-low average daily stock return differences positive and statistically significant at the 1% level.

Given that other work shows some evidence that option volume has power in predicting future equity returns, we provide a direct comparison of the prediction power of option volume relative to open-interest changes. Table 4 presents average daily stock returns for portfolios created based on call option trading volume, put option trading volume, and the ratio of call option volume to put option volume over open-interest change measurement periods. Analysis is performed as in Table 2, where firms are sorted into quintiles weekly based on volume measures and mean returns are presented for each quintile. High-low differences are also presented.

High-low differences are of the predicted sign for each of the volume sorts. These differences are not statistically significant, however, for call option volume and call/put volume, and are only marginally significant for put option volume (t-statistic $= 1.70$). Magnitudes of differences are also reduced. The high-low quintile return difference when the sample is divided based on call option volume is 0.2 basis points per day compared to 1.6 basis points per day when changes in call option

Table 3 Mean daily returns following changes in open interest w/base controls. This table presents average daily stock returns for quintile portfolios created based on changes in the call open interest, put open interest, and call/put open-interest ratios after controlling for firm characteristics. Call and put open interest are measured as the total end-of-day open interest for all call and all put options with between 30 and 365 days to expiration on the initial measurement day for the firm/week. Firm/weeks with beginning call or put open interest less than 50 contracts are excluded from the sample. Ratio changes, as a percentage of the beginning ratio for the period, are measured from each Wednesday, day $t-7$, to the following Tuesday, day $t-1$. ΔCall, ΔPut, and ΔC/P are call, put, and call/put open-interest changes, respectively. Firms are first sorted into quintiles weekly based on the control variable. Within each control variable quintile, firms are then sorted into quintiles based on open-interest change measures. Firms are then aggregated weekly based on open-interest change quintiles and means of these average daily returns across weeks are reported for each portfolio. Panel A controls for the market equity of firms the day before the beginning of the return period. Panel B controls for the book-to-market level of firms, calculated as the ratio of the most recently available book value of equity to the market value of equity the day before the start of the return period. Panel C controls for the firm buy-and-hold return from the prior return period. Panel D controls for the implied volatility of firms the day before the beginning of the return period. IV is moneyness-weighted implied volatility measured at the end of the open-interest change measurement week, where options nearest at-the-money are given the most weight. Panel E controls for option trading volume during the open-interest measurement week, using the same maturity restrictions applied to options in open-interest calculations. Differences between high and low quintile mean returns are also presented, with t-statistics in parentheses. The sample period is from January 1996 through September 2009

	Panel A: Size control			Panel B: Book-to-market control			Panel C: Momentum control		
	ΔCall	ΔPut	ΔC/P	ΔCall	ΔPut	ΔC/P	ΔCall	ΔPut	ΔC/P
Quintile									
Low	0.027	0.052	0.035	0.024	0.048	0.036	0.025	0.05	0.035
2	0.041	0.04	0.033	0.040	0.038	0.035	0.036	0.039	0.033
3	0.045	0.035	0.035	0.045	0.034	0.036	0.046	0.036	0.034
4	0.045	0.036	0.046	0.047	0.042	0.042	0.043	0.038	0.042
High	0.045	0.039	0.054	0.047	0.041	0.053	0.053	0.041	0.059
High–Low	0.019	−0.013	0.019	0.023	−0.007	0.017	0.028	−0.01	0.024
t-stat	(4.07)	(−2.73)	(4.01)	(5.00)	(−1.48)	(3.65)	(5.91)	(−2.06)	(5.05)

	Panel D: IV control			Panel E: Volume control		
	ΔCall	ΔPut	ΔC/P	ΔCall	ΔPut	ΔC/P
Quintile						
Low	0.024	0.052	0.036	0.027	0.049	0.04
2	0.043	0.037	0.035	0.037	0.036	0.03
3	0.044	0.037	0.034	0.046	0.035	0.034
4	0.044	0.038	0.046	0.042	0.036	0.044
High	0.048	0.04	0.052	0.051	0.048	0.056
High–Low	0.023	−0.012	0.016	0.023	−0.002	0.015
t-stat	(4.93)	(−2.45)	(3.32)	(5.12)	(−0.36)	(3.32)

open interest are used. For put option volume, the difference is −0.8 basis points per day compared to −1.4 basis points per day when put option open-interest changes are used. For the put/call volume ratio, the difference is 0.7 basis points per day compared to 1.6 basis points per day when the put/call open-interest ratio is used.

