# Collaring the Cube:

# Protection Options for a QQQ ETF Portfolio

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# Abstract

This article assesses the effectiveness of a long collar as a protective strategy. We examine the risk/return characteristics of a passive collar strategy on the Powershares QQQ trust exchange traded fund (Ticker: QQQQ) from March 1999 to March 2008 and find that, over this time period, a 6-month put/1-month call collar provides far superior returns to the buy and hold QQQ strategy at about 1/3 of the volatility. Since returns from protective strategies are not normally distributed, we use both Leland alpha and the Stutzer index to measure risk-adjusted performance. In the analysis we consider a number of implementations of a long collar strategy, where for each strategy the impact of bid/ask spreads on the strategy's performance are taken into account. We vary the moneyness of the puts and calls as well as the time to maturity of the puts to create a total of 27 different implementations, and create indices to represent the returns to each of these collar implementations. To examine the collar's performance in different market environments, the time period is further segmented into two sub-periods, an early period which is generally favorable to the collar and a later period which is clearly unfavorable to a collar strategy. Most implementations significantly outperform the QQQ in the overall period, as well as in the favorable period. All of the implementations under perform the QQQ in the unfavorable (to the collar) period. However, all of the implementations of the collar exhibit lower risk than the buy and hold QQQ in all of the periods. The magnitude of the risk reduction of the collar is quite impressive.

## Introduction

The purpose of this article is to examine the effectiveness of a long collar as a protective investment strategy. We examine the risk/return characteristics of a passive collar strategy on the QQQ ETF[1] from March 1999 to March 2008 and find that, over this time period, a 6-month put/1-month call collar provides far superior returns to the QQQ buy and hold strategy at about 1/3 of the volatility.

Downside market protection is a central focus of a myriad of trading strategies. In addition to collar strategies, investors may implement protective strategies by utilizing such products as equity indexed annuities, applying such methodologies as portfolio insurance, and investing in vehicles with limited market exposure such as hedge funds or short bias/bear ETFs.

There are a number of reasons to choose a collar strategy from the wide range of protective strategies available, not the least of which are the strategy's transparency, flexibility and the ease of marking to market of the collar's highly liquid and exchange traded positions. In addition, many of the alternative strategies possess other limitations that are less prevalent in collar strategies. Equity indexed annuities can provide protection and market participation to investors, but have been often criticized for their high fees and controversial sales practices.[2] Hedge fund strategies such as hedged equity can provide returns with limited market exposure, but often derive their returns from "bearing types of risks that other asset managers are less willing or otherwise unable to assume such as the ability to hold illiquid assets" (Schneeweis et al, 2002). In addition, hedge

[1] Options are available both on the NDX NASDAQ-100 index and on the QQQ NASDAQ tracking ETF. While the NDX has a longer history, we focused the study on the QQQ due to its significantly higher volume. In this case we consider the collar on the QQQ NASDAQ tracking ETF, often referred to as "the Cube".

[2] See WSJ June 6, 2007 "Reducing the risk of variable annuities"

fund investors face significant barriers to entry and exit. Portfolio insurance is another popular alternative for market downside protection, but it is potentially much more complicated to implement than a collar and is sensitive to a number of factors such as volatility, the risk-free rate and transaction costs.[3]

In general, a long collar strategy involves the purchase of a put against a long position in the underlying, combined with the writing of a call on the same underlying. The purpose of the put is to provide protection against a downside move of the long underlying position. The call is written to cover the cost of the purchase of the put, at the expense of limiting the strategy's participation in upside moves of the underlying. In this study, we implement the collar passively in the sense that it is a rules based strategy with no market timing component.

A collar strategy is particularly appealing for investors that are seeking some protection from a potential down side move, or a reduction in the market exposure of their portfolio. Ultimately, the collar strategy is expected to offer an investor an opportunity to significantly reduce the volatility of their returns, relative to a long position in the underlying index. This is due to the fact that the payoff of the long put reduces the losses of the long index position in downward market moves, while the short call reduces the gains of the long index position in upward market moves. The main appeal of the collar strategy lies in its flexibility. At one extreme, a very wide collar which utilizes far out-of-the-money (OTM) options is essentially equivalent to a long position in the QQQ, with no protection from downside market moves, and full

[3] See Clarke and Arnott (1987). Of course, the returns to a collar strategy may also have significant sensitivity to these factors, depending on the particular implementation.

participation in upside moves. At the other extreme, a maturity matched[4] collar which utilizes at-the-money (ATM) options is essentially a cash or money market position, totally insulated from market movements when held to expiration.

From an absolute return perspective, the ideal return situation for a collar is for the underlying to gradually increase over the life of the call, ending at or just below the short call's strike price at expiration. However, when compared to the returns of a long position in the underlying index, the collar strategy has the highest relative advantage when the market experiences a strong downward trend and has the highest relative disadvantage during sustained strong upward trends. Of course, the degree of the relative advantage depends largely on the particular implementation of the strategy, especially the degree of moneyness and the time to maturity of the puts and calls.

Ultimately, the relative risk of the collar strategy (as opposed to holding the underlying) is an opportunity cost risk. This is a fundamental risk of hedging. The risk is that the underlying performs extremely well and some of the potential returns are lost on the short call position (which is written to fund the purchase of the put's downside protection)[5]. Likewise, the ultimate relative benefit is the protection provided by any typical insurance contract or hedge. That is, in the case of a catastrophic downward move, losses are largely eliminated by the put.

## Data and Methodology

Despite the great advantages of the collar strategy, little research has focused on it. This study closely follows the methodology of previous studies on the S&P 500 buy-write

[4] In this case the put and calls would have the same time to expiration.

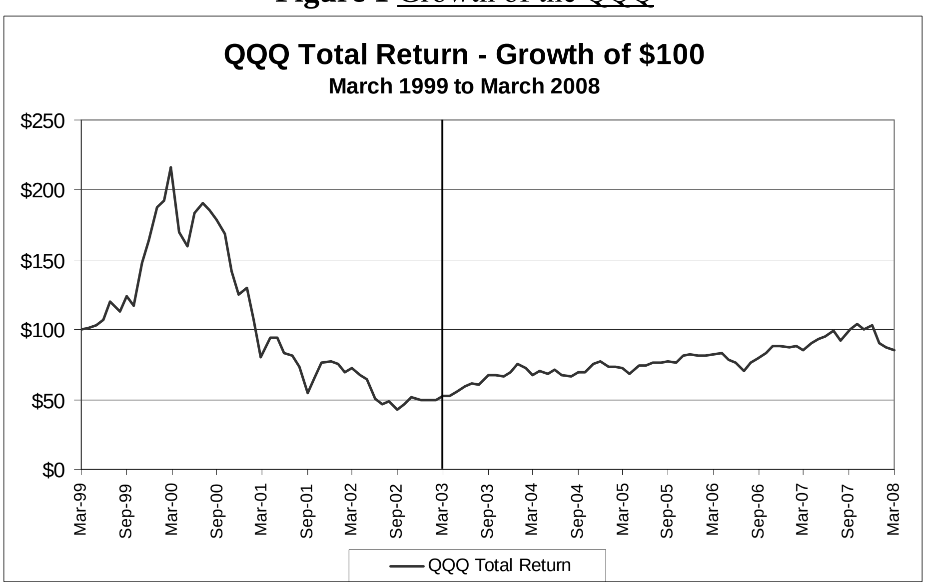
[5] The call premium may not fully cover the cost of the put premium, depending on the particular implementation of the collar.

index including work by Whaley (2002),[6] as well as the research on a Russell 2000 buy-write strategy by Kapadia and Szado (2007).

In this paper, we utilize the underlying QQQ as a benchmark. The analysis spans the period from March 1999 to March 2008. In addition, we analyze two sub-samples of the time period to assess performance in different markets conditions. We consider a number of different collar implementations. We vary both the moneyness and the time to expiration of the put as well as varying the moneyness of the call. The moneyness of the put largely determines the degree of downside protection of the strategy. Likewise, the moneyness of the call determines the degree of upside participation.

Option prices, QQQ prices and dividends are provided by Optionmetrics. In addition, the one-month LIBOR rate is obtained from Datastream. The dataset spans the period from the introduction of QQQ options (in March 1999) to March 2008. We utilize the daily highest closing bid and lowest closing offer across all exchanges for options, and daily closing prices and dividend payouts for the underlying QQQ ETF.

**Figure 1** Growth of the QQQ




[6] See also Ibbotson Associates (2004), Lehman Brothers (2005) and Hill et al (2006).

As noted earlier, we break the data into two time periods. As illustrated in Figure 1, the first period (from March 1999 to March 2003) exhibits extremely high volatility (40.99% annualized standard deviation), while the second period (April 2003 to March 2008) exhibits a more moderate but still relatively high (16.51%) volatility. In the first period, the QQQ experiences extremely large up and down moves, while in the second period the QQQ experiences a relatively consistent trend (at least in comparison to the violent upheavals of the early period).

We create a total of 27 variations on the strategy by altering the time to expiration of the puts and the moneyness of the puts and calls. The moneyness of both puts and calls is set at 5% OTM, 2% OTM and ATM[7]. Call expirations are held at one-month to minimize the number of variations considered. We use three different initial expirations of the puts (one, three and 6-months), and all options are held until expiration. The intention here is to determine whether the collar can benefit from selling a set of 6 sequential rapidly decaying one-month calls while purchasing a single relatively slower decaying 6-month put for each 6-month period.[8] In addition, it is tempting to suggest writing far OTM calls, since this would greatly increase returns in upside moves. However, there is a tradeoff. The far OTM calls carry a significantly lower premium than the ATM calls, and therefore do not cover a significant portion of the cost of the puts. While it may at first glance sound appealing to utilize a number of cheap (deep OTM) calls to cover the cost of a single put, we avoid any put to call ratios other than one-to-one. Other ratios would result in a leveraging effect, which is not in keeping with using a collar as an insurance strategy.

[7] The results for the 2% OTM call implementations are provided in appendix A for the sake of clarity.
[8] This is consistent with Kapadia and Szado (2007), in which a buy write strategy on the Russell 2000 performed best when implemented with one-month calls.

**Index construction**

We create indices to reflect the return streams of the various implementations of a collar strategy. The returns of each collar index are determined by the combined returns of the QQQ total return index, the returns of the long put positions and the returns of the short call positions.

To calculate the total return index for the QQQ, we assume that all dividends disbursed are fully reinvested in the QQQ[9]. Thus the daily QQQ total return is calculated as:

$$R_t = \frac{QQQ_t - QQQ_{t-1} + Div_t}{QQQ_{t-1}}$$

We use daily option prices and the daily QQQ total return index to create a monthly collar return index whose month ends correspond to the option expirations. This methodology is preferred to a standard month-end because it more closely aligns the index to the actual order flow experienced in an implementation of the strategy.

In the simplest case, in which we utilize one-month calls and one-month puts, a new call and put position is established each month. Each month, generally at the close on the Friday preceding the Saturday expiration date of QQQ options[10], a one-month put is purchased and a one-month call is written to replace the expiring options. In the other variations of the strategy, we utilize a longer maturity put (3 or 6-month) with a one-

[9] Adjustments are also made to the total return index and the option prices and strikes to reflect a 2:1 stock split paid on 3/17/2000.

