THE RELATIONSHIPS BETWEEN THE CHICAGO BOARD OPTIONS EXCHANGE (CBOE) VOLATILITY INDEX (VIX) AND STOCK PRICES: A STATISTICAL ANALYSIS

Steven V. Le, Department of Finance, California State University, Long Beach, 1250 Bellflower Blvd., Long Beach, CA 90840, 562.985.1608, svle@usa.net
Darrell Le, SVL Investment Management, 1620 N. Placentia Ave., Placentia CA 92870

ABSTRACT

Given the record high of oil prices, the budget and trade deficit, rising interest rates, and turmoil in Iraq, we expect the stock market to be volatile. Yet the market is registering some of the lowest volatility readings in nearly 10 years, as measured by the Chicago Board Options Exchange (CBEO) Volatility Index (VIX). The VIX is calculated using current options prices, and since options are short-lived instruments, the prices incorporate some expectation of market volatility. In this paper, we investigate the relationships between VIX and valuation of firms. This statistical analysis, based on monthly financial data of 1,810 Value Line companies (98 industries) between January 2003 and August 2005, reveals that there is a negative correlation between the CBOE Volatility Index (VIX) and stock prices.

METHODOLOGY AND DATA

In 1993, the Chicago Board Options Exchange® (CBOE®) introduced the CBOE Volatility Index®, VIX®, and it quickly became the benchmark for stock market volatility. The Chicago Board Options Exchange CBOE Volatility Index (VIX), also known as the CBOE Market Volatility Index, sometimes referred to as the "Investor Fear Gauge", indicates the level of anxiety or complacency of the market. The objective of this study is to examine the relationship between VIX and valuation of public firms.

The generalized formula for VIX calculation is:

$$\sigma^2 = \frac{2}{T} \sum_i \frac{\Delta K_i}{K_i^2} e^{RT} Q(K_i) - \frac{1}{T}\left[\frac{F}{K_0} - 1\right]^2 \qquad \textbf{(1)}$$

Where…

σ	is	VIX/100 -> VIX = σ x 100
T		Time to expiration
F		Forward index level derived from index option prices
K_i		Strike price of ith out-of-the money option; a call if $K_i > F$ and a put if $K_i < F$
ΔK_i		Interval between strike prices – half the distance between the strike on either side if K_i:

$$\Delta K_i = \frac{K_{i+1} - K_{i-1}}{2}$$

(Note: ΔK_i for the lowest strike is simply the difference between the lowest strike and the next higher price. Likewise, ΔK for the highest strike is the difference between the highest strike and the next lower strike.)

K0	First strike below the forward index level, F
R	Risk-free interest rate to expiration
$Q(K_i)$	The midpoint of the bid-ask spread for each option with strike K_i

The statistical model constructed for this study is based on the generally accepted theory of common stock valuation:

$$\frac{P_0}{B_0} = \frac{D_1/B_0}{K-g} = f(D_1/B_0, K, g) \qquad (2)$$

Where P_0 / B_0 = market price-to-book ratio
B_0 = book value
D_1/B_0 = book yield
K = R_f + risk
R_f = Risk-free rate
g = Expected dividend growth rate

Equation (2) attempts to quantify the impact and the relationship between stock prices and a number of economic, financial and risk factors associated with each company. The ratio of market price and book values of security i can be written as a function of several explanatory variables and can be expressed as follows:

$$P_i/B_i = f(\text{RF, book yield, g, risk}) \qquad (3)$$

There are four types of variables, which were hypothesized to affect the market price-to-book ratio of companies:

(1) Economic Variables: Interest rates and inflation should have an effect on market price-to-book ratio.
(2) Dividend Policy: High book yield, retention ratio, and expected earnings growth rate should have a positive effect on market price-to-book ratio.
(3) Risk Factors: CBOE Volatility Index (VIX), high debt, high beta, and low Value Line Safety Rank should have a negative impact on market price-to-book ratio.
(4) Financial Factors: High return on equity, high percent of cash to total asset, good Value Line Timeliness Rank, high sales growth, positive money flow, and high annual return should have a positive impact upon market price-to-book ratio.

In specifying (3), our intent is to construct a statistical model to quantify the changes in the market price-to-book ratio and to examine the relative importance of CBOE Volatility Index (VIX) versus other economic and financial factors in the valuation of stock prices.

EMPIRICAL RESULT

P /B = -0.753 - 0.11 TR - 0.20 SR - 0.175 B + 0.784 RPE + 0.088 RR + 0.123 ROE +
(-9.96) (-14.64) (-4.558) (24.713) (38.703) (48.02)

0.006 DG + 0.003 TT + 0.003 RS + 1.237 PPE + 0.016 PEG +
(7.00) (9.75) (7.38) (32.02) (14.792)

$0.005\ IH + 8.058\ BYD - 0.062\ I – 0.003\ D + e_{it}$
(7.805) (26.235) (-4.91) (-8.10) (4)

(t-statistics in parentheses below the coefficients) (R2 = 0.862)

TABLE 1: STATISTICAL RESULTS

Dependent Variable: P/B: Market Price/Book Value			
Independent Variables	B	Standard Error B	t
VIX: Volatility Index	-.038	.002	-15.084
TR: Timeliness Rank	-.111	.011	-9.963
SR: Safety Rank	-.200	.014	-14.64
B: Beta	-.175	.038	-4.560
RPE: Relative P/E Ratio	.784	.032	24710
RR: % Retained to Common Equity	.088	.002	38.70
ROE: Est Return on Shareholders Equity	.123	.003	48.02
EG: Earning Per Share Growth 10-Year	.006	.001	4.695
TT: Total Return 1-Year	.003	.000	9.750
RS: Relative Strength 1 Week	.003	.000	7.380
MF: 1-Month Money Flow	.001	.000	3.778
PPE: Proj 3-5 Yr Relative P/E	1.237	.039	32.02
PEG: Proj EPS Growth Rate	.016	.001	14.792
IH: % Insider Holdings	.005	.001	7.805
BYD: Dividend Declared/Book Value	8.058	.306	26.235
I: 2-Year Treasury	-.062	.013	-4.910
D: %Debt/Capital Latest Quarter	-.003	.001	-8.100
(CONSTANT)	-1.938		
R Square	.862		
Adjusted R Square	.862		

With a t-statistic of -15.084, the empirical results indicated that there is a strong negative correlation between the stock prices and the Chicago Board Options Exchange (CBEO) Volatility Index (VIX).

CONCLUSIONS

- The statistical analysis has shown that there is a strong negative relationship between contemporaneous changes in the Chicago Board Options Exchange (CBEO) Volatility Index (VIX) and the stock prices.

- The empirical evidence suggest that high projected earnings growth, return on equity, quality earnings and good balance sheet would have a positive impact upon the value of common stocks.