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Research Paper

Covering the world: global evidence on covered calls

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ABSTRACT

Typical covered call strategies may be decomposed, using a risk and performance attribution methodology, into three components: equity exposure, short volatility exposure and equity timing. This paper applies that attribution methodology to covered calls on eleven global indexes. We find that the relative risk and return contributions of the three components are remarkably consistent across our cross-section of indexes. Across the board, the covered call's equity exposure is responsible for most of the strategy's risk and return, while the short volatility exposure has the highest Sharpe ratio of the strategy's components. The returns from the equity timing exposure are statistically insignificant in all eleven indexes, yet this exposure contributes a relatively large amount of the strategy's risk. These results provide further evidence that managing equity exposure in covered calls provides superior risk-adjusted returns. Further, a globally diversified portfolio of risk-managed covered calls may be viewed as a defensive alternative to global equity, providing similar returns with lower volatility and lower drawdowns.

Keywords: covered call; call overwriting; options; volatility risk premium; BuyWrite; PutWrite.

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1 INTRODUCTION

Covered calls written on the Standard & Poor's 500 (S&P 500) index are often described as providing "equity-like" returns with lower volatility. An at-the-money (ATM) covered call has a beta of approximately 0.5 to the underlying equity index, which is what drives the lower volatility relative to the underlying index. Less equity exposure means less equity risk premium is captured, but selling call options earns the volatility risk premium, which replaces much of the lost equity risk premium. Thus, the S&P 500 index covered call earns "equity-like" returns while realizing substantially lower volatility by combining lowly correlated long equity and short volatility exposures.[1]

However, there is more to the story regarding a covered call's equity exposure. As the underlying index's value increases, for example, the call option's equity exposure also increases. This means the portfolio's equity exposure will decrease since it is short the call option. The covered call's equity exposure is therefore dynamic, changing in negative relation to its underlying index's value. The strategy's equity exposure also depends on the option's implied volatility. Even the simple passing of time, ceteris paribus, affects the covered call's equity exposure. The resulting dynamic equity exposure adds risk to the strategy, yet it should not influence the strategy's expected returns if equity markets are efficient.[2]

Israelov and Nielsen (2015), henceforth IN2015, attribute the performance of an ATM S&P 500 index covered call to its (1) passive equity, (2) short volatility and (3) dynamic equity exposures. They report that the three components earned annualized returns of 3.5%, 1.9% and 0.5%, respectively, over the period beginning March 1996 and ending December 2014. The three components' respective variance contributions were 67%, 7% and 26%. They do not find a persuasive reason for dynamic equity exposure having a positive expected return. They conclude their paper by comparing a traditional covered call strategy (CBOE S&P 500 BuyWrite Index) with a risk-managed version of the strategy that hedges the dynamic equity exposure. Hedging had little impact on the strategy's average return but reduced its annualized volatility from 11.4% to 9.2%, thereby increasing its geometric Sharpe ratio from 0.37 to 0.52.

The volatility risk premium is not isolated to S&P 500 index options. Londono (2011) computes the volatility risk premium that is priced in options on eight global indexes (including the S&P 500) and finds that, on average, options are richly priced (their implied volatilities are higher than their underlying indexes' realized volatilities) in all of them. Fallon *et al* (2015) also show that the volatility risk premium exists

[1] However, the covered call strategy does add risk relative to a 0.5-beta equity strategy.
[2] Or are at least efficient with respect to the covered call's dynamic equity exposure.

across eleven global equity indexes. Thus, one might expect that global index covered calls can also serve as equity replacements for their underlying equity indexes.

This paper explores whether IN2015's findings extend globally. We find that they do. Specifically, we apply IN2015's performance attribution to an extended set of covered calls written on eleven global equity indexes (including the S&P 500 index), and we observe that the risk and return contributions on global covered calls are remarkably similar to those reported by IN2015 for covered calls written on the S&P 500 index.[3]

We continue by testing the risk-managed covered call approach suggested by IN2015 in each of the eleven indexes. Consistent with their results in the S&P 500, we find that hedging decreased volatility and increased the average Sharpe ratio. Concluding, we analyze global portfolios of hedged equity index covered calls, which can provide investors with a globally diversified exposure to equities and a globally diversified exposure to short volatility, without the uncompensated equity timing exposure inherent in traditional covered call implementations. We show that, compared with their constituent single-asset covered call strategies, illustrative globally diversified covered call portfolios have realized similar arithmetic returns but with lower volatility and consequently improved Sharpe ratios.

2 COVERED CALL DECOMPOSITION

IN2015 show how the covered call may be split into three economically distinct components:[4]

$$\begin{aligned}
\text{covered call} &= \text{equity} - \text{call} \\
&= (1 - \text{initial call delta}) \times \text{equity} && \text{(passive equity)} \\
&\quad - (\text{call} - \text{call delta} \times \text{equity}) && \text{(short volatility)} \\
&\quad + (\text{initial call delta} - \text{call delta}) \times \text{equity} && \text{(dynamic equity)}.
\end{aligned}$$

The passive equity exposure, which is less than 1.0 by construction, earns the equity risk premium. It represents the strategy's long-term average allocation to equity markets. For example, an out-of-the-money covered call has a greater allocation to equity markets and earns more equity risk premium than does an ATM covered call.

Short volatility exposure comes from the delta-neutralized short call option and adds volatility risk premium to the covered call strategy. Equity index options tend

[3] The indexes used are S&P 500, DAX, Euro Stoxx 50, FTSE 100, Hang Seng, Hang Seng China Enterprises, KOSPI 200, NASDAQ 100, Nikkei 225, Russell 2000 and Swiss Market Index.
[4] The online appendix provides details on actual return computations.

to be richly priced relative to their fair values (ie, their implied volatilities tend to be higher than the coincident volatility realized by their underlying indexes). Thus, selling these richly priced options is a positive source of return for covered call strategies.

The covered call's equity exposure changes with the passage of time, the value of the underlying index and the implied volatility of the call option. This dynamic exposure to equity is close to zero on average and thus provides little to no equity risk premium. However, time-varying equity exposure is a source of risk to the strategy. Unless it predicts future returns, which it should not under efficient markets, its contribution to the strategy's expected return is zero.

3 DATA

The OptionMetrics IVY database supplies daily closing prices, implied volatilities, dividends and option deltas through September 2015 for the eleven equity indexes analyzed in this paper.[5] The start dates vary by index, but data for all eleven indexes are available by January 2006. Underlying equity index values and US London Interbank Offered Rate (Libor) are from Bloomberg. Equity index futures returns were also derived from Bloomberg data.[6]

4 PERFORMANCE ATTRIBUTION

Before attributing global equity index covered call performance to (passive and dynamic) equity exposures and to volatility exposure, we begin by comparing performance with the respective underlying equity indexes. Table 1 reports summary statistics for the strategies, with full sample statistics provided in part (a) and

[5] For US indexes, OptionMetrics provides "best bid" and "best offer" prices, and we calculate the option price as the midpoint between these two values. More specifically, before March 4, 2008, the "best bid" and "best offer" refer to "the best, or highest, closing bid [or ask, respectively] price across all exchanges on which the option trades", while after that date they refer to the "best, or highest, 15:59 EST bid [or ask] price across all exchanges on which the option trades". For European and Asian indexes, for each option on a given date, we use the price specified by the "calculation price" field; this is typically the settlement price provided by the exchange, but on some occasions it can be the last traded price, the bid, the ask or the average of the bid and ask.

[6] Our full-sample backtest start dates are: January 22, 2002 for DAX, Euro Stoxx 50 (SX5E), Swiss Market Index (SMI) and FTSE 100 (UKX); March 25, 1996 for S&P 500 (SPX), NASDAQ 100 (NDX) and Russell 2000 (RUT); May 17, 2004 for KOSPI 200 (KOSPI2); July 13, 2004 for Nikkei 225 (NKY); and January 30, 2006 for Hang Seng China Enterprises (HSCEI) and Hang Seng Index (HSI).

matched-sample statistics over the period beginning in January 2006 and ending in September 2015 in part (b).

On average, over the full sample, global covered calls delivered 6.6% annualized returns versus 7.2% for the underlying indexes and 14.8% annualized volatility versus 21.2% for the underlying indexes, with an average Sharpe ratio of 0.45 versus 0.33 for the underlying indexes. Due to the benefit of reduced volatility drag, covered calls' annualized geometric excess returns were 5.4% on average versus 4.5% for their underlying indexes. Maximum peak-to-trough drawdowns were also lower on average for covered calls: 45% versus 63% for their respective indexes. In sum, we find global evidence in favor of equity index covered calls providing equity-like returns with lower volatility and smaller drawdowns.

