Received 10 May 2018
Revised 21 June 2018
Accepted 3 July 2018

Risk management in student-managed funds

Earnings announcements and the collar strategy

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Abstract

Purpose – Student-managed investment funds typically pursue "plain vanilla" objectives. The purpose of this paper is to demonstrate the value of adding option strategies to reduce the risk of equity positions around earnings announcements. The collar strategy is one such technique with the advantages of a low net cost and limited potential losses.

Design/methodology/approach – The authors provide recommendations for utilizing the collar strategy around earnings announcements. The authors also discuss how the value of this strategy is related to the literature on option pricing and earnings announcement returns.

Findings – Risk management strategies can enhance the pedagogical value of student-managed investment funds. The authors document how students have successfully utilized the collar strategy to immunize risk.

Originality/value – The collar strategy can enhance the pedagogical value of student-managed investment classes in several ways. First, students learn how to implement risk reduction strategies. Second, the proper implementation of these strategies requires students to learn the complex mechanisms associated with corporate earnings dissemination and analyst coverage. This also provides an opportunity to study earnings drift, which is a persistent and economically significant financial anomaly.

Keywords Student-managed investment funds, Earnings announcements, Option hedging, Collar strategies

Paper type Research paper

Introduction

Universities are under increasing pressure to provide students with the skills and learning experiences to transition into the work force and earn a return on their educational investment. Some institutions are increasingly moving away from the traditional lecture model and delivering knowledge in innovative ways to provide better learning outcomes. One approach is the use of experiential projects, which challenge students with real-world problems. Such projects increase student understanding of current events, promote critical thinking and increase the retention of skills.

Many business schools offer student-managed investment funds as a popular experiential learning opportunity in finance. These funds give college students the opportunity to manage a portfolio that is typically part of the endowment fund of the university. While the practice of finance is constantly evolving, many of these student-managed investment funds have maintained the same basic approach: a long-only strategy targeting large-cap US stocks. This asset class is widely followed by the media, receives significant research coverage from Wall St analysts and is the least likely to contain inefficiently priced securities. We argue that strategies employed by student-managed investment funds should stay innovative with the current practice of finance while still maintaining appropriate risk exposure.

At the University of Denver, our undergraduate student-managed investment fund puts such an innovative strategy into practice. We employ a three-pronged approach that is

Managerial Finance
Vol. 46 No. 5, 2020
pp. 692-702

0307-4358
DOI 10.1108/MF-05-2018-0198

JEL Classification — G11, G12, G17

The authors appreciate the research support from the Reiman School of Finance at the Daniels College of Business.

unique from the typical student fund that benchmarks to the ubiquitous S&P 500 Index. First, we target mid-cap stocks, which receive low coverage from Wall St analysts and have relatively few actively managed mutual funds targeting this market segment[1]. Second, we employ a unique strategy of sector allocation based on the EV/EBITDA ratio[2]. Third, we use options to put a collar on our exposure to certain holdings around earnings announcements. In this paper, we explore the justification and implementation of this third aspect of our strategy.

Risk management strategies

A portfolio manager has multiple ways to immunize a stock position[3]. These techniques are particularly useful when a forthcoming event has two characteristics: it will likely cause higher stock price volatility; and the company will be challenged to meet lofty investor expectations associated with the event.

The first technique that a portfolio manager can use to reduce the portfolio exposure to a position is to simply liquidate the stock. This approach incurs transaction costs and potentially triggers capital gains taxes. Often a portfolio manager will not choose this option because the short-term risk does not offset the long-term benefit of maintaining the position. In other words, the security offers an attractive risk-to-reward profile over the long-term, even though the position lacks a near-term catalyst or has high short-term risk. Thus, liquidating the position is not the most advantageous approach.