[10] In cases where the market is closed on the Friday, we roll the position on the preceding Thursday.

month call.[11] In these implementations, we value the put at the bid/ask midpoint in the months in which we are not purchasing a new put.[12]

We do not explicitly include all transaction costs and the effect of taxes in our calculations, however, we provide a reasonable adjustment for the impact of transaction costs by purchasing the puts at the ask price and selling the calls at the bid price when rolling into the new option positions. This methodology reflects the fact that the investor may often go to the market to fill their call sales and put purchases. At expiration, we value the options at their intrinsic value, assuming that they are exercised/assigned if they are in-the-money. Thus, on the option roll dates, the short call position expires at the intrinsic value of the call, while the new call is written at the current bid. Likewise, the new long put position is initiated at the offer and the old put is exercised for the intrinsic value of the put. In this manner, we create a series of monthly QQQ collar indices.

Each month, at expiration, the next month's strikes are set based on the current level of the QQQ. The OTM strikes are calculated and rounded to the nearest available strike. The ATM strikes, are rounded to the nearest just OTM strike. Thus, the utilized strikes deviate from the desired strikes due to rounding of the calculated strikes to the discrete strikes available. In addition, a number of quotes are not available for these rounded strikes. In those cases, we substitute the next available strike for OTM options, and the next available further OTM strike for the ATM options.[13]

[11] In the case when the QQQ has fallen significantly since the purchase of the 6 or 3-month put, the newly written 1-month call may have a strike price that is well below the strike of the put.

[12] These implementations are not self-financing if one assumes that it is not possible to roll in and out of the put positions at the mid-point of the bid and ask. As a robustness check, a self financing implementation is provided in Appendix B.

[13] In fact, for one of the 6-month holding periods, the 6-month strategies have to be executed using two sequential three month to expiration puts, since a 6-month to expiration put is not quoted at any strike on the roll-in date.

**Exhibit 1 Deviation of Strikes**

| | Calls | Puts | | |
|---|---|---|---|---|
| | 1 Month | 1 Month | 3 Month | 6 Month |
| **5% OTM** | -\$0.18 | \$0.21 | \$0.09 | \$0.13 |
| **Max. Absolute Deviation** | \$7.14 | \$5.46 | \$1.12 | \$1.19 |
| **2% OTM** | -\$0.16 | \$0.07 | \$0.11 | \$0.00 |
| **Max. Absolute Deviation** | \$2.59 | \$1.35 | \$1.19 | \$1.19 |
| **ATM** | \$0.51 | -\$0.52 | -\$0.53 | -\$0.58 |
| **Max. Absolute Deviation** | \$1.50 | \$1.63 | \$1.63 | \$1.63 |
| **Mean Deviation** | \$0.06 | -\$0.08 | -\$0.11 | -\$0.15 |

Exhibit 1 provides the average deviation of the utilized strikes from the calculated strikes. While the deviations are as high as \$7.14 (for the 5% OTM calls), the absolute average deviation is generally under \$0.20 for the OTM options and around \$0.50 for the ATM options[14].

**Return Stream Generation: One-month put and One-month call**

In the case when we utilize a one-month expiration for both the put and the call, the index calculation is quite straightforward. The return for any period is given by:

$$R_t = \frac{QQQ_t - QQQ_{t-1} + Div_t + \left(PutExpir_t - PutAsk_{t-1}\right) - \left(CallExpir_t - CallBid_{t-1}\right)}{QQQ_{t-1} + PutAsk_{t-1} - CallBid_{t-1}}$$

This methodology produces an index representing a self-financing strategy, as all proceeds of the strategy are assumed to be reinvested each month.

**Multi-month put and One-month call**

In the case of 3 or 6-month expiration for the put (and one-month for the call), the options are again bought at the offer and sold at the bid when initially purchased/sold. In these months, the return is given by:

[14] In practice, only the rounding issue is encountered since quotes are available in the market for any desired strikes.

$$R_t = \frac{QQQ_t - QQQ_{t-1} + Div_t + \left(PutMid_t - PutAsk_{t-1}\right) - \left(CallExpir_t - CallBid_{t-1}\right)}{QQQ_{t-1} + PutAsk_{t-1} - CallBid_{t-1}}$$

In the months in which the 3 or 6-month put expires, the index return calculation is as follows:

$$R_t = \frac{QQQ_t - QQQ_{t-1} + Div_t + \left(PutExpir_t - PutMid_{t-1}\right) - \left(CallExpir_t - CallBid_{t-1}\right)}{QQQ_{t-1} + PutMid_{t-1} - CallBid_{t-1}}$$

In all remaining months between the initiation of the option positions and their expiration, the returns are calculated as follows:

$$R_t = \frac{QQQ_t - QQQ_{t-1} + Div_t + \left(PutMid_t - PutMid_{t-1}\right) - \left(CallExpir_t - CallBid_{t-1}\right)}{QQQ_{t-1} + PutMid_{t-1} - CallBid_{t-1}}$$

Thus, return streams are generated which simulate the exposures that may actually be faced in implementing a collar strategy. This follows the practice of the previous work on the buy write strategy by Whaley (2002) and Kapadia and Szado (2007).

## Summary Statistics

Traditional risk adjusted performance measures, such as the Sharpe ratio and Jensen's alpha assume that returns are normally distributed. When returns are non-normal, it is important to consider the fact that investors that exhibit non-increasing absolute risk aversion prefer positive skewness, so the expected returns for negatively skewed return distributions should be higher than expected returns for positively skewed distributions, all else being equal[15].

The returns generated by the underlying QQQ are not normally distributed (as measured by the Jarque-Bera statistics provided in the exhibits). Due to its truncation of the extremes of the return distribution, a collar's skewness and kurtosis may significantly

[15] See Arditti (1967)

differ from that of the underlying. For the full period from 1999 to 2008, the QQQ collar returns are generally closer to normal than the QQQ returns. In fact, the Jarque-Bera statistic for the QQQ is 12.416, while the corresponding collar strategy statistic ranges from 1.245 to 26.690, with an average of 9.076. The underlying QQQ exhibits both negative skewness (-0.308) and excess kurtosis (1.542).

With these facts in mind, we utilize performance measures that are robust to non-normality.[16] Exhibits 2 to 10 provide the higher moments of the return distributions (skewness and kurtosis), other measures of risk (maximum drawdown, minimum monthly return, maximum monthly return), as well as risk adjusted performance measures which are not sensitive to the normality of the strategy's returns and take skewness and kurtosis into account such as Leland's alpha and the Stutzer index.[17]

## Risk and Return Characteristics

### Full Sample Results

Exhibits 2, 3 and 4 provide strong evidence with regard to the effectiveness of the collar as a protection strategy. The collar's protection from market movements is clearly evident in the returns and volatilities of the various implementations. While the underlying QQQ is almost flat over the 108 months, providing an annualized loss of 1.69% (at almost 30% volatility, as measured by the annualized standard deviation of returns), the annualized returns of the various iterations of the collar strategy range from a loss of 1.82% to a gain of 12.86%. The 5% OTM 6-month put/2% OTM call collar has the highest returns at 12.86%, at less that 1/3 of the QQQ volatility. In general, the collar

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[16] The Sharpe ratio is also included to be consistent with previous literature.

[17] For additional information on these measures see Appendix D of this paper.

returns are far higher than the QQQ returns, and they are generated at a far lower volatility. The ability to drastically reduce return volatility is perhaps the most striking characteristic of the collar. In fact, the highest collar volatility is less than 1/2 of the QQQ volatility (12.83% versus 29.93%) while the lowest collar volatility (3.98%) is about 1/8 of the QQQ volatility. Figure 2 graphically illustrates the volatility reduction of the collar by comparing the 12-month rolling annualized standard deviations of the QQQ and the 6-month ATM put/ATM call collar.

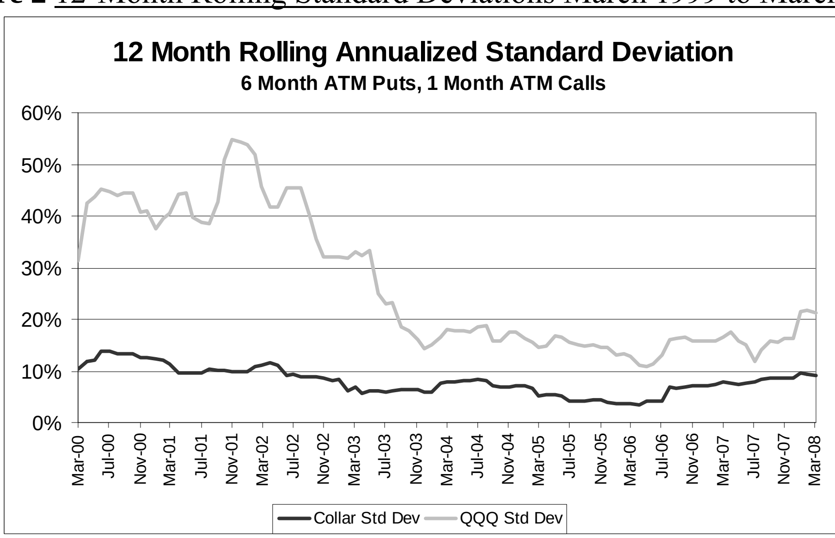
**Exhibit 2** 6-month Put, 1-month Call Summary Statistics March 1999 to March 2008

| Full Period | | 5% OTM Calls | | | ATM Calls | | |
|---|---|---|---|---|---|---|---|
| 6 month Puts, 1 Month Calls | QQQ | 5% OTM Puts | 2% OTM Puts | ATM Puts | 5% OTM Puts | 2% OTM Puts | ATM Puts |
| Annualized Return | -1.69% | 10.65% | 10.08% | 10.08% | 12.80% | 12.14% | 12.11% |
| Annual Standard Deviation | 29.93% | 11.30% | 10.76% | 10.60% | 8.89% | 8.71% | 8.63% |
| Mean Monthly Return | 0.24% | 0.90% | 0.85% | 0.85% | 1.04% | 0.99% | 0.99% |
| Median Monthly Return | 0.30% | 0.97% | 0.73% | 0.90% | 1.37% | 1.30% | 1.32% |
| Monthly Standard Deviation | 8.64% | 3.26% | 3.11% | 3.06% | 2.57% | 2.51% | 2.49% |
| Skewness | -0.308 | -0.341 | -0.291 | -0.261 | -0.688 | -0.626 | -0.602 |
| Excess Kurtosis | 1.542 | -0.181 | -0.050 | -0.064 | 0.237 | 0.270 | 0.251 |
| Minimum Monthly Return | -25.45% | -6.83% | -6.69% | -6.69% | -5.95% | -5.81% | -5.81% |
| Maximum Monthly Return | 26.57% | 8.62% | 8.62% | 8.62% | 6.02% | 6.02% | 6.02% |
| Maximum Drawdown | -80.44% | -11.61% | -11.96% | -13.30% | -8.59% | -8.42% | -8.42% |
| Annual Sharpe Ratio | -0.180 | 0.616 | 0.593 | 0.602 | 1.025 | 0.970 | 0.976 |
| Monthly Stutzer Index | 0.028 | 0.182 | 0.176 | 0.178 | 0.280 | 0.268 | 0.269 |
| CAPM Beta | 1.000 | 0.225 | 0.194 | 0.184 | 0.092 | 0.062 | 0.052 |
| Leland Beta | 1.000 | 0.221 | 0.191 | 0.181 | 0.091 | 0.062 | 0.052 |
| Monthly Leland Alpha | 0.00% | 0.61% | 0.56% | 0.56% | 0.74% | 0.69% | 0.69% |
| Jarque-Bera Statistic | 12.416 | 2.244 | 1.540 | 1.245 | 8.765 | 7.373 | 6.817 |
| Probability Normal | 0.20% | 32.56% | 46.30% | 53.65% | 1.25% | 2.51% | 3.31% |

