

Return and Risk of CBOE Buy Write Monthly Index

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Recently, the CBOE introduced its Buy Write Monthly index in an effort to provide option portfolio managers with a benchmark for gauging the performance of buy-write option strategies and the investment community with an understanding of a particular option trading strategy and its performance through time. This study describes the construction of the index, examines the properties of its return distribution generated over the past 13-plus years, and evaluates its performance using a number of portfolio performance measures.

A recent introduction at the Chicago Board Options Exchange (CBOE) is a Buy Write Monthly index (ticker symbol BXM). Underlying the BXM is a portfolio formed by writing a one-month, just out-of-the-money, S&P 500 index call against a long position in the S&P 500 portfolio. The call is held to expiration, when a new one-month call is written. The strategy is passive in the sense that no trade is motivated by market timing or by how much the option is underpriced or overpriced.

A number of factors contributed to development of an index tied to a particular option trading strategy. First, over the years options portfolio managers had asked the CBOE to provide an objective benchmark for evaluating performance of buy-write programs—one of the most popular option trading strategies. And, while exchange-traded options have traded for nearly 30 years, many

people still think options are difficult-to-understand instruments and always risk-enhancing. A buy-write strategy by contrast is straightforward and risk-reducing.

Finally, even those who understand the buy-write strategy may not have the resources to see how well a particular implementation of the strategy has performed in the past. While BXM returns represent the returns of only a single passive buy-and-hold option strategy that writes a one-month, just out-of-the-money, S&P 500 index call each month against a long position in the S&P 500 portfolio, the BXM's return-risk attributes provide an interesting contrast to those of the underlying S&P 500 index itself.¹

My purposes here are threefold. First, I outline the construction of the BXM index in detail to provide a clearer understanding of the implementation of a buy-write strategy and its return measurement. Second, I examine the properties of BMX's monthly return distribution. While the monthly return distribution of a buy-write strategy is highly negatively skewed, the repeated use of the strategy month after month tends to cause the expected return distribution to become more and more symmetric.

Finally, I analyze the performance of the BXM during the past 13-plus years, and compare it with the performance of the S&P 500 index portfolio. In the measurement of performance, care is taken to account for the effects of possible asymmetries in the return distributions. Interestingly, the BXM is shown to have had a monthly return approximately equal to

the S&P 500 portfolio over the sample period, but at only two-thirds the level of return standard deviation.

I. CONSTRUCTION OF THE CBOE BUY WRITE INDEX

The S&P 500 Buy Write Monthly (BXM) index is a total return index based on writing the nearby, just out-of-the-money, S&P 500 call option against the S&P 500 index portfolio each month on the day the previous nearby contract expires, which is usually the third Friday of the month.² To understand its construction, first consider the total return series of the S&P 500 index. In computing S&P 500 index returns, Standard & Poor's makes the assumption that any daily cash dividends paid on the index are immediately invested in more shares of the index portfolio. The daily return of the S&P 500 index portfolio is computed as

$$R_{S,t} = \frac{S_t - S_{t-1} + D_t}{S_{t-1}} \quad (1)$$

where S_t is the reported S&P 500 index level at the close of day t , and D_t is the cash dividend on paid on day t . The numerator consists of the income over the day, which comes in the form of price appreciation, $S_t - S_{t-1}$, and dividend income, D_t . The denominator is the investment outlay; that is, the level of the index as of the previous day's close, S_{t-1} .

The daily return of the BXM is computed in a similar fashion:

$$R_{BXM,t} = \frac{S_t + D_t - S_{t-1} - (C_t - C_{t-1})}{S_{t-1} - C_{t-1}} \quad (2)$$

where C_t is the reported call price at the close of day t . The numerator in (2) incorporates the price appreciation and dividend income of the stock index less the price appreciation of the call, $C_t - C_{t-1}$. The income from holding the BXM portfolio exceeds the S&P 500 portfolio on days the call price falls, and vice versa. The investment cost in the denominator of the BXM return is the S&P 500 index level less the call price at the close on the previous day.