We now turn to our performance attribution. Figure 1 graphically summarizes the three components' (passive equity, short volatility and dynamic equity) matched-sample performance across the eleven indexes. The passive equity component has generally had the highest return contribution, short volatility has tended to realize the highest Sharpe ratio, and dynamic equity has on average been uncompensated. The passive equity component has been the most volatile, followed by the dynamic equity component and then finally by the short volatility component. The uncompensated dynamic equity component has realized more than twice the volatility of the compensated short volatility component in traditional covered calls.

Tables 2, 3 and 4 report, respectively, detailed statistics by index for the passive equity, short volatility and dynamic equity components of the covered call strategies. Part (a) reports full sample statistics and part (b) reports matched-sample statistics. Part (c) reports matched-sample cross-index correlations. We focus our discussion on matched-sample results, noting that conclusions drawn over the full sample are similar.

On average, passive equity exposure (see Table 2) delivered 3.6% annualized arithmetic returns with 11.5% annualized volatility and a Sharpe ratio of 0.31. Passive equity exposure was the dominant source of risk for covered calls, responsible for 70% of the strategies' variance on average. This is very similar to IN2015's finding that the passive equity component was responsible for 67% of the S&P 500 covered call's variance. The passive equity components' average cross-index correlations were all in the 0.6–0.8 range, with an average of 0.7.

Short volatility exposure (see Table 3), however, was the smallest contributor to covered call risk, as measured by its volatility and its variance contribution. Its annualized volatility was 2.7% on average, about a quarter the size of the passive equity component's volatility. Short volatility was responsible for 7% of the covered calls' variance on average, identical to IN2015's finding for the S&P 500. Yet, short volatility was also responsible for 37% of the covered calls' return, delivering 1.9% per year on average in volatility risk premium with an average Sharpe ratio of 0.74, which

TABLE 1 Global equity and covered call summary statistics. [Table continues on next three pages.]

(a) Full sample (through September 2015)

	DAX		HSCEI		HSI		KOSPI2		NDX		NKY	
	EQ	**CC**	**EQ**	**CC**	**EQ**	**CC**	**EQ**	**CC**	**EQ**	**CC**	**EQ**	**CC**
Excess return (simple)	5.7%	4.5%	11.4%	9.4%	8.1%	9.2%	10.2%	11.5%	11.7%	8.0%	6.6%	4.6%
Excess return (geom.)	3.0%	3.3%	6.2%	7.0%	5.0%	7.9%	8.3%	11.1%	7.9%	6.3%	3.8%	3.0%
Volatility	21.6%	15.1%	31.7%	21.0%	23.6%	15.6%	19.9%	13.4%	25.7%	16.4%	22.0%	16.4%
Sharpe ratio (simple)	0.26	0.30	0.36	0.45	0.34	0.59	0.51	0.86	0.45	0.49	0.30	0.28
Max. drawdown	−62%	−39%	−74%	−63%	−64%	−49%	−53%	−38%	−85%	−56%	−63%	−53%
Skew	−0.8	−1.1	0.0	−0.7	−0.2	−0.9	−0.4	−0.9	−0.3	−1.3	−0.8	−2.2
Kurtosis	2.2	6.3	1.3	5.0	2.1	6.0	2.4	6.3	2.0	5.3	3.3	11.3
Beta to equity	1.00	0.62	1.00	0.58	1.00	0.58	1.00	0.60	1.00	0.56	1.00	0.66
• Upside beta	1.00	0.55	1.00	0.36	1.00	0.40	1.00	0.46	1.00	0.41	1.00	0.35
• Downside beta	1.00	0.81	1.00	0.86	1.00	0.81	1.00	0.83	1.00	0.81	1.00	0.95

TABLE 1 Continued.

(a) Full sample (through September 2015) (continued)

	RUT		SMI		SPX		SX5E		UKX		Avg	
	EQ	**CC**	**EQ**	**CC**	**EQ**	**CC**	**EQ**	**CC**	**EQ**	**CC**	**EQ**	**CC**
Excess return (simple)	7.2%	5.8%	5.0%	2.6%	6.3%	5.8%	3.2%	6.0%	3.9%	4.8%	7.2%	6.6%
Excess return (geom.)	4.8%	4.7%	3.3%	1.8%	4.7%	5.1%	0.4%	4.8%	2.2%	4.1%	4.5%	5.4%
Volatility	20.9%	14.8%	16.5%	11.9%	16.2%	11.3%	19.9%	14.7%	15.8%	11.8%	21.2%	14.8%
Sharpe ratio (simple)	0.34	0.39	0.30	0.22	0.39	0.51	0.16	0.41	0.25	0.41	0.33	0.45
Max. drawdown	–61%	–48%	–56%	–34%	–62%	–39%	–61%	–42%	–48%	–36%	–63%	–45%
Skew	–0.6	–1.6	–0.7	–1.0	–0.7	–1.7	–0.6	–0.8	–0.9	–1.4	–0.5	–1.2
Kurtosis	2.6	7.5	2.1	4.3	3.2	8.8	1.6	4.0	2.9	5.9	2.3	6.4
Beta to equity	1.00	0.64	1.00	0.65	1.00	0.62	1.00	0.68	1.00	0.67	1.00	0.62
• Upside beta	1.00	0.45	1.00	0.50	1.00	0.45	1.00	0.60	1.00	0.55	1.00	0.46
• Downside beta	1.00	0.89	1.00	0.82	1.00	0.86	1.00	0.81	1.00	0.83	1.00	0.84

TABLE 1 Continued.

(b) Matched sample (January 2006 to September 2015)

	DAX		HSCEI		HSI		KOSPI2		NDX		NKY	
	EQ	**CC**	**EQ**	**CC**	**EQ**	**CC**	**EQ**	**CC**	**EQ**	**CC**	**EQ**	**CC**
Excess return (simple)	6.9%	3.3%	11.4%	9.4%	8.1%	9.2%	5.4%	8.5%	10.7%	4.2%	3.9%	2.7%
Excess return (geom.)	4.6%	2.2%	6.2%	7.0%	5.0%	7.9%	3.0%	7.6%	8.9%	3.1%	0.5%	0.9%
Volatility	20.7%	14.3%	31.7%	21.0%	23.6%	15.6%	20.0%	13.9%	18.8%	13.1%	23.0%	17.3%
Sharpe ratio (simple)	0.33	0.23	0.36	0.45	0.34	0.59	0.27	0.61	0.57	0.32	0.17	0.16
Max. drawdown	–57%	–39%	–74%	–63%	–64%	–49%	–53%	–38%	–55%	–47%	–63%	–53%
Skew	–0.8	–1.7	0.0	–0.7	–0.2	–0.9	–0.5	–0.9	–1.0	–2.0	–0.7	–2.1
Kurtosis	2.3	7.2	1.3	5.0	2.1	6.0	2.8	6.3	3.4	8.6	2.9	10.2
Beta to equity	1.00	0.61	1.00	0.58	1.00	0.58	1.00	0.62	1.00	0.63	1.00	0.66
• Upside beta	1.00	0.45	1.00	0.36	1.00	0.40	1.00	0.47	1.00	0.42	1.00	0.35
• Downside beta	1.00	0.85	1.00	0.86	1.00	0.81	1.00	0.83	1.00	0.87	1.00	0.96

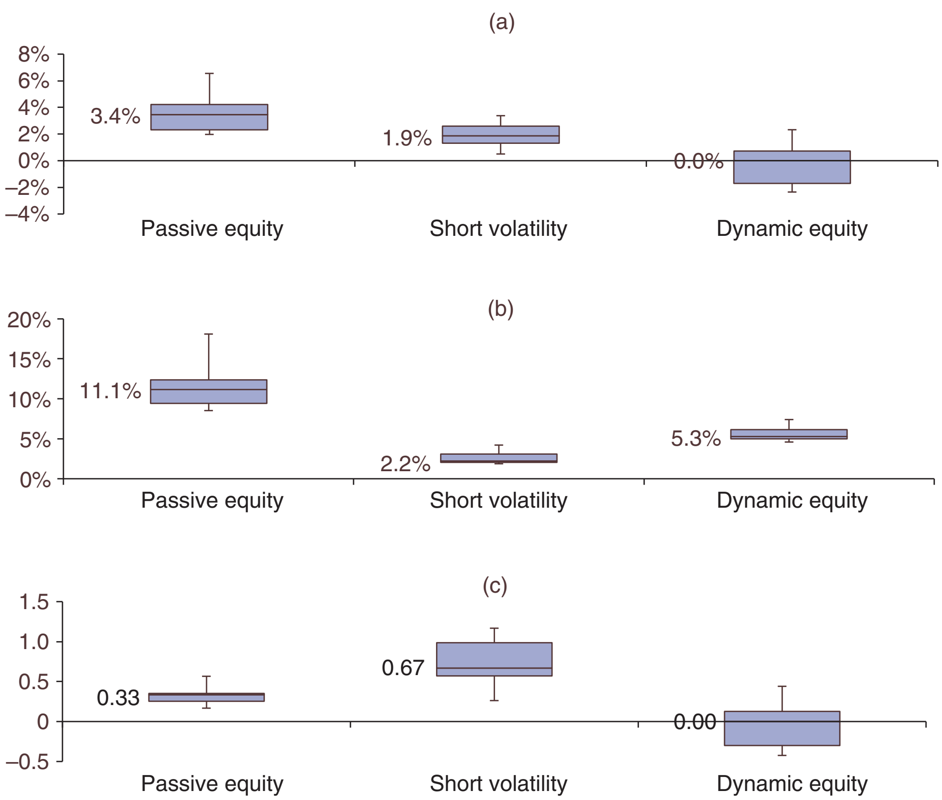
TABLE 1 Continued.