**Exhibit 3** 3-month Put, 1-month Call Summary Statistics March 1999 to March 2008

| Full Period | | 5% OTM Calls | | | ATM Calls | | |
|---|---|---|---|---|---|---|---|
| 3 month Puts, 1 Month Calls | QQQ | 5% OTM Puts | 2% OTM Puts | ATM Puts | 5% OTM Puts | 2% OTM Puts | ATM Puts |
| Annualized Return | -1.69% | 6.10% | 5.75% | 5.51% | 8.27% | 7.78% | 7.51% |
| Annual Standard Deviation | 29.93% | 11.78% | 10.29% | 10.05% | 9.23% | 8.28% | 8.16% |
| Mean Monthly Return | 0.24% | 0.55% | 0.51% | 0.49% | 0.70% | 0.65% | 0.63% |
| Median Monthly Return | 0.30% | 0.35% | 0.25% | 0.21% | 1.04% | 0.84% | 0.89% |
| Monthly Standard Deviation | 8.64% | 3.40% | 2.97% | 2.90% | 2.66% | 2.39% | 2.35% |
| Skewness | -0.308 | -0.369 | -0.316 | -0.342 | -0.795 | -0.699 | -0.725 |
| Excess Kurtosis | 1.542 | -0.294 | 0.167 | 0.387 | 0.896 | 1.628 | 1.957 |
| Minimum Monthly Return | -25.45% | -8.81% | -8.95% | -9.20% | -7.92% | -8.07% | -8.32% |
| Maximum Monthly Return | 26.57% | 7.88% | 7.70% | 7.58% | 5.75% | 5.94% | 5.79% |
| Maximum Drawdown | -80.44% | -15.32% | -14.08% | -14.82% | -9.41% | -8.07% | -8.32% |
| Annual Sharpe Ratio | -0.180 | 0.204 | 0.200 | 0.181 | 0.496 | 0.494 | 0.468 |
| Monthly Stutzer Index | 0.028 | 0.073 | 0.070 | 0.065 | 0.146 | 0.145 | 0.138 |
| CAPM Beta | 1.000 | 0.249 | 0.185 | 0.174 | 0.111 | 0.049 | 0.038 |
| Leland Beta | 1.000 | 0.245 | 0.182 | 0.171 | 0.110 | 0.048 | 0.038 |
| Monthly Leland Alpha | 0.00% | 0.26% | 0.22% | 0.20% | 0.40% | 0.36% | 0.33% |
| Jarque-Bera Statistic | 12.416 | 2.844 | 1.919 | 2.785 | 14.984 | 20.708 | 26.690 |
| Probability Normal | 0.20% | 24.12% | 38.30% | 24.84% | 0.06% | 0.00% | 0.00% |

**Figure 2** 12-Month Rolling Standard Deviations March 1999 to March 2008



The other measures of risk provide additional evidence that the collar strategy significantly reduces the risk of the underlying QQQ. The minimum monthly return of the collar strategies ranges from -9.20% to -2.24% (versus -25.45% for the QQQ). Likewise, the maximum drawdown ranges from -45.36% to -8.07% for the collar strategy (versus -80.44% for the QQQ), with the 2% OTM 3-month put/ATM call collar exhibiting the smallest drawdown of -8.07%. While all these measures are important, maximum drawdown is a particularly relevant measure in assessing the effectiveness of the collar strategy (as in other strategies and investment vehicles intended to protect capital against market downturns). The price one must pay for the collar's downside protection is evident in the fact that the maximum monthly return for the QQQ (26.57%) is significantly higher than for any of the implementations of the collar strategy (the maximum collar return is 8.62%).

**Exhibit 4** 1-month Put, 1-month Call Summary Statistics March 1999 to March 2008

| Full Period | | 5% OTM Calls | | | ATM Calls | | |
|---|---|---|---|---|---|---|---|
| 1 month Puts, 1 Month Calls | QQQ | 5% OTM Puts | 2% OTM Puts | ATM Puts | 5% OTM Puts | 2% OTM Puts | ATM Puts |
| Annualized Return | -1.69% | -1.82% | -1.38% | -1.40% | 0.34% | 0.65% | 0.59% |
| Annual Standard Deviation | 29.93% | 12.83% | 9.64% | 8.66% | 8.56% | 5.11% | 3.98% |
| Mean Monthly Return | 0.24% | -0.08% | -0.08% | -0.09% | 0.06% | 0.06% | 0.06% |
| Median Monthly Return | 0.30% | 0.07% | -0.51% | -0.91% | 0.96% | 0.43% | 0.08% |
| Monthly Standard Deviation | 8.64% | 3.70% | 2.78% | 2.50% | 2.47% | 1.48% | 1.15% |
| Skewness | -0.308 | -0.139 | 0.186 | 0.283 | -0.560 | -0.197 | -0.142 |
| Excess Kurtosis | 1.542 | -1.435 | -1.499 | -1.444 | -1.100 | -1.093 | -1.174 |
| Minimum Monthly Return | -25.45% | -6.69% | -4.12% | -3.99% | -5.49% | -3.24% | -2.24% |
| Maximum Monthly Return | 26.57% | 5.13% | 4.50% | 4.45% | 3.83% | 3.19% | 2.08% |
| Maximum Drawdown | -80.44% | -45.36% | -37.29% | -33.44% | -29.10% | -18.38% | -10.86% |
| Annual Sharpe Ratio | -0.180 | -0.430 | -0.526 | -0.588 | -0.391 | -0.595 | -0.780 |
| Monthly Stutzer Index | 0.028 | -0.105 | -0.137 | -0.156 | -0.100 | -0.164 | -0.218 |
| CAPM Beta | 1.000 | 0.366 | 0.263 | 0.230 | 0.226 | 0.123 | 0.089 |
| Leland Beta | 1.000 | 0.363 | 0.259 | 0.226 | 0.226 | 0.121 | 0.088 |
| Monthly Leland Alpha | 0.00% | -0.36% | -0.36% | -0.37% | -0.23% | -0.23% | -0.24% |
| Jarque-Bera Statistic | 12.416 | 9.618 | 10.736 | 10.819 | 11.095 | 6.070 | 6.560 |
| Probability Normal | 0.20% | 0.82% | 0.47% | 0.45% | 0.39% | 4.81% | 3.76% |

The exhibits indicate that the collar strategy can often provide significantly higher returns at a lower volatility than a long QQQ position. However, this is not true of all collar implementations in all time periods. The monthly Leland alpha (benchmarked to the QQQ) of the collar strategy ranges from -0.37% to 0.75%, with an average alpha of

0.24%. A positive Leland alpha indicates that an implementation outperforms the market (in this case the QQQ) on a risk adjusted basis. Thus, under this measure, most of the collar implementations outperform the QQQ. The 5% OTM 6-month put/2% OTM call collar has the highest Leland alpha of 0.75%. From an annualized return perspective, the majority of the collar implementations outperformed the QQQ, however, some implementations under performed the QQQ (-1.69% annualized return) and LIBOR (3.69% annualized return). The monthly Stutzer index of the underlying QQQ is 0.028, while the monthly Stutzer index for the collar ranges from -0.218 to 0.280, with a mean of 0.071. The 5% OTM 6-month put/ATM call collar has the highest Stutzer index. Thus, most implementations outperformed the QQQ based on the Stutzer index.

Clearly, no single implementation of the collar outperforms all others on all measures. However, it is clear that the collars that utilize 6-month puts outperformed the 1-month and 3-month put strategies on most measures. This is consistent with the hypothesis that the slower decay of the longer maturity puts benefits a collar strategy.

In the following two sections we break the data into two time periods, with a break point of the March 2003 expiration. As noted earlier, the earlier period is expected to be a relatively favorable period for a collar strategy, while the later period is expected to be relatively unfavorable.

**Collar Strategy in a Favorable Market Environment**

The early period is a mixed, but generally favorable, environment for the strategy from a relative returns perspective. The first year of the early period is an exceptionally difficult period for a collar, due the meteoric rise of the QQQ. During this 12-month period, the value of QQQ more than doubles.  In contrast, the period from July 2000 through September 2001 is a near ideal environment for a collar strategy. The remainder of the early period is quite favorable for the collar. Therefore, we consider the period from March 1999 to March 2003 a reasonably favorable environment for a collar and use it to assess how the strategy may perform in a favorable, albeit not perfect, market.