The daily prices and dividends used in generating the historical return series of the BXM are drawn from two sources. The S&P 500 closing index levels and cash dividends are taken monthly from *Standard & Poor's S&P 500 Index Focus Monthly Review*. Since Standard & Poor's began reporting daily cash dividends for the S&P 500 on

June 1, 1988, the history of the BXM begins on that date. The daily S&P 500 index option prices are drawn from the CBOE's Master Data Retrieval files.³

Three types of call prices are used in construction of the BXM. The bid price is used when the call is first written; the settlement price is used when the call expires; and the bid-ask midpoint is used at all other times. The bid price is used when the call is written to account for the fact that a market order to sell the call would likely be consummated at the bid price. In this sense, the BXM index already incorporates an implicit trading cost equal to one-half the bid-ask spread.

To generate the history of BXM returns, I account for the fact that calls were written and settled under two different S&P 500 option settlement regimes. Prior to October 16, 1992, the *PM settlement* S&P 500 calls were the most actively traded, so they were used in construction of the BXM. The newly written call was assumed to be sold at the prevailing bid price at 3PM (CST), when the settlement price of the S&P 500 index was being determined.

The expiring call's settlement price is

$$C_{settle,t} = \max(0, S_{settle,t} - X) \quad (3)$$

After October 16, 1992, the *AM settlement* contracts became the most actively traded and were used in construction of the BXM. The expiring call option was settled at the open on expiration day using the opening S&P 500 settlement price.⁴ A new call with an exercise price just above the S&P 500 index level was written at the prevailing bid price at 10AM (CST).

Other than when the call was written or settled, daily BXM returns are based on the midpoint of the last pair of bid-ask quotes appearing before or at 3PM (CST) each day:

$$C_{3PM,t} = \frac{\text{bid price}_{3PM} + \text{ask price}_{3PM}}{2} \quad (4)$$

A history of daily BXM returns was thus computed for the BXM for the period June 1988 through December 2001. On all days except expiration days after October 16, 1992, the daily return is computed using Equation (2). On expiration days since October 16, 1992, the daily return is computed using

$$R_{BXM,t} = (1 + R_{ON,t}) \times (1 + R_{ID,t}) - 1 \quad (5)$$

EXHIBIT 1

Summary Statistics—June 1988-December 2001

Statistic	Money Market	S&P 500 Portfolio	BXM Portfolio	Alternative Buy-Write Using Midpoints
Monthly Returns				
Number of Months	163	163	163	163
Mean	0.483%	1.187%	1.106%	1.159%
Median	0.467%	1.475%	1.417%	1.456%
Standard Deviation	0.152%	4.103%	2.663%	2.661%
Skewness	0.4677	-0.4447	-1.4366	-1.4055
Excess Kurtosis	-0.2036	0.7177	4.9836	4.8704
Jarque-Bera Test Statistic	6.22	8.87	224.75	214.77
Probability of Normal	0.045	0.012	0.000	0.000
Annual Returns				
Mean	5.95%	14.07%	13.63%	14.34%

where $R_{ON,t}$ is the overnight return of the buy-write strategy based on the expiring option, and $R_{ID,t}$ is the intraday buy-write return based on the newly written call. The overnight return is computed as

$$R_{ON,t} = \frac{S_{10AM,t} + D_t - S_{close,t-1} - (C_{settle,t} - C_{close,t-1})}{S_{close,t-1} - C_{close,t-1}} \quad (6)$$

where $S_{10AM,t}$ is the reported level of the S&P 500 index at 10AM on expiration day, and $C_{settle,t}$ is the settlement price of the expiring option. Note that the daily cash dividend, D_p , is assumed to be paid overnight. The intraday return is defined as

$$R_{ID,t} = \frac{S_{close,t} - S_{10AM,t} - (C_{close,t} - C_{10AM,t})}{S_{10AM,t} - C_{10AM,t}} \quad (7)$$

where the call prices are for the newly written option.

