Covered Calls Uncovered*

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Equity index covered calls have historically provided attractive risk-adjusted returns largely because they collect equity and volatility risk premia from their long equity and short volatility exposures. However, they also embed exposure to an uncompensated risk, a naïve equity market reversal strategy. This paper presents a novel performance attribution methodology, which deconstructs the strategy into these three identified exposures, in order to measure each's contribution to the covered call's return. The covered call's equity exposure is responsible for most of the strategy's risk and return. The strategy's short volatility exposure has had a realized Sharpe ratio close to 1.0, but its contribution to risk has been less than 10 percent. The equity reversal exposure is responsible for about one quarter of the covered call's risk, but provides little reward. Finally, we propose a risk managed covered call strategy that hedges the equity reversal exposure in an attempt to eliminate this uncompensated risk. Our proposed strategy improved the covered call's Sharpe ratio and reduced its volatility, and downside equity beta.

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Equity index covered calls are the most easily accessible source of the volatility risk premium to most investors.[1] The volatility risk premium, which is absent from most investors' portfolios, has had more than double the risk-adjusted returns (Sharpe ratio) of the equity risk premium, which is the dominant source of return for most investors. By providing the equity and volatility risk premia, equity index covered calls returns have been historically attractive, nearly matching the returns of their underlying index with significantly lower volatility.[2]

Options are a form of financial insurance and the volatility risk premium is compensation paid by option buyers to the option sellers who provide this insurance. Bakshi and Kapadia (2003) show that equity index options include a volatility risk premium by analyzing delta-hedged option returns. Bollen and Whaley (2004) and Garleanu, Pedersen, and Poteshman (2005) show how option demand by natural buyers can lead to a risk premium. Litterman (2011) suggests that long-term investors, such as pensions and endowments, should be natural providers of financial insurance and sellers of options.

Yet, many investors remain skeptical of covered call strategies. Although deceptively simple – long equity and short a call option – covered calls are not well understood. Israelov and Nielsen (2014) identify and dispel eight commonly circulated myths on covered calls. These myths sound plausible; they would not have such longevity if that were not the case. But they can be problematic if they affect portfolio construction decisions. The securities overwritten and the strikes and maturities of the call options that are sold should be explicitly selected to achieve the portfolio's allocation to equity and volatility risk premia without taking unnecessary risk. Price targets, downside protection, and income generation are a diversion.

One source of confusion on covered calls may be due to the opacity of the strategy's risk exposures. Our paper's first contribution is a novel performance attribution methodology for portfolios holding options, such as the covered call strategy. We demonstrate how to decompose the portfolio return into three distinct risk exposures: passive equity, equity market timing, and short volatility.

Our performance attribution methodology provides investment managers with a tool to effectively and transparently communicate their strategy's performance to their investors and allows investors to properly place the covered call's risk exposures and returns in the context of their overall portfolios. Further, it provides a framework by which portfolio managers can evaluate the impact of strike, maturity, underlying security selection, risk management, and leverage on their strategy's risk and returns. Proper performance attribution facilitates improved portfolio construction.

Although we use our performance attribution to better understand covered call strategies, it may be more broadly applied to any portfolio that includes options. For example, protected strategies which are long an index and long a protective put option or collar strategies which are long an index,

[1] Bollerslev, Gibson, and Zhou (2006) defines the volatility risk premium as the spread between an option's implied volatility and the underlying security's realized volatility. Although it is not an investment return *per se* when defined as such, the volatility risk premium is an intuitive measure of an option's richness. The volatility risk premium has also become industry jargon for the expected excess return earned when selling options. In our paper, we apply the terminology volatility risk premium to both contexts.

[2] A number of papers, such as Whaley (2002), Feldman and Dhruv (2004), and Hill et al. (2006), have shown that S&P 500 covered calls have had average returns in line with the S&P 500 Index. Kapadia and Szado (2012) report a similar result for the Russell 2000.

short a call option, long a protective put may be more thoroughly investigated using our proposed attribution methodology.

