Loosening Your Collar: *Alternative Implementations of QQQ Collars*

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The credit crisis and the associated decline in equity markets have rekindled new interest in option-based equity collars and in protective strategies in general. In 2008, the QQQ experienced a drawdown of about 50% from peak to trough. Many other asset classes that are generally considered effective equity diversifiers also faced significant losses. This type of contagion across asset classes suggests that in times of major systematic stress, direct hedges through protective option strategies may provide equity portfolios with greater downside risk protection than standard multi-asset diversification programs. There are a variety of option strategies that can provide capital protection for equity-based portfolios. The focus of this article is one of the more straightforward option-based strategies: the collar. A collar effectively limits (or collars) the returns on an investment in an underlying asset to fall within a chosen range. An investor who holds a long position in an underlying asset can convert that position into a collar (collar his position) by purchasing a put option on the underlying asset and simultaneously selling (writing) a call option on the underlying asset. The strike price on the call defines the upper bound of the collar and is set above the strike price for the put (which defines the lower bound of the collar). In a standard collar, the call and put have the same expiration dates. The value of a portfolio constructed in this manner is essentially restricted to fluctuate within the bounds set by the strike prices of the options (adjusted for the net cost of the option positions).[1]

This article extends previous research on collar strategies (Schneeweis and Spurgin [2001] and Szado and Kazemi [2009]) by considering the performance and risk characteristics of active as well as passive collars. In addition, it provides an example of the effectiveness of applying a collar strategy to a sample equity mutual fund on which options are not available. It is worth noting that this article does not address whether these strategies generate "alpha" based on any specific definition of investor risk aversion. The significance of the results may be interpreted differently by any individual based on his particular risk aversion.

This article analyzes the performance of passively implemented collars on the Powershares QQQ ETF (ticker: QQQQ). The collars are passive in the sense that they follow a rigid set of rules that do not vary with market conditions. The passive implementations do vary in their choice of the initial moneyness and time to expiration of the calls and puts. This article also considers a more active implementation of the collar strategy. Rather than simply applying a set of fixed rules as for the passive collar, for the active collar adjustment strategy we apply a set of rules that adapt the

collar to varying economic and market conditions. This approach is similar to applying a set of tactical asset allocation rules to a set of investments. There is, of course, an unlimited number of conditioning factors that can be used to determine the strategy implementation. This article, for purposes of presentation, combines three conditioning factors that have been suggested in academic literature (momentum, volatility, and a compound macroeconomic factor (unemployment and business cycle)) to generate a dynamic collar adjusted trading strategy.[2] Finally, the article considers the implementation of an active and passive collar strategy using QQQ options applied to a non-QQQ equity portfolio represented by a small-cap equity mutual fund. This provides an additional analysis of the use of the collar strategy for a wider range of market participants.

The following sections summarize the methodology and data used in this analysis. It is important to note that all empirical research may be data and time-period dependent. This analysis covers the period from the introduction of options on the QQQ (March 19, 1999) through May 31, 2009. This period is broken into various sub-periods to offer a better picture of the benefits and risks of the implemented collar strategies in various market environments. The methodology section describes both the passive and active collar implementations. The active collar section describes how we combine the momentum, volatility, and macroeconomic signals to generate a dynamic collar adjustment trading strategy process.[3] In this process, the initial moneyness of the puts and calls is determined based on the momentum and macroeconomic signals, and the ratio of written calls is determined by the volatility signal. The marginal effect of the momentum signal is to widen or tighten the collar by increasing or decreasing the amount OTM, respectively. The marginal effect of the macroeconomic signal is to shift the collar up by increasing the amount OTM of the calls and decreasing the amount OTM of the puts, or shift the collar down by moving the strikes in the opposite direction. The marginal effect of the volatility signal is to increase or decrease the number of calls written per QQQ and put purchased.

Results show that the passive and active collar strategies underperformed the QQQ in the strong market climb of October 2002 to September 2007. However, in the period around the tech bubble and in the credit crisis, the passive and active collar strategies provided capital protection and, in the case of the tech bubble, generated significant returns at relatively low volatility. In addition, we provided evidence of the effectiveness of wrapping a passive or active collar strategy around a portfolio for which no options are available (in this case, represented by a small-cap mutual fund). Results for the mutual fund collars are similar to those reported for the collar strategies on the QQQ. Finally, results show that active collar strategies on the QQQ and on a small-cap mutual fund that use a set of three simple trading rules to create a dynamic collar adjustment process could provide added benefits over similar passive collars.

DATA AND METHODOLOGY

Data

The option price data is provided by Optionmetrics and covers the period from the first expiration after the introduction of QQQ options on March 19, 1999, to May 31, 2009. The QQQ, NDX, Treasury bill, and VIX data is provided by Datastream,[4] while mutual fund data is provided by Morningstar. Business cycle announcement data are provided by the National Bureau of Economic Research.

Methodology

In order to assess the performance of active and passive collar strategies, we construct indices that represent the return streams generated by such strategies. The passive strategies follow a fixed set of option selection rules defining the initial moneyness and time to expiration of the calls and puts, regardless of market conditions. In contrast, the active[5] collar strategies base their option selection rules on a combination of three simple market/economic-based signals (momentum, volatility, and a macroeconomic factor) and thus adjust to various market conditions:

Passive Collar Strategy. We generate a daily time series of returns for each of the passive strategies beginning on March 19, 1999.[6] At the close on this day, a 1-month call is written and a one-, three-, or six-month put is purchased. Depending on the particular passive implementation, the initial moneyness of the calls and puts are set at either 5%, 4%, 3%, 2%, 1% OTM or ATM. At the close on the Friday prior to the following expiration, we take one of two actions: If one-month puts are used, the puts and calls are settled at intrinsic

value and we roll into new one-month puts and calls with the specified moneyness. If three- or six-month puts are used, the calls are settled at intrinsic value and new one-month calls with the specified moneyness are rolled into, while the longer-term puts are held for another month. When the new one-month calls are written, the net proceeds from the sale of the calls and the expiration of the previous calls are fully invested in the strategy, and the position is rebalanced to ensure a 1:1:1 ratio of the underlying, puts, and calls. Once the three- or six-month puts expire they are settled at intrinsic value and we once again roll into new puts and calls with the specified moneyness and time to expiration. In order to include the impact of transaction costs, the puts are purchased at the ask price and the calls are written at the bid price when each new put or call position is established. Each trading day in between roll dates, the options are priced at the mid-point between the bid and ask prices. In this manner, daily returns are calculated for each passive strategy implementation.

ACTIVE STRATEGY MARKET SIGNALS

For the active implementations, a series of three market signals determine the choice of initial call and put moneyness, as well as the ratio of the number of calls written to the number of puts and QQQ shares purchased, while the time to expiration is fixed at one month for the calls and six months for the puts.

Active Collar Adjustment Strategy

Three different sets of active market signals are used for the strategy implementations, differing by their time horizon: short, medium, and long. The three signals are based on momentum, volatility, and a compound macroeconomic indicator (unemployment claims and business cycle), respectively. In order to ensure that the strategies are investable, all signals use contemporaneously lagged data.[7]

Momentum Signal

The momentum signal is a simple moving average cross-over (SMACO) of the NASDAQ-100 index (NDX).[8] A SMACO compares a short-term moving average (SMA) and a long-term moving average (LMA) to determine whether an upward or downward trend exists. The rule is defined by the number of days covered by each of the moving averages. For example, a 5/150 SMACO rule compares a five-day SMA with a 150-day LMA. If the SMA is greater (less) than the LMA, then an upward (downward) trend is indicated, suggesting a buy (sell) signal. Our choice of signals is based on Szakmary, Davidson, and Schwarz [1999] and Lento [2008],[9] which both consider 1/50, 1/150, 5/150, 1/200, and 2/200 SMACO rules on the NDX. Szakmary et al. apply NASDAQ index SMACOs as buy/sell signals for individual stocks for the period from 1973 to 1991.[10] They find some significant excess returns, although their significance does not survive transaction costs. Similarly, Lento finds some significant forecasting abilities in the same SMACO rules on the NASDAQ at a 10-day lag over the period 1995 to 2008. Following their methodology, we use 1/50, 5/150, and 1/200 SMACO rules on the NDX. This provides a short-, medium-, and long-term momentum signal. Each roll date, we calculate the SMA and LMA for each of the three momentum rules and use them to generate the momentum signals. All else equal, if the calculation results in a buy signal, the collar widens (increasing upside participation with a corresponding reduction in downside protection). In contrast, all else equal, the collar is tightened in response to sell signal (increasing downside protection while reducing upside participation).

Volatility Signal

The volatility signal is based on Renicker and Mallick [2005]. Renicker and Mallick create an "enhanced" S&P 500 buy-write strategy and back test it over the period from 1997 to September 2005.[11] They find excess returns for a strategy that writes 0.75 calls to each long index position when the markets short-term anxiety level is high (as indicated by a situation in which the one-month ATM S&P 500 implied volatility is more than one standard deviation above its current 250-day moving average level) and writes 1.25 calls per index position when the anxiety level is low (when the one-month implied volatility is more than one standard deviation below the 250-day average level).[12] Their goal in varying the quantity of written calls is to have a longer exposure to the market in times of high anxiety and shorter exposure in times of complacency. We make two minor modifications to their strategy. First, we use the daily VIX close as an indicator of implied volatility levels.

Second, we consider a short-, medium-, and long-term time frame to generate the three corresponding signals. In order to match the time frames of our momentum signals, our short-, medium-, and long-term volatility signals use 50-, 150-, and 250-day windows, respectively. In keeping with the methodology of Renicker and Mallick, on roll dates we sell 0.75 (1.25) calls per index position when the previous day's VIX close is more than one standard deviation above (below) its current moving average level, otherwise we sell one call per index position as illustrated by the following formula:

$$\#\ of\ Calls\ Written\ per\ Long\ Put\ and\ Long\ QQQ\ Position = 1 + (0.25 * Volatility\ Signal),$$

where the volatility signal is –1, 0 or +1.

