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The Efficiency of Weekly Option Prices around Earnings Announcements

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Abstract: This study examines the efficiency of weekly option prices around firms' earnings announcements. With most of the largest firms now having options that expire on a weekly basis, option traders can hedge or speculate on earnings news using options that expire very close to a firm's earnings announcement date. For earnings announcements near an options expiration date, one can estimate a firm's expected stock price move in response to its earnings news (i.e., its option implied earnings announcement move) as the price of its at-the-money straddle as a proportion of its stock price. This study tests whether differences between historical earnings announcement moves and option implied earnings announcement moves predict straddle returns. Through the analysis of portfolio returns and Fama–MacBeth regressions, this study finds that straddle returns are significantly higher (lower) when the historical earnings announcement move is high (low) relative to the option implied earnings announcement move. In contrast to prior research, this study does not find an association between straddle returns and historical volatility, historical earnings announcement volatility, implied volatility, or the difference between historical volatility and implied volatility. Overall, this study suggests that weekly straddle prices around earnings announcements are not optimally efficient.

Keywords: option returns; straddle returns; weekly options; earnings announcement volatility; earnings announcements

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1. Introduction

This study examines the efficiency of weekly option prices around firms' earnings announcements. It does this by testing for associations between straddle returns on weekly options expiring in the same week as a firm's earnings announcement and five signals of a firm's earnings announcement volatility. Four of these signals (i.e., historical volatility, historical earnings announcement volatility, implied volatility, and the difference between historical volatility and implied volatility) have been found in prior research to predict straddle returns in earlier sample periods using monthly options. The fifth signal, which is unique to this study, is the difference between a firm's historical earnings announcement volatility and the firm's option implied earnings announcement move. If weekly option prices around firms' earnings announcements are efficient, then none of the five signals should predict straddle returns.

The opening of a long (short) straddle position consists of buying (selling) both a call option and a put option with the same strike prices and expiration dates on the same underlying stock. Straddles allow option traders to speculate on the magnitude of a future stock price move (i.e., volatility) rather than its direction. Prior research, such as that by Zhou and Shon (2013), Chung and Louis (2017), and Gao et al. (2018), examines straddle returns around earnings announcements because earnings announcements are frequent and expected events that can increase a firm's price volatility (e.g., Beaver 1968; Patell and Wolfson 1979). An option trader that expects a large (small) stock price move up or down in response to a firm's earnings news could buy (sell) a straddle before the firm's earnings

announcement that expires after the firm's earnings announcement to try to profit from their prediction.

This study differs from prior studies on straddle returns around earnings announcements (i.e., Zhou and Shon 2013; Chung and Louis 2017; Gao et al. 2018) in that it examines weekly options, while prior studies only examine monthly options. These prior studies were unable to study weekly options because their sample periods all ended prior to a significant number of firms having weekly options. Prior research on weekly options largely focuses on indices rather than individual stocks (e.g., Andersen et al. 2017; Oikonomou et al. 2019; Jain and Kotha 2022). The few studies that examine weekly options on individual stocks do not examine earnings announcements or straddle returns (e.g., Wen 2020; Bryzgalova et al. 2022). This study examines weekly options because they offer option traders much greater leverage (e.g., Bryzgalova et al. 2022). Greater leverage in weekly options increases the potential for extreme returns, making these options potentially more attractive to option traders.

This study also differs from those by Zhou and Shon (2013), Chung and Louis (2017), and Gao et al. (2018) in that it sorts earnings announcements based on the difference between historical and implied volatility as a potential signal of option mispricing. Goyal and Saretto (2009) found that large differences between historical volatility and implied volatility indicate option mispricing. They find that straddle returns are high (low) when historical volatility is high (low) relative to implied volatility. In other words, straddle prices are too low when historical volatility is high relative to implied volatility, and straddle prices are too high when historical volatility is low relative to implied volatility. Goyal and Saretto (2009) studied straddle returns in general, and did not specifically examine straddle returns around earnings announcements. An innovation of this study is in adapting Goyal and Saretto's (2009) idea of comparing historical volatility and implied volatility to the setting of weekly options around firms' earnings announcements.

2. Literature Review

This study examines firms' historical volatility as the first of its earnings announcement volatility signals. Gao et al. (2018) found a positive association between firms' historical volatility and monthly straddle returns around earnings announcements. Their findings suggest that option traders, on average, underestimate (overestimate) the earnings announcement volatility of more (less) volatile firms. This means that the straddle prices around earnings announcements for more (less) volatile firms are set too low (high) by option traders, which results in higher (lower) straddle returns for these firms.

This study examines firm's historical volatility specifically around past earnings announcements as its second earnings announcement volatility signal. Historical earnings announcement volatility is of interest because this study examines straddle returns solely around earnings announcements. Firm's historical earnings announcement volatility is also of interest because prior research shows that volatility spikes around a firm's earnings announcements (e.g., Beaver 1968). This means that a firm's earnings announcement volatility is often significantly higher than its volatility on non-earnings announcement days (e.g., Basu et al. 2013). Gao et al. (2018) found a positive association between straddle returns and historical earnings announcement volatility. Their finding suggests that option traders, on average, underestimate (overestimate) the earnings announcement volatility of firms with more (less) volatile earnings announcements in the past.

