THE RELATIONSHIPS BETWEEN BOND YIELDS, THE CHICAGO BOARD OPTIONS EXCHANGE VOLATILITY INDEX (VIX) AND FIRM VALUATION: A STATISTICAL ANALYSIS

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ABSTRACT

Given the changing monetary policy, rising interest rates, deteriorating corporate earnings, high stock valuation, the budget and trade deficit, the stock market is expected to be volatile. The stocks, bonds and foreign-exchange markets are undergoing their sharpest increase of volatility since the onset of the Covid-19 pandemic. Stocks and bonds are falling in tandem at a pace not seen in decades, leaving investors with few places to hide from the market volatility.

The failure of so-called *60/40 portfolios* to offer investors protection from the bear market in stocks has upended what had become conventional wisdom among the markets: Stock prices and bond prices do not move in the same direction. That thinking has been a foundation of diversification strategies for many years. Driving this significant shift in market behavior this year has been stubbornly high inflation and the Federal Reserve's breakneck pace of interest-rate increases.

The CBOE Volatility Index (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 statistical relationships between bond yields, VIX and valuation of firms. This statistical analysis reveals that increase in bond yields and CBOE Volatility Index (VIX) have a negative impact upon the firm's intrinsic value. The traditional 60/40 portfolio model (a mix of 60% stocks and 40% bonds) cannot be used as a hedge against the decline in stock prices during this "fighting inflation" period of the Federal Reserve's Monetary Policy.

I. INTRODUCTION

Countries throughout Europe are working to cope with a deepening energy crisis after Russia cut the continent's supply of natural gas. And almost every place in the world has faced setbacks from supply chain disruptions, while others are still experiencing shocks from the COVID-19 pandemic—all of which has led to the extremely high inflation and faltering stock markets.

Stocks have come under pressure as inflation has swelled to a four-decade high and the Federal Reserve has begun raising interest rates aggressively to stem rising prices. The benchmark S&P 500 is down over 20% in 2022.

Most portfolio is taking a beating right now as stock and bond prices fall together for the first time in decades. This year's declines have dealt a blow to the 60/40 portfolio model—a mix of 60% stocks and 40% bonds that has long been advertised as offering strong returns and hedging against the expected occasional pullback in stocks, which typically are viewed as being much

riskier than bonds. That hedge has evaporated this year. Investors have dumped both stocks and bonds as the Federal Reserve has embarked on a campaign to raise interest rates to combat inflation, which is at 40-year high. Even the safest investments, Treasurys, have fallen sharply.

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. It does this by measuring how much people are willing to pay to buy options on the S&P 100 index (OEX), typically "put" options which are a bet that the market will decline.

The CBOE developed a formula for averaging various options for S&P 100 futures to get a hypothetical, normalized option. The volatility component can be isolated from the price of this option and called VIX. Although both "put" and "call" options are included in the calculation, it is the "put" options that lead to most of the excess demand that VIX measures. VIX is considered to be a good surrogate for market sentiment.

The objective of this study is to examine the relationship between bond yields, VIX and valuation of large public firms. The remaining sections of this paper are organized as follows. Section II presents the statistical model, methodology and data. Section III discusses the empirical results. The conclusions are in Section IV.

II. METHODOLOGY AND DATA

The CBOE Volatility Index (VIX)

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 i^{th} 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

Multi-Factors Model

The statistical model constructed for this study is based on the generally accepted theory of common stock valuation. This approach is based on the principle that rational investors evaluate the expected returns and risks of securities in the financial market and set a price for a particular security which adequately compensates investors for the risks. The Discounted Cash Flow valuation approach is based on the proposition that the maximum price that a rational investor will pay for a security is an amount equal to the present value of the expected dividends plus its resale price, including capital gains. Therefore, the present market price or a stock is given by the formula:

$$P_0 = \frac{D_1}{(1+K)^1} + \frac{D_2}{(1+K)^2} + \ldots + \frac{D_t}{(1+K)^t} + \frac{P_t}{(1+K)^t} \qquad (2)$$

Equation (1) was simplified by Gordon (1962) as follows:

$$P_0 = \frac{D_1}{K-g} \qquad (3)$$

Where g is the expected dividend growth rate. Equation (2) can be expressed as follows:

$$\frac{P_0}{B_0} = \frac{D_1/B_0}{K-g} = f(D_1/B_0, K, g) \qquad (4)$$

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

Equation (3) 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:

$$P_i/B_i = f(RF, \text{book yield}, g, \text{risk}) \quad (5)$$

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), %Cash to Net Asset Value, 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, % Return on Total Asset, 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.

This empirical study is based on monthly Value Line financial and economic data from January 2015 through October 2022 of approximately 2,000 companies (98 industries). The monthly data was obtained from Value Line and Federal Reserve Statistical Release. The dependent and independent variables were defined as follows:

- **Market/book ratio (P_0/B_0):** The month-end market price divided by book value per share.

- **Dividend Declared/Book Value (BYD):** Indicated declared dividend divided by book value per share.