II. PROPERTIES OF REALIZED MONTHLY RETURNS OF THE BXM

Exhibit 1 provides summary statistics for the realized monthly returns of a one-month money market instrument, the S&P 500 index portfolio, and the BXM index portfolio. The monthly returns are generated by linking daily returns geometrically.⁵

$$R_{monthly} = \prod_{t=1}^{no. \text{ of days in month}} (1 + R_{daily,t}) - 1 \quad (8)$$

The money market rate is assumed to be the rate of return of a Eurodollar time deposit with days to maturity to match the number of days in the month. The Eurodollar rates are downloaded from Datastream.

The average monthly return of the one-month money market instruments over the 163-month period was 0.483%. Over the same period, the S&P 500 index portfolio generated an average monthly return of 1.187%, while the BXM generated an average monthly return of 1.106%.

Interestingly, although the monthly average monthly return of the BXM is only 8.1 basis points lower than the S&P 500, the BXM risk, as measured by the standard deviation of return, is substantially lower. For the BXM, the standard deviation of monthly returns was 2.663%, compared to 4.103% for the S&P 500. In other words, BXM produced a monthly return approximately equal to the S&P 500 index portfolio, but at less than 65% of the S&P 500's risk, where risk is measured in the usual way.

The return and risk of the BXM index portfolio relative to the S&P 500 index portfolio are depicted in Exhibit 2. The index was set equal to 100 on June 1, 1988. The closing index level for each subsequent day is computed using the daily index return, that is, $BXM_t = BXM_{t-1} \times (1 + R_{BXM,t})$. To facilitate comparison of the BXM with the S&P 500 index over the same period, the total return index of the S&P 500 index portfolio is also normalized to a level of 100 on June 1, 1988, and plotted in the figure.

EXHIBIT 2

Month-End Total Return Indexes for S&P 500 and CBOE BXM Index—June 1988-December 2001

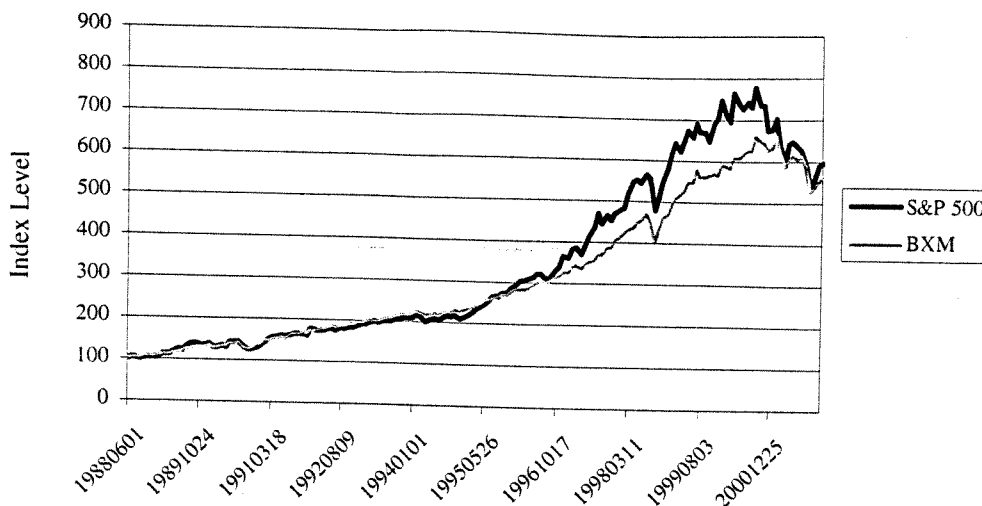
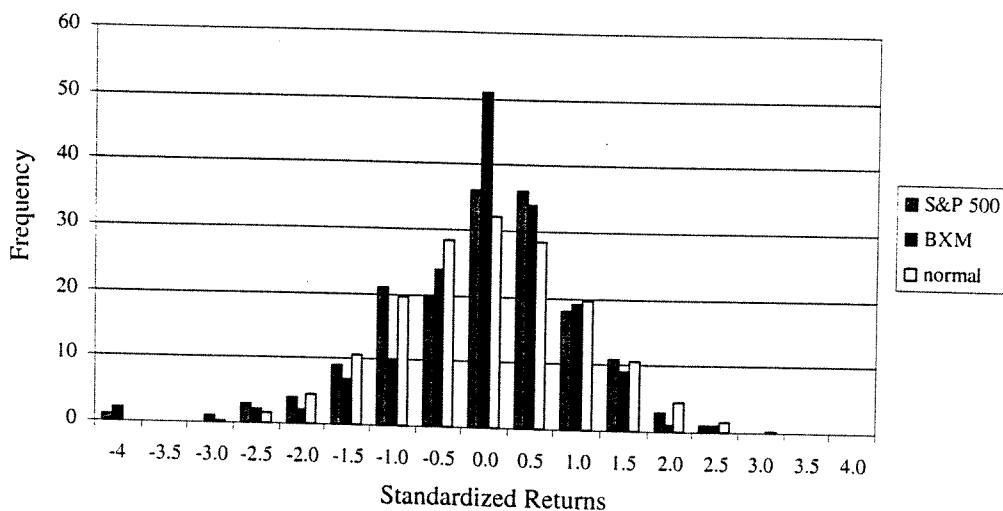