This study examines implied volatility as its third earnings announcement volatility signal. Gao et al. (2018) found a positive association between implied volatility and straddle returns. Their findings suggest that options traders, on average, underestimate (overestimate) the earnings announcement volatility of the firms that they expect to have the highest (lowest) earnings announcement volatility. In other words, the firms with the most (least) expensive straddle prices around earnings announcements should have even higher (lower) straddle prices. This study uses a firm's option implied earnings announcement move based on its at-the-money straddle price as its measure of implied volatility. For

firms with an earnings announcement near an options expiration date, the price of their at-the-money straddle as a proportion of their stock price provides an estimate of their expected stock price move in response to their earnings news. For example, a USD 100 stock with an at-the-money straddle price of USD 10, expiring in the same week as the earnings announcement, suggests an option implied earnings announcement move of 10%. This means that if the stock were to move up or down by more than (less than) 10%, a buyer of the straddle would have a profit (loss) and a seller of the straddle would have a loss (profit). Option implied earnings announcement moves receive significant attention from option traders as they are often mentioned on the CNBC television program devoted to options trading, *Options Action* (e.g., Bailey 2021, 2022). While popularly discussed, option implied earnings announcement moves have not been studied in prior research. This is likely due to the fact that this measure of implied volatility works best with options very close to expiration, and, as mentioned previously, prior research does not examine weekly options around earnings announcements.

The fourth and fifth earnings announcement volatility signals in this study compare the firm's general historical volatility and its historical earnings announcement volatility to its option implied earnings announcement move. This study examines a new hypothesis that the difference between a firm's historical earnings announcement volatility and a firm's option implied earnings announcement move will better predict the straddle return around a firm's earnings announcement. This hypothesis follows from the finding in Goyal and Saretto (2009) that the difference between historical volatility and implied volatility has a positive association with straddle returns. Their findings suggest that straddles are most likely to be mispriced when volatility expectations deviate the most from a firm's past volatility. Their finding should also apply to weekly straddles around earnings announcements, except that this study hypothesizes that using a firm's historical earnings announcement volatility will result in a superior signal compared to using a firm's general historical volatility.

3. Data

The sample for this study consists of 2690 quarterly earnings announcements made by firms with weekly options. Due to the sample requirement that firms have weekly options, each earnings announcement in the sample occurs in an options expiration week. At the earliest, the earnings announcements in the sample occur after the market closes on a Monday, and at the latest, the earnings announcements occur before the market opens on a Friday. Thus, for a typical week with weekly options expiring at the close on a Friday, the earnings announcements in the sample occur between one and four days from options expiration. In this study, the daily stock and options prices are derived from the Chicago Board Options Exchange (CBOE) Datashop, the earnings announcement dates are from IBES, and the market capitalization data are from CRSP.

Weekly options were introduced on a small number of individual stocks in 2010. Figure 1 shows the number of earnings announcements by firms with weekly options by calendar quarter from the fourth quarter of 2010 through the first quarter of 2017, which was the last quarter available when the options data for this study were acquired. Figure 1 shows that the number of earnings announcements in an options expiration week by firms with weekly options increased from 6 to 258 over this period. To have diversified quintile portfolios for each quarter in the sample (i.e., at least 20 firms per quintile), the sample for this study begins in the first quarter of 2014, which is when the number of quarterly earnings announcements with weekly options first exceeds 100.

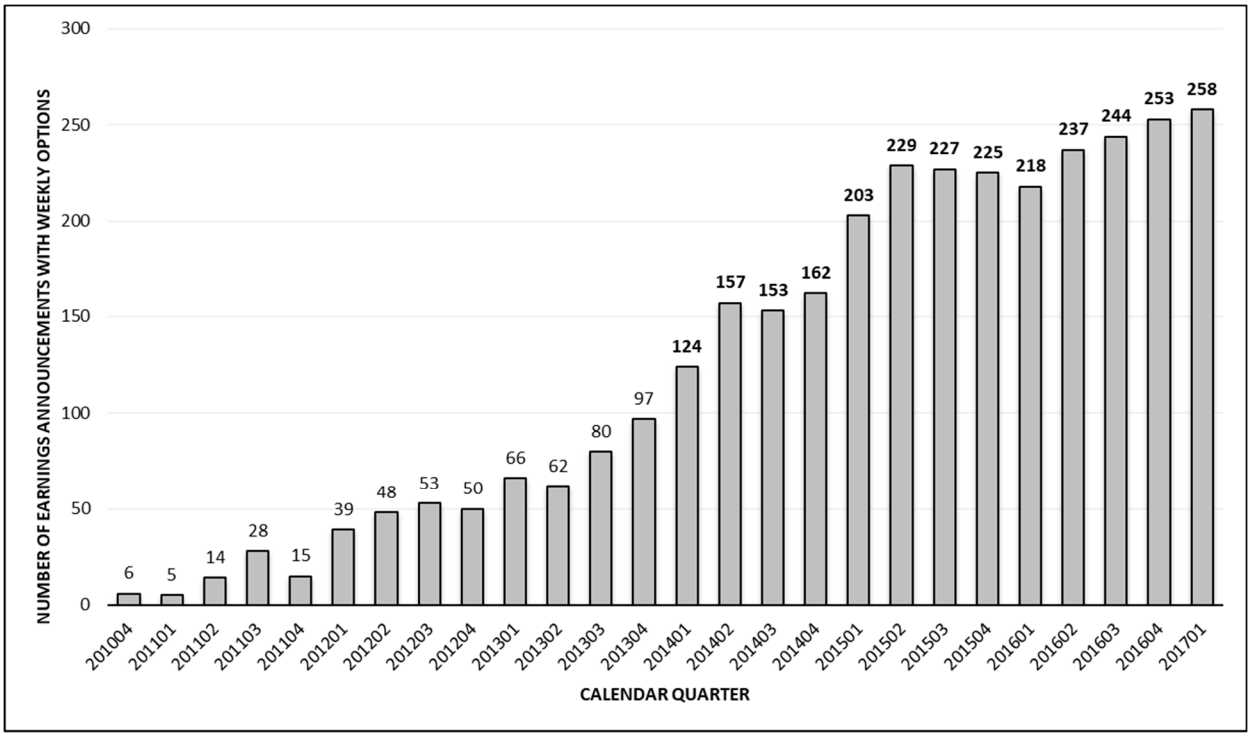

Figure 1. Number of earnings announcements with weekly options. This figure shows the number of earnings announcements by firms with weekly options by calendar quarter. The sample period consists of the first quarter of 2014 through the first quarter of 2017. The bold values beginning in the first quarter of 2014 indicate observations included in the sample. The figure also graphs the number of earnings announcements with weekly options prior to the sample period examined in this study.