It is worth noting that the volatility signal only affects the call writing portion of the strategy; puts are always purchased at a 1:1 ratio with the index.[13]

Macroeconomic Signal

The final variable used in the active collar adjustment strategy signal process is based on the trend of initial unemployment claims and the state of the economy with respect to the business cycle. Boyd, Hu, and Jagannathan [2005] consider the impact of unemployment rate surprise on the stock market in the period from 1973 to 2000. They find that in expansionary periods, stocks typically rise on bad unemployment news, while the opposite holds in contractionary periods.[14] This is consistent with Veronesi [1999], who suggests that bad news in expansionary periods and good news in contractionary periods are typically correlated with an increase in uncertainty and an increase in the equity risk premium (corresponding to an increase in expected returns). We use these findings to construct a signal based on initial unemployment claims. The announcements from the NBER's Business Cycle Dating Committee are used to identify the state of the business cycle. It is worth noting that NBER does not define a recession as two consecutive quarters of negative GDP growth. They define it as follows: "A recession is a significant decline in economic activity spread across the economy, lasting more than a few months, normally visible in real GDP, real income, employment, industrial production and wholesale-retail sales."[15] These announcements are generally considered the authority on the current state of the business cycle. Since there is often a significant delay in announcement dates, we base the signals on announcement dates to avoid hindsight biases. For example, the December 2007 peak was announced about one year later on December 1, 2008. Our signal would be based on an expansionary economy until December 1, 2008. Since initial unemployment claims are released on a weekly basis, we include a one-week lag in the calculations to ensure the investability of our strategy. In order to closely match the macroeconomic signal methodology with those of the momentum and volatility signals, we base our short-, medium-, and long-term macroeconomic signals on 1/10, 1/30, and 1/40 week SMACOs for weekly initial unemployment claims. Since rising unemployment claims in an expansionary economy is a bullish stock market price and volatility signal, if the SMA is greater than the LMA, we shift the collar toward the ATM put and OTM call (increasing both strike prices), thereby increasing the portfolio's exposure to upside moves as well as increasing its vega.[16] In contractionary periods, rising unemployment claims would cause us to shift the strike prices in the opposite direction.

Trading Rules

We combine the momentum, volatility, and macroeconomic signals for each time frame to generate our short-, medium-, and long-term active strategies. Due to the excessive transaction costs that would be associated with daily rolling of option positions, changes in the signals are not incorporated into the strategies on any days except the roll dates.[17] On each roll date, the initial moneyness of the puts and calls is determined based on the momentum and macroeconomic signals, and the ratio of written calls is determined by the volatility signal. Our rules are constructed in such a manner to ensure that the target initial percentage moneyness of the options will be an integer that falls between ATM and 5% OTM. The signals adjust the initial moneyness of the puts and calls from a level near the center of the range at 3% OTM and 2% OTM, respectively.[18] From this central point, the momentum signal will serve to widen or tighten the collar by increasing or decreasing the amount OTM, respectively. The macroeconomic signal will shift the collar up by increasing the amount OTM of the calls and decreasing the amount OTM of the puts, or shift the collar down by moving the strikes in

the opposite direction. The net effect can be illustrated by the following formulas for the call strikes:

$$Call\ \%\ OTM = 2 + (Momentum\ signal + Macroeconomic\ signal),$$

and for puts:

$$Put\ \%\ OTM = 3 + (Momentum\ signal - Macroeconomic\ signal),$$

where the momentum signal and the macroeconomic signal are +1/–1 binary signals.

The trading rules that result from the signals are provided in Exhibit 1. The frequency distributions of the strike prices and call writing ratios are provided in Exhibit 2.

In a later section of the article we also apply an active and passive collar to a typical small-cap mutual fund. Since the beta of a fund will not necessarily be 1.0 with respect to the QQQ and the price level of the fund will not match the QQQ underlying price, we scale the option positions by the 65-day rolling one-day lagged beta as well as by the relative price levels of the fund and the QQQ. To adjust for the relative price levels, each day we rebalance our portfolio so that the ratio of the number of options to the number of shares of the fund is equal to beta times the ratio of the mutual fund price over the QQQ price, as given by the following formula:[19]

$$\#\ of\ puts\ or\ calls = Beta_{mutual\ fund,\ QQQ} * Price_{mutual\ fund}/Price_{QQQ}$$

EXHIBIT 1
Trading Rules

	NDX Momentum Signal	Macroeconomic signal	Call% OTM = 2 + (Momentum Signal + Macroeconomic Signal)	Put% OTM = 3 + (Momentum Signal - Macroeconomic Signal)	Call Initial % OTM	Put Initial % OTM
Scenario 1	-1	-1	= 2 - 1 - 1	= 3 - 1 - (-1)	0%	3%
Scenario 2	+1	-1	= 2 + 1 - 1	= 3 + 1 - (-1)	2%	5%
Scenario 3	-1	+1	= 2 - 1 + 1	= 3 - 1 - (+1)	2%	1%
Scenario 4	+1	+1	= 2 + 1 + 1	= 3 + 1 - (+ 1)	4%	3%

	VIX Signal	QQQ/Call Ratio
Scenario 1	-1	1.0/0.75
Scenario 2	0	1.0/1.0
Scenario 3	1	1.0/1.25

EXHIBIT 2
Trading Rule Frequency Distributions

	Short-Term Signals		Medium-Term Signals		Long-Term Signals	
Initial % OTM	Call Moneyness Frequency	Put Moneyness Frequency	Call Moneyness Frequency	Put Moneyness Frequency	Call Moneyness Frequency	Put Moneyness Frequency
ATM	20%	0%	16%	0%	15%	0%
1% OTM	0%	29%	0%	24%	0%	34%
2% OTM	58%	0%	65%	0%	69%	0%
3% OTM	0%	29%	0%	41%	0%	17%
4% OTM	22%	0%	19%	0%	15%	0%
5% OTM	0%	41%	0%	34%	0%	49%
QQQ/Call Ratio	Call Ratio Frequency		Call Ratio Frequency		Call Ratio Frequency	
1.0/0.75	20%		21%		20%	
1.0/1.0	45%		42%		48%	
1.0/1.25	36%		37%		32%	

This process allows us to maintain the equivalent of a 1:1:1 ratio collar. While the beta is set at each roll date, the relative balance due to price changes is reset each day.[20] For example, if the rolling beta of the mutual fund is 0.75, the price of the mutual fund is $20, and the price of the QQQ is $60 on the roll-in date, we write 0.25 calls and purchase 0.25 puts for each long position in the mutual fund, and rebalance each day (using the 0.75 beta and the current prices) until the expiration of the options, at which time we rebalance using the new rolling beta level as well as the current prices.

RESULTS

Before reviewing the results of the passive and active approaches to collar protection, it is perhaps important to briefly discuss three issues in option-based risk management:

1. The use of alternative approaches to protecting equity investments.
2. The impact of option-based strategies on traditional forms of risk comparisons (e.g., Sharpe Ratio).
3. The necessity for analyzing results over alternative time periods.

Alternative Approaches to Option-Based Risk Management

There are alternative option-based approaches to protecting equity based investments. The most obvious choice is typically the use of protective puts. Unfortunately, the use of protective puts tends to be a relatively expensive method of capital protection, especially in periods of high volatility. The existence of a negative volatility risk premium and the resulting excess returns associated with put writing are indicative of the potential cost of purchasing protective puts.[21] Another option-based approach is the buy-write or covered call strategy. The covered call strategy typically entails the writing of call options against a long underlying index position at a one-to-one ratio. A number of studies have suggested that covered call writing can provide return enhancement as well as a cushion to mitigate losses from market downturns. These include Schneeweis and Spurgin [2001], Whaley [2002], and Hill et al. [2006], who apply the strategy to the S&P 500, and Kapadia and Szado [2007], who apply the buy-write to a broader index, the Russell 2000. Unfortunately, covered call writing still leaves an investor exposed to large down moves.

Impact of Option Use on Traditional Risk Measures

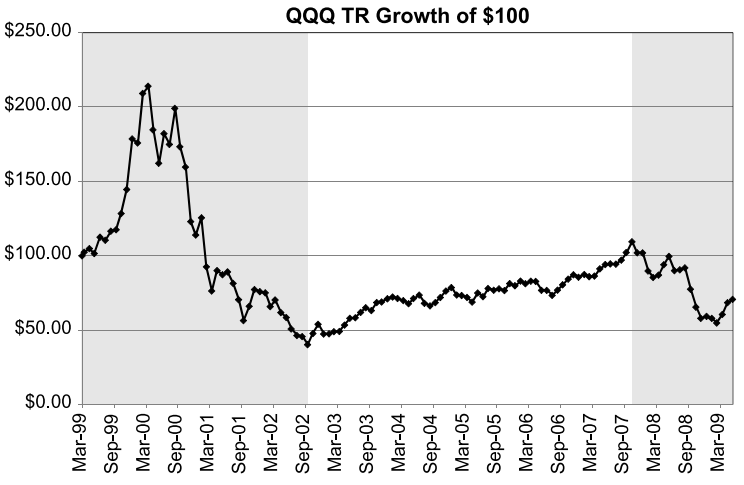
It should also be noted that we have included Sharpe ratios with our other performance measures for the sake of consistency with previous literature, but great care should be taken in interpreting the Sharpe ratios. First, a number of the calculated Sharpe ratios are negative. Negative Sharpe ratios are uninformative. Second, even with positive excess returns, traditional risk-adjusted performance measures such as the Sharpe ratio and Jensen's alpha can be misleading. This is particularly true for portfolios that include option strategies or other strategies that may result in skewed or kurtotic return distributions. The Sharpe ratio and Jensen's alpha assume normally distributed returns.[22] In recognition of the fact that the return distributions generated by our collar strategies may be non-normal, we utilize the Stutzer index and Leland's alpha as measures of risk-adjusted performance. These measures adjust for the fact that investors who exhibit non-increasing absolute risk aversion prefer positive skewness.[23] Therefore, positively skewed return distributions should exhibit lower expected returns than negatively skewed distributions, ceteris paribus.

Alternative Time Period Analysis

This article does not assume any particular model of investor risk aversion. The significance of the results for any particular investor may therefore depend on that investor's individual risk tolerance. Results should therefore be presented over various market conditions that provide investors a wider range of results consistent with a particular risk environment. In order to assess the performance and risk management characteristics of the passive and active collar strategies in different market environments, we break up our time period into three sub-periods (see Exhibit 3).