EXHIBIT 3

Distribution of Monthly Rates of Return—June 1988-December 2001



As the graph shows, the BXM tracked the S&P 500 index closely at the outset. Then, starting in 1992, the BXM began to rise faster than the S&P 500, but by mid-1995 the level of the S&P 500 total return index surpassed the BXM. Beginning in 1997, the S&P 500 index charged upward in a fast but volatile fashion. The BXM lagged, as should be expected. When the market reversed in mid-2000, the BXM again moved ahead of the S&P 500.

The steadier path taken by the BXM reflects the fact that it has lower risk than the S&P 500. That both indexes wind up at approximately the same level after 13-plus years reflects the fact that both had similar returns.

Exhibit 1 also reports the skewness and excess kurtosis of the monthly return distributions and the Jarque-Bera statistic for testing the hypothesis that the return distribution is normal. It is interesting to note that both the S&P 500 portfolio and the BXM have negative skewness.

For the BXM, negative skewness should not be surprising, in the sense that a buy-write strategy truncates the upper end of the index return distribution.⁶ The Jarque-Bera statistic rejects the hypothesis that returns are normal not only for the BXM and S&P 500 but also for the money market rates. The negative skewness for the BXM and S&P 500 does not appear to be severe, however.

Exhibit 3 shows the standardized monthly returns of the S&P 500 and BXM in relation to the normal distribution. The S&P 500 and BXM return distributions appear more negatively skewed than the normal, but only slightly. What stands out in the plot is that both the S&P 500 and the BXM return distributions have greater kurtosis than the normal distribution. This is reassuring in the sense that the usual measures of portfolio performance work well for symmetric distributions but not asymmetric ones.

Finally, to illustrate the degree to which writing the calls at the bid price rather than the bid/ask midpoint affected returns, I regenerate the BXM assuming that the calls were written at the bid-ask price midpoint. As the last column in Exhibit 1 shows, the average monthly return increases by about 6 basis points per month. The difference in annualized returns is about 70 basis points.

III. PERFORMANCE

I describe typical portfolio performance measures, before looking at BXM performance.

Portfolio Performance Measures

The most commonly applied measures of portfolio performance are the Treynor [1965] ratio, Sharpe [1966] ratio, Jensen's [1968] alpha, and Modigliani and Modigliani's [1997] M^2 . The formulas for each measure are shown in Exhibit 4.

In assessing ex post performance, the parameters of the formulas are estimated from historical returns over the evaluation period. First, \bar{R}_f , \bar{R}_m , and \bar{R}_p are the mean monthly returns of a risk-free money market instrument, the market, and the portfolio under consideration over the evaluation period. Second, $\hat{\sigma}_m$ and $\hat{\sigma}_p$ are the standard deviations of the returns (total risk) of the market and the portfolio. Finally, $\hat{\beta}_p$ is the portfolio's systematic risk (beta) estimated by an ordinary least squares, time series regression of the excess returns of the portfolio on the excess returns of the market. That is:

$$R_{p,t} - R_{f,t} = \alpha_p + \beta_p(R_{m,t} - R_{f,t}) + \varepsilon_{p,t} \quad (9)$$

Almost as frequent as the application of these measures is criticism of their use. All four measures are based on the Sharpe [1964]/Lintner [1965] mean-variance capital asset pricing model. In the mean-variance CAPM, investors measure total portfolio risk by the standard deviation of returns.