The daily data from the Chicago Board Options Exchange (CBOE) Datashop provide data from two points of time each day. They provide daily stock and option prices at both the close of trading and 15 min before the close. The data provider recommends using the data from 15 min prior to the close, as liquidity is better at this point in time than at the end of the day. This study follows the data provider's recommendation and uses stock and option prices 15 min before the close in its analyses. Throughout this study, the term "near the end of the day" refers to 15 min before the close. The results in this study are not materially different if the closing prices are used instead.

This study examines the association between straddle returns on weekly options expiring in an earnings announcement week and five signals of earnings announcement volatility. Table 1 provides descriptive statistics on straddle returns, the five signals of earnings announcement volatility, and three characteristics related to the straddles and the underlying firms in the sample.

StraddleRet measures the return on an at-the-money straddle purchased near the end of the day before a firm's earnings announcement and sold near the end of the following day. Thus, the holding period for the straddles examined in this study is the one-day period containing the market's initial reaction to a firm's earnings announcement. Because theta or time decay increases as option expiration approaches, examining one-day holding periods reduces the effect that time decay has on option returns compared to longer holding periods. Consistent with Zhou and Shon (2013), this study requires the strike price of the straddle be within five percent of the stock price at the time the straddle position is opened in order for the straddle to be considered at-the-money and included in the sample. Consistent with prior research (e.g., Gao et al. 2018), this study uses the midpoint of the at-the-money put and the at-the-money call when computing the return on the at-the-money straddle. Using the midpoint allows this study to determine whether any of the five earnings announcement volatility signals predict straddle returns in the absence of trading costs. In addition, it is

not clear how much of the bid-ask spread option traders actually incur. Muravyev and Pearson (2020) show that option traders that time their executions incur trading costs that are much lower than conventional estimates. They argue that this explains why trading volumes on options are so high despite the seemingly large quoted bid-ask spreads.

Table 1. Descriptive statistics.

	N	Mean	Std. Dev.	25th	Median	75th
StraddleRet	2690	0.48%	71.26%	−46.28%	−17.69%	27.65%
Vol	2690	3.26%	1.89%	2.06%	2.74%	3.82%
AvgEA	2690	5.07%	3.82%	2.33%	3.89%	6.66%
Implied	2690	5.72%	3.19%	3.33%	4.79%	7.56%
Vol-Implied	2690	−2.46%	2.53%	−3.70%	−1.83%	−0.81%
AvgEA-Implied	2690	−0.65%	2.70%	−1.89%	−0.71%	0.54%
MarketCap	2690	51.8	79.1	6.0	22.0	62.5
DTE	2690	2.4	1.0	2.0	2.0	3.0
Spread	2690	7.4%	12.8%	2.0%	3.7%	7.4%

This table presents descriptive statistics for the sample of earnings announcements by firms with weekly options from the first quarter of 2014 through the first quarter of 2017. *StraddleRet* is the return on the weekly straddle held over the one-day period containing the firm's earnings announcement. *Vol* is a firm's historical volatility. It is equal to the standard deviation of a firm's daily returns over the one-year period prior to its earnings announcement expressed as the volatility over the number of days from the earnings announcement to options expiration. *AvgEA* is a firm's historical earnings announcement volatility. It is a firm's average one-day absolute stock return from its previous four earnings announcements. *Implied* is the firm's option implied earnings announcement move. It is the price of the at-the-money straddle on the weekly option near the end of the day before a firm's earnings announcement divided by the firm's stock price at that same time. *Vol-Implied* is equal to *Vol* minus *Implied*. *AvgEA-Implied* is equal to *AvgEA* minus *Implied*. *MarketCap* is the market capitalization of the firm, in billions of dollars, prior to its earnings announcement. *DTE* is the number of days to expiration for the straddle when the position is opened. *Spread* is the quoted half-spread on the straddle. It is equal to the difference between the ask and bid prices on the straddle at the time the straddle position is opened times one-half and expressed as a percentage of the bid-ask midpoint. All five earnings announcement volatility signals (*Vol*, *AvgEA*, *Implied*, *Vol-Implied*, and *AvgEA-Implied*) are winsorized at the 1% and 99% levels.

StraddleRet has a mean of 0.48%. Consistent with Zhou and Shon (2013), at-the-money straddle returns do not differ signficantly from zero in the sample. Additionally consistent with Zhou and Shon (2013) and with long straddles around earnings announcements typically losing money, *StraddleRet* has a negative median of −17.69%. Chung and Louis (2017) and Gao et al. (2018) find that straddles around earnings announcements earn significantly positive returns. Their findings suggest that option traders, on average, underprice straddles around earnings announcements. However, both of these studies have sample periods that entirely predate the sample period in this study, and both studies do not have weekly options in their samples.

The first earnings announcement volatiliy signal, *Vol*, measures a firm's historical volatility. *Vol* is the standard deviation of a firm's daily returns over the one-year period prior to its earnings announcement and expressed as the volatility over the number of days from the earnings announcement to options expiration. *Vol* has a mean of 3.26%, which indicates that about 68% of the time, the average firm in the sample will rise or fall in price by less than 3.26% over the number of days to option expiration. This measure does not take into account that an earnings announcement will occcur during this period.

