The Performance of Options-Based Investment Strategies: Evidence for Individual Stocks During 2003–2013

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Abstract

Using data from January, 2003, through August, 2013, we examine the relative performance of options-based investment strategies versus a buy-and-hold strategy in the underlying stock. Specifically, using ten stocks widely held in 401(k) plans, we examine monthly returns from five strategies that include a long stock position as one component: long stock, covered call, protective put, collar, and covered combination. To compare performance we use four standard performance measures: Sharpe ratio, Jensen's alpha, Treynor ratio, and Sortino ratio. Ignoring early exercise for simplicity, we find that the covered combination and covered call strategies generally outperform the long stock strategy, which in turn generally outperforms the collar and protective put strategies regardless of the performance measure considered. These results hold for the entire period 2003–2013 and both subperiods 2003–2007 and 2008–2013. The findings suggest that options-based strategies can be useful in improving the risk-return characteristics of a long equity portfolio. Inferences regarding superior or inferior performance are problematic, however, as the findings reflect the Leland (1999) critique of standard CAPM-based performance measures applied to option strategies.

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1. Introduction

Options-based investment strategies are popular and valuable tools in portfolio management. A portfolio manager holding a long stock position might want to change the risk-return profile of his portfolio without liquidating that stock position. Adding options to the portfolio can be a convenient and effective way for the manager to tailor his equity position, augment income, or limit risk as market conditions change.

Numerous studies have analyzed options-based strategies in portfolio management. One popular strategy is the covered call, or buy-write, strategy. In this strategy one combines a long equity position with a short position in an out-of-the-money call option having the same underlying equity. Whaley (2002) examines the CBOE Buy Write Index (ticker symbol BXM) during 1988–2001. He concludes that the "BXM outperformed the S&P 500 portfolio by approximately 0.2% a month on a risk-adjusted basis." Hill, Balasubramanian, Gregory, and Tierens (2006) analyze the strategy underlying the BXM, along with other short-term S&P 500-overwriting strategies with both fixed and dynamic strike prices. They conclude that such strategies "have very favorable performance characteristics at a range of risk levels." Kapadia and Szado (2007) examined the buy-write strategy on the Russell 2000 Index. Using returns over the period 1996–2006, they conclude that "the buy-write strategy can outperform the index."

Similarly, several papers have analyzed the collar strategy. In this strategy one combines a long equity position with a short call option position and a long put position, where the options are out-of-the-money and have the same underlying equity. For instance, Szado and Schneeweis (2012) provide a recent and comprehensive analysis of collar strategies across a wide range of asset classes, including equity, currency, commodity, fixed income, and real estate. They conclude that "for most of the asset classes considered, an option-based collar strategy, using six-month put purchases and consecutive one-month

call writes, provides improved risk-adjusted performance and significant risk reduction." For instance, they examine collars based on the SPDR S&P 500 (SPY) ETF over a 55-month sample period. They find that a 2% out-of-the-money collar position gained over 22% while a long SPY position lost 9%. Moreover, not only did the collar have a superior return, but it also had less than half the risk, where risk is measured as standard deviation of return. These findings echo earlier results of Szado and Schneeweis (2010), in which they find that a protective collar strategy using 6-month put purchases and consecutive 1-month call writes earned superior returns, and reduced risk by almost 65%, when compared to the corresponding buy-and-hold strategy where the underlying asset is the PowerShares QQQ exchange-traded fund.

As do the aforementioned studies, our paper investigates the performance of options-based investment strategies. We extend the literature in two respects, however. First, we compare the performance of several strategies rather than concentrating on a single strategy such as a covered call or collar. Second, unlike prior studies that have primarily focused on the S&P 500 index which has European options, we examine individual stocks which have American options. American options raise the complicating factor of early exercise.

Specifically, we examine five strategies (long stock, covered call, protective put, collar, and covered combination) for ten stocks commonly used in 401(k)s. We analyze their performance in 2003–2013, both over the entire period and over the first and second halves separately, using four widely used measures, i.e., Sharpe ratio, Jensen's alpha, Treynor ratio, and Sortino ratio. In general, the covered combination and covered call strategies outperform the long stock strategy, and the long stock strategy outperforms the collar and protective put strategies. Inferences regarding superior or inferior performance are problematic, however. The relative performance rankings reflect the Leland (1999) critique of standard CAPM-based performance measures applied in settings where returns are nonsymmetrical, which is clearly the case with options-based investment strategies.

The paper proceeds as follows. Section 2 describes the data and methodology. Section 3 gives empirical results. Section 4 provides concluding remarks.

2. Data and Methodology

In deciding which stocks to use, we wanted a small, representative sample that would be of interest to all investors, but especially to large institutional investors such as pension funds and endowments. We also wanted a "third party" to choose the stocks so that we did not cherry-pick firms and bias the sample. Consequently, we searched popular press articles and found a CNBC story published September 12, 2012, entitled "Widely Held Stocks in 401(k)s." (See www.cnbc.com/id/48939384.) CNBC first asked Brightscope (which rates 401(k) plans for more than 45,000 employers) to identify the top five equity mutual funds in most 401(k) plans. CNBC then asked researchers at Morningstar to determine the ten most widely held stocks in those funds.

In decreasing order, the top ten firms were as follows: ExxonMobil, Comcast, Berkshire Hathaway (Class A), Oracle, Microsoft, Coca-Cola, Amazon, Wells Fargo, Google, and Apple. Listed options trade for all of these firms except Berkshire Hathaway (Class A). Listed options do trade, however, for Berkshire Hathaway (Class B). Rather than drop Berkshire Hathaway completely from our sample of firms, we decided to substitute Berkshire Hathaway (Class B) for Berkshire Hathaway (Class A). Therefore, given this substitution we have ten stocks with listed options in our sample. For simplicity, we shall refer to these stocks as the ten most widely held stocks in 401(k) plans.

In deciding which options-based strategies to investigate, we wanted all strategies to include a long equity position. We wanted to explore how investors might utilize options to improve the risk-return profiles of their equity positions. We did not, therefore, analyze naked option positions. The long equity restriction led us to choose five strategies for any given stock. The first strategy is simply to hold the stock. The other four strategies combine holding the stock with one or more options which have that stock as the underlying stock. The four options-based strategies are: covered call (long stock plus short call), protective put (long stock plus long put), collar (long stock plus short call plus long put), and covered combination (long stock plus short call plus short put).

In deciding what sample period to use, we originally chose the last ten calendar years for which we had data, i.e., 2003–2012. This period seemed especially interesting due

to the Financial Crisis of 2007–2008 that occurred approximately halfway through the sample period. Besides examining relative performance over the entire period, we wanted to examine performance over the first and second halves to see whether it differed significantly. During our preliminary work, option data became available through August, 2013. Thus, our updated sample period covers the period from January, 2003, through August, 2013. There are 128 monthly observations for all but two stocks, Google and Berkshire Hathaway. These two stocks have only 108 and 50 observations because their listed options began trading in 2004 and 2009, respectively.

Our data comes from various sources. Our options data comes from OptionMetrics via Wharton Research Data Services (WRDS). We calculate options returns based on bid-ask midpoints. Our stock and T-bill data comes from the Center for Research in Security Prices (CRSP) via WRDS. Individual stock returns are from the Stock Return File. S&P 500 returns are from the S&P 500 Indexes File. These returns are value-weighted returns including distributions. Treasury bill returns are from the Treasury and Inflation Index File. These returns are based on a thirty day target maturity using representative Treasury bills having at least thirty days to their maturity date.

One critical issue is how to implement the strategies. All options-based strategies involve the choice of one or more options. We choose options based on their moneyness and time to expiration. In particular, we choose call and put options that are at least 5% out of the money, but have strike prices as close as possible to the opening stock price on the day in which an option strategy is initiated. There are a handful of instances with Amazon and Comcast where no option is at least 5% out of the money, in which case we use whichever option is closest to being 5% out of the money. In addition, because we are rolling over our positions monthly, each month we choose standard equity options, i.e., not Weeklys or LEAPS, that expire the month following the holding month.

We illustrate our process using Amazon on December 31, 2002. The closing price for Amazon that day is \$18.89. Consider implementing a covered call strategy that day using a call that has a moneyness of at least 5%, but whose strike price is as small as possible. Hence, the strike price must exceed \$19.83 ($= 1.05 \times \$18.89$). We shall be closing the

position on January 31, 2003; thus, we examine all call options that expire on February 22, 2003. From OptionMetrics, there is data on six options that expire on that date and have strike prices exceeding $19.83. These options have strike prices of 20.00, 22.50, 25.00, 27.50, 30.00, and 32.50. We then choose the option with strike price of 20.00 because that is the call with the lowest possible strike price that has moneyness of 5% or more.

By way of contrast, if we want the analogous call option with a moneyness of 10% rather than 5%, then we would get a different option. In this case the xoption must have a strike price that exceeds $20.78 ($= 1.10 \times \$18.89$). The lowest possible strike price that satisfies this new criterion is 22.50, not 20.00. Hence, for moneyness of 10% or more, we would choose the call option with strike price 22.50.