**Figure 3** Collar Strategy in a Favorable Market Environment

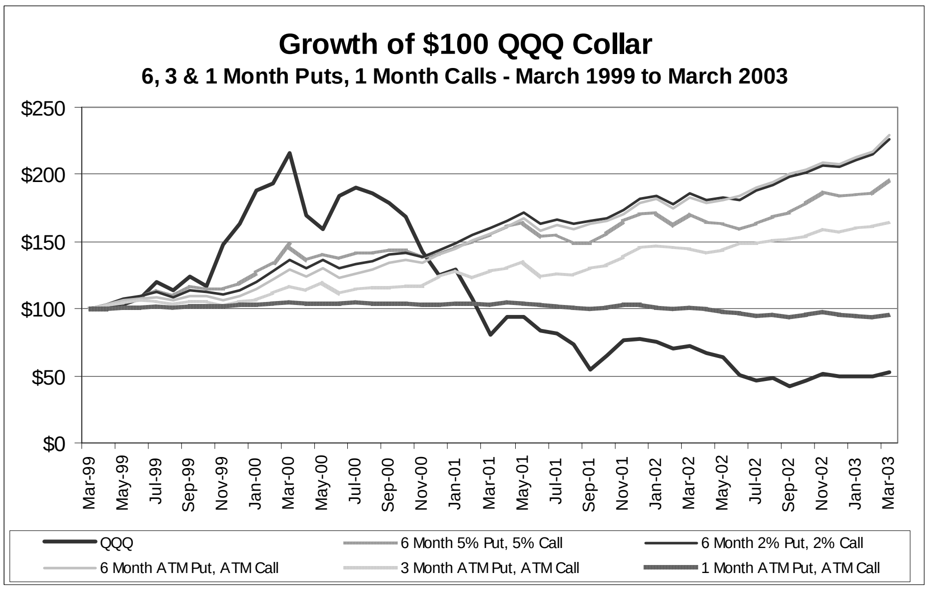



**Exhibit 5** 6-month Put, 1-month Call Summary Statistics March 1999 to March 2003

| 3/1999 to 3/2003 | | 5% OTM Calls | | | ATM Calls | | |
|---|---|---|---|---|---|---|---|
| 6 month Puts, 1 Month Calls | QQQ | 5% OTM Puts | 2% OTM Puts | ATM Puts | 5% OTM Puts | 2% OTM Puts | ATM Puts |
| Annualized Return | -14.66% | 18.44% | 18.39% | 18.66% | 22.94% | 22.79% | 23.01% |
| Annual Standard Deviation | 40.99% | 12.51% | 12.11% | 11.87% | 9.95% | 9.88% | 9.79% |
| Mean Monthly Return | -0.61% | 1.48% | 1.48% | 1.49% | 1.78% | 1.77% | 1.78% |
| Median Monthly Return | -0.65% | 2.19% | 2.26% | 2.22% | 2.31% | 2.29% | 2.35% |
| Monthly Standard Deviation | 11.83% | 3.61% | 3.50% | 3.43% | 2.87% | 2.85% | 2.83% |
| Skewness | -0.080 | -0.469 | -0.467 | -0.455 | -0.899 | -0.889 | -0.906 |
| Excess Kurtosis | -0.154 | -0.338 | -0.303 | -0.267 | 0.098 | 0.081 | 0.138 |
| Minimum Monthly Return | -25.45% | -6.81% | -6.04% | -5.88% | -5.03% | -5.00% | -5.00% |
| Maximum Monthly Return | 26.57% | 8.62% | 8.62% | 8.62% | 6.02% | 6.02% | 6.02% |
| Maximum Drawdown | -80.44% | -9.29% | -9.29% | -9.29% | -5.59% | -5.00% | -5.00% |
| Annual Sharpe Ratio | -0.458 | 1.143 | 1.176 | 1.223 | 1.889 | 1.887 | 1.927 |
| Monthly Stutzer Index | -0.081 | 0.301 | 0.309 | 0.320 | 0.464 | 0.464 | 0.472 |
| CAPM Beta | 1.000 | 0.171 | 0.151 | 0.141 | 0.059 | 0.039 | 0.030 |
| Leland Beta | 1.000 | 0.171 | 0.151 | 0.141 | 0.060 | 0.040 | 0.031 |
| Monthly Leland Alpha | 0.00% | 1.31% | 1.28% | 1.29% | 1.49% | 1.46% | 1.47% |

Once again, the downside protection of the collar strategy is clearly evident in the risk and return statistics provided in exhibits 5, 6 and 7.  The annualized returns of the collar strategies range from -7.64% to 23.01%, while the QQQ returned an annualized loss of 14.66%. Not only did implementing a collar significantly improve upon the returns of the QQQ, the risk measures all clearly indicate that the collar significantly reduced the risk of the QQQ. The volatility of the QQQ is 40.99%, while the collar strategy has volatilities ranging from 3.97% to 14.28%. Similarly, the minimum monthly return for the QQQ is -25.45% and for the collar ranges from -9.20% to -2.24%. As in the full period, the difference in the maximum drawdown of the QQQ and the collar is particularly striking. The QQQ's maximum drawdown is -80.44%, while the drawdown of the collar ranges from -45.36% to -5.00%. Thus, in this case, the collar is able to reduce a potential 80% loss of capital to a mere 5% loss.

**Exhibit 6** 3-month Put, 1-month Call Summary Statistics March 1999 to March 2003

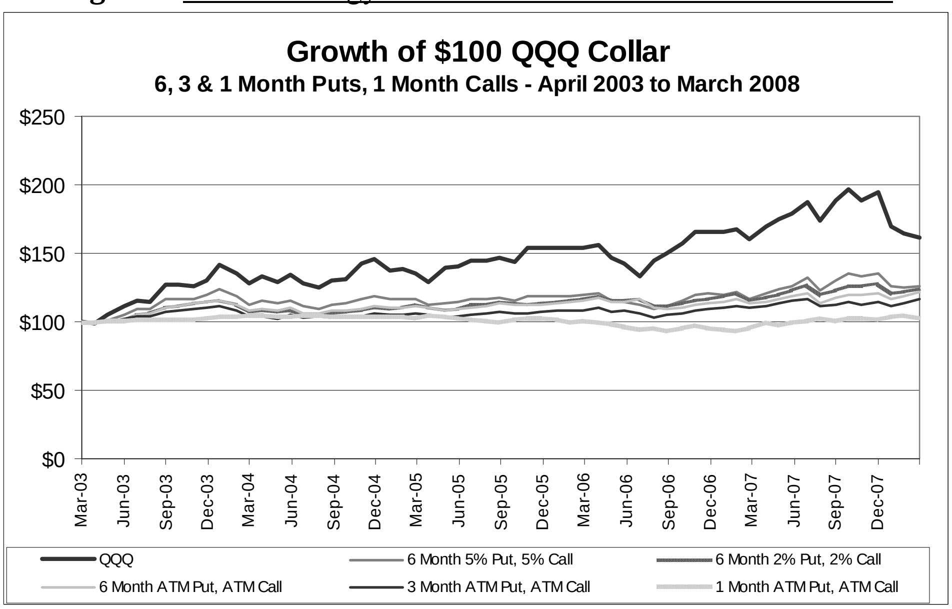
| 3/1999 to 3/2003 | | 5% OTM Calls | | | ATM Calls | | |
|---|---|---|---|---|---|---|---|
| 3 month Puts, 1 Month Calls | QQQ | 5% OTM Puts | 2% OTM Puts | ATM Puts | 5% OTM Puts | 2% OTM Puts | ATM Puts |
| Annualized Return | -14.66% | 8.70% | 8.96% | 9.03% | 13.14% | 13.24% | 13.25% |
| Annual Standard Deviation | 40.99% | 13.68% | 12.46% | 12.05% | 11.19% | 10.46% | 10.30% |
| Mean Monthly Return | -0.61% | 0.77% | 0.78% | 0.78% | 1.09% | 1.09% | 1.09% |
| Median Monthly Return | -0.65% | 1.07% | 1.21% | 1.33% | 1.67% | 1.34% | 1.34% |
| Monthly Standard Deviation | 11.83% | 3.95% | 3.60% | 3.48% | 3.23% | 3.02% | 2.97% |
| Skewness | -0.080 | -0.422 | -0.458 | -0.500 | -0.927 | -0.952 | -1.011 |
| Excess Kurtosis | -0.154 | -0.446 | -0.114 | 0.237 | 0.747 | 1.282 | 1.668 |
| Minimum Monthly Return | -25.45% | -8.81% | -8.95% | -9.20% | -7.92% | -8.07% | -8.32% |
| Maximum Monthly Return | 26.57% | 7.88% | 7.70% | 7.58% | 5.75% | 5.94% | 5.79% |
| Maximum Drawdown | -80.44% | -13.95% | -11.13% | -11.37% | -7.92% | -8.07% | -8.32% |
| Annual Sharpe Ratio | -0.458 | 0.334 | 0.387 | 0.406 | 0.804 | 0.870 | 0.885 |
| Monthly Stutzer Index | -0.081 | 0.073 | 0.083 | 0.087 | 0.204 | 0.218 | 0.221 |
| CAPM Beta | 1.000 | 0.192 | 0.145 | 0.131 | 0.074 | 0.029 | 0.015 |
| Leland Beta | 1.000 | 0.191 | 0.145 | 0.131 | 0.074 | 0.029 | 0.015 |
| Monthly Leland Alpha | 0.00% | 0.62% | 0.58% | 0.57% | 0.82% | 0.78% | 0.76% |

However, from a risk adjusted return perspective, the results are once again mixed. The monthly Leland alpha ranges from -0.63% to 1.52%, with the majority of the implementations experiencing a positive alpha. This suggests that most implementations of the collar outperformed the QQQ on a risk adjusted basis, but not all. In particular, the one-month put strategies tend to under perform the QQQ. Similarly, the majority of the collar implementations exhibit a positive Stutzer index, in contrast to the negative Stutzer index of the QQQ.

**Exhibit 7** 1-month Put, 1-month Call Summary Statistics March 1999 to March 2003

| 3/1999 to 3/2003 | | 5% OTM Calls | | | ATM Calls | | |
|---|---|---|---|---|---|---|---|
| 1 month Puts, 1 Month Calls | QQQ | 5% OTM Puts | 2% OTM Puts | ATM Puts | 5% OTM Puts | 2% OTM Puts | ATM Puts |
| Annualized Return | -14.66% | -7.64% | -5.97% | -4.89% | -3.69% | -2.14% | -1.08% |
| Annual Standard Deviation | 40.99% | 14.28% | 10.45% | 9.31% | 9.22% | 5.10% | 3.97% |
| Mean Monthly Return | -0.61% | -0.58% | -0.47% | -0.38% | -0.28% | -0.17% | -0.08% |
| Median Monthly Return | -0.65% | -1.04% | -1.84% | -1.78% | 0.50% | -0.67% | -0.20% |
| Monthly Standard Deviation | 11.83% | 4.12% | 3.02% | 2.69% | 2.66% | 1.47% | 1.15% |
| Skewness | -0.080 | 0.079 | 0.397 | 0.399 | -0.236 | 0.179 | 0.023 |
| Excess Kurtosis | -0.154 | -1.675 | -1.559 | -1.470 | -1.509 | -1.025 | -0.671 |
| Minimum Monthly Return | -25.45% | -6.69% | -4.08% | -3.99% | -5.15% | -3.04% | -2.24% |
| Maximum Monthly Return | 26.57% | 5.13% | 4.50% | 4.45% | 3.83% | 3.19% | 2.08% |
| Maximum Drawdown | -80.44% | -45.36% | -36.55% | -30.62% | -29.10% | -18.38% | -10.86% |
| Annual Sharpe Ratio | -0.458 | -0.825 | -0.967 | -0.970 | -0.849 | -1.231 | -1.314 |
| Monthly Stutzer Index | -0.081 | -0.209 | -0.243 | -0.238 | -0.198 | -0.262 | -0.227 |
| CAPM Beta | 1.000 | 0.304 | 0.217 | 0.186 | 0.184 | 0.097 | 0.066 |
| Leland Beta | 1.000 | 0.303 | 0.216 | 0.185 | 0.184 | 0.096 | 0.065 |
| Monthly Leland Alpha | 0.00% | -0.63% | -0.60% | -0.54% | -0.44% | -0.42% | -0.36% |

**Figure 4** Collar Strategy in an Unfavorable Market Environment




## Collar Strategy in an Unfavorable Market Environment

In this section, we consider the performance of the strategy in an environment which clearly favors a long position in the underlying QQQ. The period from April 2003 to March 2008 represents a market environment that exhibits a relatively stable upward trending market. Of course, this characterization is made relative to the previous period.

In absolute terms, this later period experiences significant volatility and has a number of downturns. The summary statistics for this period are provided in exhibits 8, 9 and 10.