While *Vol* measures a stock's general historical volatility, the second earnings announcement volatility signal, *AvgEA*, measures a stock's historical volatility specifically at its earnings announcements. *AvgEA* is a firm's average one-day absolute stock return from its previous four earnings announcements. *AvgEA* has a mean of 5.07%. The results in this study are robust to using the standard deviation of a firm's one-day stock returns from its previous four earnings announcements rather than *AvgEA*. The average standard deviation of the firms' previous four earnings announcement returns in the sample is 5.80% (untabulated).

The third earnings announcement volatility signal, *Implied*, measures the option implied earnings announcement move. It is the market's expected move in the stock price from near the end of the day before the earnings announcement to option expiration. With all the straddles in the sample being very close to expiration and containing the earnings announcement before expiration, the implied move largely reflects the expected move due to the firm's earnings announcement. *Implied* is computed as the price of the at-the-money straddle on the weekly option near the end of the day before a firm's earnings announcement divided by the firm's stock price at that same time. For example, a USD 100 stock with an at-the-money (weekly) straddle price of USD 10 (prior to its earnings announcement) suggests an option implied earnings announcement move of 10%. This means that if the stock were to move up or down by more than (less than) 10%, a buyer of the straddle would have a profit (loss). The mean of *Implied* is 5.72%.

The fourth earnings announcement volatility signal, *Vol-Implied,* measures the difference between a firm's historical volatility and its option implied earnings announcement move. *Vol-Implied* is defined as *Vol* minus *Implied*. *Vol-Implied* has a mean of −2.46%, consistent with the expected volatility around an earnings announcement being signficantly greater than a firm's general historical volatility. This is also consistent with prior research, which finds that earnings annnouncement volatility exceeds non-earnings announcement volatility (e.g., Basu et al. 2013).

The fifth earnings announcement volatility signal, *AvgEA-Implied,* measures the difference between a firm's historical earnings announcement volatility and its option implied earnings announcement move. *AvgEA-Implied* is computed as the difference between *AvgEA* and *Implied*. *AvgEA-Implied* has a mean of −0.65%. This indicates that, on average, a firm's option implied earnings announcement move is slightly larger than the firm's average historical earnings announcement move. However, the option implied earnings announcement does not always exceed the historical earnings announcement moves, as the interquartile range of *AvgEA-Implied* ranges from −1.89% to 0.54%.

The remaining three variables in Table 1, *MarketCap*, *DTE*, and *Spread,* provide basic descriptive information about the firms and straddles in the sample. *MarketCap* is the market capitalization of the firm, in billions of dollars, prior to its earnings announcement. Consistent with large firms having weekly options, the mean of *MarketCap* is USD 51.8 billion. *DTE* is the number of days to expiration for the straddle at the time the straddle position is opened (i.e., near the end of the day, before the earnings announcement). The straddles in the sample have a *DTE* ranging from 1 to 4, with a mean of 2.4 days. *Spread* is the quoted half-spread on the straddle. Following Muravyev and Pearson (2020), it is computed as the difference between the ask and bid prices on the straddle at the time the straddle position is opened (i.e., near the end of the day prior to the earnings announcement) times one-half and expressed as a percentage of the bid-ask midpoint. *Spread* has a mean of 7.4%.

Table 2 presents the Pearson correlation coefficients for *StraddleRet* and the five earnings announcement volatiltiy signals. There is a significantly positive correlation of 0.05 between *StraddleRet* and *AvgEA-Implied*. There is no significant correlation between *StraddleRet* and any of the other four earnings announcement volatility signals. This suggests that *AvgEA-Implied* shows the most promise out of the five signals in predicting straddle returns. The significantly positive correlations between *Vol* and both *Implied* and *AvgEA* indicates that firms with greater historical volatility tend to have larger option implied earnings announcement moves and larger stock price moves at their past earnings announcements.

Table 2. Correlations.

	StraddleRet	*Vol*	*AvgEA*	*Implied*	*Vol-Implied*	*AvgEA-Implied*
StraddleRet	1.00	−0.00	0.02	−0.02	0.02	0.05 **
Vol		1.00	0.41 ***	0.61 ***	−0.02	−0.13 ***
AvgEA			1.00	0.71 ***	−0.59 ***	0.58 ***
Implied				1.00	−0.80 ***	−0.16 ***
Vol-Implied					1.00	0.09 ***
AvgEA-Implied						1.00

This table presents Pearson correlation coefficients for the sample. *StraddleRet* is the return on the weekly straddle held over the one-day period containing the firm's earnings announcement. *Vol* is a firm's historical volatility. It is equal to the standard deviation of a firm's daily returns over the one-year period prior to its earnings announcement, expressed as the volatility over the number of days from the earnings announcement to options expiration. *AvgEA* is a firm's historical earnings announcement volatility. It is a firm's average one-day absolute stock return from its previous four earnings announcements. *Implied* is the firm's option implied earnings announcement move. It is the price of the at-the-money straddle on the weekly option near the end of the day before a firm's earnings announcement divided by the firm's stock price at that same time. *Vol-Implied* is equal to *Vol* minus *Implied*. *AvgEA-Implied* is equal to *AvgEA* minus *Implied*. *** and ** indicate statistical significance at the 1% and 5% levels, respectively.

4. Method

The first test for determining whether any of the earnings announcement volatility signals predict straddle returns consists of examining the returns to quintile portfolios and hedge portfolios based on the sorts of each of the five earnings announcement volatility signals. Each quarter, the earnings announcements are sorted into quintiles based on each of the five signals, with quintile 5 (1) portfolios consisting of the firms with the highest (lowest) values of these signals. To avoid a look-ahead bias when forming the portfolios, the quintiles are created based on the distributions of the earnings announcement volatility signals from the previous calendar quarter. The quintile portfolios consist of equally weighted long positions in at-the-money straddles. The hedge portfolios take equally weighted long positions in at-the-money straddles on firms in the top quintle and equally weighted short positions in at-the-money straddles on firms in the bottom quintile. In other words, the hedge portfolio is long the quintile 5 portfolio and short the quintile 1 porfolio. All of the at-the-money straddles are opened near the end of the day before a firm's earnings announcement (on weekly options expiring at the end of the firm's earnings announcement week) and closed near the end of the following day. Focusing on one-day holding periods allows this study to examine whether straddle prices are efficient with respect to the markets' initial reaction to firms' earnings news (and reduces the effects of theta or time decay on option returns). A statistically significant return on a signal's hedge portfolio indicates that the signal can predict staddle returns, which would suggest that option prices are not efficient with respect to that signal.