Table 4 Average daily stock returns by option volume. This table presents average daily stock returns for quintile portfolios created based on call option trading volume, put option trading volume, and the ratio of call option volume to put option volume. Call and put volume are measured as the total volume for all call and all put options with between 30 and 365 days from each Wednesday, day $t-7$, to the following Tuesday, day $t-1$. Firm/weeks with beginning call or put open interest less than 50 contracts are excluded from the sample. Firms are sorted into quintiles and placed in portfolios weekly based on volume measures. Means of these average daily returns across weeks are reported for each portfolio. Differences between high and low quintile mean returns are also presented, with t-statistics in parentheses. The sample period is from January 1996 through September 2009

	Call volume	Put volume	Call/Put volume
Quintile			
Low	0.037	0.043	0.040
2	0.047	0.043	0.037
3	0.042	0.047	0.035
4	0.039	0.036	0.044
High	0.039	0.035	0.047
High–Low	0.002	−0.008	0.007
t-stat	0.42	−1.69	1.60

These results show open-interest changes are better predictors of future equity returns than are option volumes over the week-long periods we examine. Furthermore, over these periods, option volumes have only marginally statistically significant predictive power.

3.2 Controlled regressions

Control measures are also adopted in the regression of average daily stock returns on recent one-week open-interest changes via the Fama–Macbeth framework. Results are presented in Table 5.

As suggested by the control double sorts of Table 3, ΔCall and ΔC/P are positively and strongly significantly linked to future returns when analyzing the one-week measurement and subsequent one-week return periods. Those firms with the greatest increases in call open interest markedly outperform the simple case (control case) at the 5% (1%) significance level. Such evidence does not significantly persist in the Fama–Macbeth framework, however, for the analysis of changes in put open interest. In fact, the ΔPut coefficient is significantly positive in the full control case. This result is initially puzzling; however, we note the significantly negative put volume coefficient, which, in effect, counterbalances a portion of the positive put open-interest link to equity returns. Call and call/put volume exhibit no statistical significance as control variables in the equity return regressions featuring ΔCall and ΔC/P, respectively. In fact, the ΔC/P Fama–Macbeth results are the statistically strongest of all, particularly after the simultaneous inclusion of all the control measures utilized in Table 3's double sorts: market equity, book-to-market ratio, momentum, implied volatility, and option trading volume. Even in the presence of all control measures, the Fama–Macbeth regression coefficient of 0.022 for ΔC/P is statistically significant at the 1% level.

Table 5 Fama–Macbeth regressions. This table presents Fama and Macbeth (1973) regression coefficients and significance levels. Regressions are performed each period where the dependent variable is the average daily firm return in the week following open-interest change measurements. Call and put open interest are measured as the total end-of-day open interest for all call and all put options with between 30 and 365 days to expiration on the initial measurement day for the firm/week. Firm/weeks with beginning call or put open interest less than 50 contracts are excluded from the sample. Ratio changes, as a percentage of the beginning ratio for the period, are measured from each Wednesday, day $t-7$, to the following Tuesday, day $t-1$. ΔCall, ΔPut, and ΔC/P are call, put, and call/put open interest, respectively. Market equity (ME), in billions of dollars, is measured at the end of the open-interest measurement period. The book-to-market level of firms is calculated as the ratio of the most recently available book value of equity to the market value of equity the day before the start of the return period. Momentum (MOM) is the firm buy-and-hold return from the previous one-week return period. IV is moneyness-weighted implied volatility measured at the end of the open-interest change measurement week, where options nearest at-the-money are given the most weight. Call volume, put volume, and call/put volume, respectively, are the total option trading volume for calls, puts, and ratio of call option volume to put option volume during the open-interest measurement week, using the same maturity restrictions applied to options in open-interest calculations. The sample period is from January 1996 through September 2009

α	0.046	0.048	0.047	0.049	0.051	0.050
	(1.74)	(1.79)	(1.78)	(5.44)	(5.65)	(5.52)
ΔCall	0.015			0.032		
	(2.46)			(5.94)		
ΔPut		−0.006			0.010	
		(−0.14)			(2.32)	
ΔC/P			0.016			0.020
			(2.91)			(8.01)
ME				0.006	−0.005	−0.002
				(0.12)	(−0.10)	(−0.01)
BM				0.002	0.002	0.002
				(5.46)	(5.46)	(5.28)
MOM				−0.422	−0.418	−0.42
				(−12.89)	(−12.75)	(−12.88)
Call volume				−0.007		
				(−1.48)		
Put volume					−0.011	
					(−3.22)	
Call/Put volume						−0.001
						(−0.97)
IV				−0.019	−0.018	−0.019
				(−0.76)	(−0.74)	(−0.77)
n	1763	1763	1763	1546	1546	1546

As another control mechanism for stock return performance, we regress the zero-cost daily portfolio returns of positions that are long (short) the highest (lowest) quintiles of the three open-interest measures (ΔCall, ΔPut, and ΔC/P) on the three daily Fama–French factors and, subsequently, on the three factors and the fourth, momentum factor as well. Results are shown in Table 6.