3. Empirical Results

3.1. Descriptive Statistics for Returns from the Five Strategies

We begin with descriptive evidence regarding the behavior of the underlying stocks and benchmark indices over the sample period. Table 1 presents summary statistics for the monthly returns of the ten stocks considered, the value-weighted S&P 500 portfolio (including distributions), and a representative thirty day Treasury bill. The statistics are for three periods: the full sample (January, 2003–August, 2013), the first half (January, 2003–December, 207), and the second half (January, 2008–August, 2013). The statistics include the mean, standard deviation, skewness, excess kurtosis, the Jarque-Bera statistic for testing the hypothesis that the return distribution is normal along with the corresponding p-value. The first two statistics are important for determining the risk-return tradeoff for these assets. The last four statistics are important for assessing the normality of returns, which impacts the validity of typical portfolio performance measures.

What does Table 1 tell us? The average monthly Treasury bill return is 0.127% over the full sample, and it decreases significantly from 0.240% in the first half to 0.027% in the second half. The average monthly return on the S&P 500 is 0.574% over the full sample, and it also decreases significantly from 0.887% in the first half to 0.297% in the second half. For the individual stocks, average monthly returns range from 0.651% for Microsoft to 3.935% for Apple over the entire sample. In the first half, they range from 0.445% for

Comcast to 6.201% for Apple. In the second half, they range from 0.217% for ExxonMobil to 1.935% for Apple. Only two stocks, Comcast and Wells Fargo, have average returns increase from the first half to the second half. Perhaps surprisingly, no stock has a negative average return in any of the three periods.

In regard to skewness, returns on the S&P 500 exhibits negative skewness over the entire sample and the second half. Returns on three stocks exhibit negative skewness over the entire sample. Two exhibit negative skewness in the first half, and six exhibit negative skewness in the second half. Skewness decreases from the first half to the second half for all but two stocks. In regard to excess kurtosis, over the full sample excess kurtosis exceeds 2.00 for the S&P 500 and for four of the ten stocks. Indeed, for Wells Fargo it equals 7.083. From the first half to the second half, excess kurtosis increases for the S&P 500, but decreases for six of the ten stocks. As for the Treasury bill returns, both skewness and excess kurtosis increase markedly from the first half to the second half.

Overall, the skewness and excess kurtosis statistics suggest that assuming normality of returns is problematic, and the Jarque-Bera statistics and p-values reinforce that conclusion. For instance, consider the ten individual stocks over the entire period. In six out of ten cases, the p-values for testing normality are less than 0.01. The p-values for the two subperiods are somewhat larger, but that is expected given the smaller sample sizes.

We now consider the four options-based strategies, which are the covered call (long stock plus short call), protective put (long stock plus long put), collar (long stock plus short call plus long put), and covered combination (long stock plus short call plus short put) strategies. For each of these strategies, we calculate the monthly return observable at time t as follows:

$$(Covered\ Call)\ \ \frac{S(t)+D(t)-S(t-1)-(C(t)-C(t-1))}{S(t-1)-C(t-1)},$$

$$(Protective\ Put)\ \ \frac{S(t)+D(t)-S(t-1)+(P(t)-P(t-1))}{S(t-1)+P(t-1)},$$

$$(Collar)\ \ \frac{S(t)+D(t)-S(t-1)-(C(t)-C(t-1))+(P(t)-P(t-1))}{S(t-1)-C(t-1)+P(t-1)},$$

$$(Covered\ Combination)\ \ \frac{S(t)+D(t)-S(t-1)-(C(t)-C(t-1))-(P(t)-P(t-1))}{S(t-1)-C(t-1)-P(t-1)}.$$

Here we let $S(t)$, $C(t)$, and $P(t)$ denote the stock, call, and put prices, respectively, at time t. $D(t)$ denotes the value at time t of dividends paid and reinvested over the interval from $t-1$ to t.

These returns are approximate in the sense that they assume that no options are exercised early. The possibility of early exercise is an important difference between our study and earlier studies that examined, for example, covered calls on the S&P 500 index. Such covered calls use SPX options that have European-style exercise. Options on individual equities have American-style exercise. It could be optimal to exercise an American call option early if the underlying equity pays dividends. It could be optimal to exercise an American put early even if the underlying equity does not pay dividends. Hence, because early exercise is ignored for the moment, the formulae above potentially overstate returns (and associated performance measures) for the covered call and covered combination strategies. On the other hand, the formula above potentially understates returns (and associated performance measures) for the protective put strategy. Returns for the collar strategy could be overstated or understated. For the moment we ignore this early exercise issue and compute returns as formulated above. After we have preliminary results using these simplified returns, we shall investigate early exercise and how it impacts our results.

We give descriptive statistics for these four strategies, respectively, in Tables 2–5. The results are for each of the ten individual stocks, both over the entire period 2003–2013 and over each of the subperiods 2003–2007 and 2008–2013. We provide the same statistics that we gave in Table 1 to facilitate comparison of these options-based strategies versus the corresponding long equity strategy documented in Table 1. The main goal is to see how the risk-return tradeoff has changed in going from the long equity strategy to the corresponding options-based strategy.

Table 2 gives the covered call results. What do we expect to find? Compared to the long equity strategy, we expect the covered call to yield smaller standard deviations, and it does for all stocks and all periods. Perhaps more surprising is that the covered call often gives higher mean returns. For instance, five stocks (Coca Cola, Microsoft, Oracle, Wells Fargo, and ExxonMobil) all have higher mean returns over the entire period and over each

subperiod. In each of these cases, performance measures such as Sharpe ratios are higher for the covered call strategy than for the corresponding long equity strategy. Indeed, when we present Sharpe ratios later in Exhibit 6, it is clear that for a majority of these stocks, covered calls yield larger Sharpe ratios than the corresponding long equity strategies.

Table 3 gives the protective put results. What do we expect to find? Compared to the long equity strategy, we expect the protective put to yield smaller standard deviations, and it does for all stocks in all periods. On the other hand, the mean returns for the protective put are lower than the mean returns for the corresponding long equity strategies for all stocks and all periods. Hence, unlike the case of the covered call, it is not clear that the protective put generally yields a more favorable risk-return tradeoff than the corresponding equity position.

Table 4 gives the collar results. What do we expect to find? Compared to the long equity strategy, we expect the collar to yield smaller standard deviations, and it does for all stocks and all periods. Indeed, the collar typically yields standard deviations that are lower than the ones for the corresponding covered calls and protective puts. Like the protective put, in all cases the collar yields mean returns that are lower than the mean returns for the corresponding long equity strategies. Hence, as was the case with the protected put, it is not clear that the collar generally yields a more favorable risk-return tradeoff than the corresponding equity position.

Table 5 gives the covered combination results. Our expectations here differ considerably from our expectations for the three other options-based strategies. The covered combination strategy is more aggressive than the other three in terms of how it seeks more income at initiation by selling two options. Hence, we expect the covered combination to have both a higher mean return and a higher standard deviation of return than the corresponding long equity strategy. This expectation generally occurs. Recall that the previous three option strategies gave lower standard deviations than the long equity strategy for all stocks in all time periods. In the 29 cases examined in Table 5, however, the covered combination gives lower standard deviations in only eight cases. On the other hand, in the 29 cases considered, the covered combination gives higher mean returns in all 29 cases.

The covered call considered in Table 2 gives higher mean returns in 17 cases, which is impressive but still less than what the covered combination gives.

3.2. Comparing Risk Versus Return for Option Strategies Relative to Long Equity

To get a better picture of how the means and standard deviations for these option strategies compare to their counterparts for the long equity strategy, consider Figure 1. Figure 1 presents average differential means and standard deviations of returns between the four option strategies and the corresponding long equity strategy. Specifically, for a given stock and time period, we compute the change in the mean and standard deviation of return when one switches from the long equity strategy to each of the four option strategies. After calculating those mean and standard deviation differentials, we average them across all ten stocks for each of the three time periods.

What do we find? Not surprisingly, the twelve data points cluster into four groups, one for each of the four strategies. Three of the strategies — the covered call, protective put, and collar — yield smaller average standard deviation of return than the long equity strategy. All three option strategies also yield a smaller average mean return. Of those three strategies, the covered call does best in terms of decreasing standard deviation while sacrificing as little expected return as possible. Most striking, however, is the performance of the covered combination. For all three time periods, the covered combination raises the average mean return. While standard deviation increases for the full sample and the second half, for the first half standard deviation actually decreases on average. Overall, the covered combination seems the most attractive strategy while the protective put seems the least attractive strategy.