As another method for testing whether weekly option prices are efficient with respect to the five earnings announcement signals, this study examines the association between straddle returns and quintiles of the earnings announcement volatility signals using Fama–MacBeth regressions. One advantage of using Fama–MacBeth regressions is that they allow for the examination of one signal while controlling for the effects of another. A second advantage is that Fama–MacBeth regressions correct standard errors for cross-sectional correlation. This study estimates the Fama–MacBeth regressions on both the quintile ranks and the levels of the five earnings announcement volatility signals. For the analysis of quintile ranks, each of the five earnings announcement volatility signals are transformed into quintile ranks, with quintile 1 taking the value of 0, quintile 5 taking the value of 1, and the quintiles in between taking the values of 0.25, 0.50, and 0.75, respectively. An analysis of the quintile ranks allows for easier interpretation of the results at the cost of losing some information by converting the earnings announcement volatility signals into quintiles. The advantage of the analysis of the levels of the earnings announcement volatility signals is that it avoids the losing of any information in the signals.

5. Results

5.1. Do the Signals Generate Significant Hedge Portfolio Returns?

Table 3 presents the average quarterly returns on the quintile and hedge portfolios based on the sorts of each of the five earnings announcement volatility signals. The quintile and hedge portfolios for *Vol*, *AvgEA*, *Implied*, and *Vol-Implied* have insignificant mean quarterly returns. This indicates that sorting firms on their historical volatility, historical earnings announcement volatility, option implied earnings announcement move, and the difference between historical volatility and the option implied earnings announcement move does not predict weekly straddle returns around earnings announcements. Our finding that *Vol-Implied* does not significantly predict straddle returns suggests that the finding of Goyal and Saretto (2009)—that the difference between historical volatility and implied volatility predicts straddle returns—does not hold in this recent sample of straddles using weekly options in earnings announcement weeks. The lack of significant returns on the *Vol*, *AvgEA*, and *Implied* portfolios indicates that the positive association between straddle returns and historical volatiltiy, historical earnings announcement volatility, and implied volatility in Gao et al. (2018) does not hold in this sample.

Table 3. Mean quarterly portfolio returns.

	Vol	***AvgEA***	***Implied***	***Vol-Implied***	***AvgEA-Implied***
Quintile 5	−2.56%	2.07%	−2.95%	3.38%	8.78%
Quintile 4	2.13%	3.63%	1.75%	−3.89%	−0.66%
Quintile 3	0.12%	−0.77%	−0.35%	2.46%	0.58%
Quintile 2	0.38%	−0.26%	2.21%	1.15%	−1.72%
Quintile 1	1.48%	−3.10%	1.15%	−1.52%	−5.42% ***
Hedge Portfolio	−4.05%	5.17%	−4.10%	4.89%	14.20% **
t-statistic	−0.92	1.61	−1.18	1.32	2.72
N	13	13	13	13	13

This table presents mean quarterly returns for quintile portfolios and a hedge portfolio for each of the five earnings announcement volatility signals. Each of the quintile portfolios takes equally weighted long straddle positions in the straddles from that quintile. The number of straddle positions within each of the quintile portfolios ranges from 24 to 52, with an average of 41. The hedge portfolio takes equally weighted long positions in the quintile 5 portfolio and equally weighted short positions in the quintile 1 porfolio. *Vol* is a firm's historical volatility. It is equal to the standard deviation of a firm's daily returns over the one-year period prior to its earnings announcement, expressed as the volatility over the number of days from the earnings announcement to options expiration. *AvgEA* is a firm's historical earnings announcement volatility. It is a firm's average one-day absolute stock return from its previous four earnings announcements. *Implied* is the firm's option implied earnings announcement move. It is the price of the at-the-money straddle on the weekly option near the end of the day before a firm's earnings announcement divided by the firm's stock price at that same time. *Vol-Implied* is equal to *Vol* minus *Implied*. *AvgEA-Implied* is equal to *AvgEA* minus *Implied*. *** and ** indicate statistical significance at the 1% and 5% levels, respectively.

Sorting earnings announcements based on the difference between a firm's historical earnings announcement moves and the option implied earnings announcement move results in the only porfolios in Table 3 having an average quarterly return significanlty different from zero. The quintile 1 portfolio for *AvgEA-Implied* has a mean return of −5.42%, which is significantly different from zero at the 1% significance level. The mean return of 8.78% on the quintile 5 portfolio for *AvgEA-Implied* does not quite reach significance at the 10% significance level (p-value = 0.106). The hedge portfolio for *AvgEA-Implied* has a mean return of 14.20%, which is significant at the 5% level. The evidence in Table 3 suggests that the difference between historical earnings announcement volatility and the option implied earnings announcement move predicts straddle returns. Thus, this study finds that high (low) historical earnings announcement volatility relative to option implied earnings announcement moves suggests lower (higher) straddle prices and thus higher (lower) straddle returns. A strategy that buys straddles on high *AvgEA-Implied* earnings announcements and sells straddles on low *AvgEA-Implied* earnings announcements earns significant returns in the absence of trading costs.