We demonstrate our proposed performance attribution by analyzing and comparing two covered call strategies. The first strategy mimics the CBOE S&P 500 BuyWrite Index (BXM), selling one-month at-the-money call options on option expiration dates. The second strategy mimics the CBOE S&P 500 2% OTM BuyWrite Index (BXY), selling one-month 2% out-of-the money call options on option expiration dates. Our performance attribution shows that passive equity is the dominant exposure for both covered call strategies. Short volatility contributes less than 10% of the risk, but with a Sharpe ratio near 1.0, adds approximately 1.7% annualized return to the covered call strategies.

Option savvy market participants, such as market makers, are well aware that options include market timing, an active equity exposure. In fact, they often employ a delta-hedging program specifically designed to reduce the risk arising from this dynamic exposure. However, the covered call benchmark (CBOE BuyWrite Index) and most covered call funds do not hedge the time varying equity exposure arising from option convexity. Further, the risk and return contribution of an unhedged short option position's dynamic equity exposure is by-and-large not reported by those who manage to those who invest in covered call strategies and is unaddressed in the covered call literature.

We employ our performance attribution to document that market timing is responsible for about one quarter of the at-the-money covered call's risk. The timing bet is smallest immediately after option expiration and largest just prior to option expiration. In fact, on the day before the call option expires, the equity timing position provides on average nearly the same risk as the passive equity exposure. We further show that covered call investors are not compensated for bearing this risk. Because the embedded market timing is hedgeable by trading the underlying equity, covered call investors do not need to take that bet to earn the volatility risk premium. In other words, by shorting an option, covered calls include a market timing exposure that bets on equity reversals whose risk is material, uncompensated, and unnecessary for earning the volatility risk premium.

Having identified the covered call's active equity exposure as an uncompensated contributor to risk, our final contribution analyzes a risk-managed covered call strategy that hedges away the dynamic equity exposure. On each day, the covered call's active equity exposure may be measured by computing the delta of the strategy's call option. The strategy trades an offsetting amount of the S&P 500 so that the covered call's equity exposure remains constant. This risk management exercise mimics the delta-hedging approach taken by volatility desks. In so doing, the risk-managed covered call achieves higher risk-adjusted returns than does the traditional covered call because it continues to collect the same amount of equity and volatility risk premium, but is no longer exposed to active equity risk. The risk-managed strategy improved the covered call Sharpe ratio from 0.37 to 0.52 by reducing its annualized volatility from 11.4% to 9.2%.

The risk-managed covered call has an additional benefit beyond improving risk-adjusted returns. The strategy's goal, design, and execution are clear and they transparently map to its performance. The strategy seeks to collect equity and volatility risk premia and does so by being long equity and short volatility. We may explicitly construct a portfolio by choosing how much risk to allocate to the two desired exposures and subsequently measure their resulting contributions to the strategy's performance.

Covered Call Performance Attribution

A covered call is a combined long position in a security and a short position in a call option on that security. The combined position caps the investor's upside on the underlying security at the option's strike price in exchange for the option premium.

Exhibit 1 graphically constructs an at-the-money covered call payoff diagram when the call option premium is \$25 and the current asset price is \$100. We may take the long equity exposure and split it in half. The top left plot depicts a portfolio that owns \$50 of equity and \$50 of cash. The top right plot depicts a portfolio that is short an at-the-money call option, owns \$50 of equity, and is short \$50 cash to finance the equity position.

Exhibit 1 introduces the foundation for our performance attribution. By splitting the positions in such a manner, we immediately see two distinct components. The first component provides the long-term strategic long equity allocation. In our above example, we have a 50% passive equity allocation. The second component provides the long-term strategic short volatility allocation. However, the second component provides the covered call with a third exposure: time-varying equity exposure that is zero on average. Although the top right plot shows the payoff at expiration, the exposures profile has a similar shape on all the days leading up to the option's expiration. It has positive slope when the call option is out of the money, negative slope with the call option is in the money, and approximately no exposure to the stock when the call option is at the money.