(b) Matched sample (January 2006 to September 2015) (continued)

	RUT		SMI		SPX		SX5E		UKX		Avg	
	EQ	**CC**	**EQ**	**CC**	**EQ**	**CC**	**EQ**	**CC**	**EQ**	**CC**	**EQ**	**CC**
Excess return (simple)	7.3%	6.2%	4.0%	1.1%	6.6%	5.2%	3.5%	4.0%	4.2%	4.1%	6.5%	5.3%
Excess return (geom.)	4.0%	4.7%	2.4%	0.1%	4.8%	4.3%	0.7%	2.7%	2.4%	3.3%	3.9%	4.0%
Volatility	21.5%	15.9%	16.2%	11.5%	16.4%	12.0%	20.0%	14.6%	16.2%	12.1%	20.7%	14.7%
Sharpe ratio (simple)	0.34	0.39	0.25	0.10	0.40	0.44	0.17	0.28	0.26	0.34	0.32	0.35
Max. drawdown	–61%	–48%	–56%	–34%	–57%	–39%	–61%	–42%	–48%	–36%	–59%	–44%
Skew	–0.8	–1.7	–0.7	–1.1	–1.1	–2.0	–0.6	–1.2	–0.8	–1.5	–0.7	–1.4
Kurtosis	4.1	9.7	1.7	4.3	5.3	11.3	1.5	4.0	2.7	6.1	2.7	7.2
Beta to equity	1.00	0.67	1.00	0.63	1.00	0.67	1.00	0.67	1.00	0.66	1.00	0.64
• Upside beta	1.00	0.55	1.00	0.43	1.00	0.55	1.00	0.53	1.00	0.51	1.00	0.46
• Downside beta	1.00	0.88	1.00	0.83	1.00	0.85	1.00	0.86	1.00	0.84	1.00	0.86

Source: OptionMetrics, CBOE, Bloomberg. The tables show summary statistics for various global equity indexes (columns labeled "EQ") and ATM covered call strategies (columns labeled "CC"), mimicking the methodology of the CBOE S&P 500 BuyWrite Index (BXM). For each index, the backtest is long the underlying equity and short ATM front-month call options, held to expiry (more details on the calculation in the online appendix). Returns are excess of US three-month Libor. Volatility, skew, kurtosis, beta, upside beta and downside beta were all computed using twenty-one-day overlapping returns. The end date for all series was September 30, 2015. In panel (a), the start dates are: January 22, 2002 for DAX, Euro Stoxx 50 (SX5E), Swiss Market Index (SMI) and FTSE 100 (UKX); March 25, 1996 for S&P 500 (SPX), NASDAQ 100 (NDX) and Russell 2000 (RUT); May 17, 2004 for KOSPI 200 (KOSPI2); July 13, 2004 for Nikkei 225 (NKY); and January 30, 2006 for Hang Seng China Enterprises (HSCEI) and Hang Seng Index (HSI). Panel (b) is a matched sample starting on January 30, 2006. For illustrative purposes only.

FIGURE 1 Matched-sample performance charts for covered call components: (a) average annualized return (arithmetic), (b) annualized volatility and (c) Sharpe ratio.



Source: OptionMetrics, CBOE, Bloomberg. Charts show performance statistics for the passive equity, short volatility and dynamic equity components of ATM covered call strategies, mimicking the methodology of the CBOE S&P 500 BuyWrite Index (BXM). For each index, the backtest is long the underlying equity and short ATM front-month call options, held to expiry (more details on the calculation in the online appendix). These returns are then decomposed into three components: passive equity exposure, dynamic equity timing exposure due to the call option's time-varying delta and short volatility exposure. Returns are excess of US three-month Libor. Volatility was computed using twenty-one-day overlapping returns. The date range for this analysis was January 30, 2006 through September 30, 2015. The list of indexes included is: S&P 500, DAX, Euro Stoxx 50, FTSE 100, Hang Seng, Hang Seng China Enterprises, KOSPI 200, NASDAQ 100, Nikkei 225, Russell 2000 and Swiss Market Index. The points on the box-and-whisker plot represent the minimum, 25th percentile, median, 75th percentile and maximum values, across indexes. For illustrative purposes only.

is approximately 2.3 times higher than that of the underlying equity indexes. It may seem remarkable that short volatility should realize such a high Sharpe ratio over the period, given that equity markets crashed and implied volatilities spiked during the 2008 global financial crisis (GFC). It is indeed true that the maximum peak-to-trough drawdowns for the components were 6.7% on average, reaching their troughs in late 2008 for most indexes. However, this is only 2.5 times their average annualized volatility of 2.7%, so there was still ample time over the period for the Sharpe ratio to recover as the strategies earned the volatility risk premium. Finally, the short volatility components were more diversifying than the passive equity components, realizing a 0.4 average cross-index correlation.

IN2015 argue that dynamic equity exposure should not contribute to a covered call's expected returns, even though it is a significant source of risk. We confirm both claims in our global sample. On average, dynamic equity exposure (see Table 4) has realized 5.6% annualized volatility, approximately half that of the passive equity exposure. Just as IN2015 found that dynamic equity accounts for 26% of the variance in S&P 500 covered calls, we again find that, globally, the component has been responsible for approximately 23% of the covered calls' variance. Despite this, its contribution has on average detracted from performance by 0.3% per year, with six indexes seeing positive performance and five indexes seeing negative performance. Dynamic equity exposure's average return is not statistically significant in any of the indexes. These results provide additional evidence in favor of the claim that the equity timing exposure embedded in covered calls is uncompensated. Similar to the short volatility components, the dynamic equity pieces were also moderately correlated across indexes, with an average cross-index correlation of 0.4.

5 RISK-MANAGED COVERED CALLS

It is unfortunate that covered calls include a significant yet uncompensated risk arising from their dynamic equity exposure. The good news is that this exposure is hedgeable. Investors do not need to bear this risk in order to earn equity and volatility risk premiums. Portfolio managers may estimate the covered call's ex ante equity exposure via an options pricing model, such as Black–Scholes, and trade an equity instrument, such as a futures contract, to stabilize the strategy's equity exposure. Following IN2015, we do precisely that. We test risk-managed ATM covered call strategies, hedging equity exposure deviations from 0.5.

Figure 2 graphically summarizes the results, showing higher returns, lower volatilities, higher Sharpe ratios and reduced maximum peak-to-trough drawdowns for the risk-managed covered call strategies compared with the non-risk-managed versions.

Table 5 reports detailed performance statistics (gross of transaction costs) for the covered calls with and without the risk-management overlay. Given our findings from the previous section, we do not expect the risk-management overlay to have a large effect on the average excess return. In this sample, it improved annualized excess

TABLE 2 Summary statistics of covered call passive equity components. [Table continues on next two pages.]

(a) Full sample (through September 2015)

	DAX	HSCEI	HSI	KOSPI2	NDX	NKY	RUT	SMI	SPX	SX5E	UKX	Avg
Excess return (simple)	3.0%	6.6%	4.5%	5.7%	6.2%	4.0%	3.9%	2.8%	3.3%	1.8%	2.1%	4.0%
Excess return (geom.)	2.3%	5.0%	3.6%	5.2%	5.3%	3.0%	3.3%	2.3%	2.9%	0.9%	1.6%	3.2%
Volatility	11.4%	18.1%	13.1%	11.1%	13.5%	13.4%	11.3%	9.1%	8.4%	11.3%	8.5%	11.8%
Sharpe ratio (simple)	0.26	0.36	0.34	0.51	0.46	0.30	0.34	0.30	0.39	0.16	0.25	0.33
Max. drawdown	−38%	−52%	−42%	−33%	−59%	−43%	−38%	−35%	−36%	−40%	−28%	−40%
Skew	−0.9	−0.1	−0.3	−0.6	−0.4	−0.9	−0.7	−0.8	−0.8	−0.7	−0.9	−0.6
Kurtosis	2.5	1.5	2.4	2.9	2.1	3.7	2.9	2.2	3.5	1.8	3.1	2.6
Risk contribution	70%	72%	68%	70%	69%	74%	68%	71%	67%	72%	69%	70%
T-stat. of excess return	0.9	1.1	1.0	1.6	1.8	0.9	1.4	1.0	1.5	0.5	0.8	1.1
Beta to equity	0.53	0.57	0.56	0.56	0.53	0.61	0.54	0.55	0.52	0.57	0.54	0.55
• Upside beta	0.52	0.56	0.54	0.54	0.51	0.59	0.53	0.54	0.51	0.56	0.53	0.54
• Downside beta	0.54	0.59	0.57	0.57	0.54	0.62	0.55	0.56	0.53	0.58	0.55	0.56

TABLE 2 Continued.