The first sub-period is April 1999 to September 2002. We would expect that this would be a relatively favorable period for the collar strategy, when compared to holding a long index position. In this period the QQQ exhibited extremely high realized volatility and

EXHIBIT 3
Growth of $100 in QQQ, March 1999 to May 2009



experienced a rapid loss of more than three-fourths of its value from peak to trough. While one would expect that protective strategies would be very beneficial with a drop of this magnitude, there are two factors that mitigate the benefits of the protective puts. First, put options would likely be very expensive in this environment. Second, the short call position would greatly limit the upside participation of the collar in the incredibly strong run-up of the early part of the sub-period. This is a particularly interesting sub-period to study, because it captures the run-up and collapse of a bubble in the underlying.

The second sub-period, which covers October 2002 to September 2007, is less favorable for the collar strategy. In fact, one might argue that this time period is representative of nearly the worst environment for the collar (when compared to a long underlying position). In this period, the QQQ exhibits a steady growth rate with relatively low volatility[24] and few sharp downward moves. In this environment, the collar may lose significant revenue on the upside due to the short calls while it gains very little from the protective puts.

The final sub-period covers October 2007 to May 2009. This is another favorable period for the collar and covers a major financial crisis that negatively impacted most asset classes. Unlike the first sub-period, this favorable period does not include a strong run-up in the underlying. Thus we have two relatively favorable sub-periods to consider (one that covers the tech bubble and one that covers the credit crisis) as well as one clearly unfavorable sub-period.

Before discussing the performance of the collar strategies, it is worth noting that the one-month/six-month and one-month/three-month strategies require rebalancing each month in order to reinvest the funds that are collected from the sale of the calls and the funds that are disbursed to cover the cost of calls that expire ITM between put expirations. No adjustment is made for the transactions costs that would be incurred by these rebalancing activities.

EMPIRICAL RESULTS

Passive Collars

We first consider the performance of passive collar strategies. Our discussion is centered on one-month call/six-month put collar strategies.[25] Results comparing the one-month call/six-month put collars to the one-month call/one-month put collars are available from the authors.

While the exhibits provide statistics for a wide range of collar implementations, our discussion is focused on the 2% OTM strategies, since they represent a middle ground between the ATM and the far OTM strategies. Exhibits 4a, 4b, 4c, and 4d provide summary statistics for passive one-month call/six-month put collar strategies utilizing 2% OTM puts with ATM to 5% OTM calls for the full period as well as the three sub-periods. Similarly, Exhibits 5a, 5b, 5c, and 5d provide summary statistics for 2% OTM call collars that use ATM to 5% OTM puts. It is immediately apparent when reviewing the exhibits that, while the performance characteristics of the strategy are sensitive to the choice of moneyness for the options, they are far more sensitive to the market environment (rising and/or falling) in which the strategy is implemented. In contrast, the choice of time to maturity for the calls of one-month versus six-month can have a far more significant impact.[26]

The summary statistics for the overall period are provided in Exhibits 4a and 5a. Over the 122 months of the study, the 2% OTM collar significantly reduces risk and improves realized returns. The returns are improved from a –3.6% annualized loss to a 9.3% gain; meanwhile, standard deviation is reduced by about one-third, from 30.4% to 11.0%. Similarly, the sign of the Stutzer index

EXHIBIT 4A

Passive Collars with 2% OTM Puts—April 1999 to May 2009

Monthly Data: April, 1999–May, 2009	QQQQ TR FUND ONLY - No Options	QQQQ TR PASSIVE COLLAR - 0% OTM, 1 Mo Call.2% OTM. 6 Mo Put.	QQQQ TR PASSIVE COLLAR - 1% OTM, 1 Mo Call.2% OTM. 6 Mo Put.	QQQQ TR PASSIVE COLLAR - 2% OTM, 1 Mo Call.2% OTM. 6 Mo Put.
Annualized Return	-3.57%	10.69%	9.12%	9.26%
Annualized Std Dev	30.40%	9.86%	10.45%	10.98%
Sharpe Ratio	-0.22	0.77	0.58	0.56
Annual Stutzer Index	-0.07	0.79	0.60	0.59
CAPM Beta	1.00	0.02	0.11	0.13
Leland Beta	1.00	0.01	0.10	0.13
Monthly Leland Alpha	0.00%	0.64%	0.54%	0.56%
Information Ratio	0.00	0.45	0.44	0.45
Skew	-0.21	0.45	0.18	0.16
Kurtosis	0.55	2.75	3.34	3.52
Maximum Drawdown	-81.08%	-14.21%	-17.08%	-17.90%
Correlation with QQQ	1.00	0.05	0.31	0.37
Min Monthly Return	-26.20%	-8.15%	-9.29%	-9.95%
Max Monthly Return	23.48%	12.81%	14.09%	15.06%
Number of Months	122	122	122	122
% Up Months	52%	67%	63%	65%
% Down Months	48%	33%	37%	35%

Monthly Data: April, 1999–May, 2009	QQQQ TR PASSIVE COLLAR - 3% OTM, 1 Mo Call.2% OTM. 6 Mo Put.	QQQQ TR PASSIVE COLLAR - 4% OTM, 1 Mo Call.2% OTM. 6 Mo Put.	QQQQ TR PASSIVE COLLAR - 5% OTM, 1 Mo Call.2% OTM. 6 Mo Put.
Annualized Return	9.23%	8.84%	7.61%
Annualized Std Dev	11.54%	11.94%	12.37%
Sharpe Ratio	0.53	0.48	0.37
Annual Stutzer Index	0.57	0.52	0.41
CAPM Beta	0.17	0.21	0.23
Leland Beta	0.17	0.20	0.23
Monthly Leland Alpha	0.57%	0.55%	0.46%
Information Ratio	0.47	0.47	0.44
Skew	0.14	0.09	0.03
Kurtosis	3.51	2.95	2.99
Maximum Drawdown	-19.49%	-20.14%	-21.37%
Correlation with QQQ	0.46	0.52	0.57
Min Monthly Return	-10.10%	-10.67%	-10.73%
Max Monthly Return	15.48%	15.37%	15.64%
Number of Months	122	122	122
% Up Months	67%	62%	60%
% Down Months	33%	38%	40%

is turned from negative to positive, and the information ratio (relative to the QQQ) for the collar is positive at 0.45. Perhaps the most visible impact of implementing the collar strategy is a reduction of the maximum drawdown from –81.1% to –17.9% for the 10+ year overall period.

The effectiveness of the collar strategy in the April 1999 to September 2002 period is evident from Exhibits 4b and 5b. In the early bubble run-up and collapse, the QQQ experienced an annualized return of –23.3% with a 42.4% volatility. In this volatile market, the 2% OTM passive collar strategy generated an annualized return of 21.2% at a volatility of only 13.7%. Thus the collar was able to turn a sizeable loss into a significant gain, while cutting risk (as measured by standard deviation) by more than two-thirds. Other measures confirm the risk reduction, including the minimum monthly return, the percentage of up

EXHIBIT 4B

Passive Collars with 2% OTM Puts—April 1999 to September 2002

Monthly Data: April, 1999–September, 2002	QQQQ TR FUND ONLY - No Options	QQQQ TR PASSIVE COLLAR - 0% OTM, 1 Mo Call.2% OTM. 6 Mo Put.	QQQQ TR PASSIVE COLLAR - 1% OTM, 1 Mo Call.2% OTM. 6 Mo Put.	QQQQ TR PASSIVE COLLAR - 2% OTM, 1 Mo Call.2% OTM. 6 Mo Put.
Annualized Return	-23.31%	26.02%	21.66%	21.16%
Annualized Std Dev	42.44%	12.94%	13.27%	13.69%
Sharpe Ratio	-0.65	1.69	1.32	1.24
Annual Stutzer Index	0.51	1.58	1.27	1.21
CAPM Beta	1.00	0.00	0.06	0.08
Leland Beta	1.00	0.00	0.06	0.08
Monthly Leland Alpha	0.00%	1.67%	1.50%	1.50%
Information Ratio	0.00	1.11	1.08	1.08
Skew	0.14	0.17	0.26	0.39
Kurtosis	-0.70	0.87	2.00	2.47
Maximum Drawdown	-81.08%	-5.28%	-7.54%	-7.54%
Correlation with QQQ	1.00	0.00	0.21	0.27
Min Monthly Return	-26.20%	-5.28%	-7.54%	-7.54%
Max Monthly Return	23.48%	12.81%	14.09%	15.06%
Number of Months	42	42	42	42
% Up Months	40%	74%	71%	74%
% Down Months	60%	26%	29%	26%

Monthly Data: April, 1999–September, 2002	QQQQ TR PASSIVE COLLAR - 3% OTM, 1 Mo Call.2% OTM. 6 Mo Put.	QQQQ TR PASSIVE COLLAR - 4% OTM, 1 Mo Call.2% OTM. 6 Mo Put.	QQQQ TR PASSIVE COLLAR - 5% OTM, 1 Mo Call.2% OTM. 6 Mo Put.
Annualized Return	19.43%	17.85%	15.85%
Annualized Std Dev	14.33%	14.50%	14.91%
Sharpe Ratio	1.07	0.95	0.79
Annual Stutzer Index	1.06	0.96	0.81
CAPM Beta	0.11	0.14	0.16
Leland Beta	0.12	0.14	0.16
Monthly Leland Alpha	1.44%	1.37%	1.28%
Information Ratio	1.07	1.06	1.04
Skew	0.43	0.41	0.40
Kurtosis	2.78	2.51	2.80
Maximum Drawdown	-9.16%	-9.16%	-10.39%
Correlation with QQQ	0.34	0.41	0.47
Min Monthly Return	-9.16%	-9.16%	-10.39%
Max Monthly Return	15.48%	15.37%	15.64%
Number of Months	42	42	42
% Up Months	74%	67%	64%
% Down Months	26%	33%	36%

months, and the Leland beta. The capital protection ability of the collar strategy can be illustrated by the maximum drawdown. The maximum drawdown of the QQQ is reduced significantly, from –81.1% to –7.5%, over the most severe market move that the QQQ has ever experienced.