- **Risk-free rate (I):** The interest rate of the 10-year U. S. Treasury Bonds.

- **CBOE Volatility Index (VIX)**: The Index calculated by the Chicago Board Options Exchange

- **Timeliness Rank (TR)** measures probable price performance during the next 6 to 12 months, relative to all other Value Line stocks. These equities represent 94% of the trading volume on all U.S. stock exchanges. The rank of a stock's probable relative market performance in the year ahead. It is derived by a computer program using as input the long-term price and earnings history, recent price and earnings momentum, and earnings surprise. All data are known and actual. Stocks ranked 1 (Highest) and 2 (Above Average) are likely to outpace the year-ahead market. Those ranked 4 (Below Average) and 5 (Lowest) are not expected to outperform most stocks over the next 12 months.

- **Safety Rank (SR):** A measurement of potential risk associated with individual common stocks. The Safety Rank is computed by averaging two other Value Line indexes – the Price Stability Index and the financial strength Rating. Safety Ranks range from 1 (Highest) to 5 (Lowest).

- **Relative P/E Ratio (RPE)**: A stock price-earnings ratio divided by the price-earnings ratio for a market measure.

- **% Retained to Common Equity (RR):** Net profit less all common and preferred dividends divided by common equity including intangible assets, expressed as a percentage.

- **Estimated Return on Shareholders' Equity (ROE):** Indicator of profitability. Determined by dividing net income for the past 12 months by common stockholder equity (adjusted for stock splits). Result is shown as a percentage.

- **% Return on Total Asset (Latest Quarter) (RTA):** Percent of net profit to total assets

- **Total Return 1-Year (TT):** The capital gain or loss for the stock price plus the sum of dividends reinvested at year-end for the past year, expressed as a percentage.

- **Relative Strength 3 Months (RS):** The stock's price over time divided by the Value Line Composite Average over the same time span. Arising relative strength line means the stock has been outperforming the market; a declining line means just the opposite.

- **% Cash to Total Asset (CA)**

- **Projected 3-5 Year Relative P/E (PPE)**

- **Projected Earnings Per Share Growth Rate (PEG):** The estimated growth rate in earnings expressed as a percentage.

- **% Book Value Growth 1 Year (BG)**

Utilizing a cross sectional time series data, this model may be expressed as follows:

$$P_{it}/B_{it} = a + b_1TR_{it} + b_2SR_{it} + b_3RPE5_{it} + b_4RR_{it} + b_5ROE_{it} + b_6BG_{it} + b_7TT_{it} + b_8RS_{it} + b_9RTA_{it} + b_{10}PPE_{it} + b_{11}PEG_{it} + b_{12}CA_{it} + b_{13}BYD_{it} + b_{14}I_{it} + b_{15}VIX_{it} + e_{it} \quad (6)$$

Where: i = company i
t = time t
a = the intercept
b = regression coefficient

e_{it} = the random error

III. EMPIRICAL RESULT

As shown in Table 1, a cross-sectional regression estimates of expression (4) and (5) yield the following result:

$$P/B = -2.807 - .035\,VIX - .101\,TR - 0.194\,SR + 1.329\,RPE + 0.121\,RR + 0.133\,ROE +$$
$$(-31.172)\quad(-11.10)\quad(-16.426)\quad(71.088)\quad(150.744)\quad(126.172)$$

$$0.004\,BG + 0.009\,TT + 0.001\,RS + 2.137\,PPE + 0.036\,PEG +$$
$$(13.834)\quad(40.389)\quad(3.493)\quad(91.553)\quad(35.311)$$

$$0.002\,CA + 12.593\,BYD - 0.438\,I + 0.038\,RTA + e_{it} \qquad (7)$$
$$(3.319)\quad(90.392)\quad(-37.154)\quad(8.981)$$

(t-statistics in parentheses below the coefficients) ($R2 = 0.707$)

Durbin-Watson *test* was utilized to test the hypothesis of no autoregression. As shown in Table 2, the Durbin-Watson statistic indicates that there is no autoregression and we can retain the statistical estimates without concerning a bias of the estimated standard error. The low correlation coefficients of the correlation matrix indicate little multicolinearity between the independent variables.

TABLE 1

Statistical Results

Dependent Variable: P/B: Market Price/Book Value

Independent Variables	B	Standard Error B	t
VIX: Volatility Index	-.035	.001	-31.172
TR: Timeliness Rank	-.101	.009	-11.101
SR: Safety Rank	-.194	.012	-16.426
RPE: Relative P/E Ratio	1.329	.019	71.088
RR: % Retained to Common Equity	.121	.001	150.744
ROE: Est Return on Shareholders Equity	.133	.001	126.172
BG: Book Value Growth 1-Year	.004	.000	13.834
TT: Total Return 1-Year	.009	.000	40.389
RS: Relative Strength 3 Months	.001	.000	3.493
PPE: Proj 3-5 Yr Relative P/E	2.137	.023	91.553
PEG: Proj EPS Growth Rate	.036	.001	35.311

CA: % Cash to Total Asset	.002	.000	3.319
BYD: Dividend Declared/Book Value	12.593	.139	90.392
I: 10-Year Treasury	-.438	.012	-37.154
RTA: % Return on Total Asset	.038	.004	8.981
(CONSTANT)	-2.807		
R Square	.707		
Adjusted R Square	.707		
Durbin-Watson Statistic	1.919		

With a t-statistic of -31.172 and -37.154, 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) as well as bond yields.