(b) Matched sample (January 2006–September 2015)												
	DAX	**HSCEI**	**HSI**	**KOSPI2**	**NDX**	**NKY**	**RUT**	**SMI**	**SPX**	**SX5E**	**UKX**	**Avg**
Excess return (simple)	3.6%	6.6%	4.5%	3.0%	5.6%	2.3%	3.9%	2.2%	3.4%	2.0%	2.3%	3.6%
Excess return (geom.)	3.1%	5.0%	3.6%	2.3%	5.3%	1.2%	3.1%	1.8%	3.0%	1.1%	1.8%	2.8%
Volatility	10.9%	18.1%	13.1%	11.1%	9.9%	14.0%	11.7%	8.9%	8.5%	11.4%	8.8%	11.5%
Sharpe ratio (simple)	0.33	0.36	0.34	0.27	0.57	0.17	0.34	0.25	0.40	0.17	0.26	0.31
Max. drawdown	−35%	−52%	−42%	−33%	−33%	−43%	−38%	−35%	−34%	−40%	−28%	−38%
Skew	−0.9	−0.1	−0.3	−0.6	−1.1	−0.8	−0.9	−0.7	−1.3	−0.7	−0.9	−0.8
Kurtosis	2.7	1.5	2.4	3.3	3.8	3.4	4.6	1.8	5.8	1.7	3.0	3.1
Risk contribution	70%	72%	68%	69%	67%	74%	69%	69%	65%	73%	70%	70%
T-stat. of excess return	1.0	1.1	1.0	0.8	1.5	0.5	0.9	0.7	1.0	0.5	0.7	0.9
Beta to equity	0.53	0.57	0.56	0.56	0.53	0.61	0.54	0.55	0.52	0.57	0.54	0.55
• Upside beta	0.52	0.56	0.54	0.54	0.52	0.59	0.53	0.54	0.51	0.56	0.53	0.54
• Downside beta	0.54	0.59	0.57	0.57	0.54	0.62	0.56	0.56	0.53	0.58	0.55	0.56

TABLE 2 Continued.

(c) Correlations (January 2006–September 2015)

	DAX	HSCEI	HSI	KOSPI2	NDX	NKY	RUT	SMI	SPX	SX5E	UKX	Avg cross-correlation
DAX	1.00	0.60	0.68	0.72	0.78	0.72	0.80	0.79	0.84	0.95	0.86	0.77
HSCEI	0.60	1.00	0.93	0.70	0.58	0.55	0.55	0.49	0.60	0.59	0.62	0.62
HSI	0.68	0.93	1.00	0.75	0.68	0.62	0.65	0.58	0.71	0.69	0.73	0.70
KOSPI2	0.72	0.70	0.75	1.00	0.70	0.63	0.69	0.58	0.70	0.70	0.71	0.69
NDX	0.78	0.58	0.68	0.70	1.00	0.71	0.87	0.72	0.92	0.77	0.80	0.75
NKY	0.72	0.55	0.62	0.63	0.71	1.00	0.71	0.69	0.74	0.70	0.71	0.68
RUT	0.80	0.55	0.65	0.69	0.87	0.71	1.00	0.73	0.94	0.78	0.80	0.75
SMI	0.79	0.49	0.58	0.58	0.72	0.69	0.73	1.00	0.81	0.82	0.82	0.70
SPX	0.84	0.60	0.71	0.70	0.92	0.74	0.94	0.81	1.00	0.84	0.88	0.80
SX5E	0.95	0.59	0.69	0.70	0.77	0.70	0.78	0.82	0.84	1.00	0.88	0.77
UKX	0.86	0.62	0.73	0.71	0.80	0.71	0.80	0.82	0.88	0.88	1.00	0.78
Avg cross-correlation	0.77	0.62	0.70	0.69	0.75	0.68	0.75	0.70	0.80	0.77	0.78	0.73

Source: OptionMetrics, CBOE, Bloomberg. Panels (a) and (b) show summary statistics for the passive equity components of ATM covered call strategies mimicking the methodology of the CBOE S&P 500 BuyWrite Index (BXM). Panel (c) shows the twenty-one-day correlation matrix for these components. For each index, the backtest is long the underlying equity and short ATM front-month call options, held to expiry (more details on the calculation in the online appendix). These returns are then decomposed into three components: passive equity exposure, dynamic equity timing exposure due to the call option's time-varying delta and short volatility exposure. Returns are excess of US three-month Libor. Risk contribution is defined as the covariance of the component with the full strategy, divided by the variance of the full strategy. Volatility, skew, kurtosis, beta, upside beta and downside beta were all computed using twenty-one-day overlapping returns. The end date for all series was September 30, 2015. In panel (a), the start dates are: January 22, 2002 for DAX, Euro Stoxx 50 (SX5E), Swiss Market Index (SMI) and FTSE 100 (UKX); March 25, 1996 for S&P 500 (SPX), NASDAQ 100 (NDX) and Russell 2000 (RUT); May 17, 2004 for KOSPI 200 (KOSPI2); July 13, 2004 for Nikkei 225 (NKY); and January 30, 2006 for Hang Seng China Enterprises (HSCEI) and Hang Seng Index (HSI). Panels (b) and (c) use a matched sample starting on January 30, 2006. For illustrative purposes only.

returns from 5.3% to 5.9%.[7] Risk management reduced the strategies' volatilities by 20% on average, from 14.7% for the covered call strategies to 11.7% for the risk-managed covered calls. Due to benefits of lower volatility drag, compounded annualized excess returns improved from 4.0% to 5.4%. Over a ten-year period, this translates to an improvement in compounded returns from 47.8% to 68.5% in excess of cash. With higher return and lower volatility, the risk-managed covered calls' Sharpe ratios increased on average from 0.35 to 0.51.

Actively managing covered calls' equity exposures also reduces downside risk characteristics. Risk-managed covered calls were −1.0 skewed on average versus −1.4 for their non-risk-managed counterparts. The risk-managed version of covered calls also had lower downside betas on average: 0.59 versus 0.86. Further, maximum peak-to-trough drawdowns were lower for the risk-managed version in every index. On average, maximum peak-to-trough drawdowns improved from −44% to −35% by actively managing the covered call's equity exposure.

6 TRANSACTION COSTS

We now consider the impact of trading costs on covered call strategies. Covered calls pay one-way trading costs each month when selling options. In addition, the risk-managed covered call pays trading costs each day when trading the underlying equity to bring the strategy's equity exposure back to its target.

Trading costs for options are typically reported in terms of implied volatility. For example, a call option's bid and offer "prices" may be implied volatilities of 16.0% and 16.2%. In this case, the one-way implied volatility cost of selling the option is 0.1 volatility points. If we know the annualized volatility exposure that is traded (as measured by the option Greek known as vega) and the half-spread in implied volatility points, we can compute annualized option trading cost. Similarly, for the risk-managed covered call, we can compute the annualized risk-management costs by multiplying the annualized hedging turnover by the one-way equity trading cost.

Table 6 reports the two covered call strategies' turnovers, both for the options and for the equity hedges (which would apply only to the risk-managed strategy). A relatively conservative one-way trading cost of 0.2 volatility points for options would

[7] Note that the return of the risk-management overlay for a given index is not exactly the negative of the dynamic equity component of the unhedged covered call. For one, the dynamic equity component calculation uses the full-sample average portfolio delta as the baseline for determining the portfolio's delta deviation. This number is greater than 0.5 for each index, since the call strikes are chosen to be strictly above the spot (mimicking the CBOE S&P 500 BuyWrite methodology). However, to avoid look-ahead bias, the risk-management overlay assumes 0.5 as the baseline. Another source of bias is due to an effect on expiration dates, where the market-directional exposures of the strategies change for a few hours. A similar expiration-day effect is further explored by Israelov (2016).

TABLE 3 Summary statistics of covered call short volatility components. [Table continues on next two pages.]