To consider these results in a different light, the collar could have earned an investor 21.2% per year over the period with a maximum loss of capital of 7.5%, regardless of how poorly the investor timed the entry into the strategy. Clearly in this case, the collar was an effective way of capturing a significant return from the bubble run-up without experiencing the magnitude of losses that came with the collapse.

We expected the collar to perform poorly in the next sub-period due to the low volatility and steady positive returns with very few sharp down moves. The results confirm this expectation. Exhibits 4c and 5c provide the

EXHIBIT 4C

Passive Collars with 2% OTM Puts—October 2002 to September 2007

Monthly Data: October, 2002–September, 2007	QQQQ TR FUND ONLY - No Options	QQQQ TR PASSIVE COLLAR - 0% OTM, 1 Mo Call.2% OTM. 6 Mo Put.	QQQQ TR PASSIVE COLLAR - 1% OTM, 1 Mo Call.2% OTM. 6 Mo Put.	QQQQ TR PASSIVE COLLAR - 2% OTM, 1 Mo Call.2% OTM. 6 Mo Put.
Annualized Return	20.37%	3.73%	4.57%	5.19%
Annualized Std Dev	17.54%	5.58%	7.08%	7.93%
Sharpe Ratio	1.00	0.15	0.24	0.29
Annual Stutzer Index	1.01	0.17	0.26	0.32
CAPM Beta	1.00	0.07	0.26	0.30
Leland Beta	1.00	0.09	0.28	0.33
Monthly Leland Alpha	0.00%	-0.04%	-0.24%	-0.26%
Information Ratio	0.00	-0.96	-1.11	-1.12
Skew	0.33	-0.13	-0.21	-0.22
Kurtosis	1.63	0.24	0.03	0.04
Maximum Drawdown	-12.36%	-6.62%	-11.83%	-14.02%
Correlation with QQQ	1.00	0.20	0.63	0.67
Min Monthly Return	-12.09%	-3.67%	-4.67%	-5.49%
Max Monthly Return	18.47%	4.46%	4.88%	5.59%
Number of Months	60	60	60	60
% Up Months	62%	65%	57%	57%
% Down Months	38%	35%	43%	43%

Monthly Data: October, 2002–September, 2007	QQQQ TR PASSIVE COLLAR - 3% OTM, 1 Mo Call.2% OTM. 6 Mo Put.	QQQQ TR PASSIVE COLLAR - 4% OTM, 1 Mo Call.2% OTM. 6 Mo Put.	QQQQ TR PASSIVE COLLAR - 5% OTM, 1 Mo Call.2% OTM. 6 Mo Put.
Annualized Return	6.88%	7.42%	6.14%
Annualized Std Dev	8.55%	9.14%	9.75%
Sharpe Ratio	0.47	0.50	0.33
Annual Stutzer Index	0.49	0.52	0.37
CAPM Beta	0.38	0.43	0.48
Leland Beta	0.40	0.44	0.50
Monthly Leland Alpha	-0.23%	-0.24%	-0.42%
Information Ratio	-1.10	-1.15	-1.36
Skew	-0.25	-0.02	0.20
Kurtosis	-0.05	-0.07	0.37
Maximum Drawdown	-12.12%	-14.33%	-16.45%
Correlation with QQQ	0.77	0.82	0.86
Min Monthly Return	-5.49%	-5.50%	-6.90%
Max Monthly Return	5.91%	6.86%	6.86%
Number of Months	60	60	60
% Up Months	62%	60%	58%
% Down Months	38%	40%	42%

evidence. In this steadily climbing, near-ideal market for the QQQ and poor market for the collar, the collar exhibits a far lower return. The annualized return of the QQQ over the period is 20.4% at relatively moderate volatility of 17.5%. The 2% OTM collar provides only a 5.2% return over this period. It does, however, do so at a far lower volatility. In this period, the collar provides about one-fourth of the returns of the QQQ at less than one-half the volatility. By most measures, the collar underperforms the QQQ on a risk-adjusted basis in this period. It has a slightly higher maximum drawdown, fewer up months, a lower Stutzer index, a negative information ratio, and a –0.26% monthly Leland alpha. It is interesting to note that this underperformance is not nearly as significant as the QQQ's underperformance in the early period.

EXHIBIT 4D

Passive Collars with 2% OTM Puts—October 2007 to May 2009

Monthly Data: October, 2007–May, 2009	QQQQ TR FUND ONLY - No Options	QQQQ TR PASSIVE COLLAR - 0% OTM, 1 Mo Call.2% OTM. 6 Mo Put.	QQQQ TR PASSIVE COLLAR - 1% OTM, 1 Mo Call.2% OTM. 6 Mo Put.	QQQQ TR PASSIVE COLLAR - 2% OTM, 1 Mo Call.2% OTM. 6 Mo Put.
Annualized Return	-19.78%	2.44%	-1.33%	-1.44%
Annualized Std Dev	29.23%	10.46%	11.00%	11.56%
Sharpe Ratio	-0.73	0.10	-0.25	-0.25
Annual Stutzer Index	-0.67	0.15	-0.20	-0.20
CAPM Beta	1.00	0.13	0.21	0.25
Leland Beta	1.00	0.12	0.20	0.24
Monthly Leland Alpha	0.00%	0.31%	0.14%	0.20%
Information Ratio	0.00	0.81	0.74	0.77
Skew	-0.16	-0.95	-1.53	-1.64
Kurtosis	-0.88	2.18	2.74	3.08
Maximum Drawdown	-49.74%	-14.21%	-17.08%	-17.90%
Correlation with QQQ	1.00	0.35	0.56	0.62
Min Monthly Return	-15.57%	-8.15%	-9.29%	-9.95%
Max Monthly Return	13.06%	5.64%	3.84%	3.84%
Number of Months	20	20	20	20
% Up Months	50%	60%	65%	70%
% Down Months	50%	40%	35%	30%

Monthly Data: October, 2007–May, 2009	QQQQ TR PASSIVE COLLAR - 3% OTM, 1 Mo Call.2% OTM. 6 Mo Put.	QQQQ TR PASSIVE COLLAR - 4% OTM, 1 Mo Call.2% OTM. 6 Mo Put.	QQQQ TR PASSIVE COLLAR - 5% OTM, 1 Mo Call.2% OTM. 6 Mo Put.
Annualized Return	-3.35%	-4.20%	-3.93%
Annualized Std Dev	12.15%	12.92%	13.29%
Sharpe Ratio	-0.39	-0.44	-0.40
Annual Stutzer Index	-0.35	-0.40	-0.36
CAPM Beta	0.27	0.32	0.34
Leland Beta	0.27	0.31	0.34
Monthly Leland Alpha	0.08%	0.09%	0.16%
Information Ratio	0.71	0.71	0.75
Skew	-1.47	-1.34	-1.36
Kurtosis	2.43	2.12	2.00
Maximum Drawdown	-19.49%	-20.14%	-21.37%
Correlation with QQQ	0.65	0.71	0.76
Min Monthly Return	-10.10%	-10.67%	-10.73%
Max Monthly Return	4.65%	5.26%	5.39%
Number of Months	20	20	20
% Up Months	70%	60%	55%
% Down Months	30%	40%	45%

The results pertaining to the final sub-period are provided in Exhibits 4d and 5d. This is the credit crisis period from October 2007 to May 2009. Once again, the collar provides significant capital protection. The –19.8% annualized loss of the QQQ is reduced to only –1.4%, while the standard deviation is cut from 29.2% to 11.6%. Therefore, the collar cuts a significant loss to less than 1/10 its size while cutting volatility by almost 2/3. Other results confirm the collar's outperformance in this period. The monthly Leland beta is 0.2%, the information ratio is 0.77, and the maximum drawdown is reduced from 49.7% to 17.9%.

Active Collars

The next set of exhibits provides results relating to active implementations of the collar strategies. Exhibits 6a, 6b, 6c, and 6d provide summary statistics

EXHIBIT 5A

Passive Collars with 2% OTM Calls—April 1999 to May 2009

Monthly Data: April, 1999–May, 2009	QQQQ TR FUND ONLY - No Options	QQQQ TR PASSIVE COLLAR - 2% OTM, 1 Mo Call.0% OTM. 6 Mo Put.	QQQQ TR PASSIVE COLLAR - 2% OTM, 1 Mo Call.1% OTM. 6 Mo Put.	QQQQ TR PASSIVE COLLAR - 2% OTM, 1 Mo Call.2% OTM. 6 Mo Put.
Annualized Return	-3.57%	8.91%	9.35%	9.26%
Annualized Std Dev	30.40%	10.27%	10.87%	10.98%
Sharpe Ratio	-0.22	0.57	0.58	0.56
Annual Stutzer Index	-0.07	0.60	0.60	0.59
CAPM Beta	1.00	0.09	0.13	0.13
Leland Beta	1.00	0.08	0.12	0.13
Monthly Leland Alpha	0.00%	0.52%	0.56%	0.56%
Information Ratio	0.00	0.42	0.46	0.45
Skew	-0.21	0.47	0.20	0.16
Kurtosis	0.55	4.20	3.68	3.52
Maximum Drawdown	-81.08%	-18.83%	-17.91%	-17.90%
Correlation with QQQ	1.00	0.26	0.36	0.37
Min Monthly Return	-26.20%	-7.70%	-9.90%	-9.95%
Max Monthly Return	23.48%	15.02%	15.06%	15.06%
Number of Months	122	122	122	122
% Up Months	52%	63%	63%	65%
% Down Months	48%	37%	37%	35%

Monthly Data: April, 1999–May, 2009	QQQQ TR PASSIVE COLLAR - 2% OTM, 1 Mo Call.3% OTM. 6 Mo Put.	QQQQ TR PASSIVE COLLAR - 2% OTM, 1 Mo Call.4% OTM. 6 Mo Put.	QQQQ TR PASSIVE COLLAR - 2% OTM, 1 Mo Call.5% OTM. 6 Mo Put.
Annualized Return	9.74%	9.85%	9.89%
Annualized Std Dev	11.10%	11.26%	11.35%
Sharpe Ratio	0.60	0.60	0.60
Annual Stutzer Index	0.63	0.63	0.62
CAPM Beta	0.15	0.15	0.16
Leland Beta	0.14	0.15	0.16
Monthly Leland Alpha	0.60%	0.61%	0.62%
Information Ratio	0.48	0.48	0.49
Skew	0.14	0.06	0.05
Kurtosis	3.35	3.24	3.12
Maximum Drawdown	-17.90%	-18.81%	-18.81%
Correlation with QQQ	0.40	0.42	0.44
Min Monthly Return	-9.95%	-10.30%	-10.30%
Max Monthly Return	15.11%	15.11%	15.15%
Number of Months	122	122	122
% Up Months	64%	63%	61%
% Down Months	36%	37%	39%

for the short-, medium-, and long-horizon active collar strategies for each of the periods discussed earlier, as well as corresponding statistics for the 2% OTM passive collar and the QQQ.