Figure 2 graphs the quarterly return over the 13 quarters in the sample for the *AvgEA-Implied* hedge portfolio, which is the only hedge portfolio with a statistically significant return in Table 3. Here, USD 1 invested in this strategy at the beginning of 2014-Q1 grows to USD 4.79 at the end of 2017Q1, ignoring transaction costs (e.g., bid-ask spreads, price impact, commissions, and taxes). The *AvgEA-Implied* hedge portfolio does not appear excessively risky based on its time-series of quarterly returns. The worst quarterly performance was in 2016-Q2, with a return of −11.1%. The biggest drawdown for the strategy occurred over the two quarter period from 2014-Q4 to 2015-Q1, when the *AvgEA-Implied* hedge portfolio fell by a total of 14.9% over those two quarters. The best quarterly return occurred in 2015-Q3, when the strategy earned a return of 48.0%.

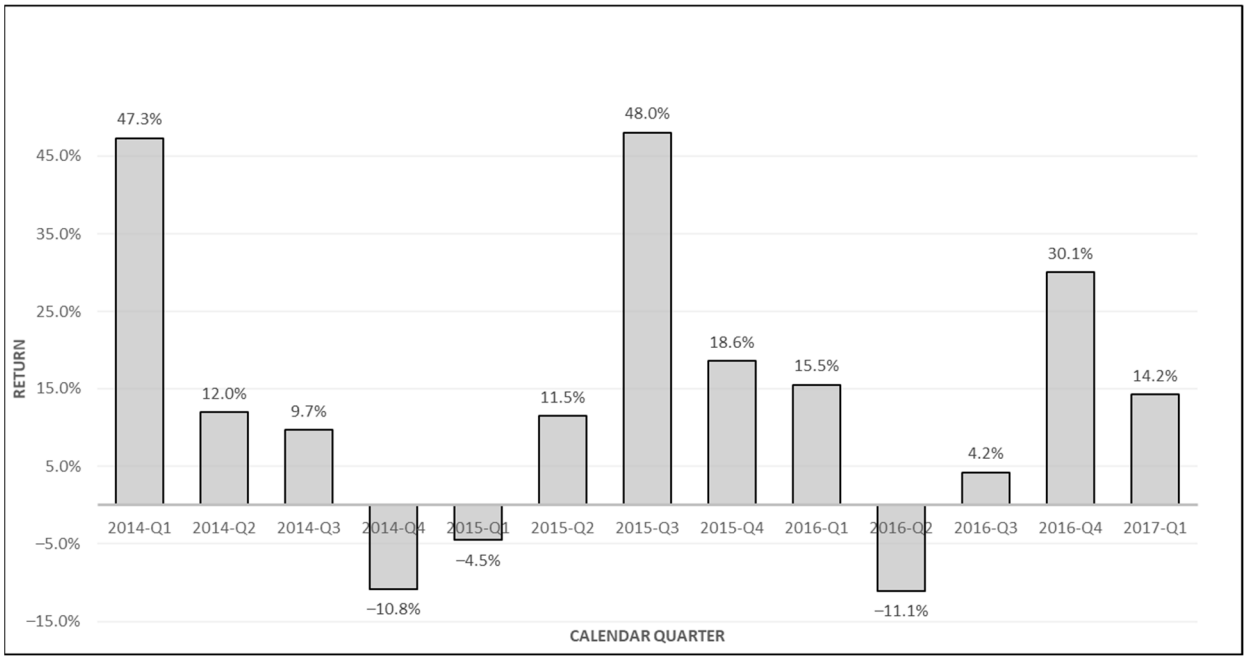

Figure 2. *AvgEA-Implied* hedge portfolio return by quarter. This figure shows the returns on the *AvgEA-Implied* hedge portfolio by calendar quarter for the sample period (i.e., the first quarter of 2014 through the first quarter of 2017). *AvgEA* is a firm's historical earnings announcement volatility. It is a firm's average one-day absolute stock return from its previous four earnings announcements. *Implied* is the firm's option implied earnings announcement move. It is the price of the at-the-money straddle on the weekly option near the end of the day before a firm's earnings announcement divided by the firm's stock price at that same time. *AvgEA-Implied* is equal to *AvgEA* minus *Implied*.

5.2. Are the Signals Associated with Straddle Returns?

5.2.1. Quintile Ranks of the Earnings Announcement Volatilility Signals

Table 4 presents the results of the Fama–MacBeth regressions with quintile ranks of the earnings announcement volatility signals as the independent variables. Columns 1 through 5 show the results for the quintile ranks of each of the earnings announcement volatility signals. Columns 1 through 4 have insignificant coefficients on the quintile ranks of *Vol*, *AvgEA*, *Implied*, and *Vol-Implied*. This indicates that historical volatility, historical earnings announcement volatility, the option implied earnings announcement move, and the difference between historical volatility and the option implied earnings announcement move do not predict straddle returns. Column 5 has a significantly positive coefficient of 0.12 on *AvgEA-Implied*. The coefficient of 0.12 can be interpreted as a 12% difference in quarterly returns between quintile 5 and quintile 1 of *AvgEA-Implied*. This indicates that the difference between a firm's historical earnings announcement volatility and its option implied earnings announcement move positively predicts straddle returns. These results are consistent with the mean quarterly portfolio returns from Table 3, which showed

a statistically significant mean quarterly return of 14.20% for the *AvgEA-Implied* hedge portfolio. These results are also inconsistent with the findings by Gao et al. (2018) and Goyal and Saretto (2009) of a positive association between straddle returns and historical volatility, historical earnings announcement volatility, implied volatility, and the difference between historical volatility and implied volatility.