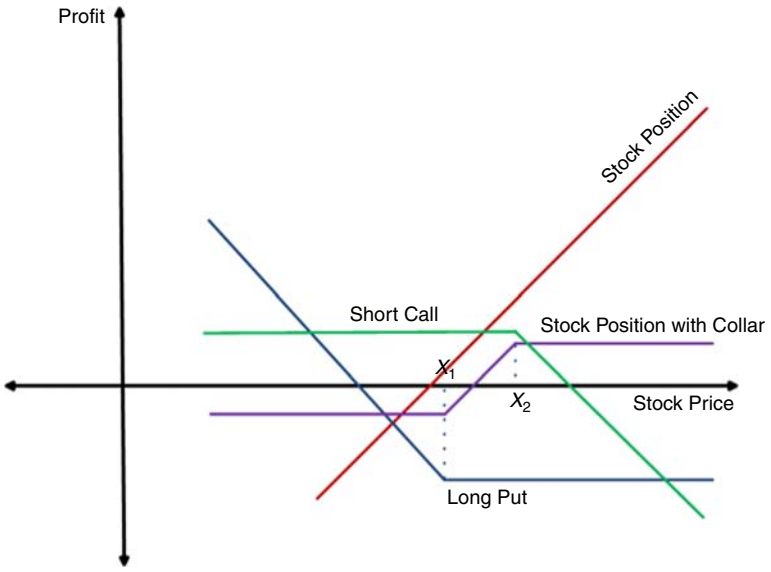
Another technique to reduce the exposure to a stock position is purchasing a put option. This provides a fixed price for selling the stock for a certain period and establishes a floor to the value of the position. However, the cost of the option may be expensive, especially if the implied standard deviation is high due to significant differences in investor expectations around the release of material information.

The student-managed investment fund at the University of Denver regularly reduces position risk by employing an additional approach that is called a collar strategy. A collar strategy is implemented for a stock position by executing the following two trades simultaneously: writing a call option with a strike price above the market price; and purchasing a put option with a strike price lower than the market price. This effectively puts a "floor" and "ceiling" on the value of the stock position until the maturity date of the options. This combination of positions provides exposure to stock price fluctuations within the range of the strike prices for the call and put options. Also, it reduces the potential portfolio return volatility around the earnings announcement date.

Implementation of the collar strategy

Figure 1 illustrates the payoffs of a collar strategy and its components at the expiration date of the options. Consider only the position in the stock, which has a profit that changes on a one-to-one basis with the price and is represented by a line with a slope of 1. In combination with a short call and long put, the stock position with a collar has an overall profit with both a maximum and minimum until the expiration date. In other words, the portfolio does not experience additional losses as the stock price falls below X_1, and profits are maximized at stock prices at or above X_2.

The lines representing the stock position and the stock position with the collar are parallel between X_1 and X_2. The vertical distance between the lines represents the net cost of implementing the collar strategy. If the cost of the put option exceeds the premium received from writing the call option, the collar strategy has a positive net cost, and the associated profitability line will be below the profitability of the stock position between X_1 and X_2.



Notes: This graph illustrates the value of a collar strategy and its components at the expiration date of the options. The collar strategy consists of three positions: long stock, short call option and long put option. The put and call options have strike prices at X_1 and X_2, respectively. This illustration assumes that $X_1 < X_2$ and the net cost of the options is positive

Figure 1.
Profitability of collar strategy

Levels of option trading

In order to trade options, an account holder needs authorization from their brokerage firm. Clients may be approved for one of the four levels of trading described in Table I. This authorization process is an essential risk management tool for brokerage firms. Options may be used to reduce or magnify risk, and many transactions involving these derivatives have the potential for unlimited losses. The approval process for various levels of trading is designed to protect inexperienced account holders from quickly generating large losses and protect brokerage firms from traders who do not have the liquidity or assets to stand behind the potential losses associated with some options trading.

Option trading level	Approved transactions
Level 1	Covered call writing
Level 2	Level 1 transactions, purchases of call and put options, purchase of straddle and strangle strategies, collar strategies, and writing of cash covered puts A straddle strategy includes long positions in call and put options on an underlying stock. The options have the same expiration date and exercise price. A strangle strategy is similar with the exception that the strike prices for the call and put options are different
Level 3	Levels 1 and 2 transactions, and spreads Spreads are implemented by the purchase and sale of options with different expiration dates or strike prices
Level 4	Levels 1, 2 and 3 transactions, and uncovered writing of options and option combinations

Notes: While most brokerages use a classification system similar to the descriptions in Table I, firms may use a unique definition for option trading levels

Table I.
Option trading levels

As shown in Table I, collar strategies may be implemented through an account authorized for Level 2 or higher. Student-managed investment funds may encounter difficulty in gaining authorization for this option trading level as university administrators are traditionally risk-averse. However, all of the approved transactions associated with Level 2 option trading involve limited losses.