Exhibit 6a provides statistics covering the overall period. As we mentioned earlier, the passive collar clearly outperformed the QQQ in the overall period. The active collar adjustment strategy outperformed both the QQQ and the passive collar. All three active collars performed similarly, with the short active collar performing the best. While the volatility is slightly higher for the short active collar than the passive collar, returns are more than 2% higher annually. This is also reflected in the Stutzer index, at 0.75 versus 0.59 for the passive collar. Similarly, the monthly Leland alphas are 0.74% and 0.56%, respectively. Therefore, the short active implementation of the collar increases the Stutzer index and the Leland alpha both by a factor of about one-half.

EXHIBIT 5B

Passive Collars with 2% OTM Calls—April 1999 to September 2002

Monthly Data: April, 1999–September, 2002	QQQQ TR FUND ONLY - No Options	QQQQ TR PASSIVE COLLAR - 2% OTM, 1 Mo Call.0% OTM. 6 Mo Put.	QQQQ TR PASSIVE COLLAR - 2% OTM, 1 Mo Call.1% OTM. 6 Mo Put.	QQQQ TR PASSIVE COLLAR - 2% OTM, 1 Mo Call.2% OTM. 6 Mo Put.
Annualized Return	-23.31%	22.67%	21.48%	21.16%
Annualized Std Dev	42.44%	13.27%	13.58%	13.69%
Sharpe Ratio	-0.65	1.40	1.28	1.24
Annual Stutzer Index	-0.51	1.34	1.24	1.21
CAPM Beta	1.00	0.05	0.08	0.08
Leland Beta	1.00	0.05	0.08	0.08
Monthly Leland Alpha	0.00%	1.55%	1.51%	1.50%
Information Ratio	0.00	1.09	1.09	1.08
Skew	0.14	0.39	0.40	0.39
Kurtosis	-0.70	2.93	2.60	2.47
Maximum Drawdown	-81.08%	-7.47%	-7.54%	-7.54%
Correlation with QQQ	1.00	0.18	0.25	0.27
Min Monthly Return	-26.20%	-7.47%	-7.54%	-7.54%
Max Monthly Return	23.48%	15.02%	15.06%	15.06%
Number of Months	42	42	42	42
% Up Months	40%	74%	71%	74%
% Down Months	60%	26%	29%	26%

Monthly Data: April, 1999–September, 2002	QQQQ TR PASSIVE COLLAR - 2% OTM, 1 Mo Call.3% OTM. 6 Mo Put.	QQQQ TR PASSIVE COLLAR - 2% OTM, 1 Mo Call.4% OTM. 6 Mo Put.	QQQQ TR PASSIVE COLLAR - 2% OTM, 1 Mo Call.5% OTM. 6 Mo Put.
Annualized Return	21.38%	21.43%	20.84%
Annualized Std Dev	13.75%	13.72%	13.86%
Sharpe Ratio	1.25	1.26	1.21
Annual Stutzer Index	1.22	1.23	1.18
CAPM Beta	0.09	0.09	0.10
Leland Beta	0.09	0.10	0.10
Monthly Leland Alpha	1.53%	1.54%	1.51%
Information Ratio	1.10	1.10	1.10
Skew	0.37	0.36	0.38
Kurtosis	2.44	2.51	2.41
Maximum Drawdown	-7.48%	-7.48%	-7.48%
Correlation with QQQ	0.29	0.30	0.32
Min Monthly Return	-7.48%	-7.48%	-7.48%
Max Monthly Return	15.11%	15.11%	15.15%
Number of Months	42	42	42
% Up Months	74%	74%	69%
% Down Months	26%	26%	31%

The information ratio is also increased, suggesting that an active implementation does provide a benefit to collar performance. On the other hand, maximum drawdown and minimum monthly return are both slightly increased in magnitude.

In the bubble sub-period, the short active collar significantly outperforms the passive collar. The active collar generates almost a one-third higher annualized return at essentially the same standard deviation. Similarly, Exhibit 6b provides evidence that the Stutzer index, Leland alpha, and information ratio are all significantly higher for the active collar. In fact, in this period, the active collar generates almost 2% *per month* of Leland's alpha.

Exhibit 6c provides statistics for the second, unfavorable to the collar, sub-period. In this sub-period, the short active strategy significantly mitigates the underperformance of the passive strategy. While it still

EXHIBIT 5C

Passive Collars with 2% OTM Calls—October 2002 to September 2007

Monthly Data: October, 2002–September, 2007	QQQQ TR FUND ONLY - No Options	QQQQ TR PASSIVE COLLAR - 2% OTM, 1 Mo Call.0% OTM. 6 Mo Put.	QQQQ TR PASSIVE COLLAR - 2% OTM, 1 Mo Call.1% OTM. 6 Mo Put.	QQQQ TR PASSIVE COLLAR - 2% OTM, 1 Mo Call.2% OTM. 6 Mo Put.
Annualized Return	20.37%	2.91%	5.02%	5.19%
Annualized Std Dev	17.54%	7.11%	7.91%	7.93%
Sharpe Ratio	1.00	0.00	0.27	0.29
Annual Stutzer Index	1.01	0.04	0.30	0.32
CAPM Beta	1.00	0.23	0.30	0.30
Leland Beta	1.00	0.26	0.33	0.33
Monthly Leland Alpha	0.00%	-0.35%	-0.27%	-0.26%
Information Ratio	0.00	-1.19	-1.13	-1.12
Skew	0.33	-0.24	-0.21	-0.22
Kurtosis	1.63	0.14	0.06	0.04
Maximum Drawdown	-12.36%	-16.37%	-14.02%	-14.02%
Correlation with QQQ	1.00	0.57	0.67	0.67
Min Monthly Return	-12.09%	-5.23%	-5.49%	-5.49%
Max Monthly Return	18.47%	4.75%	5.59%	5.59%
Number of Months	60	60	60	60
% Up Months	62%	58%	57%	57%
% Down Months	38%	42%	43%	43%

Monthly Data: October, 2002–September, 2007	QQQQ TR PASSIVE COLLAR - 2% OTM, 1 Mo Call.3% OTM. 6 Mo Put.	QQQQ TR PASSIVE COLLAR - 2% OTM, 1 Mo Call.4% OTM. 6 Mo Put.	QQQQ TR PASSIVE COLLAR - 2% OTM, 1 Mo Call.5% OTM. 6 Mo Put.
Annualized Return	5.79%	6.39%	6.83%
Annualized Std Dev	8.18%	8.32%	8.47%
Sharpe Ratio	0.35	0.42	0.46
Annual Stutzer Index	0.38	0.44	0.48
CAPM Beta	0.33	0.34	0.36
Leland Beta	0.36	0.37	0.38
Monthly Leland Alpha	-0.26%	-0.22%	-0.21%
Information Ratio	-1.11	-1.08	-1.06
Skew	-0.16	-0.18	-0.24
Kurtosis	0.16	0.02	-0.08
Maximum Drawdown	-13.04%	-11.74%	-11.74%
Correlation with QQQ	0.71	0.71	0.73
Min Monthly Return	-5.56%	-5.56%	-5.56%
Max Monthly Return	6.24%	6.24%	6.24%
Number of Months	60	60	60
% Up Months	55%	55%	55%
% Down Months	45%	45%	45%

underperforms the QQQ, the monthly Leland beta is improved from a –26 basis point loss to a –8 basis point loss per month. Similarly, annualized returns are improved from 5.2% to 6.7%, while volatility is slightly reduced. The active implementation also improves maximum drawdown and minimum monthly return. The improvements of the medium-horizon active strategy are even more significant in this period.

The credit crisis sub-period is the only period in which the active strategy underperforms the passive strategy (albeit only slightly), and it still significantly outperforms the QQQ. These results suggest that a dynamic collar adjustment approach that is actively managed may have been able to overcome the small performance deficit between our passive and active strategies. However, "may" is the operative word. These

EXHIBIT 5D

Passive Collars with 2% OTM Calls—October 2007 to May 2009

Monthly Data: October, 2007–May, 2009	QQQQ TR FUND ONLY - No Options	QQQQ TR PASSIVE COLLAR - 2% OTM, 1 Mo Call.0% OTM. 6 Mo Put.	QQQQ TR PASSIVE COLLAR - 2% OTM, 1 Mo Call.1% OTM. 6 Mo Put.	QQQQ TR PASSIVE COLLAR - 2% OTM, 1 Mo Call.2% OTM. 6 Mo Put.
Annualized Return	-19.78%	0.54%	-1.03%	-1.44%
Annualized Std Dev	29.23%	9.54%	11.16%	11.56%
Sharpe Ratio	-0.73	-0.09	-0.22	-0.25
Annual Stutzer Index	-0.67	-0.05	-0.17	-0.20
CAPM Beta	1.00	0.17	0.23	0.25
Leland Beta	1.00	0.17	0.22	0.24
Monthly Leland Alpha	0.00%	0.23%	0.20%	0.20%
Information Ratio	0.00	0.79	0.77	0.77
Skew	-0.16	-1.41	-1.72	-1.64
Kurtosis	-0.88	2.32	3.70	3.08
Maximum Drawdown	-49.74%	-15.49%	-17.91%	-17.90%
Correlation with QQQ	1.00	0.52	0.60	0.62
Min Monthly Return	-15.57%	-7.70%	-9.90%	-9.95%
Max Monthly Return	13.06%	3.75%	3.84%	3.84%
Number of Months	20	20	20	20
% Up Months	50%	55%	65%	70%
% Down Months	50%	45%	35%	30%

