

THE RELATION BETWEEN CHICAGO BOARD OPTIONS EXCHANGE VOLATILITY INDEX AND THE BUCHAREST STOCK EXCHANGE INDEX

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Abstract

The paper analyzes the relationship between the VIX, also known as fear index and namely the Volatility index of the Chicago Board Options Exchange and the BET Plus stock index of the Bucharest Stock Exchange, highlighting how global uncertainty influences the evolution of the Romanian market. The relationship between the fear index and the BET Plus index is negative. In conditions of global uncertainty, demand for risky financial assets decreases, while supply increases, causing stock market declines. When optimism returns to financial markets and the VIX decreases, the demand and supply trend reverses, leading to an increase in stock market indices. The Romanian market, although smaller and less liquid, reacts to international shocks.

Keywords: Stock Market Volatility, Capital Market Contagion, Romanian Emerging Stock Exchange

JEL Classification Codes: G14

1. Introduction

Uncertainty and risk are essential factors that profoundly influence the economy and the financial markets. In the economic literature, the first author to introduce explicit definitions for risk and uncertainty is Knight (1921). Risk refers to the situation where the probabilities of outcomes are known or can be estimated. Uncertainty refers to the inability of decision-makers to forecast the probability of future events and even to list all eventualities.

Uncertainty increases volatility in financial markets, as investors react emotionally through massive sell-offs and sudden portfolio changes. They demand higher returns, becoming more demanding regarding uncertainty premiums. Anderson et al. (2009) argue that there is an uncertainty premium just as there is a risk premium in the market.

2. Literature review

There are several measures of uncertainty. Arnold and Vurgst (2006) rely on the dispersion from the mean of the forecasts of the main economic variables.

Bloom (2009) uses the VIX, which is a 30-day implied volatility measure of the Standard & Poor's 500 (S&P 500) index options. This financial indicator, also called "the fear index", is published daily by the Chicago Board Options Exchange and reflects market expectations regarding volatility for the next month.

Bloom (2014) shows that the VIX is highly countercyclical, increasing by as much as 58% during recessionary periods, which recommends it as a relevant measure of uncertainty, consistent with economic theories supporting the intensification of uncertainty in recessions. However, the VIX can be decomposed into a component strictly associated with uncertainty and one reflecting investors' risk aversion.

Many studies find that the relationship between investor sentiment and stock market returns is statistically significant.

Sarwar (2012) uses US stock data for 1993-2007 and finds that VIX and US stock market returns are negatively correlated. Moreover, the negative relationship is especially significant when

the US stock market is characterized by high volatility. Sarwar (2012) also examines the impact of VIX on market returns of four BRIC countries and finds that a significant negative relationship exists between VIX and the Chinese and Brazilian stock markets, with the negative relationship being particularly strong when the Brazilian stock market is experiencing high volatility. However, there was apparently no negative relationship between VIX and the Russian and Indian stock markets.

Smales, Lee A., (2016) demonstrate a strong relationship between VIX and stock returns. The presence of investor sentiment pushes asset prices away from the equilibrium level justified by underlying fundamentals. The market response to sentiment is greatest during recession, particular for those stocks most susceptible to speculative demand.

Banerjee et al (2007) examine the forecasting power of implied volatility for future returns of portfolios grouped by the characteristics book-to-market equity, size, and beta and find that VIX variables significantly affect returns for most portfolios, with the relationship stronger for high beta portfolios.

Fernandes et al. (2014) confirm the evidence in the literature that there is a negative relationship between the VIX and the S&P 500 index return, finding a strong negative relationship with both contemporary and lagged S&P 500 returns, as well as a positive link with the contemporary S&P 500 trading volume.

3. Research methodology

This study aims to test the existence of a statistically significant relationship between the VIX and the BVB BET Plus index. As a financial market indicator, we used the daily performance of the BET PLUS index (from the BSE database), and as an uncertainty indicator, we used the VIX, also known as the fear index. BET Plus is an extended index of the Bucharest Stock Exchange, which more accurately reflects the evolution of the Romanian market by including a larger number of companies than the BET index. The data for CBOE Volatility Index (VIX) were taken from the investing.com website. (<https://www.investing.com/indices/volatility-s-p-500-historical-data>).