**Exhibit 8** 6-month Put, 1-month Call Summary Statistics April 2003 to March 2008

| 4/2003 to 3/2008 | | 5% OTM Calls | | | ATM Calls | | |
|---|---|---|---|---|---|---|---|
| 6 month Puts, 1 Month Calls | QQQ | 5% OTM Puts | 2% OTM Puts | ATM Puts | 5% OTM Puts | 2% OTM Puts | ATM Puts |
| Annualized Return | 10.09% | 4.80% | 3.85% | 3.66% | 5.30% | 4.30% | 4.10% |
| Annual Standard Deviation | 16.51% | 10.05% | 9.29% | 9.17% | 7.41% | 7.01% | 6.90% |
| Mean Monthly Return | 0.92% | 0.43% | 0.35% | 0.33% | 0.45% | 0.37% | 0.35% |
| Median Monthly Return | 0.57% | 0.32% | 0.21% | 0.19% | 1.05% | 0.94% | 0.91% |
| Monthly Standard Deviation | 4.77% | 2.90% | 2.68% | 2.65% | 2.14% | 2.02% | 1.99% |
| Skewness | -0.151 | -0.453 | -0.422 | -0.370 | -1.159 | -1.185 | -1.135 |
| Excess Kurtosis | -0.042 | 0.122 | 0.473 | 0.394 | 1.092 | 1.418 | 1.356 |
| Minimum Monthly Return | -12.45% | -6.83% | -6.69% | -6.69% | -5.95% | -5.81% | -5.81% |
| Maximum Monthly Return | 10.94% | 6.47% | 6.47% | 6.47% | 4.25% | 4.25% | 4.25% |
| Maximum Drawdown | -17.71% | -11.61% | -11.96% | -13.30% | -8.59% | -8.42% | -8.42% |
| Annual Sharpe Ratio | 0.409 | 0.145 | 0.055 | 0.035 | 0.264 | 0.136 | 0.110 |
| Monthly Stutzer Index | 0.135 | 0.055 | 0.029 | 0.023 | 0.083 | 0.048 | 0.040 |
| CAPM Beta | 1.000 | 0.528 | 0.445 | 0.437 | 0.296 | 0.215 | 0.207 |
| Leland Beta | 1.000 | 0.540 | 0.456 | 0.446 | 0.319 | 0.236 | 0.226 |
| Monthly Leland Alpha | 0.00% | -0.19% | -0.22% | -0.23% | -0.02% | -0.05% | -0.06% |

In the later period, the annualized return of the QQQ is 10.09%, exceeding the returns of all the collar implementations, which range from 1.49% to 5.47%. However, by most measures, the collar strategy exhibited much lower risk. The annualized standard deviation for the QQQ is 16.51%, while for the collar implementations the range is from 3.97% to 11.48%. The minimum monthly return is -12.45% for the QQQ, while the collar minimum return is considerably better, ranging from -6.83% to -1.89%. Similarly, the drawdown of the QQQ is -17.71%, while the collar's draw-downs range from a -16.30% to -5.28%. Thus, even in the unfavorable period where the collar exhibits lower returns than the long QQQ, it does so at a significantly lower risk level.

The risk adjusted performance measures also indicate that the QQQ under performs the QQQ in this period. All implementations exhibit a negative monthly Leland alpha (ranging from -0.40% to -0.02%). Similarly, all implementations provide a lower Stutzer index than the QQQ (-0.095 to 0.085 for the collar versus 0.135 for the QQQ).

**Exhibit 9** 3-month Put, 1-month Call Summary Statistics April 2003 to March 2008

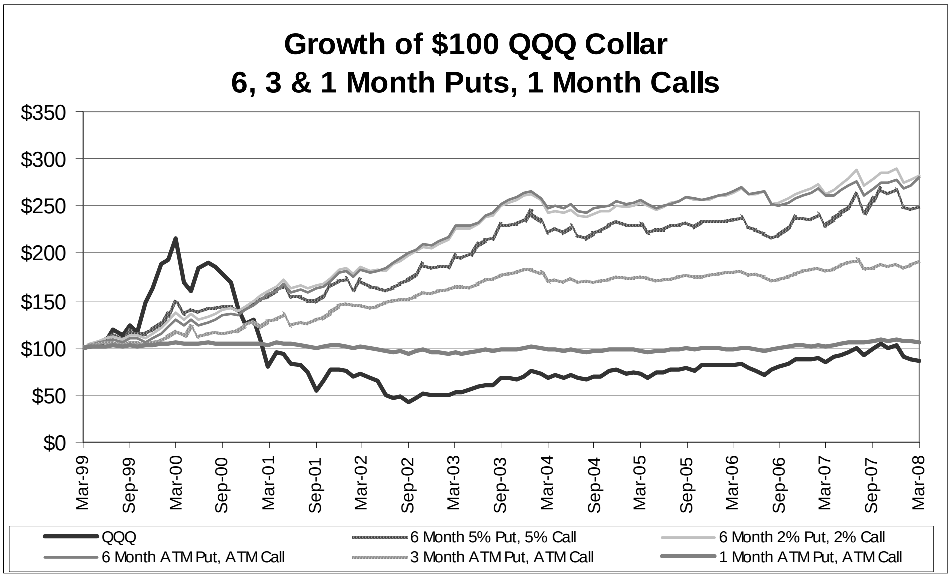
| 4/2003 to 3/2008 | | 5% OTM Calls | | | ATM Calls | | |
|---|---|---|---|---|---|---|---|
| 3 month Puts, 1 Month Calls | QQQ | 5% OTM Puts | 2% OTM Puts | ATM Puts | 5% OTM Puts | 2% OTM Puts | ATM Puts |
| Annualized Return | 10.09% | 4.06% | 3.25% | 2.78% | 4.52% | 3.60% | 3.13% |
| Annual Standard Deviation | 16.51% | 10.08% | 8.18% | 8.12% | 7.21% | 5.83% | 5.71% |
| Mean Monthly Return | 0.92% | 0.37% | 0.29% | 0.26% | 0.39% | 0.31% | 0.27% |
| Median Monthly Return | 0.57% | 0.35% | 0.19% | 0.16% | 0.94% | 0.68% | 0.64% |
| Monthly Standard Deviation | 4.77% | 2.91% | 2.36% | 2.34% | 2.08% | 1.68% | 1.65% |
| Skewness | -0.151 | -0.410 | -0.249 | -0.275 | -0.976 | -0.760 | -0.745 |
| Excess Kurtosis | -0.042 | -0.452 | -0.312 | -0.322 | 0.282 | -0.092 | -0.087 |
| Minimum Monthly Return | -12.45% | -5.90% | -5.37% | -5.37% | -5.01% | -4.01% | -4.01% |
| Maximum Monthly Return | 10.94% | 5.79% | 4.95% | 4.95% | 3.58% | 2.80% | 2.80% |
| Maximum Drawdown | -17.71% | -15.32% | -14.08% | -14.82% | -9.41% | -7.62% | -7.62% |
| Annual Sharpe Ratio | 0.409 | 0.072 | -0.010 | -0.069 | 0.164 | 0.045 | -0.036 |
| Monthly Stutzer Index | 0.135 | 0.034 | 0.009 | -0.008 | 0.056 | 0.021 | -0.002 |
| CAPM Beta | 1.000 | 0.551 | 0.402 | 0.408 | 0.319 | 0.170 | 0.177 |
| Leland Beta | 1.000 | 0.561 | 0.410 | 0.416 | 0.339 | 0.189 | 0.195 |
| Monthly Leland Alpha | 0.00% | -0.26% | -0.24% | -0.29% | -0.10% | -0.09% | -0.13% |

**Exhibit 10** 1-month Put, 1-month Call Summary Statistics April 2003 to March 2008

| 4/2003 to 3/2008 | | 5% OTM Calls | | | ATM Calls | | |
|---|---|---|---|---|---|---|---|
| 1 month Puts, 1 Month Calls | QQQ | 5% OTM Puts | 2% OTM Puts | ATM Puts | 5% OTM Puts | 2% OTM Puts | ATM Puts |
| Annualized Return | 10.09% | 3.10% | 2.45% | 1.49% | 3.69% | 2.93% | 1.95% |
| Annual Standard Deviation | 16.51% | 11.48% | 8.89% | 8.09% | 7.95% | 5.08% | 3.97% |
| Mean Monthly Return | 0.92% | 0.31% | 0.23% | 0.15% | 0.33% | 0.25% | 0.17% |
| Median Monthly Return | 0.57% | 0.34% | -0.06% | -0.64% | 1.08% | 0.69% | 0.17% |
| Monthly Standard Deviation | 4.77% | 3.31% | 2.57% | 2.34% | 2.29% | 1.47% | 1.15% |
| Skewness | -0.151 | -0.278 | 0.069 | 0.259 | -0.873 | -0.511 | -0.281 |
| Excess Kurtosis | -0.042 | -1.165 | -1.393 | -1.454 | -0.455 | -0.847 | -1.486 |
| Minimum Monthly Return | -12.45% | -6.35% | -4.12% | -3.38% | -5.49% | -3.24% | -1.89% |
| Maximum Monthly Return | 10.94% | 4.95% | 4.43% | 4.02% | 3.21% | 2.51% | 1.62% |
| Maximum Drawdown | -17.71% | -16.30% | -11.31% | -13.90% | -11.25% | -5.91% | -5.28% |
| Annual Sharpe Ratio | 0.409 | -0.021 | -0.100 | -0.229 | 0.044 | -0.080 | -0.350 |
| Monthly Stutzer Index | 0.135 | 0.011 | -0.016 | -0.054 | 0.024 | -0.015 | -0.095 |
| CAPM Beta | 1.000 | 0.657 | 0.476 | 0.436 | 0.423 | 0.241 | 0.201 |
| Leland Beta | 1.000 | 0.657 | 0.464 | 0.422 | 0.434 | 0.240 | 0.198 |
| Monthly Leland Alpha | 0.00% | -0.39% | -0.34% | -0.40% | -0.22% | -0.18% | -0.23% |

It is clear from Exhibits 2, 3 and 4 and from Figure 4 that the performance of the collar is highly sensitive to the time to expiration of the puts, and generally less sensitive to the moneyness of the options. While we provide results for all of the implementations, the following section of the paper concentrates on the strategies that utilize 6-month puts.

**Figure 5** Growth of $100 by Time to Maturity




## Return Decomposition

In order to provide some insight into what is driving the results, the return of the collar strategy can be decomposed into its component returns. We concentrate on the 6-month put strategies for the sake of simplicity. In this section, we decompose the returns into the returns generated by the following sources:

1) Total Return of the QQQ - The movement of the QQQ ETF and its dividend stream.
2) Returns to the long put position – This represents the net tradeoff between the cost of the put and the protection provided by the collar.
3) Returns to the short call position – These returns represent the net tradeoff between the funds generated by the sale of the call (to cover the cost of the put) and the sacrificed upside of the market.
4) Transaction Cost – These transaction costs are associated with writing the calls and purchasing the puts. This is captured by assuming the calls sell at the bid and

the puts are purchased at the offer. Transaction costs associated with the underlying long QQQ position are not considered.

The most obvious and generally most significant source of returns is the long QQQ position. Its returns consist of price appreciation and dividends. Between March 1999 and March 2008, the Powershares QQQ provides 12 dividend payouts and a single two-for-one split.

The returns associated with the QQQ position are calculated as follows[18]:

$$RQQQ_t = \frac{\left(QQQ_t - QQQ_{t-1}\right) + Div_t}{QQQ_{t-1} + Put_{t-1} - Call_{t-1}},$$

The next sources of returns are the short calls and the long puts. For these components of the returns, we price the options at the mid-point between the bid and ask, so that we can later isolate the effect of transactions costs.