Collar Greeks

When using options in risk management, portfolio managers need to navigate multiple complexities associated with these derivatives. Option positions are typically closed prior to their expiration date, but Figure 1 illustrates the value of these positions at expiration. Before the maturity date, the option premium is a function of time value and intrinsic value. In this case, it is useful to consider the sensitivity of the premium to the determinants of option value. The sensitivities are commonly called the Greeks.

The first of these sensitivities is delta, which measures the change in the option price as the underlying stock price increases. For the collar strategy, the combination of the short call and long put options on the same quantity of the underlying asset has a negative delta. For a stock position with the same number of shares as specified in the option contracts, the net negative delta from the option positions only partially offsets the positive delta of the underlying stock position. Thus, the net exposure of the three positions is a positive delta. To minimize the portfolio's sensitivity to changes in the stock price, the delta of the option positions should have an absolute value that is close to the delta of the stock position[4].

Time to maturity is another determinant of an option's value. Theta measures the sensitivity of the premium to changes in the time to maturity. When a collar strategy is implemented with strike prices that are equidistant to the stock price, the thetas for the options are approximately equal. Thus, the long and short positions result in a net θ near 0, which implies that the collar strategy is relatively unaffected by the passage of time. However, if the stock price is closer to X_2 (the strike price of the call), then the theta of the call is greater than for the put. In this case, the value of the collar strategy slightly increases with time erosion, ceteris paribus. When the strike prices for the collar are chosen such that the strike price for the put is closer to the stock price, the strategy has positive theta and will lose value as maturity approaches[5].

Vega is the relation between the option price and the implied standard deviation of the stock price. All options have positive vegas. Even though the call option and put option will have slightly different vegas, the combination of the long and short positions in a collar strategy results in a vega near zero. Thus, a collar is relatively insensitivity to changes in volatility.

By allowing participants in a student-managed investment fund class to analyze and recommend risk management strategies like the collar, they are able to learn about the complex exposures that options add to an actual portfolio. They also learn that the collar strategy offers the advantage of near neutral exposure to several factors, like time to maturity and volatility.

Economic cost of the collar strategy

Portfolio managers often attempt to implement a collar strategy with zero cost, which occurs when the premium received from selling the call offsets the cost of the put option. However, this view of cost focuses only on the relative size of the premiums and ignores the effect on the risk/return of the overall position. In theory, the return of a strategy is positively related to its risk. By viewing the expected return of the collar strategy from the perspective of the equity risk premium, the economic cost of the strategy can be different than that implied by the label of "zero-cost collar." Israelov and Klein (2016) argue that zero-cost collars usually have negative alpha. This results from the put option having a negative alpha with absolute value greater than the positive alpha from writing the call option[6].

Thus, the collar strategy lowers both the expected return and the return-to-risk ratio as measured by the Sharpe ratio. Adding the downside protection from the put option lowers the

risk-adjusted portfolio performance. This result can also be explained from a behavioral perspective as investors value loss avoidance, which is documented by Kahneman and Tversky (1979). This is evidenced by out-of-the-money put options being generally more expensive than out-of-the-money call options. From this perspective, a collar strategy involves buying what is relatively more expensive (put options) and selling what is relatively less expensive (call options). The impact of these positions when implemented to achieve offsetting premiums (zero cost) has a negative alpha and lowers risk-adjusted performance. Thus, the economic cost is typically greater than the explicit outlays from implementation of the transactions.

In order to add value and offset this economic cost, portfolio managers need an informational advantage when implementing this strategy. In the next section, we discuss research that is useful in determining when the advantages of the collar strategy outweigh the economic costs.