In addition, the statistical results indicated that investors respond positively to the stocks with high dividend and quality earnings, which is reflected in the book yield and return on equity variables. The results also suggest that expected growth in earnings or capital appreciation is an investment objective of stockholders. This is consistent with the discounted cash flow approach in the valuation theory of common stock.

IV. CONCLUSIONS

This study examines the relationships between stock prices, bond yields and Chicago Board Options Exchange Volatility Index (VIX). The empirical results led to the following conclusions:

- The empirical analysis of Section III demonstrated that the contemporaneous increases in bond yields and Chicago Board Options Exchange Volatility Index (VIX) has a negative impact on the valuation of common stocks.

- Stocks and bonds are falling in tandem at a pace not seen in decades. If inflation stays high, it could spell continued trouble for 60/40 diversification. The traditional 60/40 portfolio can no longer be used as a hedge against the decline in stock prices during this "fighting inflation" period of the Federal Reserve's Monetary Policy.

- The empirical evidence also suggests 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.

REFERENCES

[1] Afarony, J. and I. Swaryi (1980), "Quarterly Dividend and Earnings Announcements and Stockholder's Returns: An Empirical Analysis," *Journal of Finance,* 35, 1-12.

[2] Cottle, S. and D.L. Dodd and B. Graham. "Security Analysis: Principles and Techniques," (1962). McGraw-Hill, New York.

[3] Feldstein, M. (1980), "Inflation and the Stock Market," *The American Economic Review;* 70 (5).

[4] Feldstein, M. and J. Green (1983), "Why do companies pay dividends?" *American Economic Review,* (73), 17-30.

[5] Gordon, M.J. (1962), "The Investment, Financing and Valuation of the Corporation," Homewood, Ill., Richard D. Irwin.

[6] Gordon, M.J. (1959), "Dividends, earnings and stock prices," *Review of Economics and Statistics,* 41, 99-105.

[7] Gordon, M.J. (1962), "The savings investment and valuation of a corporation," *Review of Economics and Statistics,* 44, 37-51.

[8] Hakansson, N.H. (1982), "To pay or not to pay dividends," *Journal of Finance* 37, (2), 415-428.

[9] Hong, H. (1977), "Inflections and the Market Value of the Firm: Theory and Tests," *Journal of Finance,* (32), 1031-1048.

[10] Kolbe, A. Lawrence and Williams B. Tye (1990), "The Supreme Court's Duquesne Opinion-Practical Implication for Regulated Industries," *Public Utilities Fortnightly,* 126 (5), 19-22.

[11] Le, Steven, Ying Zhang, Jimmy Lockwood, and Wikrom Prombutr (2016), ''Investor Response to Online Value Line Rank Changes: Foreign versus Local Stocks", by Ying Zhang, Steven V. Le, Jimmy Lockwood, and Wikrom Prombutr, Global Finance Journal.

[12] Le, Steven, Ying Zhang, Hongfei Tang, and Wikrom Prombutr (2016), "Pre-Event Trading Based on Value Line's Weekly Rank Change Announcements", Journal of Trading.

[13] Le, Steven, Ying Zhang, and Giao X. Nguyen (2010), **"**Yes, the Value Line Enigma Is Still Alive: Evidence from Online Timeliness Rank Changes", The Financial Review, Vol. 45, No. 2, pp. 355-373.

[14] Le, Steven (1991), "Regulatory Risk and Valuation of Regulated Firm: An Implication to the Utility Companies' Fair Rate of Return in Light of the 1989 Supreme Court's Duquesne Opinion," *Mid-Atlantic Journal of Business,* Vol. 27, No. 23.

[15] Litzenberger, R.H. and K. Ramaswamy (1982), "The effect of dividends on common stock prices, tax effects or information effects," *Journal of Finance,* 37, 429-443.

[16] Litzenberger, R.H. and K. Ramaswamy (1979), "The effect of personal taxes and dividends on capital asset prices," *Journal of Financial Economics,* 7, 163-195.

[17] Modigliani, F. and R. Cohn (1979), "Inflation, Rational Valuation and the Market," *Financial Analyst Journal,* 35, 3-23.

[18] Modigliani, F. and M. Miller (1961), "Dividend policy, growth and the valuation of shares," *Journal of Business* (34), 411-432.

[19] Van Horne, J. and W.G. Passmire, Jr. (1972), "The Impact of Unanticipated Changes in Inflation on the Value of Common Stocks," *Journal of Finance,* (L7), 1081-1092.

[20] Watts, R. (1973), "The Information Contents of Dividends," *Journal of Business,* 191- 211.