Thus, the returns resulting from the puts are given by:

$$RPut_t = \frac{\left(PutMid_t - PutMid_{t-1}\right)}{QQQ_{t-1} + Put_{t-1} - Call_{t-1}}$$

The returns from the calls are given by:

$$RCall_t = -\frac{\left(CallMid_t - CallMid_{t-1}\right)}{QQQ_{t-1} + Put_{t-1} - Call_{t-1}}$$

The final component of the collar returns is transaction costs. In this case, transaction costs are represented by the difference between the mid-point of the bid and ask and the

[18] Note that the put and call values in the numerator and denominator will be at the bid, ask or mid-point depending on the month in question, as outlined in the index generation section of this paper.

purchase or sale price of the options[19]. As noted earlier, we purchase the puts at the offer and write the calls at the bid.

Therefore, transaction cost returns are provided by:

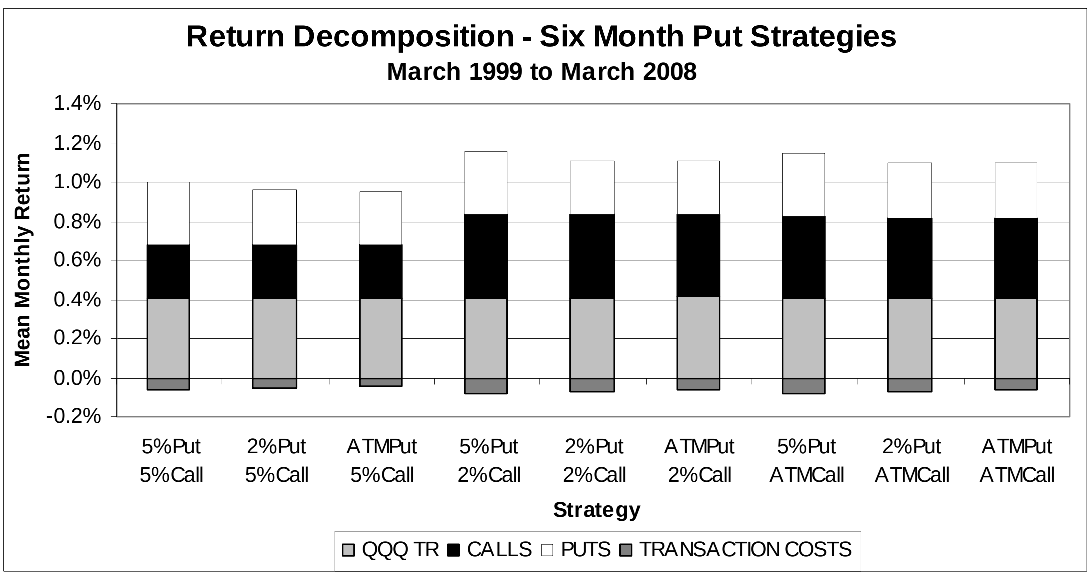
$$RTrans_t = \frac{(PutMid_{t-1} - PutAsk_{t-1}) + (CallBid_{t-1} - CallMid_{t-1})}{QQQ_{t-1} + Put_{t-1} - Call_{t-1}}$$

Thus, the overall return of the collar strategy for any month is given by the sum of these component returns. Thus the strategy returns are calculated as:

$$R_t = RQQQ_t + RCall_t + RPut_t + RTrans_t,$$

Figure 5, 6 and 7 provide graphical representations of the decomposition of the strategy returns.

**Figure 6** Return Decomposition for 6-month Put Collars – Full Period




[19] Under this paper's methodology transaction costs will only be incurred when options are purchased or sold, not in intermediate months.

**Figure 7** Return Decomposition for 6-month Put Collars – Early Period

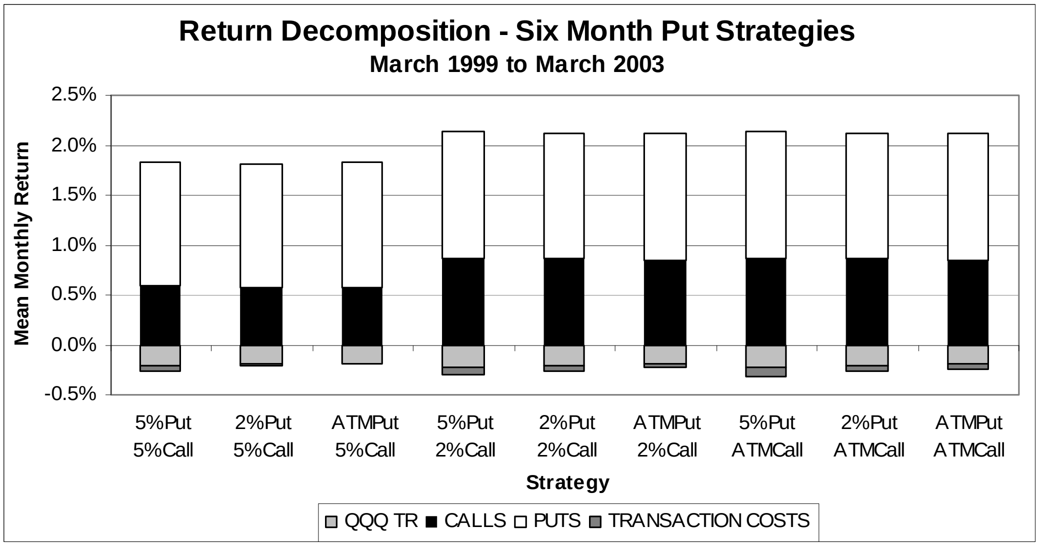
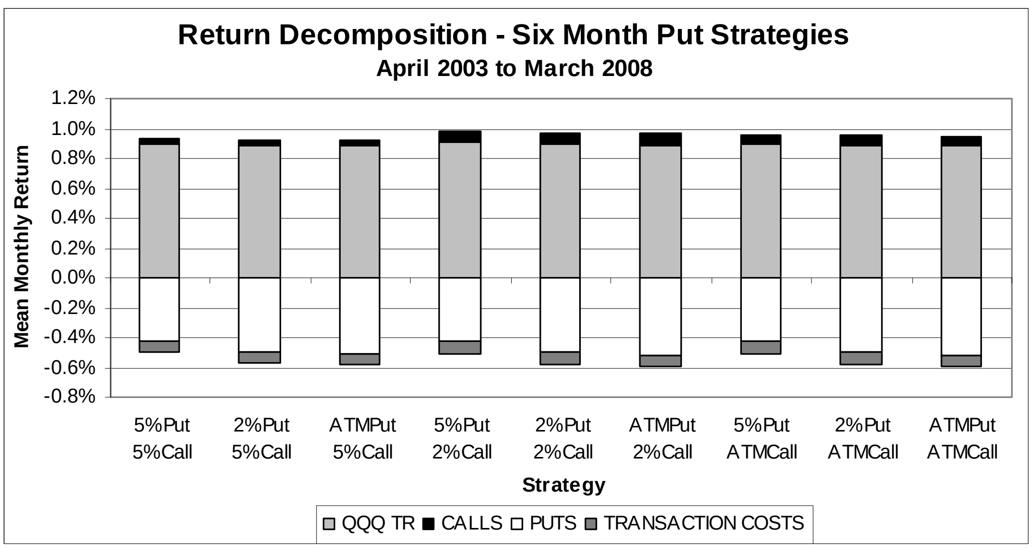



**Figure 8** Return Decomposition for 6-month Put Collars – Late Period




The most significant component of the returns is the long QQQ position. On average, the collar benefits both from the put protection and from the short call position. In fact, the short call position earns a greater return on average than the put position, when considering the entire period. The generally positive returns of the short call position suggest that the collar strategies should typically outperform a simple protective put strategy.  It is of great interest to note the significant impact that the puts and calls have on the returns, even when compared to the impact of underlying QQQ returns. This is another illustration of the variance reduction of the collar, as the call and put both work to reduce the impact of large moves in the underlying. It is also clear from the exhibits that transaction costs have limited impact on the performance of the strategies[20]. This is particularly true of the 6-month strategies, since they engage in fewer transactions by only purchasing puts once every six months.

## Conclusion

The results of this analysis confirm the effectiveness of the collar as a protective strategy. We consider a wide range of implementations of the strategy by varying both the moneyness of the calls and puts and the time to expiration of the puts. In addition, we consider the performance of the strategy in a relatively favorable sub-period and a clearly unfavorable sub-period. Performance in the overall period and the favorable period is generally far better than the underlying, from a return or risk adjusted return perspective. Not surprisingly, in the unfavorable period, the collar under performs the underlying. However, it does so at a significantly lower risk level. No single implementation dominates based on all measures of risk and return; however, the 6-month put strategies significantly outperform the shorter maturity strategies on most performance and risk measures. This is true for the overall time period as well as each of the sub-periods.

The results of the return decomposition suggest that the collar performs far better than a protective put strategy. Additionally, the decomposition suggests that transaction costs are not an overly significant consideration in the implementation of the strategy, particularly in the 6-month put strategies.

[20] Additional details regarding the impact of transaction costs are provided in Appendix C.

As a final note, while this paper focuses on strictly passive implementations of collars, a recent article in Options Trader[21] suggests that there may be additional risk adjusted gains to be made by active management of collars.

[21] See Lentz and Graham., "Collar Trade.", Futures and Options Trader, March 2006.

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# Appendix A - Summary Statistics for 2 % OTM Call Strategies

## **Exhibit A1** 6-Month Put Strategies

| 6 month Puts | Full Period | | | | 3/1999 to 3/2003 | | | | 4/2003 to 3/2008 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 month Calls | | 2% OTM Calls | | | | 2% OTM Calls | | | | 2% OTM Calls | | |
| | QQQ | 5% OTM Puts | 2% OTM Puts | ATM Puts | QQQ | 5% OTM Puts | 2% OTM Puts | ATM Puts | QQQ | 5% OTM Puts | 2% OTM Puts | ATM Puts |
| Annualized Return | -1.69% | 12.86% | 12.21% | 12.19% | -14.66% | 22.83% | 22.70% | 22.93% | 10.09% | 5.47% | 4.47% | 4.27% |
| Annual Standard Deviation | 29.93% | 9.36% | 9.10% | 8.98% | 40.99% | 10.46% | 10.29% | 10.13% | 16.51% | 7.92% | 7.45% | 7.33% |
| Mean Monthly Return | 0.24% | 1.05% | 1.00% | 1.00% | -0.61% | 1.77% | 1.76% | 1.78% | 0.92% | 0.47% | 0.39% | 0.37% |
| Median Monthly Return | 0.30% | 1.57% | 1.35% | 1.36% | -0.65% | 2.58% | 2.31% | 2.28% | 0.57% | 1.09% | 0.96% | 0.92% |
| Monthly Standard Deviation | 8.64% | 2.70% | 2.63% | 2.59% | 11.83% | 3.02% | 2.97% | 2.92% | 4.77% | 2.29% | 2.15% | 2.11% |
| Skewness | -0.31 | -0.67 | -0.61 | -0.57 | -0.08 | -0.76 | -0.74 | -0.75 | -0.15 | -1.24 | -1.30 | -1.23 |
| Excess Kurtosis | 1.54 | 0.28 | 0.31 | 0.27 | -0.15 | -0.12 | -0.16 | -0.11 | -0.04 | 1.21 | 1.53 | 1.36 |
| Minimum Monthly Return | -25.45% | -6.14% | -5.81% | -5.81% | -25.45% | -5.44% | -5.00% | -5.00% | -12.45% | -6.14% | -5.81% | -5.81% |
| Maximum Monthly Return | 26.57% | 7.02% | 7.02% | 7.02% | 26.57% | 7.02% | 7.02% | 7.02% | 10.94% | 4.25% | 4.25% | 4.25% |
| Maximum Drawdown | -80.44% | -9.44% | -9.42% | -9.42% | -80.44% | -5.50% | -5.00% | -5.00% | -17.71% | -9.44% | -9.42% | -9.42% |
| Annual Sharpe Ratio | -0.180 | 0.979 | 0.936 | 0.946 | -0.458 | 1.787 | 1.804 | 1.856 | 0.409 | 0.269 | 0.151 | 0.127 |
| Monthly Stutzer Index | 0.028 | 0.270 | 0.260 | 0.263 | -0.081 | 0.446 | 0.450 | 0.461 | 0.135 | 0.085 | 0.053 | 0.046 |
| CAPM Beta | 1.000 | 0.120 | 0.089 | 0.080 | 1.000 | 0.086 | 0.066 | 0.056 | 1.000 | 0.329 | 0.248 | 0.240 |
| Leland Beta | 1.000 | 0.119 | 0.090 | 0.080 | 1.000 | 0.087 | 0.067 | 0.058 | 1.000 | 0.354 | 0.272 | 0.262 |
| Monthly Leland Alpha | 0.00% | 0.75% | 0.70% | 0.70% | 0.00% | 1.52% | 1.49% | 1.49% | 0.00% | -0.03% | -0.06% | -0.07% |