EXHIBIT 4

Summary of Portfolio Performance Measures

Total Risk-Based Measures

$$A. \text{ Sharpe Ratio} = \frac{\bar{R}_p - \bar{R}_f}{\hat{\sigma}_p}$$

$$B. M^2 = (\bar{R}_p - \bar{R}_f) \left(\frac{\hat{\sigma}_M}{\hat{\sigma}_S} \right) - (\bar{R}_m - \bar{R}_f)$$

Systematic Risk-Based Measures

$$C. \text{ Treynor Ratio} = \frac{\bar{R}_p - \bar{R}_f}{\hat{\beta}_p}$$

$$D. \text{ Jensen's Alpha} = \bar{R}_p - \bar{R}_f - \hat{\beta}_p(\bar{R}_m - \bar{R}_f)$$

This implies, among other things, that investors view a large positive deviation from expected portfolio return with the same distaste as a large negative deviation from expected return. Common sense dictates otherwise.

Investors are willing to pay for the chance of a large positive return (i.e., positive skewness), holding other factors constant, but will want to be paid for taking on negative skewness. Since the standard performance measures do not recognize these premiums or discounts, portfolios with positive skewness will appear to underperform the market on a risk-adjusted basis, and portfolios with negative skewness will appear to overperform.

Ironically, while the Sharpe/Lintner CAPM is based on the mean-variance portfolio theory of Markowitz [1952], it was Markowitz [1959] himself who first noted that using standard deviation to measure risk is too conservative since it regards all extreme returns, positive or negative, as undesirable. Markowitz [1959, Ch. 9] advocates the use of semi-variance or semistandard deviation as a total risk measure.⁷

In the context of performance measurement, semi-standard deviation can be defined as the square root of the average of the squared deviations from the risk-free rate of interest, where positive deviations are set equal to zero:

$$\text{Total risk}_i = \sqrt{\frac{\sum_{t=1}^T \min(R_{i,t} - R_{f,t}, 0)^2}{T}} \quad (10)$$

where $i = m, p$.

Returns on risky assets, when they exceed the risk-free rate of interest, do not affect risk. To account for pos-

EXHIBIT 5

Different Performance Measures for S&P 500 Index and CBOE BXM Index—June 1988-December 2001

Performance Measure	Total Risk Measure	S&P 500 Portfolio Performance	S&P 500 Portfolio Risk	BXM Portfolio Performance	BXM Portfolio Risk	Alternative Buy-Write Using Theoretical Values Performance
Total Risk-Based						
Sharpe Ratio	Standard deviation	0.172	0.04103	0.234	0.02663	0.181
	Semistandard deviation	0.261	0.02696	0.331	0.01886	0.255
M^2	Standard deviation			0.257%		0.040%
	Semistandard deviation			0.188%		-0.017%
Systematic Risk-Based						
Treyner Ratio	Standard deviation	0.007	1.000	0.011	0.558	0.009
	Semistandard deviation	0.007	1.000	0.010	0.622	0.008
Jensen Alpha	Standard deviation			0.230%	0.558	0.095%
	Semistandard deviation			0.186%	0.622	0.045%

sible asymmetry of the portfolio return distribution, we recompute the total risk portfolio performance measures (A) and (B) in Exhibit 4 using the estimated semideviations of the returns of the market and the portfolio for $\hat{\sigma}_m$ and $\hat{\sigma}_p$.

The systematic risk-based portfolio performance measures (C) and (D) also have theoretical counterparts in a semivariance framework. The only difference lies in the estimate of systematic risk. To estimate the beta, a time series regression *through the origin* is performed using the excess return series of the market and the portfolio. Where excess returns are positive, they are replaced with a zero value.