We may re-arrange the covered call definition to define these three exposures:

Covered Call	**= Equity – Call**	
	= (1 – InitialCallDelta) * Equity	} Passive Equity Exposure
	– (Call – CallDelta * Equity)	} Short Volatility Exposure
	+ (InitialCallDelta – CallDelta) * Equity	} Dynamic Equity Exposure

The above expression decomposes the covered call into three approximately orthogonal exposures. The passive equity exposure provides the strategy with equity risk premium and represents a long-term strategic allocation to equity markets. The dynamic equity exposure is effectively a market timing strategy. It is zero on average and may be viewed as a tactical equity allocation around the long-term strategic passive exposure. Unless it correlates to (i.e. forecasts) future equity returns, it should not contribute to the strategy's average returns.

Short volatility provides the strategy with volatility risk premium. Arguably, it too may be split into passive (strategic) and active (tactical) components. Its exposure to realized volatility (gamma) fluctuates over time. Gamma is higher when the option is close to the money and close to its expiration. Its exposure to changes in implied volatility (vega) also fluctuates over time. Vega is higher when the option is close to the money and distant from its expiration. In fact, short volatility can be split across other related dimensions as well. The option's maturity represents a calendar bet and the option's strike price represents a skew bet. Decomposing across all of these dimensions may be tractable if there is a well-defined passive short volatility asset. Unfortunately, there is not and we do not attempt to define one in this paper. For this reason, and to maintain parsimony in our performance attribution, we do not further decompose short volatility across any of the above identified dimensions.

An alternative performance attribution could regress covered call returns on the S&P 500 Index return and an S&P 500 variance swap return. The regression framework is commonly used to estimate return exposures to known factors. Rolling estimation of factor coefficients provide information on exposure dynamics. We believe our attribution methodology is more appropriate for a covered call for the following reasons. First, we know the covered call's constituent assets so we may use a model to estimate equity exposure point-in-time rather than statistically estimate an average exposure over a rolling period. Option convexity can lead to rapid changes in equity exposure and the regression will not be able to fully capture these changes and thus underestimate the equity exposure dynamics. Second, there is no well-defined pure passive short volatility return series. A variance swap is one method to obtain short volatility exposure. Delta-hedging a short option is another method. Shorting VIX futures are a third, etc. The delta-hedged option has exposure to a variance swap, but with basis risk. That basis risk would be an additional term that complicates the decomposition. Our performance attribution mechanically decomposes the covered call's return using a model into passive equity, the delta-hedged option variant of short volatility, and market timing.

In order to demonstrate our attribution methodology in practice, we decompose a simple overwriting strategy, which mimics the industry standard covered call benchmark – the CBOE BuyWrite Index – into these three components. This strategy owns the S&P 500 Index and sells an at-the-money call monthly index option on option expiration dates. The three returns in the decomposition are computed as follows:

$$\pi_{pe,t} = (1-\Delta_0)(spx_t - spx_{t-1}(1+r_{cash,t}))$$

$$\pi_{sv,t} = (call_{t-1} - call_t) + \Delta_{t-1}(spx_t - spx_{t-1}(1+r_{cash,t})) + call_0 r_{cash,t}$$

$$\pi_{ae,t} = (\Delta_0 - \Delta_{t-1})(spx_t - spx_{t-1}(1+r_{cash,t}))$$

where π_t is the dollar excess profit for the respective component, spx_t is the S&P 500 Index, $call_t$ is the call price, Δ_t is the call option's delta as reported by OptionMetrics, and $t=0$ is the option expiration date on which the at-the-money call option is sold. Returns are computed by dividing the dollar profit by the net asset value on the prior date. On the call option's expiration date, $call_t = \max(spx_t - K, 0)$ and a new short call option position is established at the day's closing price, denoted $call_0$. Our short volatility return calculation is similar to that of Kapadia and Bakshi (2003), except we compute daily returns rather than returns through option expiration.

Table 1 reports the results. The passive equity exposure realized approximately 8% annualized volatility, while short volatility realized a modest 2% annualized volatility. Equity timing is a significant source of risk, realizing more than half the volatility of the passive equity exposure and contributing four times the risk of short volatility.[3]

[3] Risk contribution is defined as the covariance of the component with the BuyWrite Index divided by the variance of the BuyWrite Index.