## **Exhibit A2** 3-Month Put Strategies

| 3 month Puts | Full Period | | | | 3/1999 to 3/2003 | | | | 4/2003 to 3/2008 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 month Calls | | 2% OTM Calls | | | | 2% OTM Calls | | | | 2% OTM Calls | | |
| | QQQ | 5% OTM Puts | 2% OTM Puts | ATM Puts | QQQ | 5% OTM Puts | 2% OTM Puts | ATM Puts | QQQ | 5% OTM Puts | 2% OTM Puts | ATM Puts |
| Annualized Return | -1.69% | 8.32% | 7.86% | 7.59% | -14.66% | 13.02% | 13.16% | 13.19% | 10.09% | 4.70% | 3.79% | 3.32% |
| Annual Standard Deviation | 29.93% | 9.74% | 8.65% | 8.48% | 40.99% | 11.70% | 10.80% | 10.54% | 16.51% | 7.77% | 6.30% | 6.20% |
| Mean Monthly Return | 0.24% | 0.71% | 0.66% | 0.64% | -0.61% | 1.08% | 1.08% | 1.08% | 0.92% | 0.41% | 0.33% | 0.29% |
| Median Monthly Return | 0.30% | 1.04% | 0.84% | 0.89% | -0.65% | 1.39% | 1.46% | 1.43% | 0.57% | 0.94% | 0.74% | 0.68% |
| Monthly Standard Deviation | 8.64% | 2.81% | 2.50% | 2.45% | 11.83% | 3.38% | 3.12% | 3.04% | 4.77% | 2.24% | 1.82% | 1.79% |
| Skewness | -0.31 | -0.74 | -0.66 | -0.69 | -0.08 | -0.81 | -0.85 | -0.91 | -0.15 | -1.02 | -0.86 | -0.85 |
| Excess Kurtosis | 1.54 | 0.57 | 1.14 | 1.47 | -0.15 | 0.32 | 0.80 | 1.24 | -0.04 | 0.40 | 0.10 | 0.12 |
| Minimum Monthly Return | -25.45% | -7.92% | -8.07% | -8.32% | -25.45% | -7.92% | -8.07% | -8.32% | -12.45% | -5.22% | -4.72% | -4.72% |
| Maximum Monthly Return | 26.57% | 6.28% | 6.11% | 5.98% | 26.57% | 6.28% | 6.11% | 5.98% | 10.94% | 3.59% | 2.79% | 2.79% |
| Maximum Drawdown | -80.44% | -9.41% | -8.63% | -8.63% | -80.44% | -7.92% | -8.07% | -8.32% | -17.71% | -9.41% | -8.63% | -8.63% |
| Annual Sharpe Ratio | -0.180 | 0.475 | 0.481 | 0.460 | -0.458 | 0.759 | 0.836 | 0.859 | 0.409 | 0.175 | 0.071 | -0.003 |
| Monthly Stutzer Index | 0.028 | 0.142 | 0.143 | 0.137 | -0.081 | 0.194 | 0.211 | 0.216 | 0.135 | 0.059 | 0.029 | 0.008 |
| CAPM Beta | 1.000 | 0.140 | 0.077 | 0.066 | 1.000 | 0.102 | 0.056 | 0.042 | 1.000 | 0.352 | 0.203 | 0.210 |
| Leland Beta | 1.000 | 0.139 | 0.077 | 0.066 | 1.000 | 0.102 | 0.057 | 0.043 | 1.000 | 0.374 | 0.224 | 0.231 |
| Monthly Leland Alpha | 0.00% | 0.41% | 0.37% | 0.34% | 0.00% | 0.84% | 0.80% | 0.79% | 0.00% | -0.11% | -0.09% | -0.13% |

## **Exhibit A3** 1-Month Put Strategies

| 1 month Puts | Full Period | | | | 3/1999 to 3/2003 | | | | 4/2003 to 3/2008 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 month Calls | | 2% OTM Calls | | | | 2% OTM Calls | | | | 2% OTM Calls | | |
| | QQQ | 5% OTM Puts | 2% OTM Puts | ATM Puts | QQQ | 5% OTM Puts | 2% OTM Puts | ATM Puts | QQQ | 5% OTM Puts | 2% OTM Puts | ATM Puts |
| Annualized Return | -1.69% | 0.36% | 0.69% | 0.64% | -14.66% | -3.82% | -2.23% | -1.15% | 10.09% | 3.84% | 3.10% | 2.11% |
| Annual Standard Deviation | 29.93% | 9.45% | 5.96% | 4.81% | 40.99% | 10.42% | 6.21% | 4.89% | 16.51% | 8.57% | 5.70% | 4.75% |
| Mean Monthly Return | 0.24% | 0.07% | 0.07% | 0.06% | -0.61% | -0.28% | -0.17% | -0.09% | 0.92% | 0.34% | 0.27% | 0.18% |
| Median Monthly Return | 0.30% | 0.89% | 0.26% | 0.00% | -0.65% | 0.50% | -0.67% | -0.67% | 0.57% | 1.02% | 0.69% | 0.11% |
| Monthly Standard Deviation | 8.64% | 2.73% | 1.72% | 1.39% | 11.83% | 3.01% | 1.79% | 1.41% | 4.77% | 2.47% | 1.65% | 1.37% |
| Skewness | -0.31 | -0.52 | -0.16 | -0.11 | -0.08 | -0.21 | 0.12 | -0.05 | -0.15 | -0.83 | -0.39 | -0.15 |
| Excess Kurtosis | 1.54 | -1.19 | -1.41 | -1.20 | -0.15 | -1.62 | -1.56 | -1.29 | -0.04 | -0.54 | -1.12 | -1.14 |
| Minimum Monthly Return | -25.45% | -5.49% | -3.24% | -2.97% | -25.45% | -5.15% | -3.04% | -2.97% | -12.45% | -5.49% | -3.24% | -2.73% |
| Maximum Monthly Return | 26.57% | 3.83% | 3.19% | 2.72% | 26.57% | 3.83% | 3.19% | 2.08% | 10.94% | 3.25% | 2.72% | 2.72% |
| Maximum Drawdown | -80.44% | -32.90% | -22.88% | -15.55% | -80.44% | -32.90% | -22.70% | -15.55% | -17.71% | -11.25% | -6.93% | -6.30% |
| Annual Sharpe Ratio | -0.180 | -0.353 | -0.504 | -0.634 | -0.458 | -0.764 | -1.025 | -1.082 | 0.409 | 0.058 | -0.043 | -0.260 |
| Monthly Stutzer Index | 0.028 | -0.087 | -0.136 | -0.176 | -0.081 | -0.176 | -0.217 | -0.188 | 0.135 | 0.029 | -0.004 | -0.068 |
| CAPM Beta | 1.000 | 0.255 | 0.152 | 0.119 | 1.000 | 0.212 | 0.125 | 0.094 | 1.000 | 0.456 | 0.275 | 0.235 |
| Leland Beta | 1.000 | 0.256 | 0.151 | 0.118 | 1.000 | 0.213 | 0.125 | 0.094 | 1.000 | 0.470 | 0.277 | 0.234 |
| Monthly Leland Alpha | 0.00% | -0.22% | -0.22% | -0.23% | 0.00% | -0.42% | -0.39% | -0.34% | 0.00% | -0.23% | -0.18% | -0.24% |

## Appendix B - Self-financing 3 and 6-month Put Strategies

Technically, unless we assume that we are able to roll in and out of the put positions at the bid ask mid-point in the months between position initiation and expiration, the 3 and 6-month put strategies are not self-financing. In this section, we provide results of 3 and 6-month strategies which are self-financing. In these implementations we roll out of the puts every intermediate month by selling the puts at the bid and repurchasing them at the ask.

The transactions costs are quite significant, when compared to the implementations discussed previously. However, the self-financing collar strategies still perform well when compared to the QQQ. The extra transaction cost penalty under this methodology tends to be approximately 2% annually.

Clearly this is an extreme methodology of accounting for the transaction costs related to rebalancing. In reality, only a small portion of the collar position needs to be rebalanced each month to maintain the self-financing characteristic of the strategy. Thus the actual penalty will be far less in practice.