Table 4. Association between straddle returns and quintiles of earnings announcement volatility signals.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Intercept	0.02 [0.57]	−0.03 [−1.04]	0.02 [0.77]	−0.01 [−0.36]	−0.06 [−2.25]	−0.04 [−1.19]	−0.06 * [−2.06]	−0.04 * [−1.79]	−0.06 * [−2.09]
Vol	−0.03 [−0.62]					−0.02 [−0.45]			
AvgEA		0.06 [1.56]					0.01 [0.22]		
Implied			−0.03 [−1.27]					−0.02 [−1.06]	
Vol-Implied				0.02 [0.60]					0.01 [0.41]
AvgEA-Implied					0.12 ** [2.48]	0.11 ** [2.29]	0.11 ** [2.25]	0.12 ** [2.54]	0.12 ** [2.53]

This table presents the results of Fama–MacBeth regressions with *StraddleRet* as the dependent variable. For this table, *Vol*, *AvgEA*, *Implied*, *Vol-Implied*, and *AvgEA-Implied* are transformed into quintile ranks, with quintile 1 taking the value of 0, quintile 5 taking the value 1, and the quintiles in between taking the values of 0.25, 0.50, and 0.75, respectively. *StraddleRet* is the return on the weekly straddle held over the one-day period containing the firm's earnings announcement. *Vol* is a firm's historical volatility. It is equal to the standard deviation of a firm's daily returns over the one-year period prior to its earnings announcement, expressed as the volatility over the number of days from the earnings announcement to options expiration. *AvgEA* is a firm's historical earnings announcement volatility. It is a firm's average one-day absolute stock return from its previous four earnings announcements. *Implied* is the firm's option implied earnings announcement move. It is the price of the at-the-money straddle on the weekly option near the end of the day before a firm's earnings announcement divided by the firm's stock price at that same time. *Vol-Implied* is equal to *Vol* minus *Implied*. *AvgEA-Implied* is equal to *AvgEA* minus *Implied*. For each column, the regression is estimated for each of the 13 sample quarters. On average, there are 207 straddles in each of the 13 quarterly regressions. Each column presents the coefficients and t-statistics based on the time-series of the 13 coefficient estimates. t-statistics are in square brackets below the coefficient estimates. ** and * indicate statistical significance at the 5% and 10% levels, respectively.

Because *AvgEA-Implied* is the only earnings announcement volatility signal significantly associated with straddle returns, in columns 6 through 9, this study controls for each of the other four signals in Fama–MacBeth regressions examining the association between *StraddleRet* and *AvgEA-Implied*. There is little change in the *AvgEA-Implied* coefficients after controlling for each of the other earnings announcement volatility signals in columns 6 through 9. The difference in quarterly returns between quintile 5 and quintile 1 ranges between 11% and 12% in columns 6 through 9, and the coefficients on *AvgEA-Implied* remain statistically significant in these columns.

5.2.2. Levels of the Earnings Announcement Volatilility Signals

Columns 1 through 5 present the results of Fama–MacBeth regressions with *StraddleRet* as the dependent variable and the levels of each of the earnings announcement volatitliy signals as the independent variables. Similar to Table 4, there is a signicantly positive coefficient for *AvgEA-Implied*, and insignificant coefficients for *Vol*, *AvgEA*, *Implied*, and *Vol-Implied*. In columns 6 through 9 of Table 5, the association between straddle returns and *AvgEA-Implied* is examined after controlling for the levels of each of the other four earnings announcement volatility signals. Similar to Table 4, controlling for each of the

other signals does not signficiantly impact the statistical significance or the magnitude of the coefficients on *AvgEA-Implied*. For example, in the univariate Fama–MacBeth regression in column 5, there is a coefficient of 1.60 on *AvgEA-Implied*, which is signficant at the 10% level. In columns 6 through 9, the coefficients of *AvgEA-Implied* range from 1.47 to 1.90, with columns 6 and 7 being significant at the 10% level and columns 8 and 9 being significant at the 5% level. Overall, these results on the earnings announcement volatility levels are consistent with the results from both Tables 3 and 4.

Table 5. Association between straddle returns and levels of earnings announcement volatility signals.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Intercept	0.03 [0.78]	−0.02 [−0.66]	0.03 [1.11]	0.02 [0.93]	0.01 [0.70]	0.03 [1.04]	0.03 [1.11]	0.04 [1.31]	0.03 [1.16]
Vol	−0.75 [−0.93]					−0.71 [−0.99]			
AvgEA		0.37 [1.35]					−0.38 [−1.26]		
Implied			−0.53 [−1.56]					−0.47 [−1.61]	
Vol-Implied				0.88 [1.70]					0.76 [1.53]
AvgEA-Implied					1.60 * [2.18]	1.47 * [2.05]	1.90 ** [2.21]	1.51 * [2.12]	1.58 ** [2.19]

This table presents the results of Fama–MacBeth regressions with *StraddleRet* as the dependent variable. *StraddleRet* is the return on the weekly straddle held over the one-day period containing the firm's earnings announcement. *Vol* is a firm's historical volatility. It is equal to the standard deviation of a firm's daily returns over the one-year period prior to its earnings announcement, expressed as the volatility over the number of days from the earnings announcement to options expiration. *AvgEA* is a firm's historical earnings announcement volatility. It is a firm's average one-day absolute stock return from its previous four earnings announcements. *Implied* is the firm's option implied earnings announcement move. It is the price of the at-the-money straddle on the weekly option near the end of the day before a firm's earnings announcement divided by the firm's stock price at that same time. *Vol-Implied* is equal to *Vol* minus *Implied*. *AvgEA-Implied* is equal to *AvgEA* minus *Implied*. For each column, the regression is estimated for each of the 13 sample quarters. On average, there are 207 straddles in each of the 13 quarterly regressions. Each column presents the coefficients and t-statistics based on the time-series of the 13 coefficient estimates. t-statistics are in square brackets below the coefficient estimates. ** and * indicate statistical significance at the 5% and 10% levels, respectively.