In our sample, the passive equity exposure had close to a 0.4 Sharpe ratio. Short volatility contributed about two-thirds of the return of long equity, but with a quarter of its risk, realizing a 0.9 Sharpe ratio. Shorting volatility has provided one-third of the covered call's average return even though it is only responsible for less than 10% of its risk. Figelman (2009) reports that over the period March 1994 through September 2005, equity and volatility risk premium each contributed 2.9% to the at-the-money covered call's annual expected return.[4] Our decomposition over the period March 1996 through December 2014 shows a moderately higher equity risk premium and lower volatility risk premium. Although equity timing has also realized moderately positive returns over our sample, the 0.6% annualized return is not statistically significant given its 4.9% annualized volatility. More importantly, it is unclear why this method of equity timing would be a compensated risk premium and its alpha to S&P 500 is nearly zero.

We repeat the exercise for a strategy mimicking the CBOE S&P 500 2% OTM BuyWrite Index. The average call option delta in this strategy is 0.31. **Table 2** reports the results. Mechanically, the out-of-the-money covered call strategy has higher equity risk exposure and collects more equity risk premium than does its at-the-money counterpart. Out-of-the-money options have lower short volatility exposure than do at-the-money options. They have lower convexity as represented by gamma and they have lower exposure to changes in the options' implied volatilities as represented by vega. In this case, we do not see a significant impact to the risk or return of the short volatility exposure indicating that the 2% OTM delta-hedged call option is not materially different than an at-the-money delta-hedged call option.

These two examples demonstrate how our performance attribution allows us to determine portfolio construction's effect on risk exposures and realized returns. For instance, option strike selection influences exposure to passive equity, short volatility, and active equity. Other decisions such as option maturity selection and amount of the portfolio that is overwritten also impact these exposures. Further, delta-hedged option risk-adjusted performance may depend on the option's strike and maturity. Our proposed performance attribution methodology may help portfolio managers evaluate and improve the design of their covered call strategies.

Covered Calls Bet on Equity Reversals

The active equity exposure identified in our performance attribution is due to option convexity, its gamma. An at-the-money call option's delta is approximately 0.5. Hence, an at-the-money covered call, which is long the equity and short the straddle, also has a 0.5 delta. However, this equity exposure changes as soon as the equity's price moves. Gamma measures the change in an option's delta with respect to a change in the underlying security's price.

Exhibit 2 shows the evolution of the CBOE BuyWrite's equity exposure across four recent expiration cycles. It is slightly above 0.5 on option initiation dates, which is when the options have

[4] Figelman (2009) decomposes covered call *expected* returns into three terms: (1) risk-free return plus (2) equity risk premium minus (3) call risk premium. Because a long call option has positive exposure to the stock, in their decomposition, the call risk premium includes equity risk premium. Our equity timing plays no role in their decomposition because its expected return is zero. We decompose the covered call's excess return into three approximately orthogonal terms. As a result, the short volatility returns are equity neutral. Because we decompose actual realized covered call returns, we are able to analyze each component's contribution to the strategy's risk in addition to their contribution to the strategy's average return.

been sold. As the index price increases, the call option's delta increases to reflect the higher probability that it will expire in the money. When the equity price falls, the call option's delta declines to reflect the higher probability that it will expire out of the money. As a result, the covered call's equity exposure is negatively related to the index price. A falling market leads to larger equity exposure and a rising market leads to smaller, but still positive equity exposure. As the call option nears its expiration, the strategy's delta has converged to either zero or one, depending on whether the index has appreciated or depreciated, respectively.

Exhibit 3 plots the actual CBOE BuyWrite equity exposure as it relates to the S&P 500's return since the date the call option was written. As expected, the BuyWrite's equity exposure ranges from zero to one, is 0.5 on average, and is negatively related to the S&P 500's return since the prior call option sale. The BuyWrite Index has active equity exposure which resembles a reversal strategy and that active exposure can at times be as large as the strategy's passive equity allocation.

The size of the at-the-money covered call's active equity exposure varies over time in a predictable manner. **Exhibit 4** plots the distribution of the covered calls' equity exposure against the number of days since the call option was sold. Immediately after the call option is sold, the strategy's delta is tightly distributed around 0.5. As time passes, the covered call's delta disperses and by the time the option expires, the delta has settled on either zero or one. The active exposure is smallest immediately after the call option is sold, largest immediately prior to the option's expiration, and the average absolute active exposure is approximately 0.25.