One troubling theme throughout Tables 2–5 is the pronounced non-normality of the returns. It does not matter which of the four options-based strategies one considers. It does not matter which time period one considers. Regardless of the strategy and period, one usually rejects the hypothesis of normality for more than half of the ten stocks at the 5% confidence level. The fact that these distributions are non-normal is an important issue — it weakens the inferences one can make with respect to the risk-return relationship and standard portfolio performance measures such as the Sharpe ratio and Jensen's alpha. In

a classic critique of using performance measures based on the Capital Asset Pricing Model (CAPM) to gauge option performance, Leland (1999) stresses the unsatisfactory nature of the underlying CAPM assumptions: (i) all asset returns are normally (and thus symmetrically) distributed, and (ii) all investors have mean-variance preferences (and thus ignore skewness). These assumptions lead to mismeasurement of risk, misestimation of alpha, and flawed performance measurement by the Sharpe ratio and Jensen's alpha. Moreover, non-normality is not the only statistical property that can lead to flawed performance measurement. Lo (2002) examines estimation error associated with Sharpe ratios and finds that serial correlation in returns can lead to grossly overstated Sharpe ratios. The bottom line is that the statistical properties of these option strategy returns cannot be ignored; they must be considered when interpreting the performance measure results upcoming in Tables 6–9.

Although statistical properties of these returns can lead to faulty inference regarding performance, they are not the only such factor. Managers can manipulate or "game" performance measures so that their risk-adjusted returns are upwardly biased. Representative studies such as Spurgin (2001) and Ingersoll et al. (2007) examine how managers can improve their measured Sharpe ratios by lengthening measurement intervals, using dynamic trading strategies or options, and other methods. (For an interesting non-technical discussion see Lux (2002).)

Indeed, Leland (1999) examines both the covered call and the protective put strategies, noting how the first strategy can be considered a "rebalancing" strategy and the second strategy can be considered a "momentum" strategy. Using a simple numerical example, he demonstrates: "When skewness is positively valued, mean-variance-based performance measures will overrate the rebalancing strategies, which reduce skewness, and will underrate the momentum strategies, which buy skewness." (See pp. 29–30 and Table 1 of Leland (1999).) This demonstration foreshadows our performance results exactly. Specifically, we find that the covered call strategy outperforms the long equity strategy, which in turn outperforms the protective put strategy.

3.3. Judging Performance of Option Strategies Relative to Long Equity

Despite their imperfections, performance measures like the Sharpe ratio and Jensen's alpha are standard benchmarks for assessing managerial performance. Therefore, we calculate and report four popular performance measures for each of the five strategies under consideration. Three measures are well-known and date back to the 1960s — Sharpe ratio, Jensen's alpha, and Treynor ratio. The other measures, the Sortino ratio, is a more recent construct that addresses various criticisms of the first three measures. The Sortino ratio is an analogue of the Sharpe ratio in which one replaces the standard risk measure with a measure of downside risk. More precisely, one replaces standard deviation of return with a downside deviation, which is the standard deviation of realized returns when the asset underperforms relative to its benchmark return. For details on these measures see Sharpe (1966), Jensen (1968), Treynor (1965), and Sortino and Price (1994).

Tables 6–9 give our performance measure results. Specifically, Tables 6–9 present the Sharpe ratio, Jensen's alpha, Treynor ratio, Sortino ratio, respectively, for each of the five strategies using the ten individual stocks, both over the entire period 2003–2013 and over each of the subperiods 2003–2007 and 2008–2013. Overall, these tables all paint the same picture. It matters little which measure or time period one considers. The covered combination strategy tends to perform best. The covered call strategy also does well, and both of these strategies outperform the long stock strategy. On the other hand, not all of the options-based strategies perform well when compared to holding the stock by itself. Both the collar and protective put perform worse than simply holding stock. Given the results in Leland (1999), however, these findings are not surprising. Indeed, one would reasonably expect such results.

The results of Tables 6–9 can be consolidated and summarized as follows. For any given stock, measure, and period, we rank the strategies from 1 to 5 where 1 corresponds to the best-performing strategy and 5 corresponds to the worst performing strategy. We then average the rankings across all ten stocks for each performance measure and time period. Table 10 displays these average rankings. Clearly, the covered combination does best. If one averages these (already averaged across the ten stocks) rankings across all four

performance measures, the covered combination has the best average ranking regardless of the time period considered. The covered call has the second best average ranking regardless of the time period. The long equity strategy has the third best average ranking. The collar and protective put rank fourth and fifth, respectively. For a chart of these average rankings across both stocks and performance measures, see Figure 2.

3.4. Early Exercise

The preceding results must be tempered by the fact that the early exercise feature of American options has not been incorporated. It is worth noting, however, that portfolio managers who wish to avoid the complication of early exercise can do so. For example, a manager can restrict attention to stocks that do not pay dividends. Doing so eliminates worry over the early exercise of American call options. Moreover, although American put options might be exercised early even in the absence of dividends, managers can use European-style FLEX options (offered by the CBOE, for example) rather than their more familiar American-style counterparts.

Although we have not adjusted strategy returns to incorporate the possibility of early exercise, we do have some indirect evidence concerning the magnitude of this issue. This evidence consists of descriptive statistics on the exercise activity for the stock options and time period considered in our study. The Options Clearing Corporation records exercise data for listed options, and it makes this data available to interested researchers. (See Barraclough and Whaley (2012) for a detailed description of this data.)

We use this data to investigate the frequency with which options are exercised. Specifically, for the stocks and time period in our study, we first consider options that were actually used in calculating our option strategy returns. For any such option we compute the number of times an "exercise event" occurs over the life of that option. By "exercise event" we mean a date on which one of three types of market participants (customer, market maker, and proprietary firm) exercises that option. (Hence, one date might correspond to one, two, or three exercise events.) We also compute the total number of contracts exercised for such options. We then calculate the analogous statistics, not just for options used in our strategies, but for all options listed on each underlying stock. Finally, for each

underlying stock we calculate the percentage of exercised contracts for options actually used in our strategies relative to all exercised options listed on that stock. The results appear in Tables 11–13. Table 11 provides results for the entire period 2003–2013. Tables 12–13 provide results for the first subperiod 2003–2007 and second subperiod 2008–2013, respectively.

What general patterns do we see in Tables 11–13? Consider the full sample examined in Table 11. For the call options used in our strategies, exercise occurs a relatively low percentage of the time. For call options in our study the percentage never exceeds 0.43%. The story is different for puts. The relative exercise percentages for Amazon and Apple are 15.52% and 3.00%, respectively. During the first subperiod, the only cases where the percentage exceeds 1.00% are for Microsoft calls, when it equals 1.87%, and for Amazon puts, when it equals 16.28%. As for the second subperiod, the only case where the percentage exceeds 1.00% is for Apple puts, when it equals 4.73%. Clearly, of the ten underlying stocks, Amazon is the one that raises the most concern regarding the impact of early exercise. For that reason we investigate Amazon in more detail.

Table 14 explores exercise activity for Amazon puts from July 20, 2006, through August 19, 2006. During 2003–2007 the vast majority of exercised puts occur during this month-long interval and involve August 2006 puts with a strike price of 35. From July 20 through July 25, Amazon's closing ask price stayed above \$33.19. On July 26, however, the closing ask price fell to \$26.18, and it stayed below \$27.17 for the rest of July. Indeed, the closing ask price stayed below \$30.00 for the remaining life of the contract. The fact that it stayed much lower than the strike price during August is, however, irrelevant for our study — our option strategies using these August 35 put options would have closed the option positions on July 31. Any put options exercised during August would not affect our return calculations. As an aside, note that exercise events occurring that August and contracts exercised during August would be included in the statistics involving contracts actually used for Amazon, yet they would not affect the option strategy return calculations for Amazon. Thus, the statistics involving contracts actually used for Amazon are biased upward. They make potential exercise appear to be a bigger issue than it actually is.

Consider the dates July 20 through July 31 in more detail. For the first four dates, the put deltas range from -0.5115 to -0.5806. When the closing ask price falls to \$26.18 on July 26, OptionMetrics does not report the delta and implied volatility for the put. Evidently the put delta got so close to -1 that OptionMetrics had difficulty calculating the delta and did not report it. As for the option bid-ask midpoint and the lower boundary $X - S_{ask}$, they are virtually identical. Their difference is -0.07. Similar results hold for the rest of July. The put deltas are close to -1. The bid-ask midpoints and values of $X - S_{ask}$ are nearly the same. Hence, from July 27 through July 31, one would expect to see these put options exercised, and that is indeed the case. Of course, one might wonder why all the options are not exercised on the first possible date, July 27. Given the evidence on non-optimal exercise of put options reported in Barraclough and Whaley (2012), the fact that option exercise is spread out over several days is not particularly surprising.

4. Concluding Remarks

In this paper we investigate the performance of options-based strategies versus long equity strategies for individual stocks. In particular, we examine ten stocks widely held in 401(k) plans over the period 2003–2013. The results suggest that options-based strategies can be useful in improving the risk-return characteristics of a long equity portfolio. Specifically, the covered combination and covered call strategies consistently outperform the corresponding long stock strategy. This result holds regardless of the measure used to gauge performance or whether one uses the first half, second half, or entire time period.

Although the evidence presented here is suggestive, it still is not compelling. If one mechanically judges relative performance via standard measures such as those proposed by Sharpe, Jensen, Treynor, and Sortino, then one might conclude that the covered combination and covered call strategies are attractive alternatives to the standard long stock position. Performance evaluation is not that simplistic, however. One cannot ignore the growing literature documenting problems associated with the application of such measures to option strategies. Moreover, early exercise is another issue that must be considered more closely to judge performance more accurately.