Monthly Data: October, 2007–May, 2009	QQQQ TR PASSIVE COLLAR - 2% OTM, 1 Mo Call.3% OTM. 6 Mo Put.	QQQQ TR PASSIVE COLLAR - 2% OTM, 1 Mo Call.4% OTM. 6 Mo Put.	QQQQ TR PASSIVE COLLAR - 2% OTM, 1 Mo Call.5% OTM. 6 Mo Put.
Annualized Return	-0.84%	-2.02%	-2.02%
Annualized Std Dev	11.64%	12.32%	12.32%
Sharpe Ratio	-0.19	-0.28	-0.26
Annual Stutzer Index	-0.14	-0.23	-0.23
CAPM Beta	0.26	0.29	0.29
Leland Beta	0.25	0.28	0.28
Monthly Leland Alpha	0.26%	0.22%	0.22%
Information Ratio	0.81	0.78	0.78
Skew	-1.64	-1.55	-1.55
Kurtosis	3.04	2.47	2.47
Maximum Drawdown	-17.90%	-18.81%	-18.81%
Correlation with QQQ	0.64	0.68	0.68
Min Monthly Return	-9.95%	-10.30%	-10.30%
Max Monthly Return	3.84%	3.95%	3.95%
Number of Months	20	20	20
% Up Months	70%	65%	65%
% Down Months	30%	35%	35%

results are only for the reported time frame and might not represent results for future time frames. In addition, there may be alternative approaches that provide superior results. Exhibit 6d provides the Leland alpha, which is reduced from 20 basis points per month to 13 basis points. Annualized losses are increased from –1.4% to –3.0% and standard deviations are increased slightly from 11.6% to 13.7%. Similarly, the information ratio drops from 0.77 to 0.70.

Exhibit 7 summarizes many of these results graphically. The exhibit provides an illustration of the growth of a $100 investment in the active QQQ collar and the 2% OTM passive QQQ collar against the growth of a QQQ investment over the entire period. The difference in the performance of the QQQ and the collar strategies is clearly evident, as is the added performance gained by implementing the active collar rather than the passive collar.

EXHIBIT 6A

Active Collar Strategies—April 1999 to May 2009

Monthly Data: April, 1999–May, 2009	QQQQ TR FUND ONLY - No Options	QQQQ TR PASSIVE COLLAR - 2% OTM, 1 Mo Call.2% OTM. 6 Mo Put.	QQQQ TR Short ACTIVE COLLAR - 1 Mo Call. 6 Mo Put.	QQQQ TR Medium ACTIVE COLLAR - 1 Mo Call. 6 Mo Put.	QQQQ TR Long ACTIVE COLLAR - 1 Mo Call. 6 Mo Put.
Annualized Return	-3.57%	9.26%	11.55%	10.94%	10.67%
Annualized Std. Dev.	30.40%	10.98%	11.44%	11.54%	11.34%
Sharpe Ratio	-0.22	0.56	0.74	0.68	0.67
Annual Stutzer Index	-0.07	0.59	0.75	0.70	0.69
CAPM Beta	1.00	0.13	0.15	0.15	0.16
Leland Beta	1.00	0.13	0.14	0.15	0.15
Monthly Leland Alpha	0.00%	0.56%	0.74%	0.70%	0.67%
Information Ratio	0.00	0.45	0.54	0.52	0.52
Skew	-0.21	0.16	0.01	0.07	-0.07
Kurtosis	0.55	3.52	3.28	3.26	2.80
Maximum Drawdown	-81.08%	-17.90%	-21.73%	-23.57%	-23.91%
Correlation with QQQ	1.00	0.37	0.39	0.41	0.42
Min Monthly Return	-26.20%	-9.95%	-10.38%	-10.38%	-10.38%
Max Monthly Return	23.48%	15.06%	15.41%	15.41%	14.57%
Number of Months	122	122	122	122	122
% Up Months	52%	65%	66%	64%	66%
% Down Months	48%	35%	34%	36%	34%

EXHIBIT 6B

Active Collar Strategies—April 1999 to September 2002

Monthly Data: April, 1999–September, 2002	QQQQ TR FUND ONLY - No Options	QQQQ TR PASSIVE COLLAR - 2% OTM, 1 Mo Call.2% OTM. 6 Mo Put.	QQQQ TR Short ACTIVE COLLAR - 1 Mo Call. 6 Mo Put.	QQQQ TR Medium ACTIVE COLLAR - 1 Mo Call. 6 Mo Put.	QQQQ TR Long ACTIVE COLLAR - 1 Mo Call. 6 Mo Put.
Annualized Return	-23.31%	21.16%	27.02%	24.27%	25.90%
Annualized Std. Dev.	42.44%	13.69%	13.71%	14.13%	13.25%
Sharpe Ratio	-0.65	1.24	1.67	1.43	1.64
Annual Stutzer Index	-0.51	1.21	1.54	1.35	1.52
CAPM Beta	1.00	0.08	0.11	0.12	0.11
Leland Beta	1.00	0.08	0.11	0.12	0.11
Monthly Leland Alpha	0.00%	1.50%	1.94%	1.78%	1.87%
Information Ratio	0.00	1.08	1.26	1.20	1.24
Skew	0.14	0.39	0.13	0.23	0.12
Kurtosis	-0.70	2.47	2.82	2.55	2.57
Maximum Drawdown	-81.08%	-7.54%	-7.48%	-8.70%	-7.54%
Correlation with QQQ	1.00	0.27	0.33	0.36	0.37
Min Monthly Return	-26.20%	-7.54%	-7.48%	-8.39%	-7.54%
Max Monthly Return	23.48%	15.06%	15.41%	15.41%	14.57%
Number of Months	42	42	42	42	42
% Up Months	40%	74%	74%	74%	76%
% Down Months	60%	26%	26%	26%	24%

EXHIBIT 6C

Active Collar Strategies—October 2002 to September 2007

Monthly Data: October, 2002–September, 2007	QQQQ TR FUND ONLY - No Options	QQQQ TR PASSIVE COLLAR - 2% OTM, 1 Mo Call.2% OTM. 6 Mo Put.	QQQQ TR Short ACTIVE COLLAR - 1 Mo Call. 6 Mo Put.	QQQQ TR Medium ACTIVE COLLAR - 1 Mo Call. 6 Mo Put.	QQQQ TR Long ACTIVE COLLAR - 1 Mo Call. 6 Mo Put.
Annualized Return	20.37%	5.19%	6.72%	7.91%	6.59%
Annualized Std. Dev.	17.54%	7.93%	7.68%	7.87%	7.99%
Sharpe Ratio	1.00	0.29	0.50	0.64	0.46
Annual Stutzer Index	1.01	0.32	0.52	0.64	0.48
CAPM Beta	1.00	0.30	0.26	0.28	0.31
Leland Beta	1.00	0.33	0.29	0.30	0.35
Monthly Leland Alpha	0.00%	-0.26%	-0.08%	-0.01%	-0.18%
Information Ratio	0.00	-1.12	-0.95	-0.88	-1.03
Skew	0.33	-0.22	-0.08	-0.22	-0.23
Kurtosis	1.63	0.04	0.80	0.41	0.30
Maximum Drawdown	-12.36%	-14.02%	-9.39%	-10.79%	-11.85%
Correlation with QQQ	1.00	0.67	0.59	0.62	0.68
Min Monthly Return	-12.09%	-5.49%	-5.42%	-5.39%	-5.39%
Max Monthly Return	18.47%	5.59%	6.18%	6.18%	6.18%
Number of Months	60	60	60	60	60
% Up Months	62%	57%	63%	60%	62%
% Down Months	38%	43%	37%	40%	38%

EXHIBIT 6D

Active Collar Strategies—October 2007 to May 2009

Monthly Data: October, 2007–May, 2009	QQQQ TR FUND ONLY - No Options	QQQQ TR PASSIVE COLLAR - 2% OTM, 1 Mo Call.2% OTM. 6 Mo Put.	QQQQ TR Short ACTIVE COLLAR - 1 Mo Call. 6 Mo Put.	QQQQ TR Medium ACTIVE COLLAR - 1 Mo Call. 6 Mo Put.	QQQQ TR Long ACTIVE COLLAR - 1 Mo Call. 6 Mo Put.
Annualized Return	-19.78%	-1.44%	-3.01%	-5.02%	-5.51%
Annualized Std. Dev.	29.23%	11.56%	13.72%	13.27%	13.56%
Sharpe Ratio	-0.73	-0.25	-0.32	-0.49	-0.51
Annual Stutzer Index	-0.67	-0.20	-0.27	-0.45	-0.47
CAPM Beta	1.00	0.25	0.28	0.24	0.26
Leland Beta	1.00	0.24	0.27	0.23	0.25
Monthly Leland Alpha	0.00%	0.20%	0.13%	-0.10%	-0.12%
Information Ratio	0.00	0.77	0.70	0.60	0.58
Skew	-0.16	-1.64	-0.98	-0.89	-0.91
Kurtosis	-0.88	3.08	0.98	1.26	0.95
Maximum Drawdown	-49.74%	-17.90%	-21.73%	-23.57%	-23.91%
Correlation with QQQ	1.00	0.62	0.59	0.54	0.56
Min Monthly Return	-15.57%	-9.95%	-10.38%	-10.38%	-10.38%
Max Monthly Return	13.06%	3.84%	5.64%	5.64%	5.64%
Number of Months	20	20	20	20	20
% Up Months	50%	70%	60%	55%	60%
% Down Months	50%	30%	40%	45%	40%

EXHIBIT 7

Growth of $100 in Active and Passive Collar Strategies

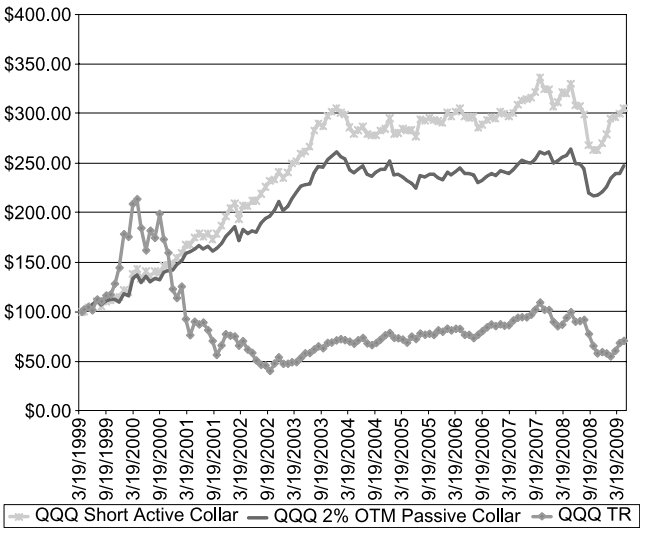


EXHIBIT 8

Rolling 12-Month Annualized Returns Active and Passive Collars

Exhibits 8 and 9 provide rolling 12-month annualized returns and standard deviations, respectively. In Exhibit 8 it is clear that the returns to the collar strategies are much more stable than those of the QQQ. In addition, the collars clearly avoid the worst of the negative returns near the beginning and at the end of the period.