Risk-Managed Covered Calls

Our covered call performance attribution indicates that active equity exposure is a significant source of risk and our analysis of the relationship between the covered call's equity exposure and the S&P 500's index level shows why. Because the covered call's equity exposure is known *ex ante* and equity exposure is easily hedged with instruments such as futures or ETFs,[5] we propose a risk-managed covered call strategy that hedges away the undesirable active equity exposure. After doing so, the resulting risk-managed covered call is effectively a long equity and short volatility portfolio, whose risk and return arise from these two exposures.

The proposed strategy is straightforward. We begin with an existing covered call allocation. Each day, we compute its equity exposure according to the Black-Scholes model. We hedge the active equity exposure using S&P 500 index futures. For instance, on September 30, 2014, the CBOE BuyWrite Index was short a 2020 strike call option expiring on October 17, 2014. The delta of that call option according to Black-Scholes is 0.15. Because the passive equity exposure of the at-the-money BuyWrite Index is 0.5, we hedge our strategy with a short futures position sized at 35% of NAV. We repeat this exercise each day.

Table 3 reports performance statistics for the CBOE S&P 500 BuyWrite Index (BXM) and CBOE S&P 500 2% OTM BuyWrite Index (BXY) and for the two indices after we employ our risk management process. Hedging the covered call strategy's active equity exposure successfully reduced the strategies' volatilities. Hedging reduced BXM's volatility from 11.4% to 9.2%, thereby

[5] Bakshi and Kapadia (2005) document the existence of a volatility risk premium in their analysis of delta-hedged option returns. They show that the sign of the volatility risk premium provides the sign of the expected delta-hedged option return, even when volatility follows a stochastic process. Similarly, Figelman (2009) shows that the volatility risk premium is not explained by stock index's returns not following a normal distribution.

increasing its Sharpe ratio from 0.37 to 0.52. Similarly, hedging reduced BXY's volatility from 13.3% to 12.4% and increased its Sharpe ratio from 0.41 to 0.46.

The BuyWrite indices have asymmetric betas in part because of their active equity reversal exposures. As the S&P 500 declines in value, their exposures to the index increases and vice versa. As a result, both BuyWrite indices have higher exposure to the S&P 500's losses than to its gains. For example, the at-the-money BuyWrite Index has 0.85 downside beta and 0.46 upside beta. Our proposed risk management process brings these two exposures closer to parity, resulting in a 0.59 downside beta and 0.49 upside beta. The remaining asymmetry in beta is due to short volatility exposure.

Conclusion

Many investors seek to protect their portfolios by purchasing equity index options. As a result, options tend to include a risk premium as a form of compensation to option sellers. Covered calls, which are short options, collect this volatility risk premium in addition to the equity risk premium earned from their long equity exposure. Because of option convexity, covered calls also embed active equity exposure which behaves like a reversal strategy.

Unfortunately, covered calls are rarely considered in terms of their risk exposures. Our paper introduces a novel performance attribution methodology that decomposes the strategy's return into its passive and active equity and short volatility exposures. Not only does the performance attribution of our samples allow covered call investors to better understand the strategy's characteristics, but it also allows portfolio managers to assess the risk and return impact of portfolio construction decisions, such as the call option's strike and maturity, so that they may improve their strategy.

As an example, our paper proposes a risk-managed covered call to hedge away the uncompensated active equity exposure, which is a significant contributor to the covered call's risk. Our proposed strategy has similar expected returns to the original covered call, but with lower risk, lower downside beta, and a higher Sharpe ratio. And while the motivation for covered calls is often confusing and muddled by a number of myths, the motivation for the risk-managed covered call is clear: earn the equity and volatility risk premium by constructing a portfolio with long equity and short volatility exposure.