The time series regression specification is

$$\min(R_{p,t} - R_{f,t}, 0) = \beta_p \min(R_{m,t} - R_{f,t}, 0) + \varepsilon_{p,t} \quad (11)$$

BXM Performance

The performance of the BXM is evaluated using all the measures listed in Exhibit 4, measuring risk using the standard deviation and the semistandard deviation of portfolio returns. To the extent that BXM returns are skewed, the measures derived from the two different models will differ. Since the standardized BXM return distribution shows slight negative skewness, the performance measures based on semistandard deviation should be less than their standard deviation counterparts, but not by much.

The portfolio performance results over the period June 1988 through December 2001 are reported in Exhibit

5. The results support two main conclusions. First, the BXM outperformed the S&P 500 index on a risk-adjusted basis over the investigation period. All estimated performance measures, whether based on the mean-standard deviation or on mean-semistandard deviation frameworks, lead to this conclusion. The outperformance appears to be on order of 0.2% per month on a risk-adjusted basis.⁸

Second, measures using mean-semistandard deviation indicate slightly worse performance than the measures using mean-standard deviation. The cause, of course, is the negative skewness in BXM returns displayed in Exhibits 1 and 3. The effect of skewness is impounded through the risk measure. In Jensen's alpha, for example, the beta of the BXM is 0.558 using the mean-standard deviation framework and 0.622 using the mean-semi-standard deviation framework. The skewness penalty is about 5 basis points per month.

An Aberration?

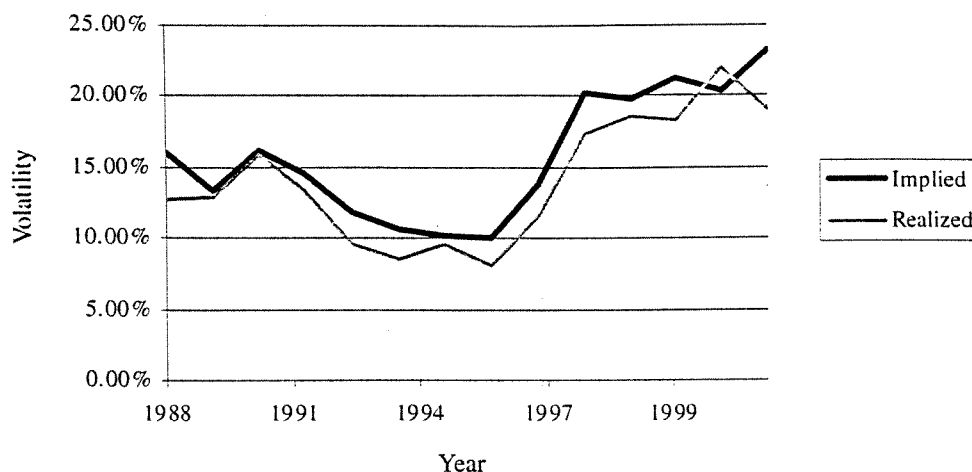
In an efficiently functioning capital market, the risk-adjusted return of a buy-write strategy using S&P 500 index options should be no different from returns of the S&P 500 portfolio. Yet, the BXM has provided an abnormally higher return over the period June 1988 through December 2000. What could cause such an aberration?

One possible explanation, suggested by Stux and Fanelli [1990], Schneeweis and Spurgin [2001], and others, is that the volatilities implied by option prices are too high relative to realized volatility.

Bollen and Whaley [2002] argue that there is excess buying pressure on S&P 500 index puts by portfolio

EXHIBIT 6

Average Implied and Realized Volatility for S&P 500 Index Options—1988-2001



insurers. Since there are no natural counterparties to these trades, market makers must step in to absorb the imbalance. As the market maker's inventory grows, implied volatility will rise relative to actual return volatility; the difference is the market maker's compensation for hedging costs and/or exposure to volatility risk. The implied volatilities of the corresponding calls also rise from the reverse conversion arbitrage supporting put-call parity.