(a) Full sample (through September 2015)

	DAX	HSCEI	HSI	KOSPI2	NDX	NKY	RUT	SMI	SPX	SX5E	UKX	Avg
Excess return (simple)	2.1%	2.8%	3.4%	2.9%	1.0%	1.7%	3.0%	0.6%	1.9%	2.7%	2.7%	2.2%
Excess return (geom.)	2.1%	2.8%	3.5%	3.0%	1.0%	1.7%	3.1%	0.6%	1.9%	2.8%	2.8%	2.3%
Volatility	2.2%	4.2%	3.0%	2.8%	2.6%	3.7%	2.2%	2.9%	1.9%	2.5%	2.0%	2.7%
Sharpe ratio (simple)	0.94	0.66	1.12	1.04	0.41	0.47	1.35	0.21	0.97	1.10	1.34	0.87
Max. drawdown	−5%	−7%	−5%	−6%	−13%	−11%	−7%	−11%	−7%	−4%	−5%	−7%
Skew	0.2	0.6	1.0	0.3	−0.7	−1.6	−0.7	−3.3	−1.1	0.2	−0.4	−0.5
Kurtosis	2.7	4.3	4.8	3.4	5.3	24.6	3.6	28.5	5.4	3.4	3.6	8.1
Risk contribution	5%	6%	8%	9%	6%	9%	6%	6%	7%	7%	7%	7%
T-stat. of excess return	2.9	1.7	2.6	2.7	1.4	1.4	4.2	0.8	3.2	2.8	4.0	2.5
Beta to equity	0.02	0.01	0.01	0.03	0.01	0.05	0.02	0.04	0.03	0.03	0.04	0.03
• Upside beta	0.00	−0.03	−0.03	0.01	−0.02	−0.04	−0.03	−0.03	−0.02	0.02	0.01	−0.01
• Downside beta	0.03	0.08	0.05	0.04	0.05	0.13	0.06	0.11	0.09	0.05	0.06	0.07

TABLE 3 Continued.

(b) Matched sample (January 2006–September 2015)												
	DAX	**HSCEI**	**HSI**	**KOSPI2**	**NDX**	**NKY**	**RUT**	**SMI**	**SPX**	**SX5E**	**UKX**	**Avg**
Excess return (simple)	2.0%	2.8%	3.4%	3.2%	0.5%	1.8%	1.4%	0.8%	1.2%	1.9%	2.4%	1.9%
Excess return (geom.)	2.0%	2.8%	3.5%	3.2%	0.5%	1.8%	1.4%	0.8%	1.3%	1.9%	2.5%	2.0%
Volatility	2.2%	4.2%	3.0%	2.9%	1.9%	3.9%	2.1%	3.1%	1.9%	2.2%	2.0%	2.7%
Sharpe ratio (simple)	0.88	0.66	1.12	1.10	0.26	0.48	0.67	0.26	0.66	0.86	1.17	0.74
Max. drawdown	–5%	–7%	–5%	–6%	–7%	–11%	–7%	–11%	–7%	–4%	–4%	–7%
Skew	0.1	0.6	1.0	0.3	–0.8	–1.5	–1.5	–3.7	–1.6	–0.3	–0.3	–0.7
Kurtosis	2.4	4.3	4.8	3.5	3.5	22.7	6.7	30.3	9.2	1.9	3.6	8.4
Risk contribution	5%	6%	8%	10%	7%	9%	5%	8%	7%	5%	6%	7%
T-stat. of excess return	2.4	1.7	2.6	2.6	0.6	1.4	1.6	0.9	1.6	2.1	3.4	1.9
Beta to equity	0.02	0.01	0.01	0.03	0.04	0.05	0.03	0.05	0.05	0.04	0.04	0.03
• Upside beta	–0.01	–0.03	–0.03	0.02	0.00	–0.04	–0.02	–0.02	0.02	0.01	0.01	–0.01
• Downside beta	0.03	0.08	0.05	0.04	0.08	0.14	0.06	0.12	0.09	0.05	0.06	0.07

TABLE 3 Continued.

(c) Correlations (January 2006–September 2015)

	DAX	HSCEI	HSI	KOSPI2	NDX	NKY	RUT	SMI	SPX	SX5E	UKX	Avg cross-correlation
DAX	1.00	0.39	0.35	0.29	0.43	0.21	0.38	0.51	0.45	0.77	0.69	0.45
HSCEI	0.39	1.00	0.78	0.39	0.37	0.31	0.21	0.35	0.30	0.34	0.48	0.39
HSI	0.35	0.78	1.00	0.42	0.38	0.27	0.23	0.34	0.35	0.34	0.46	0.39
KOSPI2	0.29	0.39	0.42	1.00	0.19	0.29	0.10	0.27	0.13	0.21	0.37	0.27
NDX	0.43	0.37	0.38	0.19	1.00	0.19	0.66	0.33	0.78	0.51	0.42	0.43
NKY	0.21	0.31	0.27	0.29	0.19	1.00	0.14	0.21	0.28	0.19	0.30	0.24
RUT	0.38	0.21	0.23	0.10	0.66	0.14	1.00	0.19	0.78	0.46	0.35	0.35
SMI	0.51	0.35	0.34	0.27	0.33	0.21	0.19	1.00	0.32	0.45	0.58	0.35
SPX	0.45	0.30	0.35	0.13	0.78	0.28	0.78	0.32	1.00	0.57	0.47	0.44
SX5E	0.77	0.34	0.34	0.21	0.51	0.19	0.46	0.45	0.57	1.00	0.70	0.45
UKX	0.69	0.48	0.46	0.37	0.42	0.30	0.35	0.58	0.47	0.70	1.00	0.48
Avg cross-correlation	0.45	0.39	0.39	0.27	0.43	0.24	0.35	0.35	0.44	0.45	0.48	0.39

Source: OptionMetrics, CBOE, Bloomberg. Panels (a) and (b) show summary statistics for the short volatility components of ATM covered call strategies, mimicking the methodology of the CBOE S&P 500 BuyWrite Index (BXM). Panel (c) shows the twenty-one-day correlation matrix for these components. For each index, the backtest is long the underlying equity and short ATM front-month call options, held to expiry (more details on the calculation in the online appendix). These returns are then decomposed into three components: passive equity exposure, dynamic equity timing exposure due to the call option's time-varying delta and short volatility exposure. Returns are excess of US three-month Libor. Risk contribution is defined as the covariance of the component with the full strategy, divided by the variance of the full strategy. Volatility, skew, kurtosis, beta, upside beta and downside beta were all computed using twenty-one-day overlapping returns. The end date for all series was September 30, 2015. In panel (a), the start dates are: January 22, 2002 for DAX, Euro Stoxx 50 (SX5E), Swiss Market Index (SMI) and FTSE 100 (UKX); March 25, 1996 for S&P 500 (SPX), NASDAQ 100 (NDX) and Russell 2000 (RUT); May 17, 2004 for KOSPI 200 (KOSPI2); July 13, 2004 for Nikkei 225 (NKY); and January 30, 2006 for Hang Seng China Enterprises (HSCEI) and Hang Seng Index (HSI). Panels (b) and (c) use a matched sample starting on January 30, 2006. For illustrative purposes only.

cost the covered call strategies about 28 basis points (bps) per year. With an annualized volatility of about 15%, the non-risk-managed covered call's net Sharpe ratio would then be about 0.02 lower due to options trading costs, thereby decreasing on average from 0.35 to 0.33.

The risk-managed covered call trades equity (via futures or exchange-traded funds) at about 16.6 times the net asset value (NAV) per year in order to implement the hedge. Assuming a 2bp one-way trading cost for equities, this means that the risk-management overlay would have a cost of about 33bps per year. With 12% annualized volatility for the risk-managed covered call, the hedging costs reduce the Sharpe ratio by an additional 0.0275, on top of the 0.025 reduction from its option trading costs.[8] Therefore, the risk-managed covered call's net Sharpe ratio is 0.46 (versus its 0.51 gross Sharpe ratio) after accounting for both costs, which leaves it well above the 0.33 average net Sharpe ratio estimate for non-risk-managed covered calls and the 0.32 average Sharpe ratio for equities.

In other words, we estimate that the risk-managed covered calls' higher Sharpe ratio should still remain intact net of the transaction costs required to implement the risk-management overlay.

7 GLOBAL DIVERSIFICATION

A globally diversified covered call portfolio may be appropriate for investors who see a covered call as a potential equity replacement, and for those whose equity portfolios are globally diversified.[9] Table 1 showed that on average covered calls provided similar compounded returns to their respective underlying indexes, but with about three-quarters of the volatility. Table 5 then showed that on average risk-managed covered calls provided one-third higher compounded returns than their respective non-risk-managed covered calls, but with about one-fifth less risk. These results present a compelling case in favor of substituting global equity exposure with global risk-managed covered call exposure.

The covered call combines long equity, short volatility exposure and dynamic equity timing. Table 2 showed that the average long equity cross-correlation has been 0.7,

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[8] Option trading costs have a greater impact on the Sharpe ratio of the risk-managed covered call than on the non-risk-managed covered call because the risk-managed covered call has lower volatility. The return impact is the same for both strategies.

[9] Diversification is often described as the only free lunch in finance. Yet, surprisingly, the debate over the benefits of global equity diversification refuses to subside. One camp argues that equity markets crash at the same time and diversification fails when you need it most (see Hartmann *et al* 2004; Christoffersen *et al* 2010). The counterargument of Asness *et al* (2011) is that focusing on short-term crashes is too short-sighted – long-term differences in economic growth matter more than short-term panics, and long-term returns are diversifiable.