With these motives clearly established, creating custom portfolio solutions for those with increased flexibility can be a straightforward exercise. Those who seek to collect more volatility risk premium than is provided by a traditional covered call can sell more options to increase their short volatility exposure. Others who wish to supplement rather than replace their equity exposure with short volatility exposure can sell delta-neutral straddles rather than a delta-reducing call option. The (risk-managed) at-the-money covered call is but one choice along a continuum of possible allocations to long equity and short volatility for those who seek to earn the equity and volatility risk premia.

Related Studies

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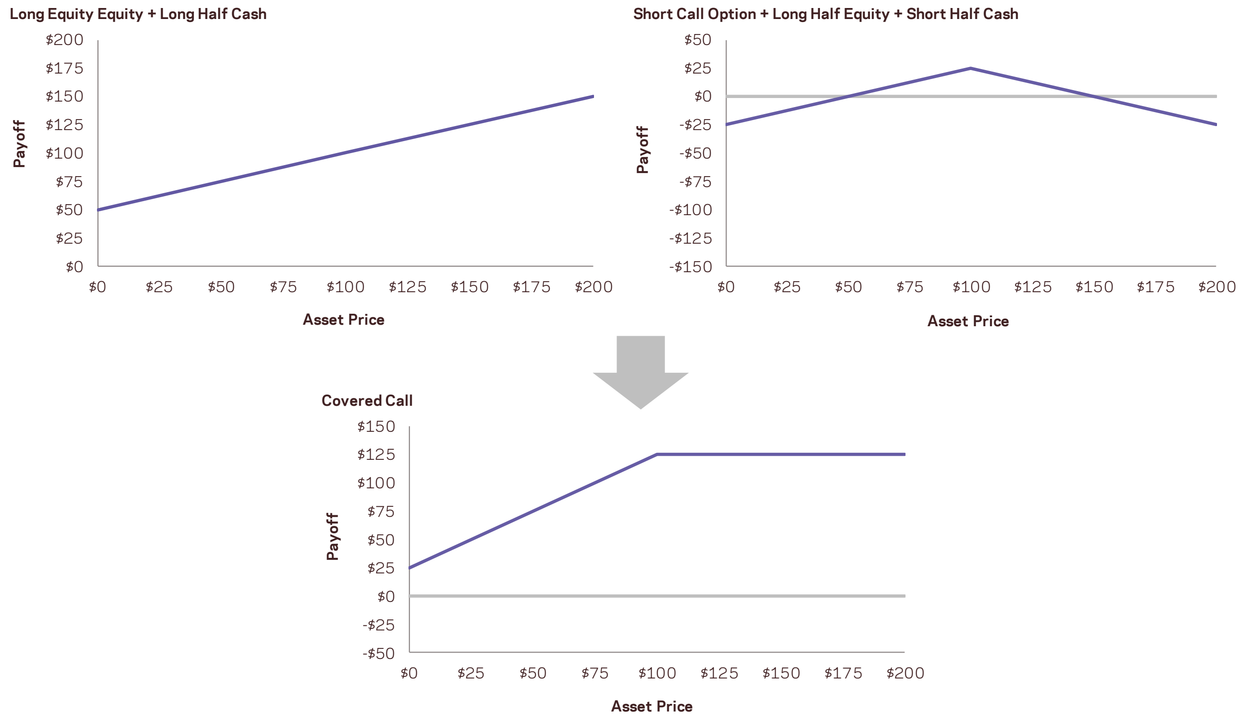
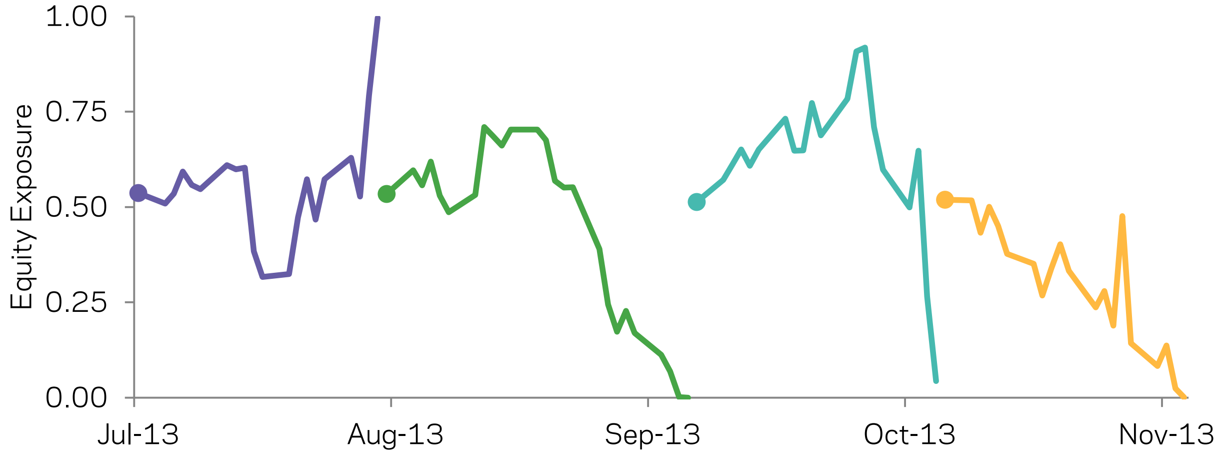
Exhibit 1 – Covered Call Payoff Diagram