Earnings announcements

Stock prices experience levels of volatility that defy easy explanation. Shiller (1981) shows that volatility is at least five times too high to be caused by dividend changes. Other economists examine how stock returns are related to earnings, which offer weak explanatory power despite getting significant attention from the popular media. Ball and Brown (1968) wrote a seminal article showing that the income disclosed in annual reports provides considerable information on corporate value but is not a relatively timely source for determining stock returns. Recent studies find that expected returns are more closely linked to other measures. Novy-Marx (2013) documents the predictive power of gross profits, while Ball *et al.* (2015) reveal that operating profits are more associated with returns than either net income or gross profits. Hughen and Strauss (2017) show that portfolio allocations – at both the security and sector level – made using such profitability measures significantly outperform popular ratios like the price-to-earnings ratio.

A number of studies document anomalies associated with earnings announcements and stock returns. These provide insight into the mechanics of reducing risk around earnings announcements using options. First, stock returns have a non-linear relation to corporate earnings (Hayn, 1995; Freeman and Tse, 1992). Second, quarterly earnings announcements explain a small portion of stock returns.

Since Fama and French (1992) showed that the book-to-market ratio has explanatory power for the cross-section of equity returns, academics have made many attempts to explain this as either a risk factor or indicator of behavioral bias. Furthermore, investors have sought ways to exploit the return premium for investing in value stocks instead of growth stocks. Later research identifies the periods during which growth stocks exhibit poor performance by showing that their returns are highly sensitive to earnings surprises. Skinner and Sloan (2002) document that these stocks experience surprisingly large negative returns when actual earnings do not meet analyst expectations. He argues that the return differential between value and growth stocks is attributable to the quarters in which growth stocks have large negative earnings surprises.

We argue that this is a salient finding with regard to risk reduction strategies in equity portfolio management. If the manager of a stock portfolio that includes growth stocks can identify holdings with optimistic growth expectations and high probabilities of failing to meet these expectations, then a collar strategy can be effectively utilized to reduce overall portfolio risk.

Analyst revisions and earnings drift

How can portfolio managers identify stocks that are likely to miss investor earnings expectations? The financial data industry has utilized both industry and academic research to create products that offer predictive value for earnings surprises. One such product is the Thomson Reuters StarMine® Analyst Revisions Model, which is described by Bonne *et al.* (2015).

This model incorporates the research of Elton and Gruber (1972) and Givoly and Lakonishok (1979) that documents the earnings revisions anomaly. This anomaly suggests that analysts exhibit a behavioral bias by "anchoring" to prior earnings estimates and are slow to alter estimates to fully reflect new information. Thus, analyst revisions are serially correlated and associated with future returns. Jegadeesh *et al.* (2004) show that while the level of analyst recommendations has explanatory power for returns only in select situations, the change is a robust and value relevant indicator. Hayunga and Lung (2014) find that the options markets anticipates changes to analysts' consensus recommendations before the stock market and could form the basis of a profitable trading strategy.

The analyst revisions model also takes into account several other factors to provide a relative rating for future earnings surprises and analyst revisions. First, the model provides a higher weighting on the estimates from analysts with superior forecasting track records. Second, the model places a higher weighting on revisions associated with the financial factors that are more relevant to valuation within a stock's industry. Thomson Reuters finds the return differential between the top and bottom decile for these ratings is approximately 20 percent per year from 1998 to 2014.

In a seminal article on earnings, Ball and Brown (1968) observe that returns continue to be abnormally positive after favorable earnings announcements. This phenomenon also occurs for "bad" earnings announcements, which are followed by negative cumulative abnormal returns. Foster *et al.* (1984) document that a long/short portfolio formed using the top and bottom deciles of earnings surprises provides an annualized return of 25 percent in the 60 trading days post-announcement. Other studies suggest this return drift could last up to nine months (Richardson *et al.*, 2010). As further evidence of the economic significance of earnings drift, Kausar (2017) finds that the predictive power of operating profitability and gross profitability for the cross-section of stock returns – as documented by Novy-Marx (2013), Ball *et al.* (2015) and Fama and French (2015) – is a reflection of this post-earnings-announcement drift and not robust to controls for earnings changes.