TABLE 4 Summary statistics of covered call dynamic equity components. [Table continues on next two pages.]

(a) Full sample (through September 2015)											
	DAX	**HSCEI**	**HSI**	**KOSPI2**	**NDX**	**NKY**	**RUT**	**SMI**	**SPX**	**SX5E**	**UKX**	**Avg**
Excess return (simple)	−0.5%	0.0%	1.3%	2.9%	0.8%	−1.2%	−1.0%	−0.8%	0.7%	1.4%	0.0%	0.3%
Excess return (geom.)	−0.8%	−0.5%	1.1%	2.9%	0.5%	−1.4%	−1.3%	−0.9%	0.5%	1.3%	−0.1%	0.1%
Volatility	6.1%	7.4%	5.6%	5.3%	7.0%	6.1%	6.1%	4.5%	4.7%	5.1%	4.5%	5.7%
Sharpe ratio (simple)	−0.09	0.00	0.24	0.56	0.11	−0.19	−0.17	−0.17	0.14	0.28	0.01	0.07
Max. drawdown	−28%	−30%	−19%	−15%	−23%	−22%	−35%	−25%	−17%	−15%	−19%	−22%
Skew	−0.5	−0.5	−0.5	−0.2	−0.7	−0.5	−1.0	−0.2	−1.4	−0.3	−0.9	−0.6
Kurtosis	6.4	2.5	3.7	1.7	3.7	9.5	5.9	3.0	7.5	3.4	4.7	4.7
Risk contribution	25%	22%	24%	21%	25%	17%	26%	23%	26%	21%	24%	23%
T-stat. of excess return	−0.3	0.0	0.6	1.7	0.4	−0.6	−0.7	−0.5	0.6	0.9	0.0	0.2
Beta to equity	0.07	0.00	0.01	0.01	0.02	0.01	0.08	0.05	0.07	0.07	0.09	0.04
• Upside beta	0.02	−0.16	−0.12	−0.10	−0.09	−0.20	−0.05	−0.02	−0.04	0.01	0.00	−0.07
• Downside beta	0.24	0.20	0.19	0.22	0.22	0.24	0.30	0.16	0.25	0.19	0.23	0.22

TABLE 4 Continued.

(b) Matched sample (January 2006–September 2015)

	DAX	HSCEI	HSI	KOSPI2	NDX	NKY	RUT	SMI	SPX	SX5E	UKX	Avg
Excess return (simple)	−2.3%	0.0%	1.3%	2.3%	−1.9%	−1.5%	0.9%	−1.9%	0.6%	0.2%	−0.5%	−0.3%
Excess return (geom.)	−2.6%	−0.5%	1.1%	2.3%	−2.2%	−1.7%	0.6%	−2.2%	0.4%	0.0%	−0.7%	−0.5%
Volatility	5.9%	7.4%	5.6%	5.3%	5.1%	6.4%	6.4%	4.6%	4.7%	5.3%	4.8%	5.6%
Sharpe ratio (simple)	−0.39	0.00	0.24	0.44	−0.37	−0.23	0.14	−0.42	0.12	0.03	−0.11	−0.05
Max. drawdown	−27%	−30%	−19%	−15%	−23%	−22%	−18%	−24%	−11%	−15%	−16%	−20%
Skew	−1.3	−0.5	−0.5	−0.3	−0.8	−0.5	−0.9	−0.3	−1.0	−0.7	−0.9	−0.7
Kurtosis	6.1	2.5	3.7	1.9	2.7	8.6	6.9	2.6	5.9	2.7	4.4	4.4
Risk contribution	25%	22%	24%	22%	25%	17%	26%	23%	28%	21%	24%	23%
T-stat. of excess return	−1.2	0.0	0.6	1.2	−1.0	−0.7	0.4	−1.1	0.3	0.1	−0.3	−0.2
Beta to equity	0.07	0.00	0.01	0.03	0.06	0.02	0.10	0.02	0.09	0.06	0.08	0.05
• Upside beta	−0.07	−0.16	−0.12	−0.09	−0.09	−0.20	0.02	−0.09	0.01	−0.05	−0.04	−0.08
• Downside beta	0.29	0.20	0.19	0.22	0.26	0.24	0.28	0.15	0.23	0.23	0.24	0.23

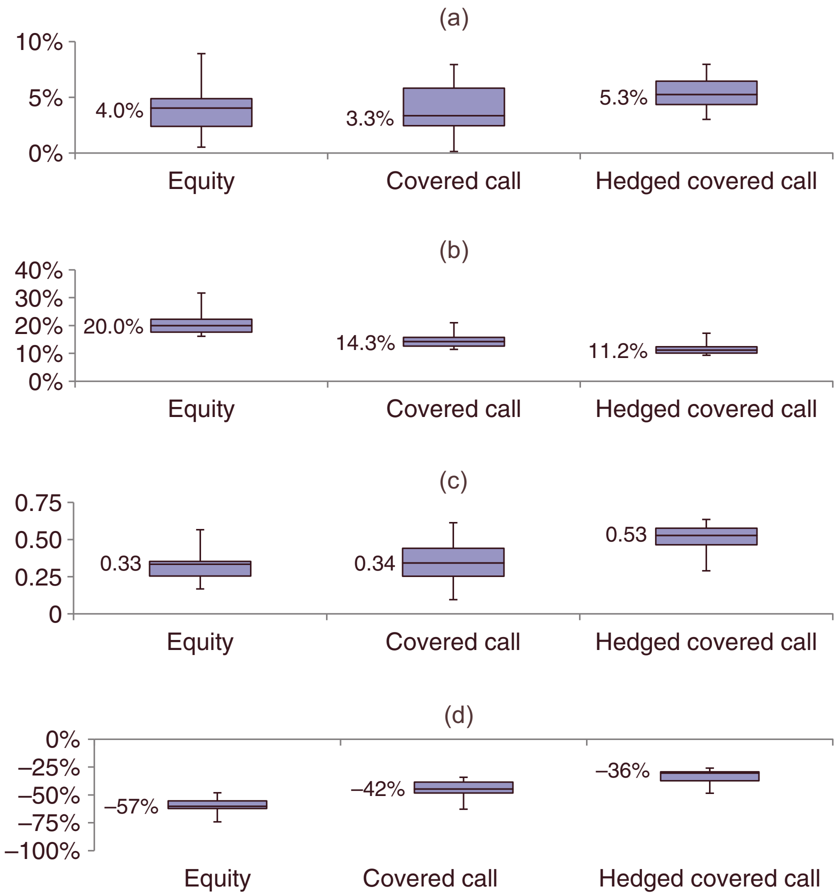
TABLE 4 Continued.

(c) Correlations (January 2006–September 2015)

	DAX	HSCEI	HSI	KOSPI2	NDX	NKY	RUT	SMI	SPX	SX5E	UKX	Avg cross-correlation
DAX	1.00	0.13	0.16	0.34	0.55	0.35	0.63	0.62	0.69	0.87	0.68	0.50
HSCEI	0.13	1.00	0.79	0.19	0.12	0.19	0.07	−0.03	0.07	0.08	0.14	0.17
HSI	0.16	0.79	1.00	0.28	0.23	0.21	0.15	−0.02	0.18	0.13	0.26	0.24
KOSPI2	0.34	0.19	0.28	1.00	0.22	0.26	0.28	0.16	0.27	0.31	0.28	0.26
NDX	0.55	0.12	0.23	0.22	1.00	0.30	0.70	0.43	0.79	0.51	0.53	0.44
NKY	0.35	0.19	0.21	0.26	0.30	1.00	0.30	0.20	0.33	0.31	0.35	0.28
RUT	0.63	0.07	0.15	0.28	0.70	0.30	1.00	0.47	0.85	0.58	0.55	0.46
SMI	0.62	−0.03	−0.02	0.16	0.43	0.20	0.47	1.00	0.59	0.66	0.56	0.36
SPX	0.69	0.07	0.18	0.27	0.79	0.33	0.85	0.59	1.00	0.69	0.69	0.52
SX5E	0.87	0.08	0.13	0.31	0.51	0.31	0.58	0.66	0.69	1.00	0.76	0.49
UKX	0.68	0.14	0.26	0.28	0.53	0.35	0.55	0.56	0.69	0.76	1.00	0.48
Avg cross-correlation	0.50	0.17	0.24	0.26	0.44	0.28	0.46	0.36	0.52	0.49	0.48	0.38

Source: OptionMetrics, CBOE, Bloomberg. Panels (a) and (b) show summary statistics for the dynamic equity components of ATM covered call strategies, mimicking the methodology of the CBOE S&P 500 BuyWrite Index (BXM). Panel (c) shows the twenty-one-day correlation matrix for these components. For each index, the backtest is long the underlying equity and short ATM front-month call options, held to expiry (more details on the calculation in the online appendix). These returns are then decomposed into three components: passive equity exposure, dynamic equity timing exposure due to the call option's time-varying delta and short volatility exposure. Returns are excess of US three-month Libor. Risk contribution is defined as the covariance of the component with the full strategy, divided by the variance of the full strategy. Volatility, skew, kurtosis, beta, upside beta and downside beta were all computed using twenty-one-day overlapping returns. The end date for all series was September 30, 2015. In panel (a), the start dates are: January 22, 2002 for DAX, Euro Stoxx 50 (SX5E), Swiss Market Index (SMI) and FTSE 100 (UKX); March 25, 1996 for S&P 500 (SPX), NASDAQ 100 (NDX) and Russell 2000 (RUT); May 17, 2004 for KOSPI 200 (KOSPI2); July 13, 2004 for Nikkei 225 (NKY); and January 30, 2006 for Hang Seng China Enterprises (HSCEI) and Hang Seng Index (HSI). Panels (b) and (c) use a matched sample starting on January 30, 2006. For illustrative purposes only.