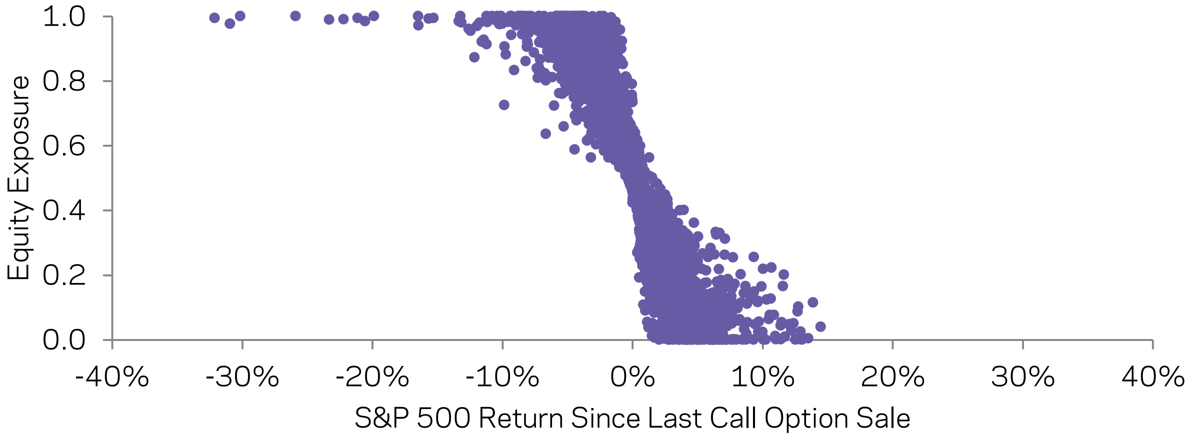
Source: AQR. For illustrative purposes only and not reflective of any investment product.

Exhibit 2 – CBOE S&P 500 BuyWrite Index's Delta Sample



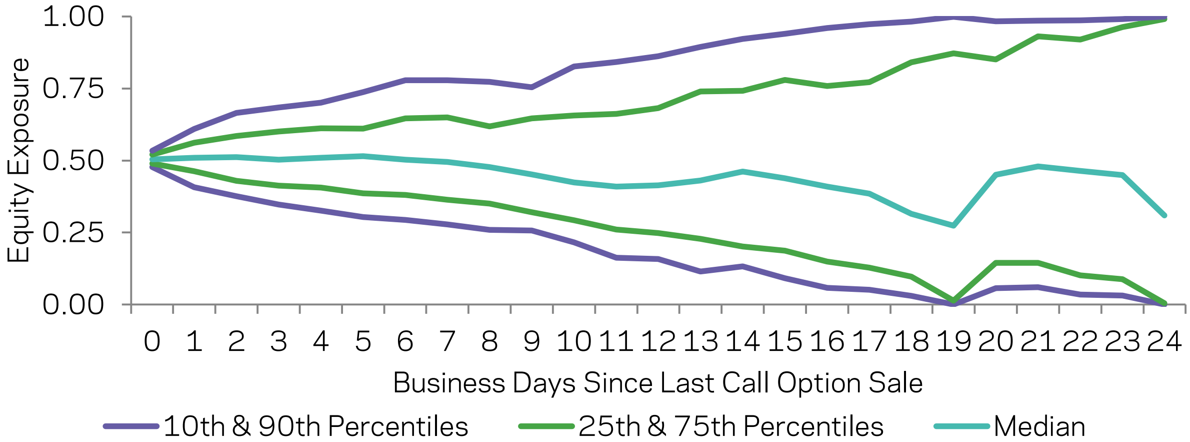
Source: AQR. For illustrative purposes only and not reflective of any investment product. Broad-based securities indices are unmanaged and are not subject to fees and expenses typically associated with managed accounts or investment funds. Investments cannot be made directly in an index. Equity exposure computed according to Black-Scholes model on the CBOE S&P 500 BuyWrite Index.