6. Discussion

This study examines the efficiency of straddle prices using weekly options immediately around firms' earnings announcements. It tests for an association between straddle returns and five signals of a firm's earnings announcement volatility (i.e., historical volatility (*Vol*), historical earnings announcement volatility (*AvgEA*), option implied earnings announcement move (*Implied*), the difference between historical volatility and the option implied earnings announcement move (*Vol-Implied*), and the difference between historical earnings announcement volatility and the option implied earnings announcement move (*AvgEA-Implied*)). This study finds that the difference between a firm's historical earnings announcement volatility and its option implied earnings announcement (*AvgEA-Implied*) move positively predicts straddle returns. This may occur because high (low) values of *AvgEA-Implied* could indicate instances where option traders have underestimated (overestimated) a firm's potential earnings announcement move relative to its historical earnings announcement moves. In other words, high values of *Avg-Implied* could indicate low straddle prices and thus higher straddle returns, while low values of *AvgEA-Implied* could indicate high straddle prices and thus lower straddle returns.

This study does not find an association between straddle returns and historical volatility, historical earnings announcement volatiltiy, implied volatility or the difference between historical volatility and implied volatility. Goyal and Saretto (2009) found a positive association between straddle returns (in general and not specifically around earnings announcements) in their 1996–2006 sample of straddles using monthly options. Gao et al. (2018) found a positive association between straddle returns and historical volatility, historical earnings announcement volatility, and implied volatility in their 1996–2013 sample of straddles around earnings announcements using monthly options. If this difference in results is not due this study's examination of weekly options, then this suggests that the options market has become more efficient in recent years with respect to these signals examined in prior research.

The main finding in this study is consistent with Goyal and Saretto's (2009) finding that differences between historical and implied volatility positively predict straddle returns. This study shows the importance of specifically considering a firm's historical earnings announcement volatility rather than its general historical volatility when assessing a firm's potential earnings announcement volatility, as these two will often differ significantly. This study also provides initial evidence on the value of computing option implied earnings announcement moves and comparing them to a firm's historical earnings announcement volatility.

7. Conclusions

This study finds that a hedge portfolio strategy that buys straddles on the top quintile of the difference between historical earnings announcement volatility and option implied earnings announcement move (i.e., *AvgEA-Implied*) and that sells straddles on the bottom quintile of this difference earns an average quarterly return of 14.20%. However, an options trader will need to carefully minimize transactions costs (e.g., bid-ask spreads, price impact, and commissions) to profit from this finding in practice. While sorting stocks on the difference between their average historical earnings announcement move and their option implied earnings announcement move produces large and statistically significant straddle returns, straddles around earnings announcements have large bid-ask spreads. Muravyev and Pearson (2020) found that option strategies such as that set out by Goyal and Saretto (2009) are highly profitable if one ignores transaction costs, but can become unprofitable if the trader must pay the conventional effective half-spread. However, they also find that these same option strategies can remain profitable for traders that can time their executions and thus significantly reduce their transactions costs. Besides timing their executions, an options trader could also use the *AvgEA-Implied* signal in combination with other predictive signals to improve their chances of generating significant profits in practice.

In addition to potentially high transactions costs, there are other limitations to consider. First, the sample for this study ends in the first quarter of 2017. It is unclear whether the strategy documented in this study will continue its strong performance. Future research could examine the performance in more recent years. A more recent analysis could be interesting, because weekly options have continued to grow in popularity since the end of the sample period. For example, this study contains 258 firms in its final quarter (see Figure 1), while the Chicago Board Options Exchange currently lists more than 500 firms with weekly options at https://www.cboe.com/available_weeklys/ (accessed on 10 April 2023). It is also important to note that although weekly options have been increasing over time, weekly options remain largely limited to very large U.S. companies.

There is also an important limitation related to option returns around earnings announcements. This study and other studies like it assume that the dates and times of earnings announcements are known perfectly in advance. While this has nearly always been the case for large firms in recent years, an unexpected earnings announcement can create a problem because the option prices do not reflect the unexpected earnings announcement, meaning that options prices in this case are too low, potentially resulting in very high option returns. Future research could examine how much unexpected earnings

announcements contaminate option returns around earnings announcements. The delay in the announcement of an already scheduled earnings announcement would also affect option strategies around earnings announcements.

While the *AvgEA-Implied* signal is easy to compute and intuitive, it is an imperfect measure of the difference between a firm's historical earnings volatility and the options market's expectation of the firm's upcoming earnings announcement volatility. This signal is subject to greater measurement error during periods of greater market volatility, and when there are more days between the earnings announcement and options expiration. This occurs because implied volatility not only reflects the options market's expectation of the firm's upcoming earnings announcement volatility, but also the general market volatility expected over the days remaining in the life of the option. The greater the number of days to option expiration, the greater the influence of volatility unrelated to the firm's upcoming earnings announcement over implied volatility, and thus *AvgEA-Implied*. A potential arbitrageur should carefully consider each of these limitations prior to using the strategy from this study in practice.

This study has implications of interest to investors and researchers on the market efficiency of option prices. The ability of *AvgEA-Implied* to predict straddle returns suggests that weekly straddle prices around earnings announcements are not perfectly efficient. The fact that the signals from prior research no longer seem to predict straddle returns in the specific setting examined in this study suggests that the efficiency of option prices may be improving over time. Future research may examine whether option prices have become more efficient over time, and what factors have led to improvements in the efficiency of option prices. Taken together, this study and that by Goyal and Saretto (2009) suggest that the key to predicting straddle returns is identifying differences between a firm's typical volatility and its expected volatility, with large positive differences suggesting high straddle returns and large negative differences indicating low straddle returns. Investors and researchers may work to better predict straddle returns by improving their measurement of a firm's typical and expected volatility, both around and outside of earnings announcements.

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