**Exhibit B1** 6-Month Put Self-Financing Strategies

**Robustness Check** **Roll every month**

| 6 Month Puts | | 5% OTM Calls | | | 2% OTM Calls | | | ATM Calls | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 Month Calls | QQQ | 5% OTM Puts | 2% OTM Puts | ATM Puts | 5% OTM Puts | 2% OTM Puts | ATM Puts | 5% OTM Puts | 2% OTM Puts | ATM Puts |
| Annualized Return | -1.69% | 7.97% | 7.44% | 7.41% | 10.10% | 9.50% | 9.45% | 10.04% | 9.43% | 9.37% |
| Annual Standard Deviation | 29.93% | 11.33% | 10.78% | 10.62% | 9.36% | 9.09% | 8.97% | 8.87% | 8.69% | 8.61% |
| Mean Monthly Return | 0.24% | 0.69% | 0.65% | 0.64% | 0.84% | 0.79% | 0.79% | 0.83% | 0.78% | 0.78% |
| Median Monthly Return | 0.30% | 0.74% | 0.57% | 0.61% | 1.34% | 1.15% | 1.17% | 1.20% | 1.10% | 1.07% |
| Monthly Standard Deviation | 8.64% | 3.27% | 3.11% | 3.07% | 2.70% | 2.62% | 2.59% | 2.56% | 2.51% | 2.49% |
| Skewness | -0.31 | -0.32 | -0.26 | -0.23 | -0.68 | -0.62 | -0.58 | -0.71 | -0.66 | -0.63 |
| Excess Kurtosis | 1.54 | -0.14 | -0.01 | -0.02 | 0.34 | 0.39 | 0.35 | 0.33 | 0.39 | 0.37 |
| Minimum Monthly Return | -25.45% | -7.24% | -6.74% | -6.74% | -6.38% | -5.85% | -5.85% | -5.98% | -5.85% | -5.85% |
| Maximum Monthly Return | 26.57% | 8.58% | 8.58% | 8.58% | 6.98% | 6.98% | 6.98% | 5.99% | 5.99% | 5.99% |
| Maximum Drawdown | -80.44% | -15.32% | -15.92% | -17.10% | -10.44% | -10.53% | -10.53% | -9.45% | -9.55% | -10.20% |
| Sharpe Ratio | -0.18 | 0.38 | 0.35 | 0.35 | 0.69 | 0.64 | 0.64 | 0.72 | 0.66 | 0.66 |

**Exhibit B2** 3-Month Put Self-Financing Strategies

**Robustness Check** **Roll every month**

| 3 Month Puts | | 5% OTM Calls | | | 2% OTM Calls | | | ATM Calls | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 Month Calls | QQQ | 5% OTM Puts | 2% OTM Puts | ATM Puts | 5% OTM Puts | 2% OTM Puts | ATM Puts | 5% OTM Puts | 2% OTM Puts | ATM Puts |
| Annualized Return | -1.69% | 4.52% | 4.08% | 3.76% | 6.69% | 6.14% | 5.79% | 6.64% | 6.06% | 5.71% |
| Annual Standard Deviation | 29.93% | 11.81% | 10.34% | 10.09% | 9.76% | 8.68% | 8.49% | 9.24% | 8.30% | 8.16% |
| Mean Monthly Return | 0.24% | 0.43% | 0.38% | 0.35% | 0.58% | 0.53% | 0.50% | 0.57% | 0.52% | 0.49% |
| Median Monthly Return | 0.30% | 0.29% | 0.13% | 0.13% | 0.96% | 0.75% | 0.77% | 0.96% | 0.71% | 0.77% |
| Monthly Standard Deviation | 8.64% | 3.41% | 2.98% | 2.91% | 2.82% | 2.51% | 2.45% | 2.67% | 2.40% | 2.35% |
| Skewness | -0.31 | -0.38 | -0.35 | -0.37 | -0.77 | -0.72 | -0.75 | -0.83 | -0.77 | -0.80 |
| Excess Kurtosis | 1.54 | -0.27 | 0.19 | 0.38 | 0.62 | 1.20 | 1.48 | 0.96 | 1.70 | 1.98 |
| Minimum Monthly Return | -25.45% | -8.86% | -9.05% | -9.25% | -7.97% | -8.17% | -8.37% | -7.97% | -8.17% | -8.37% |
| Maximum Monthly Return | 26.57% | 7.84% | 7.63% | 7.53% | 6.25% | 6.04% | 5.93% | 5.51% | 5.79% | 5.56% |
| Maximum Drawdown | -80.44% | -17.42% | -16.60% | -17.34% | -9.65% | -9.46% | -10.21% | -9.65% | -8.79% | -9.55% |
| Sharpe Ratio | -0.18 | 0.07 | 0.04 | 0.01 | 0.31 | 0.28 | 0.25 | 0.32 | 0.29 | 0.25 |

## Appendix C – Transaction Cost Details

The following exhibits provide additional details regarding the magnitude and impact of the bid ask spread as a proxy for transaction costs. Figures C1 and C2 provide a graphic illustration of the impact of the bid ask spread on the growth of the investment in the 5% OTM one-month collar, by providing the returns to the strategy when implemented with transaction costs, and without (options traded at the mid-point between the bid and ask). Exhibit C1 provides the observed bid ask spreads in dollars and as a percentage of the strike price.

**Figure C1** Growth of $100 – Early Period

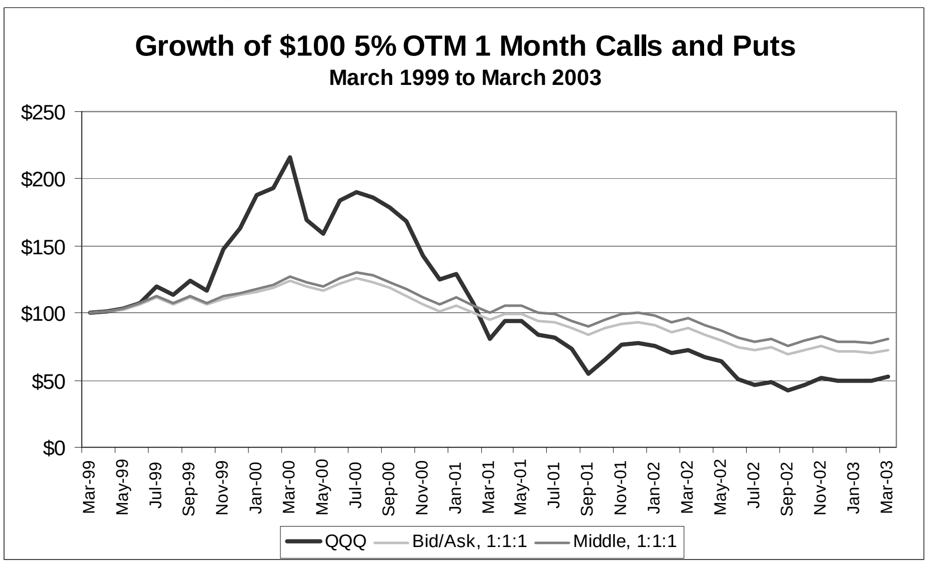

**Figure C2** Growth of $100 – Late Period

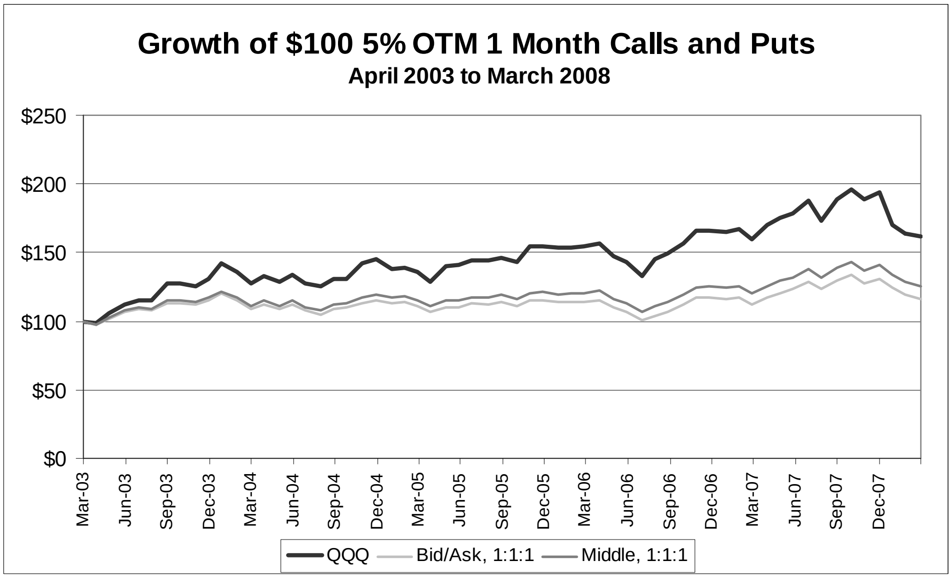


**Exhibit C1** Bid Ask Spreads – Full Period

| | Calls | Puts | | |
|---|---|---|---|---|
| **Spread in Dollars** | **1 Month** | **1 Month** | **3 Month** | **6 Month** |
| **5% OTM** | $0.10 | $0.09 | $0.11 | $0.16 |
| **2% OTM** | $0.10 | $0.10 | $0.13 | $0.16 |
| **ATM** | $0.10 | $0.10 | $0.13 | $0.16 |
| | | | | |
| **As % of Strike Price** | **1 Month** | **1 Month** | **3 Month** | **6 Month** |
| **5% OTM** | 0.16% | 0.16% | 0.19% | 0.27% |
| **2% OTM** | 0.17% | 0.16% | 0.21% | 0.27% |
| **ATM** | 0.17% | 0.16% | 0.21% | 0.27% |

# Appendix D – Measures of Risk Adjusted Returns
## Stutzer Index

In creating his performance measure, Stutzer (2000) considers a manager who is motivated to ensure that his average returns do not fall below the returns of some benchmark. If the manager holds a portfolio with an expected return greater than the expected return of the benchmark, the probability that the manager's average returns will fall below that of the benchmark decays to zero exponentially with time. Since the manager would like to maximize the rate at which the probability of under performance decays to zero, the decay rate is used as a performance index.

Stutzer's information statistic $I_p$ is given as:

$$I_p = \max_{\theta}\left[-\log\left(\frac{1}{T}\sum_{t=1}^{T} e^{\theta r_t}\right)\right]$$

Where $r_t$ is the excess return of the portfolio and θ is chosen to maximize $I_p$. The Stutzer index is derived from the information statistic using the following formula:

$$Stuzer\ Index = \frac{Abs\left[\bar{r}\right]}{\bar{r}}\sqrt{2I_p},$$

Where $\bar{r}$ is the mean excess return and $Abs\left(\bar{r}\right)$ is the absolute value of the mean excess return. When returns are normally distributed, the performance ratio is:

$$I_p = \frac{1}{2}\lambda_p^2$$

Where λ is the Sharpe ratio. Thus, the expected values of the Sharpe ratio and the Stutzer index are equal under normally distributed returns. When returns are non-normal, the Stutzer index penalizes high kurtosis and negative skewness.

**Leland's Alpha and Beta**

Leland's (1999) alpha and beta allow for non-normality in security returns, although they assume that market returns are normal. Like the Stutzer index, Leland's measures reflect the preference for low kurtosis and positive skewness.

Utilizing Rubinstein's (1976) equilibrium pricing equation,

$$P_0 = \frac{E\left[\left(1+r_p\right)P_0\right] - \lambda \times \rho\left[P_0\left(1+r_p\right), -\left(1+r_{mkt}\right)^{-b}\right] \times Stdev\left[P_0\left(1+r_p\right)\right]}{1+r_f}$$

where ρ[x,y] is the correlation of x and y, and –b is the exponent of the average investor's marginal utility function, Leland models portfolio returns as:

$$E\left[r_p\right] = r_f + B_p\left(E\left[r_{mkt}\right] - r_f\right)$$

where Leland's beta is given by:

$$B_p = \frac{Cov\left[r_p, -\left(1+r_{mkt}\right)^{-b}\right]}{Cov\left[r_{mkt}, -\left(1+r_{mkt}\right)^{-b}\right]},$$

and *b* is a market price of risk. If market returns are normally distributed, *b* is given by:

$$b = \frac{\log\left[E\left[1+r_{mkt}\right]\right] - \log\left[1+r_f\right]}{Var\left[\log\left[1+r_{mkt}\right]\right]}$$

Thus, the Leland alpha follows:

$$A_p = E\left[r_p\right] - B_p\left(E\left[r_{mkt} - r_f\right]\right) - r_f \,.$$