Exhibit 3 – CBOE BuyWrite Equity Exposure vs. S&P 500 Return



Source: AQR. For illustrative purposes only and not reflective of any investment product. Broad-based securities indices are unmanaged and are not subject to fees and expenses typically associated with managed accounts or investment funds. Investments cannot be made directly in an index. Equity exposure computed according to Black-Scholes model on the CBOE S&P 500 BuyWrite Index. Returns are for the period from March 25, 1996 to December 31, 2013.

Exhibit 4 – Range of CBOE S&P 500 BuyWrite Index's Deltas



Source: AQR. For illustrative purposes only and not reflective of any investment product. Broad-based securities indices are unmanaged and are not subject to fees and expenses typically associated with managed accounts or investment funds. Investments cannot be made directly in an index. Equity exposure computed according to Black-Scholes model on the CBOE S&P 500 BuyWrite Index. Chart and statistics are based on the period from March 25, 1996 to December 31, 2013.

Table 1: At-The-Money Overwriting Sample Return Decomposition (Annualized)

	Passive Equity	Short Volatility	Equity Timing
Excess Return	3.4%	1.8%	0.6%
Volatility	8.2%	2.0%	4.9%
Sharpe Ratio	0.41	0.94	0.11
Risk Contribution	64%	7%	28%
Alpha to S&P 500	--	1.6%	-0.0%

Source: AQR. For illustrative purposes only. Excess Returns are gross of fees. Performance is hypothetical, and is not based on an actual portfolio or account, See important disclosures relating to hypothetical results at the end of this paper. Statistics are calculated over the period March 25, 1996 to December 31, 2014.

Table 2: At-The-Money Overwriting Sample
Return Decomposition (Annualized)

	Passive Equity	Short Volatility	Equity Timing
Excess Return	4.8%	1.7%	0.5%
Volatility	11.5%	1.9%	4.3%
Sharpe Ratio	0.41	0.93	0.12
Risk Contribution	83%	5%	12%
Alpha to S&P 500		1.5%	0.3%

Source: AQR. For illustrative purposes only. Excess Returns are gross of fees. Performance is hypothetical, and is not based on an actual portfolio or account, See important disclosures relating to hypothetical results at the end of this paper. Statistics are calculated over the period March 25, 1996 to December 31, 2014.

Table 3: Summary Statistics
Return Decomposition (Annualized)

	S&P 500	BXM	Hedged BXM	BXY	Hedged BXY
Excess Return (Geometric)	5.3%	4.2%	4.8%	5.4%	5.8%
Volatility	16.4%	11.4%	9.2%	13.3%	12.4%
Sharpe Ratio	0.32	0.37	0.52	0.41	0.46
Beta to S&P 500 Index	1.00	0.62	0.54	0.76	0.75
- Upside Beta	1.00	0.46	0.49	0.61	0.71
- Downside Beta	1.00	0.85	0.59	0.89	0.78

Source: AQR using S&P 500 Total Return Index and CBOE S&P 500 BuyWrite Index reported over the period April 1, 1996 to December 31, 2014. Returns are excess of cash (US 3-Month LIBOR). Annualized volatility and betas are computed using 21-day overlapping returns.

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