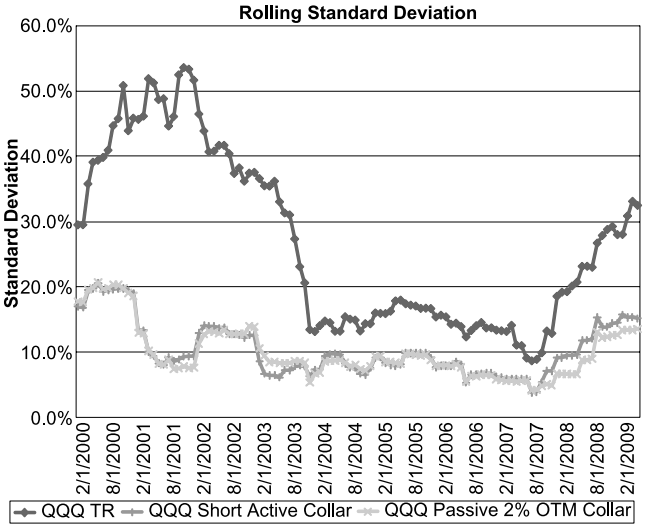
The rolling standard deviations provided in Exhibit 9 are evidence of the potential risk reduction benefits of the collar strategy. The collar strategies exhibit lower standard deviations throughout the entire period, with the difference ranging from about 5% to about 45%. It is also worth noting that both exhibits indicate that the benefits of the active collar strategy over the passive collar tend to be relatively subtle, particularly when compared to the difference between the collars and the QQQ.

COLLARING A MUTUAL FUND

We also consider applying a collar strategy to a well-known small-cap equity mutual fund. For the

EXHIBIT 9

Rolling 12-Month Annualized Standard Deviation Active and Passive Collars



analysis, we choose a fund that used the QQQ as a potential passive benchmark and is assumed to track reasonably well with the QQQ. The fund we utilize is from a well-known platform found in the Morningstar Category "Small Growth" and carries a 10-year risk rating of "Above Average" and return rating of "Average" relative to its peers. Our intention is to simulate the practice of applying a collar strategy to a standard equity portfolio on which there are no available options written. In such a case, the investor would choose options based on liquidity considerations and how well the underlying tracks the investor's portfolio.

Exhibits 10a, 10b, 10c, and 10d provide summary statistics for the mutual fund with and without the passive and active collar strategies. Before we discuss the results, it should be noted that the strategies represented are not true collar overlays. The methodology does assume daily rebalancing of the option and mutual fund positions to maintain the proper exposure and is thus simply a first approximation of the performance of a true collar overlay. In the case of a true overlay, far less rebalancing would be required to maintain the collar overlay. In order to easily apply these strategies as overlays, the investor could allocate a portion of their portfolio to cash, and use this cash reserve to manage the cash flows resulting from the option positions.

While the active mutual fund collar underperforms the active QQQ collar in the overall period (see Exhibit 10a), the improvement on the mutual fund is very significant. The return of the active mutual fund collar is more than four times the return of the mutual fund, while the standard deviation is about one-third lower. The Stutzer index increases from 0.12 to 0.45, the information ratio (relative to the QQQ) increases from 0.42 to 0.53, and the monthly Leland alpha increases from 0.42% to 0.72%. In addition, maximum drawdown is significantly improved, from –69.7% to –24.8%.

EXHIBIT 10A

Mutual Fund Collar Strategies—April 1999 to May 2009

Monthly Data: April, 1999– May, 2009	QQQQ TR FUND ONLY - No Options	Small Cap Mutual Fund FUND ONLY - No Options	Small Cap Mutual Fund PASSIVE COLLAR - 2% OTM, 1 Mo Call.2% OTM. 6 Mo Put.	Small Cap Mutual Fund Short ACTIVE COLLAR- 1 Mo Call.6 Mo Put.	QQQQ TR Short ACTIVE COLLAR - 1 Mo Call. 6 Mo Put.
Annualized Return	-3.57%	2.35%	8.37%	9.83%	11.55%
Annualized Std. Dev.	30.40%	28.89%	17.90%	18.28%	11.44%
Sharpe Ratio	-0.22	-0.02	0.30	0.37	0.74
Annual Stutzer Index	-0.07	0.12	0.38	0.45	0.75
CAPM Beta	1.00	0.84	0.33	0.34	0.15
Leland Beta	1.00	0.84	0.33	0.33	0.14
Monthly Leland Alpha	0.00%	0.42%	0.60%	0.72%	0.74%
Information Ratio	0.00	0.42	0.48	0.53	0.54
Skew	-0.21	0.18	1.13	1.07	0.01
Kurtosis	0.55	1.34	4.98	4.49	3.28
Maximum Drawdown	-81.08%	-69.70%	-25.27%	-24.82%	-21.73%
Correlation with QQQ	1.00	0.89	0.57	0.57	0.39
Min Monthly Return	-26.20%	-21.66%	-12.01%	-12.51%	-10.38%
Max Monthly Return	23.48%	27.66%	25.93%	26.03%	15.41%
Number of Months	122	122	122	122	122
% Up Months	52%	57%	55%	58%	66%
% Down Months	48%	43%	45%	42%	34%

EXHIBIT 10B

Mutual Fund Collar Strategies—April 1999 to September 2002

Monthly Data: April, 1999–September, 2002	QQQQ TR FUND ONLY - No Options	Small Cap Mutual Fund FUND ONLY - No Options	Small Cap Mutual Fund PASSIVE COLLAR - 2% OTM, 1 Mo Call.2% OTM. 6 Mo Put.	Small Cap Mutual Fund Short ACTIVE COLLAR- 1 Mo Call.6 Mo Put.	QQQQ TR Short ACTIVE COLLAR - 1 Mo Call.6 Mo Put.
Annualized Return	-23.31%	-7.05%	16.96%	20.28%	27.02%
Annualized Std. Dev.	42.44%	42.14%	27.24%	27.61%	13.71%
Sharpe Ratio	-0.65	-0.27	0.47	0.58	1.67
Annual Stutzer Index	-0.51	-0.07	0.58	0.68	1.54
CAPM Beta	1.00	0.89	0.40	0.41	0.11
Leland Beta	1.00	0.89	0.40	0.41	0.11
Monthly Leland Alpha	0.00%	1.34%	1.97%	2.24%	1.94%
Information Ratio	0.00	0.84	1.21	1.32	1.26
Skew	0.14	0.41	0.71	0.64	0.13
Kurtosis	-0.70	-0.41	1.12	0.91	2.82
Maximum Drawdown	-81.08%	-69.70%	-25.27%	-24.82%	-7.48%
Correlation with QQQ	1.00	0.89	0.62	0.63	0.33
Min Monthly Return	-26.20%	-21.66%	-12.01%	-12.51%	-7.48%
Max Monthly Return	23.48%	27.66%	25.93%	26.03%	15.41%
Number of Months	42	42	42	42	42
% Up Months	40%	48%	60%	62%	74%
% Down Months	60%	52%	40%	38%	26%

EXHIBIT 10C

Mutual Fund Collar Strategies—October 2002 to September 2007

Monthly Data: October, 2002–September, 2007	QQQQ TR FUND ONLY - No Options	Small Cap Mutual Fund FUND ONLY - No Options	Small Cap Mutual Fund PASSIVE COLLAR - 2% OTM, 1 Mo Call.2% OTM. 6 Mo Put.	Small Cap Mutual Fund Short ACTIVE COLLAR- 1 Mo Call.6 Mo Put.	QQQQ TR Short ACTIVE COLLAR - 1 Mo Call.6 Mo Put.
Annualized Return	20.37%	19.12%	7.83%	9.12%	6.72%
Annualized Std. Dev.	17.54%	14.20%	9.70%	9.77%	7.68%
Sharpe Ratio	1.00	1.14	0.51	0.64	0.50
Annual Stutzer Index	1.01	1.12	0.54	0.66	0.52
CAPM Beta	1.00	0.67	0.25	0.23	0.26
Leland Beta	1.00	0.70	0.28	0.26	0.29
Monthly Leland Alpha	0.00%	0.30%	0.03%	0.16%	-0.08%
Information Ratio	0.00	-0.13	-0.79	-0.69	-0.95
Skew	0.33	0.00	0.19	0.28	-0.08
Kurtosis	1.63	0.26	-0.20	-0.31	0.80
Maximum Drawdown	-12.36%	-13.76%	-9.66%	-9.79%	-9.39%
Correlation with QQQ	1.00	0.83	0.44	0.40	0.59
Min Monthly Return	-12.09%	-9.18%	-5.10%	-5.39%	-5.42%
Max Monthly Return	18.47%	10.97%	7.25%	7.33%	6.18%
Number of Months	60	60	60	60	60
% Up Months	62%	68%	57%	58%	63%
% Down Months	38%	32%	43%	42%	37%

Similar results are found with the passive mutual fund collar. The passive mutual fund collar provides a return almost three times the return of the mutual fund at about two-thirds the standard deviation, significantly outperforming the mutual fund while slightly underperforming the active mutual fund collar.