Therefore, we believe that at least two issues are worth pursuing in future research. The first issue is performance measurement. Do the results given here simply reflect weaknesses in the performance measures used? Should we perhaps use an alternative measure, e.g., the manipulation-proof measure proposed in Ingersoll et al. (2007)? We might also use the Leland (1999) variant of CAPM developed for nonsymmetrical returns. The second issue is early exercise. We must incorporate the early exercise feature into our return calculations to assess its impact. If these options are rarely exercised early, then the impact would be relatively small and the performance rankings would rarely change. Ideally, we should recalculate the returns adjusted for early exercise, using methodology such as that used by Pool, Stoll, and Whaley (2008) and Barraclough and Whaley (2012) in their respective analyses on the early exercise of stock options.

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Table 1

Summary statistics for monthly returns on T-Bills, the S&P 500, and ten stocks from January, 2003, through August, 2013. All stock and T-bill data are from CRSP via WRDS. The T-bill returns are based on a thirty day target maturity using representative T-bills having at least thirty days to their maturity date. The S&P 500 returns are value-weighted returns including distributions; the stock returns also include dividends. The stocks are Apple (AAPL), Amazon (AMZN), Berkshire Hathaway (BRK), Comcast (CMCSA), Google (GOOG), Coca Cola (KO), Microsoft (MSFT), Oracle (ORCL), Wells Fargo (WFC), and Exxon Mobil (XOM). The missing observations for Berkshire Hathaway and Google correspond to months prior to the introduction of exchange-traded options for these companies.

	T-Bill	S&P 500	AAPL	AMZN	BRK	CMCSA	GOOG	KO	MSFT	ORCL	WFC	XOM
2003–2013												
Number of Months	128	128	128	128	50	128	108	128	128	128	128	128
Mean (%)	0.127	0.574	3.935	2.830	1.421	1.116	2.502	0.767	0.651	1.147	1.082	1.034
Standard Deviation (%)	0.071	4.199	10.626	12.028	4.775	7.300	10.642	4.703	6.603	7.366	8.868	5.069
Skewness	0.937	-0.808	-0.284	0.383	0.828	-0.196	0.887	-0.254	0.137	0.048	0.100	0.500
Excess Kurtosis	-0.618	2.213	1.316	2.511	1.208	-0.106	2.359	1.594	0.994	-0.270	7.083	2.398
Jarque-Bera Statistic	20.747	40.033	10.956	36.768	8.753	0.878	39.213	14.928	5.668	0.439	267.799	35.995
Probability of Normal	0.000	0.000	0.004	0.000	0.013	0.645	0.000	0.001	0.059	0.803	0.000	0.000
2003–2007												
Number of Months	60	60	60	60	0	60	40	60	60	60	60	60
Mean (%)	0.240	0.887	6.201	3.586	—	0.445	5.515	0.860	0.962	1.458	0.746	1.959
Standard Deviation (%)	0.138	2.481	10.555	13.845	—	6.317	12.012	4.362	5.762	6.724	3.428	5.122
Skewness	0.039	0.197	0.255	0.563	—	0.193	1.221	-0.291	0.918	-0.125	0.557	1.162
Excess Kurtosis	-1.666	0.185	0.006	2.695	—	0.465	2.605	1.956	3.808	-0.779	0.282	4.625
Jarque-Bera Statistic	6.956	0.476	0.648	21.329	—	0.913	21.245	10.408	44.688	1.671	3.297	66.964
Probability of Normal	0.031	0.788	0.723	0.000	—	0.634	0.000	0.005	0.000	0.434	0.192	0.000
2008–2013												
Number of Months	68	68	68	68	50	68	68	68	68	68	68	68
Mean (%)	0.027	0.297	1.935	2.163	1.421	1.708	0.729	0.684	0.376	0.872	1.378	0.217
Standard Deviation (%)	0.052	5.275	10.356	10.221	4.775	8.069	9.395	5.015	7.297	7.929	11.770	4.916
Skewness	2.528	-0.675	-0.850	-0.195	0.828	-0.448	0.255	-0.222	-0.158	0.172	-0.001	-0.143
Excess Kurtosis	5.684	0.735	2.054	0.366	1.208	-0.286	0.472	1.444	-0.217	-0.061	3.308	-0.314
Jarque-Bera Statistic	163.989	6.688	20.138	0.812	8.753	2.504	1.369	6.464	0.416	0.344	31.007	0.509
Probability of Normal	0.000	0.035	0.000	0.666	0.013	0.286	0.504	0.039	0.812	0.842	0.000	0.775

Table 2

Summary statistics for monthly covered call returns on ten stocks from January, 2003, through August, 2013. All stock data are from CRSP via WRDS. All option data are from OptionMetrics via WRDS. The stock returns include distributions; the option returns assume no early exercise. The stocks are Apple (AAPL), Amazon (AMZN), Berkshire Hathaway (BRK), Comcast (CMCSA), Google (GOOG), Coca Cola (KO), Microsoft (MSFT), Oracle (ORCL), Wells Fargo (WFC), and Exxon Mobil (XOM). The missing observations for Berkshire Hathaway and Google correspond to months prior to the introduction of exchange-traded options for these companies.

	AAPL	AMZN	BRK	CMCSA	GOOG	KO	MSFT	ORCL	WFC	XOM
2003–2013										
Number of Months	128	128	50	128	108	128	128	128	128	128
Mean (%)	3.152	1.911	1.497	1.104	1.582	0.827	0.851	1.217	1.165	1.091
Standard Deviation (%)	7.266	8.425	4.148	5.971	6.258	4.171	5.406	6.046	6.656	4.137
Skewness	-1.652	-1.297	0.784	-0.738	-0.762	-0.779	-0.623	-0.382	-0.858	-0.554
Excess Kurtosis	4.863	2.035	2.411	0.360	-0.117	1.908	0.146	-0.578	6.751	0.357
Jarque-Bera Statistic	184.383	57.943	17.227	12.307	10.508	32.359	8.382	4.901	258.753	7.237
Probability of Normal	0.000	0.000	0.000	0.002	0.005	0.000	0.015	0.086	0.000	0.027
2003–2007										
Number of Months	60	60	0	60	40	60	60	60	60	60
Mean (%)	4.739	1.550	—	0.526	3.375	0.836	1.087	1.567	0.814	1.725
Standard Deviation (%)	6.456	9.563	—	5.161	5.392	3.876	4.668	6.019	3.183	3.680
Skewness	-0.788	-1.420	—	-0.549	-0.845	-0.954	-0.390	-0.335	0.399	-0.626
Excess Kurtosis	-0.101	2.098	—	0.343	0.530	2.359	-0.397	-0.758	0.196	1.513
Jarque-Bera Statistic	6.237	31.180	—	3.313	5.226	23.016	1.915	2.562	1.691	9.645
Probability of Normal	0.044	0.000	—	0.191	0.073	0.000	0.384	0.278	0.429	0.008
2008–2013										
Number of Months	68	68	50	68	68	68	68	68	68	68
Mean (%)	1.751	2.230	1.497	1.615	0.528	0.819	0.644	0.908	1.475	0.532
Standard Deviation (%)	7.689	7.336	4.148	6.599	6.525	4.445	6.009	6.097	8.652	4.454
Skewness	-2.106	-0.923	0.784	-0.913	-0.660	-0.682	-0.669	-0.429	-0.864	-0.421
Excess Kurtosis	6.387	0.785	2.411	0.417	-0.460	1.725	0.068	-0.414	3.737	-0.208
Jarque-Bera Statistic	165.861	11.411	17.227	9.937	5.538	13.701	5.078	2.573	48.039	2.134
Probability of Normal	0.000	0.003	0.000	0.007	0.063	0.001	0.079	0.276	0.000	0.344

Table 3

Summary statistics for monthly protective put returns on ten stocks from January, 2003, through August, 2013. All stock data are from CRSP via WRDS. All option data are from OptionMetrics via WRDS. The stock returns include distributions; the option returns assume no early exercise. The stocks are Apple (AAPL), Amazon (AMZN), Berkshire Hathaway (BRK), Comcast (CMCSA), Google (GOOG), Coca Cola (KO), Microsoft (MSFT), Oracle (ORCL), Wells Fargo (WFC), and Exxon Mobil (XOM). The missing observations for Berkshire Hathaway and Google correspond to months prior to the introduction of exchange-traded options for these companies.