Earnings surprises

Zhou and Shon (2013) analyze the stock returns around earnings announcements over a 26-year period for the 1,000 companies with the largest market capitalizations. The earnings announcement reaction is measured as the market-adjusted stock return over a three-day period starting on the trading day prior to the earnings announcement. The adjustment involves subtracting the return on a value-weighted index over the same period in order to measure the excess return on the stock.

We summarize several of their salient findings as related to the importance of earnings announcements. First, Zhou and Shon describe the size of earnings surprises. Over half of earnings surprises, defined as the actual quarterly EPS divided by the mean consensus analysts estimate, are positive (median surprise is 0.69 percent). This is consistent with the idea that corporations manage earnings expectations to "meet or just beat" investor expectations. However, the median surprise does not reveal the common occurrence of large earnings surprises. The average earnings surprise is −7.49 percent, and the 25th and 75th percentiles are −4.41 and 9.43 percent, respectively. Thus, students in a fund class should understand that earnings announcements frequently provide material, unexpected information that is critical to the management of the portfolio.

The second salient finding is related to volatility. While the median excess return is 0.10 percent, stock returns around earnings announcements are more volatile than during normal periods. During the three-day excess return window, about half of the returns are more than 1 standard deviation away from the mean return. With a normal distribution, this would occur only 32 percent of the time[7]. In other words, earnings announcements are frequently accompanied by large earnings surprises and significantly high levels of volatility.

A final important finding is that the reactions to earnings surprises are often counterintuitive. Zhou and Shon find that positive earnings surprises are accompanied by negative excess returns in 39.45 percent of the cases, and negative earnings surprises have positive excess returns in 38.95 percent of the cases. This could occur because management guidance is released along with earnings and is the dominant determinant of the investor reaction. Alternatively, mean consensus earnings from sell-side analysts may be a poor proxy for investor earnings expectations.

Collar strategy example

Table II describes the implementation of the collar strategy on a position in Arrow Electronics in the student-managed fund at the University of Denver. An analysis revealed that Arrow Electronics would likely not meet the lofty investor expectations for earnings in the fourth quarter of 2017. Panel A provides data on management guidance and the consensus analyst expectations. In a conference call with analysts on November 2, management offered earnings guidance for US GAAP EPS in a range of $1.86–$2.02. By January 19, the consensus mean estimate from sell-side analysts was $2.17, which was 7.4 percent higher than the top of the range from management guidance. While the consensus mean is arguably only a weak proxy for true investor expectations, the earnings estimates were consistent with lofty investor expectations and/or management providing unrealistically low earnings guidance.

The students in our fund class recommended reducing our exposure to this stock position using the collar strategy. The implementation of this hedging strategy required

Panel A: arrow Electronics 4Q17 earnings announcement

Date	Measure	EPS	Relation to actual
November 2, 2017	Guidance	$1.86–$2.02	210–237%
January 19, 2018	Consensus mean	$2.17	262%
February 6, 2018	Actual EPS	$0.60	100%

Panel B: transactions in collar strategy

Date	ARW closing price/share	Transaction	Cost/share
January 25, 2018	$83.41	Buy to open: put option X_1 = $82.50/share, expiry: February 2016	–$1.61
January 25, 2018	$83.41	Sell to open: call option X_2 = $85.00/share, expiry: February 2016	+$1.65
February 8, 2018	$76.32	Sell to close: put option X_1 = $82.50/share, expiry: February 2016	+$5.67
February 8, 2018	$76.32	Buy to close: call option X_2 = $85.00/share, expiry: February 2016	–$0.04
		Net	+$5.67

Panel C: comparison of hedging strategies

Position	Cost/share of hedge	Change in value $/share	Return
Stock only	$0.00	–$7.09	–8.5%
Stock with put option	$1.61	–$3.03	–3.6%
Stock with collar strategy	–$0.04	–$1.42	–1.7%

Notes: Panel A shows expected and actual earnings for the 4th Quarter of 2017 for arrow electronics. The ending date of the period was December 31, 2017. The earnings measure is Consolidated – US GAAP EPS. Panel B shows the transactions for a collar strategy on arrow electronics stock (ARW). The costs include transaction costs. Panel C provides the costs and changes in value from different hedging strategies using market prices on February 8, 2018