In the first (tech bubble) sub-period, the collar strategy significantly improves the returns of the mutual fund while reducing the standard deviation. As indicated in Exhibit 10b, the mutual fund exhibits a –7.1% annualized loss at a 42.1% standard deviation. In contrast, the passive and active mutual fund collars deliver 17.0% and 20.3% returns at 27.2% and 27.6% standard deviations, respectively. Similarly, the Stutzer index and Leland alpha are improved from –0.07 and 1.34% to 0.47 and 1.97% for the passive collar and further improved to 0.58 and 2.24% for the active collar.

Exhibit 10c provides results for the unfavorable period. In the unfavorable period the passive and active mutual fund collars both underperform the mutual

EXHIBIT 10D

Mutual Fund Collar Strategies—October 2007 to May 2009

Monthly Data: October, 2007–May, 2009	QQQQ TR FUND ONLY - No Options	Small Cap Mutual Fund FUND ONLY - No Options	Small Cap Mutual Fund PASSIVE COLLAR - 2% OTM, 1 Mo Call.2% OTM. 6 Mo Put.	Small Cap Mutual Fund Short ACTIVE COLLAR- 1 Mo Call.6 Mo Put.	QQQQ TR Short ACTIVE COLLAR - 1 Mo Call.6 Mo Put.
Annualized Return	-19.78%	-20.50%	-6.29%	-7.47%	-3.01%
Annualized Std. Dev.	29.23%	27.47%	10.44%	11.54%	13.72%
Sharpe Ratio	-0.73	-0.80	-0.74	-0.77	-0.32
Annual Stutzer Index	-0.67	-0.77	-0.74	-0.77	-0.27
CAPM Beta	1.00	0.87	0.23	0.25	0.28
Leland Beta	1.00	0.87	0.22	0.24	0.27
Monthly Leland Alpha	0.00%	-0.31%	-0.26%	-0.32%	0.13%
Information Ratio	0.00	-0.07	0.57	0.52	0.70
Skew	-0.16	-0.38	-0.92	-0.72	-0.98
Kurtosis	-0.88	0.00	1.57	0.80	0.98
Maximum Drawdown	-49.74%	-47.51%	-17.35%	-20.95%	-21.73%
Correlation with QQQ	1.00	0.93	0.65	0.64	0.59
Min Monthly Return	-15.57%	-19.93%	-8.41%	-8.66%	-10.38%
Max Monthly Return	13.06%	12.82%	4.76%	5.60%	5.64%
Number of Months	20	20	20	20	20
% Up Months	50%	45%	40%	50%	60%
% Down Months	50%	55%	60%	50%	40%

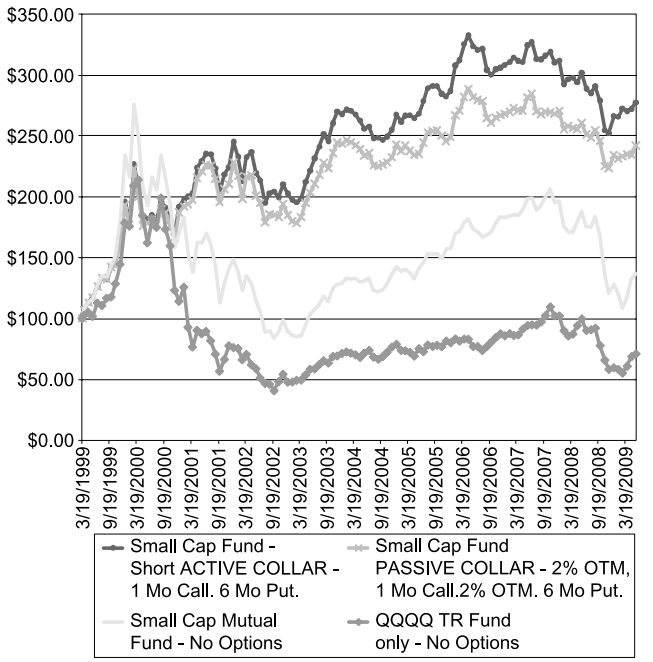
fund, with the active mutual fund collar generating 9.1% returns at 9.8% volatility versus 19.1% returns at 14.2% volatility for the mutual fund. The performance differential between the active mutual fund collar and the mutual fund is not as significant as the differential for the QQQ collar and the QQQ for this time period. The monthly Leland alpha for the active mutual fund collar is 0.16% versus 0.30% for the mutual fund.

The statistics for the credit crisis sub-period are provided in Exhibit 10d. In this period, the active and passive mutual fund collars provide very similar results, with the passive mutual fund collar slightly outperforming the active collar. Both mutual fund collars outperform the mutual fund in this period on a raw return basis. On a risk-adjusted return basis, the passive collar outperforms the mutual fund with Leland alphas of –0.26% and 0.31%, respectively. In contrast, the active collar provides virtually the same Leland alpha as the mutual fund in this sub-period. The passive collar improves returns by cutting losses by about two-thirds, from –20.1% to –6.3%, while also cutting volatility by almost two-thirds, from 27.5% to 10.4%. The maximum drawdown and minimum monthly return are cut by more than one-half for the passive collar.

Exhibit 11 provides a graphical representation of the performance of an investment in the small-cap mutual fund versus the collared mutual fund. Once again, the outperformance of the collared mutual funds is clearly evident in the overall period, with the active collar quite consistently outperforming the passive collar.

EXHIBIT 11

Growth of $100 in Mutual Fund Strategies



CONCLUSION

This article considers the performance of passive and active implementations of the collar strategy on the QQQ ETF as well as on a sample small-cap equity mutual fund. The 10+ year time horizon since the inception of QQQ options has provided us with a variety of market conditions in which to test the performance characteristics of the collar. As expected, the results of the analysis show that a passive collar strategy (whether on the QQQ or on the mutual fund) is most effective (relative to a long underlying position) in declining markets and less effective in rising markets. For the period of analysis, the active collar adjustment strategy tends to outperform the passive collar. Judgments as to the particular benefits of the passive and active collar strategies are, of course, dependent on the risk tolerance of the individual investor.

ENDNOTES

[1]Collars can be visualized as a combination of covered call and protective put strategies. The collar strategy essentially adds a long protective put to a covered call strategy. This provides the significant downside protection that the covered call strategy lacks. The purchase of the long put is financed by the sale of the call. In essence, the collar trades upside participation for downside protection. A tight collar provides less upside participation and more downside protection than a loose collar. At one extreme, the tightest collar (ATM puts and calls) effectively immunizes the portfolio from market movements. At the other extreme (very far OTM puts and calls), the collar is essentially equivalent to a long index position.

[2]While these collar implementations are active in the sense that the rules are dependent on manager decisions, they are implemented systematically with no additional manager discretion.

[3]While we combine the three signals to generate the strategy, any one of the signals could be used on its own to generate an active strategy.

[4]NDX, VIX, and Initial Unemployment Claims data are collected from March 1998 to ensure sufficient lag time for signal generation.

[5]It should be noted that while we use the term "active" to represent these strategies, they are not truly actively managed. They still follow an established set of selection rules, but the rules include a dynamic element conditioned on economic variables.

[6]This is the Friday prior to the first expiration Saturday following the introduction of QQQ options.

[7]The signals are designed so that they are based only on data that existed prior to the date on which the signal would have been generated in practice. For example, a signal for the March 19, 1999 option roll-in date would only use data that existed on March 18, 1999 or earlier.

[8]The use of the NDX rather than the QQQ provides historical data beyond the introduction of the QQQ. In this way, we can generate signals from the beginning of the QQQ data series.

[9]Additional evidence of the existence of momentum and potential explanations for its existence can be found in Jegadeesh and Titman [2001] and Schneeweis, Kazemi, and Spurgin [2008].

[10]In this article they do not take short positions. They use the signals as in/out position indicators.

[11]Note that since the Renicker and Mallick study reported results based on the period used in this study, the use of this variable is not independent from the period used to analyze its impact on the collar strategy.

[12]When the one-month implied volatility level is within the one standard deviation bounds, they follow a standard 1:1 buy-write ratio.

[13]While we could apply these signals to both the put and call positions, we chose to apply them only to the call writing to be consistent with Renicker and Mallick.

[14]These results are somewhat counterintuitive in the case of expansionary economies. One might expect rising unemployment to negatively affect stock prices regardless of the business cycle, but the literature cited above suggests that rising unemployment in expansionary economies causes expected future interest rates to decline, increasing the value of equities, while rising unemployment in contractions indicates slower future earnings growth rates, reducing the value of equities.

[15]See http://www.nber.org/cycles.html.

[16]Since vega is highest for ATM options, moving the short call further OTM and moving the long put toward the ATM will increase the vega of both option positions.

[17]In the case of strategies where the put and call expirations are not coincident, such as the one-month call/three-month put strategies, the put moneyness will only be reset when it is rolled (in this example, once every three months), while the call moneyness is reset at each call roll (every month, since we only consider strategies with one-month calls).

[18]Puts tend to cost more than calls for a given level of moneyness, so we start the puts further OTM to allow the option component of the strategy to be close to zero cost.

[19]For active strategies, we also apply the call ratio adjustment based on the volatility signal.

[20]Beta is reset only on roll dates to closely match the methodology of the passive collar strategies to the methodology of active collar strategies.

[21]The richness of put prices is not without controversy. While a great deal of literature supports option richness (particularly for put options), extensive literature debates its existence (for example, see Ungar and Moran [2009] and Bakshi and Kapadia [2003]).

[22]It is also quite possible to manipulate the Sharpe ratio. For example, see Spurgin [2001].

[23]See Arditti [1967].

[24]The 17.5% volatility in this sub-period is quite high, but much smaller than the 30% volatility of the overall period or the 42% of the early sub-period.

[25]Previous research indicates that these strategies have typically outperformed one-month call/one-month put strategies in the recent past. See for example Szado and Kazemi [2008].

[26]These results are available from the authors. They are not presented here due to space limitations.

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