	AAPL	AMZN	BRK	CMCSA	GOOG	KO	MSFT	ORCL	WFC	XOM
2003–2013										
Number of Months	128	128	50	128	108	128	128	128	128	128
Mean (%)	3.003	1.826	0.757	0.499	1.876	0.518	0.294	0.555	0.721	0.539
Standard Deviation (%)	8.831	9.918	4.420	6.226	9.149	4.107	5.677	6.303	7.631	4.595
Skewness	0.665	1.511	1.083	0.177	1.625	0.355	0.713	0.386	2.268	1.086
Excess Kurtosis	0.341	5.260	1.657	-0.304	4.438	0.216	1.452	-0.158	11.033	3.796
Jarque-Bera Statistic	10.048	196.270	15.503	1.160	136.186	2.936	22.088	3.314	758.960	102.016
Probability of Normal	0.007	0.000	0.000	0.600	0.000	0.230	0.000	0.191	0.000	0.000
2003–2007										
Number of Months	60	60	0	60	40	60	60	60	60	60
Mean (%)	4.896	2.994	—	-0.137	4.198	0.729	0.626	0.930	0.519	1.558
Standard Deviation (%)	9.702	11.559	—	5.649	11.327	3.927	5.450	5.990	3.148	4.864
Skewness	0.625	1.771	—	0.510	1.559	0.290	1.220	0.095	0.755	1.730
Excess Kurtosis	0.245	5.199	—	0.845	3.295	0.798	4.313	-0.868	0.219	5.641
Jarque-Bera Statistic	4.062	98.916	—	4.388	34.295	2.432	61.392	1.975	5.821	109.463
Probability of Normal	0.131	0.000	—	0.111	0.000	0.296	0.000	0.372	0.054	0.000
2008–2013										
Number of Months	68	68	50	68	68	68	68	68	68	68
Mean (%)	1.332	0.794	0.757	1.061	0.510	0.333	0.002	0.224	0.899	-0.361
Standard Deviation (%)	7.673	8.154	4.420	6.684	7.341	4.280	5.894	6.593	10.079	4.175
Skewness	0.435	0.408	1.083	-0.070	1.026	0.428	0.401	0.613	1.823	0.145
Excess Kurtosis	-0.508	0.746	1.657	-0.747	1.894	-0.051	-0.343	0.399	5.861	-0.455
Jarque-Bera Statistic	2.880	3.461	15.503	1.635	22.083	2.081	2.157	4.714	134.993	0.823
Probability of Normal	0.237	0.177	0.000	0.441	0.000	0.353	0.340	0.095	0.000	0.663

Table 4

Summary statistics for monthly collar returns on ten stocks from January, 2003, through August, 2013. All stock data are from CRSP via WRDS. All option data are from OptionMetrics via WRDS. The stock returns include distributions; the option returns assume no early exercise. The stocks are Apple (AAPL), Amazon (AMZN), Berkshire Hathaway (BRK), Comcast (CMCSA), Google (GOOG), Coca Cola (KO), Microsoft (MSFT), Oracle (ORCL), Wells Fargo (WFC), and Exxon Mobil (XOM). The missing observations for Berkshire Hathaway and Google correspond to months prior to the introduction of exchange-traded options for these companies.

	AAPL	AMZN	BRK	CMCSA	GOOG	KO	MSFT	ORCL	WFC	XOM
2003–2013										
Number of Months	128	128	50	128	108	128	128	128	128	128
Mean (%)	2.092	0.787	0.806	0.457	0.883	0.571	0.493	0.592	0.458	0.585
Standard Deviation (%)	4.503	5.295	3.705	4.530	3.836	3.436	4.172	4.664	3.407	3.428
Skewness	-0.100	-1.405	1.267	-0.450	-0.220	-0.085	-0.089	-0.126	-0.040	-0.111
Excess Kurtosis	-0.723	5.603	4.118	-0.472	-1.051	-0.357	-0.991	-1.056	-0.233	-0.267
Jarque-Bera Statistic	2.998	209.583	48.710	5.501	5.844	0.836	5.410	6.289	0.324	0.641
Probability of Normal	0.223	0.000	0.000	0.064	0.054	0.658	0.067	0.043	0.850	0.726
2003–2007										
Number of Months	60	60	0	60	40	60	60	60	60	60
Mean (%)	3.207	0.824	—	-0.082	1.878	0.701	0.738	1.002	0.587	1.309
Standard Deviation (%)	4.974	6.286	—	4.222	3.802	3.357	4.199	5.047	2.834	3.241
Skewness	-0.351	-1.618	—	-0.497	-0.260	-0.273	-0.116	-0.182	0.676	0.086
Excess Kurtosis	-0.666	6.107	—	-0.333	-0.873	0.376	-0.821	-1.040	-0.005	-0.117
Jarque-Bera Statistic	2.345	119.431	—	2.743	1.723	1.096	1.820	3.034	4.569	0.108
Probability of Normal	0.310	0.000	—	0.254	0.422	0.578	0.403	0.219	0.102	0.947
2008–2013										
Number of Months	68	68	50	68	68	68	68	68	68	68
Mean (%)	1.108	0.754	0.806	0.933	0.297	0.457	0.277	0.230	0.345	-0.053
Standard Deviation (%)	3.814	4.282	3.705	4.766	3.762	3.526	4.167	4.304	3.860	3.485
Skewness	-0.194	-0.644	1.267	-0.506	-0.236	0.064	-0.070	-0.148	-0.245	-0.188
Excess Kurtosis	-1.040	-0.345	4.118	-0.510	-1.276	-0.795	-1.129	-1.194	-0.603	-0.562
Jarque-Bera Statistic	3.487	5.037	48.710	3.643	5.243	1.839	3.668	4.287	1.712	1.295
Probability of Normal	0.175	0.081	0.000	0.162	0.073	0.399	0.160	0.117	0.425	0.523

Table 5

Summary statistics for monthly covered combination returns on ten stocks from January, 2003, through August, 2013. All stock data are from CRSP via WRDS. All option data are from OptionMetrics via WRDS. The stock returns include distributions; the option returns assume no early exercise. The stocks are Apple (AAPL), Amazon (AMZN), Berkshire Hathaway (BRK), Comcast (CMCSA), Google (GOOG), Coca Cola (KO), Microsoft (MSFT), Oracle (ORCL), Wells Fargo (WFC), and Exxon Mobil (XOM). The missing observations for Berkshire Hathaway and Google correspond to months prior to the introduction of exchange-traded options for these companies.

	AAPL	AMZN	BRK	CMCSA	GOOG	KO	MSFT	ORCL	WFC	XOM
2003–2013										
Number of Months	128	128	50	128	108	128	128	128	128	128
Mean (%)	4.278	3.140	2.211	1.790	2.327	1.090	1.227	1.879	2.304	1.620
Standard Deviation (%)	10.939	12.468	4.711	7.724	9.151	5.164	6.971	7.731	13.016	5.053
Skewness	-2.801	-1.532	0.412	-0.907	-1.036	-1.669	-1.088	-0.561	0.406	-0.755
Excess Kurtosis	12.388	3.579	1.431	1.460	0.821	6.933	2.105	0.462	14.634	1.669
Jarque-Bera Statistic	979.249	118.370	5.680	28.903	22.337	315.788	48.901	7.858	1145.653	27.035
Probability of Normal	0.000	0.000	0.058	0.000	0.000	0.000	0.000	0.020	0.000	0.000
2003–2007										
Number of Months	60	60	0	60	40	60	60	60	60	60
Mean (%)	6.367	2.337	—	1.169	4.968	0.975	1.452	2.160	1.018	2.149
Standard Deviation (%)	8.263	13.929	—	6.319	7.438	4.570	5.285	7.197	3.831	4.271
Skewness	-1.054	-1.833	—	-0.461	-1.274	-1.813	-0.610	-0.456	-0.587	-1.476
Excess Kurtosis	0.675	3.955	—	1.389	2.139	6.736	0.336	-0.107	3.654	5.402
Jarque-Bera Statistic	12.245	72.721	—	6.948	18.452	146.296	3.999	2.108	36.825	94.741
Probability of Normal	0.002	0.000	—	0.031	0.000	0.000	0.135	0.348	0.000	0.000
2008–2013										
Number of Months	68	68	50	68	68	68	68	68	68	68
Mean (%)	2.434	3.848	2.211	2.337	0.774	1.192	1.029	1.631	3.439	1.154
Standard Deviation (%)	12.622	11.078	4.711	8.791	9.742	5.670	8.211	8.219	17.477	5.645
Skewness	-2.987	-0.888	0.412	-1.125	-0.862	-1.612	-1.094	-0.608	0.137	-0.372
Excess Kurtosis	11.556	1.677	1.431	1.359	0.338	6.896	1.555	0.721	7.552	0.459
Jarque-Bera Statistic	479.484	16.915	5.680	19.580	8.749	164.194	20.410	5.658	161.802	2.163
Probability of Normal	0.000	0.000	0.058	0.000	0.013	0.000	0.000	0.059	0.000	0.339

Table 6

Sharpe ratios for monthly returns from five strategies on ten stocks from January, 2003, through August, 2013. All five strategies — long stock, covered call, protective put, collar, and covered combination — include a long stock position as one component. All stock data are from CRSP via WRDS. All option data are from OptionMetrics via WRDS. The stock returns include distributions; the option returns assume no early exercise. The stocks are Apple (AAPL), Amazon (AMZN), Berkshire Hathaway (BRK), Comcast (CMCSA), Google (GOOG), Coca Cola (KO), Microsoft (MSFT), Oracle (ORCL), Wells Fargo (WFC), and Exxon Mobil (XOM).