FIGURE 2 Matched-sample performance of covered call and risk-managed covered call: (a) annualized compounded return, (b) annualized volatility, (c) Sharpe ratio and (d) maximum drawdown.



Source: OptionMetrics, CBOE, Bloomberg. The charts show performance statistics for various hedged and unhedged ATM covered call strategies, mimicking the methodology of the CBOE S&P 500 BuyWrite Index (BXM). For each index, the backtest is long the underlying equity and short ATM front-month call options, held to expiry (more details on the calculation in the online appendix). Returns are excess of US three-month Libor. Volatility was computed using twenty-one-day overlapping returns. The date range for this analysis was January 30, 2006 through September 30, 2015. The list of indexes included is: S&P 500, DAX, Euro Stoxx 50, FTSE 100, Hang Seng, Hang Seng China Enterprises, KOSPI 200, NASDAQ 100, Nikkei 225, Russell 2000 and Swiss Market Index. The points on the box-and-whisker plot represent the minimum, 25th percentile, median, 75th percentile and maximum values, across indexes. To compute the hedged series, we first simulate covered call backtests as described above. Each day, we compute the equity exposure of the call option according to the Black–Scholes model. We then hedge the "active equity exposure" using the underlying equity index futures, where the "active equity exposure" is defined as the difference between the call's delta and the expected delta of the selected call options on options rebalance dates (defined as 0.5 for the ATM backtest). The hedged covered call backtest is then derived as the sum of the unhedged series and the time series of index future hedge returns. For illustrative purposes only.

TABLE 5 Global covered call and risk-managed covered call summary statistics (matched sample; January 2006–September 2015). [Table continues on next page.]

	DAX		HSCEI		HSI		KOSPI2		NDX		NKY	
	CC	**RMCC**	**CC**	**RMCC**	**CC**	**RMCC**	**CC**	**RMCC**	**CC**	**RMCC**	**CC**	**RMCC**
Excess return (simple)	3.3%	6.8%	9.4%	9.1%	9.2%	7.6%	8.5%	5.8%	4.2%	6.8%	2.7%	4.0%
Excess return (geom.)	2.2%	6.5%	7.0%	8.0%	7.9%	7.0%	7.6%	5.3%	3.1%	6.4%	0.9%	3.0%
Volatility	14.3%	11.2%	21.0%	17.2%	15.6%	12.7%	13.9%	11.4%	13.1%	10.7%	17.3%	13.7%
Sharpe ratio (simple)	0.23	0.61	0.45	0.53	0.59	0.60	0.61	0.51	0.32	0.64	0.16	0.29
Max. drawdown	−39%	−29%	−63%	−49%	−49%	−37%	−38%	−30%	−47%	−36%	−53%	−43%
Skew	−1.7	−1.0	−0.7	−0.3	−0.9	−0.5	−0.9	−0.6	−2.0	−1.3	−2.1	−1.5
Kurtosis	7.2	2.9	5.0	2.5	6.0	3.0	6.3	3.4	8.6	5.0	10.2	7.4
Beta to equity	0.61	0.52	0.58	0.53	0.58	0.52	0.62	0.55	0.63	0.55	0.66	0.57
• Upside beta	0.45	0.49	0.36	0.49	0.40	0.49	0.47	0.52	0.42	0.51	0.35	0.46
• Downside beta	0.85	0.56	0.86	0.59	0.81	0.56	0.83	0.57	0.87	0.60	0.96	0.67

TABLE 5 Continued.

	RUT		SMI		SPX		SX5E		UKX		Avg	
	CC	RMCC	CC	RMCC	CC	RMCC	CC	RMCC	CC	RMCC	CC	RMCC
Excess return (simple)	6.2%	6.3%	1.1%	3.9%	5.2%	5.3%	4.0%	4.5%	4.1%	5.2%	5.3%	5.9%
Excess return (geom.)	4.7%	5.6%	0.1%	3.5%	4.3%	4.9%	2.7%	3.8%	3.3%	4.9%	4.0%	5.4%
Volatility	15.9%	12.1%	11.5%	9.4%	12.0%	9.6%	14.6%	11.1%	12.1%	9.3%	14.7%	11.7%
Sharpe ratio (simple)	0.39	0.52	0.10	0.42	0.44	0.55	0.28	0.40	0.34	0.55	0.35	0.51
Max. drawdown	–48%	–37%	–34%	–29%	–39%	–37%	–42%	–35%	–36%	–26%	–44%	–35%
Skew	–1.7	–1.1	–1.1	–1.2	–2.0	–1.5	–1.2	–0.8	–1.5	–1.0	–1.4	–1.0
Kurtosis	9.7	5.1	4.3	3.1	11.3	7.0	4.0	2.3	6.1	3.8	7.2	4.1
Beta to equity	0.67	0.55	0.63	0.55	0.67	0.57	0.67	0.54	0.66	0.55	0.64	0.55
• Upside beta	0.55	0.52	0.43	0.47	0.55	0.54	0.53	0.50	0.51	0.51	0.46	0.50
• Downside beta	0.88	0.59	0.83	0.63	0.85	0.61	0.86	0.57	0.84	0.58	0.86	0.59

Source: OptionMetrics, CBOE, Bloomberg. The tables show summary statistics for various hedged (columns labeled “RMCC” for “risk-managed covered call”) and unhedged (labeled “CC” for “covered call”) ATM covered call strategies, mimicking the methodology of the CBOE S&P 500 BuyWrite Index (BXM). For each index, the backtest is long the underlying equity and short ATM front-month call options, held to expiry (more details on the calculation in the online appendix). Returns are excess of US three-month Libor. Volatility, skew, kurtosis, beta, upside beta and downside beta were all computed using twenty-one-day overlapping returns. To compute the hedged series, we first simulate covered call backtests as described above. Each day, we compute the equity exposure of the call option according to the Black–Scholes model. We then hedge the “active equity exposure” using the underlying equity index futures, where the “active equity exposure” is defined as the difference between the call’s delta and the expected delta of the selected call options on options rebalance dates (defined as 0.5 for the ATM backtest). The hedged covered call backtest is then derived as the sum of the unhedged series and the time series of index future hedge returns. The end date for all series was September 30, 2015. In panel (a), the start dates are: January 22, 2002 for DAX, Euro Stoxx 50 (SX5E), Swiss Market Index (SMI) and FTSE 100 (UKX); March 25, 1996 for S&P 500 (SPX), NASDAQ 100 (NDX) and Russell 2000 (RUT); May 17, 2004 for KOSPI 200 (KOSPI2); July 13, 2004 for Nikkei 225 (NKY); and January 30, 2006 for Hang Seng China Enterprises (HSCEI) and Hang Seng Index (HSI). Panel (b) is a matched sample starting on January 30, 2006. For illustrative purposes only.

TABLE 6 Global risk-managed covered call turnover statistics (matched sample; January 2006–September 2015).

	DAX	HSCEI	HSI	KOSPI2	NDX	NKY
Annualized vega traded (as % of NAV)	−1.41%	−1.39%	−1.40%	−1.39%	−1.38%	−1.35%
Annualized delta traded (as multiple of NAV)	16.6	15.8	16.4	16.5	16.9	16.2

	RUT	SMI	SPX	SX5E	UKX	Avg
Annualized vega traded (as % of NAV)	−1.38%	−1.38%	−1.38%	−1.38%	−1.39%	−1.39%
Annualized delta traded (as multiple of NAV)	17.3	16.0	17.0	16.6	16.8	16.6

Source: OptionMetrics, CBOE, Bloomberg. The tables show average summary statistics for various hedged ATM covered call strategies, mimicking the methodology of the CBOE S&P 500 BuyWrite Index (BXM). For each index, the backtest is long the underlying equity and short ATM front-month call options, held to expiry (more details on the calculation in the online appendix). The date range for this analysis was January 30, 2006 through September 30, 2015. To compute the hedged series, we first simulate covered call backtests as described above. Each day, we compute the equity exposure of the call option according to the Black–Scholes model. We then hedge the "active equity exposure" using the underlying equity index futures, where the "active equity exposure" is defined as the difference between the call's delta and the expected delta of the selected call options on options rebalance dates (defined as 0.5 for the ATM backtest). The hedged covered call backtest is then derived as the sum of the unhedged series and the time series of index future hedge returns. For illustrative purposes only.

while Table 3 showed that the average short volatility cross-correlation has been 0.4. Thus, the nonequity component of the risk-managed covered call is more diversifiable than the equity component.[10] Those who find global diversification compelling in equities should find it even more compelling in equity index covered calls.