Table II.
Example of collar strategy, arrow electronics

choosing the strike prices for the put and call options as well as the expiration date. Since earnings expectations were well outside of the range of management guidance, our students recommended minimal exposure to the stock position. This was achieved by choosing strike prices for the put and call options nearest to the market price. With the price of Arrow Electronics stock at $83.41 on January 25, 2018, the strike prices for the put and call options used in the collar strategy were $82.50 and $85.00, respectively. The management of Arrow Electronics scheduled an earnings release on February 6; therefore, the strategy employed options with the nearest expiration date after the expected earnings release.

Panel B of Table II provides the transactions for the collar strategy, which was initiated on January 25. The premiums on the put and call options were $1.61/share and $1.65/share, respectively. Because the cost of buying the put was slightly less than the premium received from writing the call, the fund gained $0.04/share from the opening transactions. On February 6, Arrow Electronics reported actual US GAAP EPS of $0.60, which was only 28 percent of the consensus mean earnings expectation. The stock price declined 8.5 percent in the two days after the earnings announcement. The collar strategy was closed on February 8 with the premiums on the put and call options at $5.67/share and $0.04/share, respectively. The closing transactions generated $5.63/share more from selling the put than buying the call. Net cash flows of $5.67/share were generated from the four transactions in the hedging strategy.

To quantify the comparative advantage of this strategy, Panel C provides the cost and change in value from three different approaches in this situation. The first approach ("stock only" position) does not reduce the portfolio's exposure to the stock price. It avoids the cost of a hedge but results in a change in value of –$7.09/share from January 25 to February 8. The second row in Panel C shows the results for combining the stock position with a put option that has a strike price of $82.50/share. This downside protection from the put costs $1.61/share but reduces the impact of the declining stock price to –$3.03/share. The final row of Panel C shows that the collar strategy generates income (shown as a negative cost) and provides the most protection from the negative earnings announcement. With the collar strategy, the portfolio has a loss on the position of 1.7 percent, which is significantly less than the loss of 8.5 percent without any protective strategy.

The results from these three approaches would be quite different if Arrow Electronics had provided financial results that beat investor earnings expectations. If the stock had a large positive return, the stock position without a hedge would provide the best results for the portfolio. A hedging strategy using only a put option would have also performed relatively well as this approach does not limit the gain from the stock position. The collar strategy would provide the least benefit to the portfolio when the stock has a large positive return. In this situation, the short position in the call option offsets the stock price gains above the strike price of the call.

Recommendations for implementation of the collar strategy

We offer three recommendations for utilizing the collar strategy around earnings announcements. First, portfolio managers should avoid initiating the collar strategy immediately prior to an earnings release. We offer two reasons for this recommendation. The effectiveness of hedging strategies can be highly sensitive to the liquidity of the derivatives market. The options market typically offers less liquidity and higher transaction costs immediately prior to an earnings announcement.

An additional reason is related to the return on stocks prior to negative earnings surprises. Skinner and Sloan (2002) find that the relatively poor performance of growth stocks occurs in quarters with negative earnings surprises. Furthermore, a significant portion of this negative performance occurs in the 31 days prior to the earnings release. A strategy to reduce the risk from negative earnings surprises will likely not provide the needed protection if implemented just prior to earnings announcements.

If a company does report earnings that are a negative surprise, a portfolio manager does not necessarily need to quickly unwind the collar strategy. As mentioned in the literature review, the post-earnings-announcement drift is an earnings anomaly that persists and is economically significant. Therefore, closing a hedging strategy soon after an earnings announcement with a negative surprise will fail to protect the portfolio from the negative returns associated with the post-announcement drift.

The second recommendation that we offer for implementing collar strategies is to utilize management guidance as a signal as to whether investors hold unrealistically positive expectations for the next quarter's earnings. On the one hand, managers often "sandbag" analyst expectations so the corporation can "meet or just beat" the consensus mean expectations for earnings. However, analyst expectations that significantly exceed management guidance for earnings are a warning sign of unrealistically optimistic investor expectations. In addition, portfolio managers should consider hedging positions in stocks with analyst estimates that have greater dispersion. Such companies with controversial future prospects are associated with more negative returns after earnings announcements.