	AAPL	AMZN	BRK	CMCSA	GOOG	KO	MSFT	ORCL	WFC	XOM
2003–2013										
Long Stock	0.3584	0.2247	0.2965	0.1356	0.2224	0.1361	0.0795	0.1385	0.1077	0.1790
Covered Call	0.4164	0.2118	0.3596	0.1638	0.2313	0.1679	0.1341	0.1804	0.1561	0.2332
Protective Put	0.3257	0.1713	0.1700	0.0599	0.1903	0.0954	0.0295	0.0680	0.0779	0.0897
Collar	0.4365	0.1247	0.2160	0.0730	0.1950	0.1295	0.0879	0.0997	0.0973	0.1338
Covered Combination	0.3795	0.2417	0.4682	0.2153	0.2396	0.1866	0.1579	0.2267	0.1673	0.2596
2003–2007										
Long Stock	0.5648	0.2417	—	0.0325	0.4326	0.1423	0.1254	0.1811	0.1477	0.3357
Covered Call	0.6970	0.1370	—	0.0555	0.5669	0.1539	0.1815	0.2206	0.1804	0.4036
Protective Put	0.4799	0.2382	—	-0.0668	0.3425	0.1246	0.0708	0.1153	0.0886	0.2709
Collar	0.5966	0.0929	—	-0.0762	0.4102	0.1374	0.1187	0.1509	0.1224	0.3299
Covered Combination	0.7416	0.1506	—	0.1470	0.6251	0.1609	0.2293	0.2667	0.2030	0.4469
2008–2013										
Long Stock	0.1843	0.2090	0.2965	0.2084	0.0747	0.1311	0.0480	0.1067	0.1148	0.0388
Covered Call	0.2244	0.3004	0.3596	0.2407	0.0769	0.1782	0.1027	0.1446	0.1674	0.1136
Protective Put	0.1701	0.0942	0.1700	0.1548	0.0658	0.0715	-0.0042	0.0300	0.0866	-0.0927
Collar	0.2836	0.1699	0.2160	0.1901	0.0720	0.1221	0.0601	0.0472	0.0825	-0.0229
Covered Combination	0.1908	0.3449	0.4682	0.2629	0.0767	0.2055	0.1221	0.1952	0.1953	0.1997

Table 7

Jensen's alphas for monthly returns from five strategies on ten stocks from January, 2003, through August, 2013. All five strategies — long stock, covered call, protective put, collar, and covered combination — include a long stock position as one component. All stock data are from CRSP via WRDS. All option data are from OptionMetrics via WRDS. The stock returns include distributions; the option returns assume no early exercise. The stocks are Apple (AAPL), Amazon (AMZN), Berkshire Hathaway (BRK), Comcast (CMCSA), Google (GOOG), Coca Cola (KO), Microsoft (MSFT), Oracle (ORCL), Wells Fargo (WFC), and Exxon Mobil (XOM).

	AAPL	AMZN	BRK	CMCSA	GOOG	KO	MSFT	ORCL	WFC	XOM
2003–2013										
Long Stock	0.0325	0.0218	0.0093	0.0055	0.0201	0.0039	0.0011	0.0052	0.0043	0.0065
Covered Call	0.0267	0.0141	0.0106	0.0060	0.0120	0.0048	0.0037	0.0070	0.0059	0.0074
Protective Put	0.0244	0.0131	0.0037	0.0004	0.0148	0.0021	-0.0014	0.0001	0.0020	0.0020
Collar	0.0174	0.0045	0.0048	0.0008	0.0061	0.0029	0.0013	0.0018	0.0013	0.0028
Covered Combination	0.0365	0.0247	0.0165	0.0116	0.0182	0.0068	0.0062	0.0125	0.0136	0.0122
2003–2007										
Long Stock	0.0492	0.0182	—	-0.0019	0.0466	0.0009	0.0018	0.0036	0.0011	0.0120
Covered Call	0.0385	0.0046	—	-0.0006	0.0269	0.0017	0.0036	0.0052	0.0023	0.0106
Protective Put	0.0371	0.0142	—	-0.0069	0.0346	0.0004	-0.0010	-0.0003	-0.0006	0.0085
Collar	0.0243	-0.0003	—	-0.0059	0.0134	0.0012	0.0008	0.0011	0.0007	0.0070
Covered Combination	0.0536	0.0100	—	0.0049	0.0414	0.0023	0.0066	0.0095	0.0037	0.0142
2008–2013										
Long Stock	0.0160	0.0189	0.0093	0.0139	0.0041	0.0052	0.0010	0.0055	0.0100	0.0005
Covered Call	0.0152	0.0200	0.0106	0.0134	0.0030	0.0067	0.0040	0.0066	0.0115	0.0038
Protective Put	0.0107	0.0060	0.0037	0.0081	0.0027	0.0021	-0.0021	-0.0004	0.0062	-0.0050
Collar	0.0097	0.0062	0.0048	0.0074	0.0016	0.0035	0.0012	0.0005	0.0020	-0.0018
Covered Combination	0.0211	0.0352	0.0165	0.0198	0.0045	0.0100	0.0070	0.0132	0.0285	0.0097

Table 8

Treynor ratios for monthly returns from five strategies on ten stocks from January, 2003, through August, 2013. All five strategies — long stock, covered call, protective put, collar, and covered combination — include a long stock position as one component. All stock data are from CRSP via WRDS. All option data are from OptionMetrics via WRDS. The stock returns include distributions; the option returns assume no early exercise. The stocks are Apple (AAPL), Amazon (AMZN), Berkshire Hathaway (BRK), Comcast (CMCSA), Google (GOOG), Coca Cola (KO), Microsoft (MSFT), Oracle (ORCL), Wells Fargo (WFC), and Exxon Mobil (XOM).

	AAPL	AMZN	BRK	CMCSA	GOOG	KO	MSFT	ORCL	WFC	XOM
2003–2013										
Long Stock	0.0308	0.0232	0.0359	0.0100	0.0215	0.0115	0.0057	0.0091	0.0081	0.0157
Covered Call	0.0376	0.0215	0.0422	0.0117	0.0190	0.0143	0.0092	0.0123	0.0104	0.0189
Protective Put	0.0292	0.0195	0.0242	0.0050	0.0217	0.0094	0.0025	0.0046	0.0068	0.0086
Collar	0.0393	0.0139	0.0308	0.0058	0.0179	0.0130	0.0070	0.0072	0.0074	0.0114
Covered Combination	0.0369	0.0248	0.0490	0.0148	0.0194	0.0150	0.0102	0.0154	0.0119	0.0241
2003–2007										
Long Stock	0.0371	0.0142	—	0.0034	0.0404	0.0076	0.0086	0.0092	0.0083	0.0214
Covered Call	0.0446	0.0100	—	0.0053	0.0355	0.0091	0.0114	0.0106	0.0109	0.0224
Protective Put	0.0318	0.0133	—	-0.0078	0.0394	0.0071	0.0052	0.0062	0.0054	0.0183
Collar	0.0358	0.0062	—	-0.0078	0.0294	0.0088	0.0077	0.0075	0.0080	0.0186
Covered Combination	0.0514	0.0124	—	0.0138	0.0381	0.0094	0.0142	0.0128	0.0122	0.0254
2008–2013										
Long Stock	0.0167	0.0231	0.0359	0.0156	0.0065	0.0129	0.0037	0.0078	0.0104	0.0036
Covered Call	0.0231	0.0298	0.0422	0.0175	0.0067	0.0173	0.0077	0.0109	0.0132	0.0107
Protective Put	0.0150	0.0123	0.0242	0.0127	0.0062	0.0084	-0.0004	0.0022	0.0092	-0.0092
Collar	0.0255	0.0189	0.0308	0.0150	0.0067	0.0141	0.0051	0.0035	0.0071	-0.0022
Covered Combination	0.0221	0.0338	0.0490	0.0189	0.0067	0.0189	0.0090	0.0151	0.0163	0.0192

Table 9

Sortino ratios for monthly returns from five strategies on ten stocks from January, 2003, through August, 2013. All five strategies — long stock, covered call, protective put, collar, and covered combination — include a long stock position as one component. All stock data are from CRSP via WRDS. All option data are from OptionMetrics via WRDS. The stock returns include distributions; the option returns assume no early exercise. The stocks are Apple (AAPL), Amazon (AMZN), Berkshire Hathaway (BRK), Comcast (CMCSA), Google (GOOG), Coca Cola (KO), Microsoft (MSFT), Oracle (ORCL), Wells Fargo (WFC), and Exxon Mobil (XOM).