To examine whether this explanation is consistent with the observed performance of the BXM, I compare the average implied volatility of the calls written in the BXM strategy to the average realized volatility over the call's life.⁹ Exhibit 6 shows that the difference has not been constant through time, perhaps indicating variation in the demand for portfolio insurance. The difference is persistently positive, however; the mean (median) difference between the ATM call implied volatility and realized volatility is about 167 (234) basis points on average.

To show that the high levels of implied volatility for S&P 500 index options were at least partially responsible for generating the abnormal returns of the BXM index, the buy-write index is reconstructed, this time using theoretical option values rather than observed option prices.

The theoretical call value is generated using the Black-Scholes [1973]/Merton [1973] formula:

$$c = (S - PVD)N(d_1) - Xe^{-rT}N(d_2) \quad (12)$$

where

$$d_1 = \frac{\ln((S - PVD) / X) + (r + .5\sigma^2)T}{\sigma\sqrt{T}}$$

$$d_2 = d_1 - \sigma\sqrt{T}, S$$

is the prevailing index level, PVD is the present value of the dividends paid during the option's life, X is the exercise price of the call, r is the Eurodollar rate with a time to expiration matching the option, and σ is the realized volatility computed using the daily returns of the S&P 500 index over the option's one-month remaining life.¹⁰

The last column in Exhibit 6 provides the performance results. Although all performance results are positive by all measures, they are all small, particularly for the theoretically superior semivariance measures. The highest semivariance measure is the Jensen alpha at 0.045%.

Given the worsened performance when theoretical values are used in place of actual prices, it seems reasonable to conclude that at least some of the risk-adjusted performance of the BXM is arising from portfolio insurance demands.

IV. SUMMARY

The CBOE's Buy Write Monthly index simulates the behavior of a passive buy-and-hold option strategy that writes a one-month, just out-of-the-money, S&P 500 index call each month against a long position in the S&P 500 portfolio. The call is held to expiration, at which time a new one-month call is written. My examination of the returns and risk-adjusted performance of the BXM index

over its history indicates that the monthly return distribution of the BXM is negatively skewed. While this undermines the usefulness of standard portfolio performance measures, the skewness is not severe, and portfolio performance measures that explicitly account for skewness preference reveal that the BXM outperformed the S&P 500 portfolio by about 0.2% a month on a risk-adjusted basis.

ENDNOTES

Comments and suggestions by Nick Bollen, Steve Figlewski, Matt Moran, Tom Smith, and Bill Speth are gratefully acknowledged.

¹While the CBOE has no plans to introduce the BXM as a tradable product, the underlying strategy is simple enough that it could be used as the basis of a mutual fund, an exchange-traded fund, or a structured product.

²Since expirations occur monthly and there are 52 weeks in the calendar year, some "one-month" options have 28 days to expiration at the time they are written, and others have 35 days.

³The *Review* is published by Standard & Poor's, 55 Water Street, New York. The entire history of the daily BXM levels beginning June 1, 1988, is available at www.cboe.com/bxm.

⁴The opening settlement price of the S&P 500 index is computed on the basis of opening trade prices of the 500 stocks in the index. On a typical day, most stocks will have traded within the first half-hour after the market opens.

⁵In compounding daily returns in this manner, dividends are assumed to be reinvested in the buy-write strategy rather than the S&P 500 index portfolio.

⁶The level of skewness in the buy-write return distribution depends on a number of factors including the investor's time horizon. If the investor's time horizon is two years, and a buy-write strategy involves writing one-month calls, the two-year total return distribution will approximate a normal distribution by virtue of the central limit theorem. See Stux and Fanelli [1990].

⁷Indeed, in his Nobel Prize acceptance speech, Markowitz [1991] continues to suggest semivariance is more plausible than variance as a measure of risk.

⁸Abnormal performance results were also computed using the Bawa-Lindenberg [1977] and Leland [1999] CAPMs, which allow for asymmetrical return distributions. The performance results are similar to those of the mean-semistandard deviation framework, but are not reported.

⁹The implied volatility is computed by setting the observed call price equal to the Black-Scholes [1973]/Merton [1973] formula value.

¹⁰Recall that this may be 28 days or 35 days as a result of the fact that options expire monthly and there are 52 weeks in the calendar year.

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