As an illustrative example, Table 7 contains performance statistics for market-cap weighted global equity and covered call portfolios, showing the latter both with and

[10] Further evidence of this can be seen when one compares the two components' volatilities in the market-cap weighted global portfolio with their average volatilities across the eleven single-index covered calls. From January 30, 2006 through September 30, 2015, the average volatility of the equity components was 11.5%, compared with 9.3% for the market-cap weighted global portfolio's equity component, for a reduction of 19%. The short volatility components had an average volatility of 2.7%, compared with 1.7% for the market-cap weighted version, for a much larger reduction of 38%. The dynamic equity timing component is also diversifiable, as seen by the 0.38 average cross-correlation in Table 4. Therefore, while the average volatility of the equity timing components of single-index covered calls was 5.6% over the sample, the market-weighted global portfolio also had a timing component realizing a lower volatility at 4.1%.

TABLE 7 Market-cap weighted global versus global individual country average summary statistics (matched sample; January 2006–September 2015).

	Global individual country average			Global market-cap weighted portfolio		
	Equity	**CC**	**RMCC**	**Equity**	**CC**	**RMCC**
Excess return	6.5%	5.3%	5.9%	6.3%	5.1%	5.5%
Excess return (geom.)	3.9%	4.0%	5.4%	5.0%	4.6%	5.3%
Volatility	20.7%	14.7%	11.7%	17.0%	12.2%	9.7%
Sharpe ratio (simple)	0.32	0.35	0.51	0.37	0.42	0.57
Max. drawdown	−59%	−44%	−35%	−55%	−37%	−33%
Skew	−0.7	−1.4	−1.0	−1.0	−1.9	−1.3
Kurtosis	2.7	7.2	4.1	4.4	10.3	6.2

Source: OptionMetrics, CBOE, Bloomberg. The tables show summary statistics for equity as well as hedged (columns labeled RMCC for "risk-managed covered call") and unhedged (columns labeled CC for "covered call") ATM covered call strategies, mimicking the methodology of the CBOE S&P 500 BuyWrite Index (BXM). Results are shown for global covered call backtests as well as the average statistics for a set of individual (single-index) backtests. The hedged and unhedged global backtests are constructed as either market-cap weighted averages of hedged and unhedged covered call backtests run on eleven global indexes (see below for the list of indexes included and the weights used). For each index, the backtests are long the underlying equity and short ATM front-month call options, held to expiry (more details on the calculation in the online appendix). Returns are excess of US three-month Libor. Volatility, skew and kurtosis were all computed using twenty-one-day overlapping returns. To compute a hedged series, we first simulate unhedged covered call backtests as described above. Each day, we compute the equity exposure of the call option according to the Black–Scholes model. We then hedge the "active equity exposure" using the underlying equity index futures, where the "active equity exposure" is defined as the difference between the call's delta and the expected delta of the selected call options on options rebalance dates (defined as 0.5 for the ATM backtest). The hedged covered call backtest is then derived as the sum of the unhedged series and the time series of index future hedge returns. The start date was January 30, 2006 and the end date was September 30, 2015. The indexes included in the global market-cap weighted backtest and their weights were: 3% DAX, 10% Euro Stoxx 50 (SX5E), 3% Swiss Market Index (SMI), 6% FTSE 100 (UKX), 47% S&P 500 (SPX), 10% Russell 2000 (RUT), 3% NASDAQ 100 (NDX), 2% KOSPI 200 (KOSPI2), 8% Nikkei 225 (NKY), 4% Hang Seng China Enterprises (HSCEI) and 4% Hang Seng Index (HSI). To construct these weights, we first specified continent-level weights of 60% for North America, 22% for Europe and 18% for Asia. Then, for Europe and Asia, we derived country weights approximately in proportion to market-caps. For North America, we derived weights for SPX, NDX and RUT based on a regression on the Vanguard Total Stock Market Index Fund. For illustrative purposes only.

without the risk-management overlay. For comparison, we also include the average outcome if investing in an individual index, following the approach of Asness *et al* (2011).[11]

The global equity portfolio's average return is similar to the average return of the individual equity indexes, which is not surprising, but the diversified portfolio achieves the same return with lower volatility (17.0% for the market-capitalization weight portfolio versus an average index volatility of 20.7%). Diversification led to a 0.05 improvement in Sharpe ratios.

[11] Like Asness *et al* (2011), we compare the diversified portfolio with the average outcome if invested in an individual index, rather than with the US index, so our comparisons do not suffer from US home bias.

The same pattern can be seen for the two versions of the covered call strategy – a finding that is perhaps unsurprising given that equity exposure accounts for such a large portion of the covered call's risk and return. Again, the arithmetic average returns of the globally diversified covered call portfolios were not substantially different than the average return of the eleven individual indexes. However, the global portfolios had lower volatility, which resulted in higher Sharpe ratios. In the risk-managed version, for example, the average volatility for the eleven individual indexes was 11.7%, compared with 9.7% for the market-cap weighted portfolio. The corresponding Sharpe ratio improvement was 0.06. The maximum peak-to-trough drawdown also improved from −35% for the individual average to −33% for the global version. Importantly, the globally diversified portfolio is less concentrated and has less exposure to idiosyncratic events than does a concentrated home-biased single-country position.

8 CONCLUSION

Equity index covered calls have provided similar average compounded returns to their underlying indexes, but with lower volatility and smaller drawdowns. Israelov and Nielsen (2015) find that covered call investing on the S&P 500 can be implemented more efficiently by hedging the equity-timing exposure embedded in options. We extend their methodology to covered calls on global indexes. We find that, in all eleven indexes, returns from this equity timing exposure are statistically insignificant, yet this exposure accounts for 23% of the variance on global covered calls on average. Therefore, the Sharpe ratio for covered call strategies that manage equity exposure improves on average by 0.16 relative to common implementations of covered calls.

We find that just as the S&P 500 covered call is an attractive alternative to S&P 500 index exposure, the same holds true globally. Index by index, we observe that covered calls tend to have realized higher Sharpe ratios and lower peak-to-trough drawdowns than their respective underlying equity indexes.

Many investors understand the benefits of global diversification. The US equity market, while large, represents only about half of the world equity portfolio. We can apply the same rationale in favor of global equity diversification to short volatility and to covered calls. All else equal, diversification should be preferred over concentration. Illustrative global risk-managed covered call strategies exhibit lower volatility and higher Sharpe ratios than single-country covered call strategies do on average.

DECLARATION OF INTEREST

The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the paper. The views and opinions expressed herein are those of the authors and do not necessarily reflect the views of AQR Capital Management, LLC, its affiliates or its employees. This document does not represent valuation judgments, investment advice or research with respect to any financial instrument, issuer, security or sector that may be described or referenced herein and does not represent a formal or official view of AQR. This information is not intended to, and does not relate specifically to, any investment strategy or product that AQR offers. It is being provided merely to provide a framework to assist in the implementation of an investor's own analysis and an investor's own view on the topic discussed herein.

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REFERENCES

Asness, C., Israelov, R., and Liew, J. (2011). International diversification works (eventually). *Financial Analysts Journal* **67**(3), 24–38 (https://doi.org/10.2469/faj.v67.n3.1).

Christoffersen, P., Errunza, V., Jacobs, K., and Jin, X. (2010). Is the potential for international diversification disappearing? Preprint, Social Science Research Network (https://doi.org/10.2139/ssrn.2066076).

Fallon, W., Park, J., and Yu, D. (2015). Asset allocation implications of the global volatility premium. *Financial Analysts Journal* **71**(5), 38–56 (https://doi.org/10.2469/faj.v71.n5.4).

Hartmann, P., Strategmans, S., and de Vries, C. (2004). Asset market linkages in crisis periods. *Review of Economics and Statistics* **86**(1), 313–326 (https://doi.org/10.1162/003465304323023831).

Israelov, R. (2016). PutWrite versus BuyWrite: yes, put–call parity holds here too. Preprint, Social Science Research Network (https://doi.org/10.2139/ssrn.2894610).

Israelov, R., and Nielsen, L. N. (2015). Covered calls uncovered. *Financial Analysts Journal* **71**(6), 44–57 (https://doi.org/10.2469/faj.v71.n6.1).

Londono, J. M. (2011). The variance risk premium around the world. Working Paper, Board of Governors of the Federal Reserve (https://doi.org/10.2139/ssrn.2009065).