	AAPL	AMZN	BRK	CMCSA	GOOG	KO	MSFT	ORCL	WFC	XOM
2003–2013										
Long Stock	0.6789	0.3949	0.6844	0.2103	0.4326	0.2155	0.1220	0.2262	0.1677	0.3151
Covered Call	0.6638	0.2933	0.8264	0.2376	0.3458	0.2540	0.1955	0.2843	0.2265	0.3727
Protective Put	0.7551	0.3536	0.3621	0.0925	0.4290	0.1593	0.0472	0.1103	0.1553	0.1590
Collar	0.9362	0.1714	0.4641	0.1032	0.3148	0.2093	0.1338	0.1533	0.1517	0.2134
Covered Combination	0.5326	0.3306	1.1107	0.3156	0.3450	0.2631	0.2218	0.3593	0.2656	0.4717
2003–2007										
Long Stock	1.4342	0.4494	—	0.0487	1.2429	0.2208	0.2133	0.2955	0.2626	0.7587
Covered Call	1.4951	0.1791	—	0.0761	1.0642	0.2216	0.2783	0.3561	0.3206	0.7171
Protective Put	1.2847	0.5996	—	-0.0955	1.0163	0.2096	0.1210	0.1850	0.1553	0.6644
Collar	1.3416	0.1237	—	-0.0960	0.7989	0.2142	0.1812	0.2374	0.2179	0.6320
Covered Combination	1.5288	0.1903	—	0.2164	1.1046	0.2162	0.3543	0.4353	0.3218	0.7263
2008–2013										
Long Stock	0.2878	0.3408	0.6844	0.3299	0.1150	0.2118	0.0705	0.1752	0.1777	0.0572
Covered Call	0.3092	0.4646	0.8264	0.3605	0.1046	0.2815	0.1467	0.2244	0.2389	0.1702
Protective Put	0.3293	0.1541	0.3621	0.2526	0.1152	0.1192	-0.0064	0.0492	0.1755	-0.1278
Collar	0.5422	0.2528	0.4641	0.2956	0.1044	0.2049	0.0916	0.0708	0.1224	-0.0321
Covered Combination	0.2406	0.5449	1.1107	0.3850	0.1020	0.3003	0.1671	0.3057	0.3098	0.3154

Table 10

Average rankings of the relative performance of five strategies for ten stocks from January, 2003, through August, 2013. All five strategies — long stock, covered call, protective put, collar, and covered combination — include a long stock position as one component. Relative performance is based on four performance measures — Sharpe ratio, Jensen's alpha, Treynor ratio, and Sortino ratio. For a given performance measure and time period, each of the five strategies receives an integer ranking from 1 to 5, with 1 representing the best performance and 5 representing the worst. Rankings are then averaged across all ten stocks for each performance measure and time period. Rankings are also averaged across all ten stocks and all four performance measures for each time period.

	Sharpe	Jensen	Treynor	Sortino	Average Across Four Measures
2003–2013					
Long Stock	3.10	2.70	3.10	2.70	2.90
Covered Call	2.10	2.40	2.30	2.50	2.33
Protective Put	4.90	4.50	4.50	4.00	4.48
Collar	3.70	4.30	3.70	3.90	3.90
Covered Combination	1.20	1.10	1.40	1.90	1.40
2003–2007					
Long Stock	2.89	2.44	2.67	2.33	2.58
Covered Call	2.22	2.67	2.44	2.33	2.42
Protective Put	4.56	4.22	4.22	4.22	4.31
Collar	4.11	4.33	4.22	4.44	4.28
Covered Combination	1.22	1.33	1.44	1.67	1.42
2008–2013					
Long Stock	3.20	2.80	3.40	3.10	3.13
Covered Call	1.90	2.30	1.90	2.20	2.08
Protective Put	4.90	4.60	4.90	4.20	4.65
Collar	3.70	4.30	3.40	3.70	3.78
Covered Combination	1.30	1.00	1.40	1.80	1.38

Table 11

Summary statistics for exercise activity of options on ten stocks from January, 2003, through August, 2013. The stocks are Apple (AAPL), Amazon (AMZN), Berkshire Hathaway (BRK), Comcast (CMCSA), Google (GOOG), Coca Cola (KO), Microsoft (MSFT), Oracle (ORCL), Wells Fargo (WFC), and Exxon Mobil (XOM). The exercise data are from the Options Clearing Corporation. For a given stock "contracts used" are contracts used in at least one option strategy for that stock, and "all options" are all options listed on that stock. An "exercise event" is a date on which one of three types of market participant (customer, market maker, and proprietary firm) exercises an option. Thus, one date might correspond to 1–3 exercise events.

Calls (2003–2013)

Ticker	Number of Expirations	Number of Exercise Events For Contracts Used	Number of Contracts Exercised For Contracts Used	Number of Exercise Events For All Contracts	Number of Contracts Exercised For All Contracts	Percentage of Exercised Contracts Used in Strategies
AAPL	128	13	56	3,442	238,730	0.02
AMZN	128	4	19	419	14,470	0.13
BRKB	50	0	0	111	4,032	0.00
CMCSA	128	16	1,879	1,780	3,396,324	0.06
GOOG	108	5	20	553	6,248	0.32
KO	128	0	0	617	229,680	0.00
MSFT	128	7	857	1,998	1,627,425	0.05
ORCL	128	5	25	629	172,507	0.01
WFC	128	6	3,627	1,512	849,946	0.43
XOM	128	4	47	1,050	361,829	0.01

Puts (2003–2013)

Ticker	Number of Expirations	Number of Exercise Events For Contracts Used	Number of Contracts Exercised For Contracts Used	Number of Exercise Events For All Contracts	Number of Contracts Exercised For All Contracts	Percentage of Exercised Contracts Used in Strategies
AAPL	128	26	33,609	9,901	1,119,366	3.00
AMZN	128	41	179,421	3,332	1,156,043	15.52
BRKB	50	0	0	165	6,381	0.00
CMCSA	128	0	0	541	341,079	0.00
GOOG	108	8	735	10,609	875,275	0.08
KO	128	1	9	1,118	320,173	0.00
MSFT	128	1	500	2,683	1,151,320	0.04
ORCL	128	2	125	1,212	228,410	0.05
WFC	128	12	1,507	1,294	273,819	0.55
XOM	128	6	21	1,725	510,981	0.00

Table 12

Summary statistics for exercise activity of options on ten stocks from January, 2003, through December, 2007. The stocks are Apple (AAPL), Amazon (AMZN), Berkshire Hathaway (BRK), Comcast (CMCSA), Google (GOOG), Coca Cola (KO), Microsoft (MSFT), Oracle (ORCL), Wells Fargo (WFC), and Exxon Mobil (XOM). The exercise data are from the Options Clearing Corporation. For a given stock "contracts used" are contracts used in at least one option strategy for that stock, and "all options" are all options listed on that stock. An "exercise event" is a date on which one of three types of market participant (customer, market maker, and proprietary firm) exercises an option. Thus, one date might correspond to 1–3 exercise events.

Calls (2003–2007)

Ticker	Number of Expirations	Number of Exercise Events For Contracts Used	Number of Contracts Exercised For Contracts Used	Number of Exercise Events For All Contracts	Number of Contracts Exercised For All Contracts	Percentage of Exercised Contracts Used in Strategies
AAPL	60	4	27	203	10,549	0.26
AMZN	60	0	0	77	1,575	0.00
CMCSA	60	0	0	36	9,220	0.00
GOOG	40	5	20	196	3,152	0.63
KO	60	0	0	118	48,364	0.00
MSFT	60	5	747	303	39,955	1.87
ORCL	60	3	10	87	4,264	0.23
WFC	60	2	121	185	255,770	0.05
XOM	60	1	3	154	23,016	0.01

Puts (2003–2007)

Ticker	Number of Expirations	Number of Exercise Events For Contracts Used	Number of Contracts Exercised For Contracts Used	Number of Exercise Events For All Contracts	Number of Contracts Exercised For All Contracts	Percentage of Exercised Contracts Used in Strategies
AAPL	60	0	0	2,821	408,739	0.00
AMZN	60	38	179,221	1,737	1,100,602	16.28
CMCSA	60	0	0	441	337,133	0.00
GOOG	40	0	0	5,732	439,254	0.00
KO	60	1	9	552	240,649	0.00
MSFT	60	1	500	1,533	628,938	0.08
ORCL	60	1	25	721	127,253	0.02
WFC	60	6	55	364	43,996	0.13
XOM	60	0	0	779	409,267	0.00

Table 13

Summary statistics for exercise activity of options on ten stocks from January, 2008, through August, 2013. The stocks are Apple (AAPL), Amazon (AMZN), Berkshire Hathaway (BRK), Comcast (CMCSA), Google (GOOG), Coca Cola (KO), Microsoft (MSFT), Oracle (ORCL), Wells Fargo (WFC), and Exxon Mobil (XOM). The exercise data are from the Options Clearing Corporation. For a given stock "contracts used" are contracts used in at least one option strategy for that stock, and "all options" are all options listed on that stock. An "exercise event" is a date on which one of three types of market participant (customer, market maker, and proprietary firm) exercises an option. Thus, one date might correspond to 1–3 exercise events.