The intercepts of the three-factor and four-factor calendar-time regressions serve as measures of abnormal performance. We again recognize significant predictive

Table 6 Calendar-time regressions. This table presents the results of calendar-time regressions that control for factors commonly linked to equity returns. Results from regressing the average daily high-minus-low open-interest change quintile stock returns for the week following open-interest change measurements on the three factors of Fama and French (1992) and the momentum factor provided on Ken French's website. Our returns are calculated weekly from Wednesday until the following Tuesday, whereas weekly factor returns provided by Ken French are calculated over calendar weeks. Therefore, we use provided daily factor returns to calculate weekly factor returns from Wednesday until the following Tuesday each period, such that timing of quintile portfolio returns and weekly factor returns are consistent. Call and put open interest are measured as the total end-of-day open interest for all call and all put options with between 30 and 365 days to expiration on the initial measurement day for the firm/week. Firm/weeks with beginning call or put open interest less than 50 contracts are excluded from the sample. Ratio changes, as a percentage of the beginning ratio for the period, are measured from each Wednesday, day $t-7$, to the following Tuesday, day $t-1$. ΔCall, ΔPut, and ΔC/P are call, put, and call/put open interest, respectively. Firms are sorted into quintiles and placed in portfolios weekly based on these changes. Results from regressing the average weekly returns for high-minus-low open-interest change quintile portfolios for the week following open-interest change measurements on the three factors of Fama and French (1992) and the momentum factor provided on Ken French's website are presented. Results are presented for each of the three open-interest change variables using both three- and four-factor models. The sample period is from January 1996 through September 2009. Coefficients are presented, with t-statistics in parentheses

	ΔCall	ΔPut	ΔC/P	ΔCall	ΔPut	ΔC/P
α	0.021	−0.012	0.018	0.017	−0.018	0.020
	(2.85)	(−1.60)	(3.44)	(2.33)	(−2.68)	(3.70)
MKT	0.083	−0.008	0.049	0.128	0.059	0.035
	(5.91)	(−0.55)	(4.87)	(8.58)	(4.14)	(3.19)
SMB	0.137	0.040	0.051	0.133	0.034	0.053
	(5.33)	(1.56)	(2.81)	(5.37)	(1.45)	(2.89)
HML	−0.241	−0.170	−0.025	−0.188	−0.091	−0.041
	(−10.31)	(−7.36)	(−1.52)	(−7.95)	(−4.05)	(−2.40)
UMD				0.105	0.156	−0.032
				(7.24)	(11.31)	(−3.04)

power based on the change of open-interest measures in the preceding week. Those firms with greater increases in call open interest are significantly more likely to enjoy higher stock returns at the 1% (5%) significance level in the three-factor (four-factor) case. The strongest results are based on ΔC/P as we find zero-cost portfolio stock returns that are significantly higher, at the 1% level, for firms with higher ΔC/P levels in both the three-factor and four-factor settings. The calendar-time alpha is statistically insignificant for the ΔPut three-factor case, but is significantly negative at the 1% level after the momentum factor is added to the regressions.

4 Conclusion

In this paper we contribute to the literature linking option market information and equity markets. Specifically, we examine the relationship between option open-interest changes and future underlying equity returns. We show that demand changes in option markets lead to changes in open interest that have power to predict future equity returns. Option traders demand relatively more (fewer) call (put) options when underlying assets perform well in the near future. Conversely, option traders demand relatively more (fewer) put (call) options when underlying assets perform poorly in the near future.

In our empirical investigation, we demonstrate a strong link between recent changes in aggregate open-interest levels and the future underlying equity price movement. We sort firms into quintiles based on our open-interest variables and find strong relationships between these measures and future equity returns. Firms with increases in recent call open interest outperform those firms that have experienced declines (or smaller increases) in call open interest. Changes in aggregate put open interest have predictive power for future equity returns as larger put open-interest changes predict poor future underlying asset performance. This relationship is less pronounced and robust, however, weakening or failing to persist after controlling for some firm characteristics. This is not surprising as many investors, informed and uninformed, enter put option positions to hedge underlying asset returns, and therefore, increased put open interest does not necessarily imply that investors have a negative opinion about future underlying asset returns, but may simply be the result of increased hedging activity. The most effective open-interest predictor of future equity returns is the ratio of the recent changes in call open interest to put open interest. Large increases in the ratio are followed by relatively strong future stock returns in the following week.

We demonstrate that our findings for call option open interest and the open-interest ratio are robust via additional tests. We show that, in general, these relationships persist after controlling for factors via double sorts. Also, by employing four-factor calendar-time and Fama–Macbeth regression analyses, we show our results hold when controlling for factors proven to have power to predict future equity returns.

Informed traders transact in both option and equity markets. This may be due to liquidity issues in option markets or trader preferences. While market efficiency suggests that information should be immediately and completely reflected in both option and equity markets, we present evidence that real-world informational differences between the two markets result in different speeds of incorporating information. Ours is the first work to consider such a predictive impact of option open-interest changes. Further, we show that over longer, weekly measurement periods, open-interest changes are better predictors of future equity returns than are option volumes. The information possessed by informed traders is revealed in option markets through open-interest changes, allowing these changes to predict future equity returns.

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