Our third recommendation is to utilize valuation metrics to identify growth stocks that would likely experience significant stock price declines from a negative earnings surprise. Portfolio managers should have a bias toward reducing their risk in such situations with asymmetric payoffs that are negatively skewed as documented by Skinner and Sloan (2002).

Pedagogical value

Some university administrators may be initially skeptical of a student-managed investment fund that is authorized to implement option strategies. However, we argue that the use of such strategies to reduce portfolio risk is a valuable learning exercise with little downside. At the University of Denver, the student-managed fund does not have a derivatives course as a prerequisite. The fund class covers the basic concepts of calls, puts and option combinations to provide a solid foundation for the implementation of the collar strategy. Our experience is that the stock analysis needed for the collar strategy complements the role that portfolio managers serve in traditional stock selection.

In addition, students learn the importance of risk management, particularly in situations with high expectations, asymmetric payoffs with a negative skew and the release of material information. In order to effectively analyze whether these conditions exist, students should learn the principles of relative valuation as well as the complex mechanisms associated with corporate earnings dissemination and analyst coverage of these events.

Furthermore, students will be exposed to stock position transformation using options. They will also benefit from learning about the post-earnings-announcement drift and how to time hedging strategies to benefit from this earnings anomaly.

Conclusions

While student-managed investment funds have become an increasingly common part of business schools, these funds often pursue relatively basic investment strategies. We recommend the incorporation of risk management techniques in the investment strategies of these funds. The collar strategy is one such technique with the advantages of a low net cost and limited potential losses. By using this approach to reduce the sensitivity of positions around earnings announcements, students gain significant insights into the complexities of option strategies and investor earnings expectations. Students retain more knowledge when conducting an analysis in an applied setting in which they can put theory into practice. Furthermore, they develop their communication skills by presenting their analysis and recommendations to their portfolio team. The incorporation of risk management strategies in the management of the student fund at the University of Denver has both lowered the overall portfolio risk and enhanced the pedagogical value to students.

Notes

1. Hughen *et al.* (2018) find that the median analyst coverage of mid-cap stocks is half the coverage of large-cap stocks. Furthermore, the percentage of mutual funds actively targeting the mid-cap space is significantly below the percentage of overall equity market capitalization for mid-cap stocks.
2. The EV/EBITDA ratio is the enterprise value divided by the earnings before interest, taxes, depreciation and amortization. Through an analysis of returns over a 35-year period, Hughen and Strauss (2017) show that profitability metrics can be consistently used for portfolio allocations that outperform approaches using traditional measures and produce Sharpe ratios over 50 percent higher than the market. Sector allocations using the EV/EBITDA ratio produce the highest portfolio payoffs, which are five times greater than the benchmark and 50 percent greater than the next best performing ratio. This ratio is robust to the sector differences associated with financial leverage and capital intensity. Hughen *et al.* (2018) explain how this strategy can be successfully implemented in a portfolio investing in mid-cap stocks.
3. While not discussed in this paper, a covered call strategy is another approach to reducing a portfolio's exposure to a stock position. This strategy combines a long position in a stock with a short position in a call option. Writing the option generates income but limits the gain from stock appreciation.
4. Consider the example of a portfolio with a stock position of 30 shares. This position has a delta of 30. To minimize the portfolio's sensitivity to changes in the stock price, the characteristics of the put and call options (maturity date, strike prices and number of contracts) in the collar strategy should be chosen to have a net delta of −30.
5. A portfolio manager can construct a theta-neutral collar strategy through the selection of out-of-the-money call and put options with maturities after the earnings announcement date.
6. The writer of put options receives compensation for the volatility risk premium, and this results in a negative alpha. In a zero-cost collar, the volatility smile results in the absolute value of the alpha from the put being larger than that of the call option. Baksi and Kapadia (2003) document the relation between the volatility risk premium and alpha from option positions.
7. Zhou and Shon (2013) provide a detailed explanation of the assumptions behind this calculation. See page 6 and endnote 3 in chapter 1.

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