Calls (2008–2013)

Ticker	Number of Expirations	Number of Exercise Events For Contracts Used	Number of Contracts Exercised For Contracts Used	Number of Exercise Events For All Contracts	Number of Contracts Exercised For All Contracts	Percentage of Exercised Contracts Used in Strategies
AAPL	68	9	29	3,239	228,181	0.01
AMZN	68	4	19	342	12,895	0.15
BRKB	50	0	0	111	4,032	0.00
CMCSA	68	16	1,879	1,744	3,387,104	0.06
GOOG	68	0	0	357	3,096	0.00
KO	68	0	0	499	181,316	0.00
MSFT	68	2	110	1,695	1,587,470	0.01
ORCL	68	2	15	542	168,243	0.01
WFC	68	4	3,506	1,327	594,176	0.59
XOM	68	3	44	896	338,813	0.01

Puts (2008–2013)

Ticker	Number of Expirations	Number of Exercise Events For Contracts Used	Number of Contracts Exercised For Contracts Used	Number of Exercise Events For All Contracts	Number of Contracts Exercised For All Contracts	Percentage of Exercised Contracts Used in Strategies
AAPL	68	26	33,609	7,080	710,627	4.73
AMZN	68	3	200	1,595	55,441	0.36
BRKB	50	0	0	165	6,381	0.00
CMCSA	68	0	0	100	3,946	0.00
GOOG	68	8	735	4,877	436,021	0.17
KO	68	0	0	566	79,524	0.00
MSFT	68	0	0	1,150	522,382	0.00
ORCL	68	1	100	491	101,157	0.10
WFC	68	6	1,452	930	229,823	0.63
XOM	68	6	21	946	101,714	0.02

Table 14

Exercise activity for Amazon put options from July 20, 2006 through August 19, 2006. All stock data are from CRSP via WRDS. The option exercise data are from the Options Clearing Corporation. All other option data are from OptionMetrics via WRDS.

Date	Option Volume	Open Interest	Number of Options Exercised	Implied Volatility of the Option	Delta of the Option	Strike Price	Amazon Closing Ask Price S_{ask}	Option Bid-Ask Midpoint	Lower Boundary for Put $X - S_{ask}$	Bid-Ask Midpoint Boundary Check
7/20/2006	3,022	12,385	0	0.5706	-0.5195	35	34.19	2.58	0.81	1.77
7/21/2006	4,308	14,007	0	0.6287	-0.5806	35	33.19	3.30	1.81	1.49
7/24/2006	4,499	15,073	0	0.6095	-0.5115	35	34.31	2.50	0.69	1.81
7/25/2006	6,877	17,027	0	0.6323	-0.5629	35	33.58	2.93	1.42	1.51
7/26/2006	65,554	20,482	62,720			35	26.18	8.75	8.82	-0.07
7/27/2006	43,326	11,693	45,722			35	26.53	8.45	8.47	-0.02
7/28/2006	8,039	6,914	8,150			35	27.17	7.80	7.83	-0.03
7/31/2006	53	6,759	1,387	0.6938	-0.9575	35	26.86	8.15	8.14	0.01
8/01/2006	39,855	6,622	40,860	0.8118	-0.9443	35	26.30	8.75	8.70	0.05
8/02/2006	6,004	3,653	6,164			35	26.09	8.90	8.91	-0.01
8/03/2006	3	3,493	0			35	26.64	8.35	8.36	-0.01
8/04/2006	12	3,496	7			35	27.26	7.70	7.74	-0.04
8/07/2006	0	3,487	4			35	26.79	8.20	8.21	-0.01
8/08/2006	6,968	3,483	7,571			35	26.35	8.60	8.65	-0.05
8/09/2006	5,808	2,880	5,804			35	26.22	8.80	8.78	0.02
8/10/2006	0	2,884	0			35	26.47	8.55	8.53	0.02
8/11/2006	2	2,884	1			35	26.02	9.00	8.98	0.02
8/14/2006	10	2,883	7			35	26.54	8.40	8.46	-0.06
8/15/2006	401	2,876	299			35	27.75	7.25	7.25	0.00
8/16/2006	0	2,565	1			35	27.92	7.10	7.08	0.02
8/17/2006	60	2,576	0			35	29.16	5.90	5.84	0.06
8/18/2006	25	2,581	0			35	29.11	5.90	5.89	0.01
8/19/2006			2,581							

Figure 1

Average differential means and standard deviations of returns between four option strategies and the corresponding long equity strategy for ten stocks from January, 2003, through August, 2013. All five strategies — long stock, covered call, protective put, collar, and covered combination — include a long stock position as one component. For a given stock and time period, compute the change in the mean and standard deviation of return when one switches from the long equity strategy to each of the four corresponding option strategies. These differential means and standard deviations are then averaged across all ten stocks for each option strategy and time period.

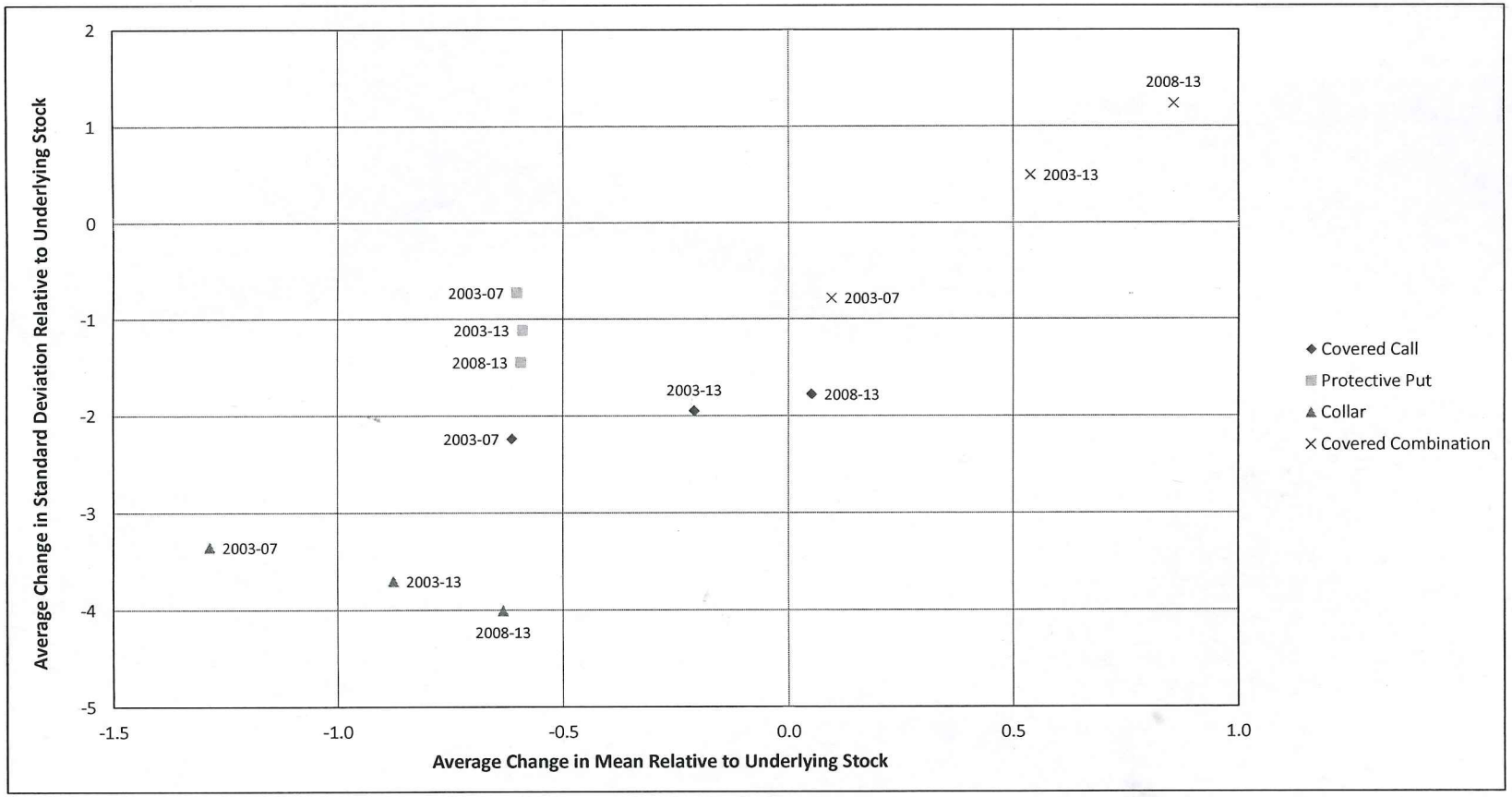

Figure 2

Average rankings of the relative performance of five strategies for ten stocks from January, 2003, through August, 2013. All five strategies — long stock, covered call, protective put, collar, and covered combination — include a long stock position as one component. Relative performance is based on four performance measures — Sharpe ratio, Jensen's alpha, Treynor ratio, and Sortino ratio. For a given performance measure and time period, each of the five strategies receives an integer ranking from 1 to 5, with 1 representing the best performance and 5 representing the worst. Rankings are then averaged across all ten stocks and all four performance measures for each time period.