The frequency of the data used is daily, for a sample spanning from June 23, 2014, to December 30, 2024. To have the same number of records for the two data series, we eliminated those VIX values from the days for which BET Plus had no records, especially on days with no activity at the Bucharest Stock Exchange.

The percentage change in the daily closing prices of the BET PLUS index was used to calculate the stock market performance, and the change in investor perception was measured by the percentage variation of the VIX closing data.

We used the EViews software package to generate a series of statistics for each of the two indicators and to test the regression model.

Although the series has a constant frequency, due to legal holidays, which cannot be defined in EViews, the *Dated* option cannot be chosen, but rather the *Unstructured/Undated* option.

The effect of investor perception on stock returns is tested by running the following regression model:

$$\text{Return BET Plus } t = \alpha + \beta * \text{Change VIX}_t + \varepsilon_t \quad (1)$$

4. Results and discussions

Estimating the model required testing the stationarity of the data series used, an essential condition for the validity of econometric models involving temporal data. Stationarity implies that the statistical properties of the series—mean, variance, and autocovariance—remain constant over time. In the absence of this property, estimation results can be distorted, leading to spurious regressions. Also, the failure to meet the stationarity condition affects the consistency and efficiency of the estimates obtained by the ordinary least squares (OLS) method, as well as the accuracy of the forecasts derived from the model.

We applied the Augmented Dickey-Fuller (ADF) test, which allows determining the existence of a unit root in the series. The test results are summarized in Table 1.

The number of lags was automatically selected based on the Akaike Information Criterion: 6 for the BET Plus return series and 7 for the VIX Change% series, respectively.

The form with intercept (constant) was chosen for the ADF test because both series represent percentage variations and oscillate around a constant mean with no observable deterministic trend.

Table 1: Augmented Dickey-Fuller test statistic - Exogenous: Constant

Null Hypothesis: the series have a unit root			
		t -Statistic	Prob
Return BET_Plus_		-19.43	p-value = 0.0000
VIX_Change		-20.19	p-value = 0.0000
Test critical values:	1% level	-3.43	Conclusions: the series do not have a unit root the series are stationary
	5% level	-2.86	
	10% level	-2.57	

Table 1 shows that both series have an ADF-statistic significantly lower than the critical values, and the p-values are approximately zero, leading to the rejection of the null hypothesis of non-stationarity. Therefore, both series can be considered stationary in level, being suitable for direct econometric modeling (for example, through the regression model).

The descriptive statistics of the two data series are presented in Figures 1 and 2.

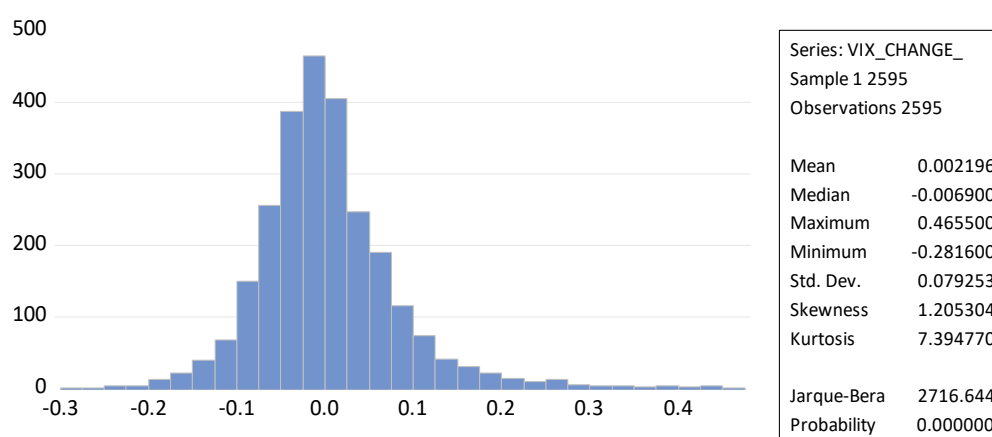


Figure 1. The histogram and the descriptive statistics of the VIX change

The VIX_Change% distribution is leptokurtic (Kurtosis = 7.395, higher than the normal value of 3), which indicates the presence of fat tails and positive asymmetry (Skewness = 1.205304 > 0), typical for high-volatility financial data. This is a signal that the distribution is not normal.

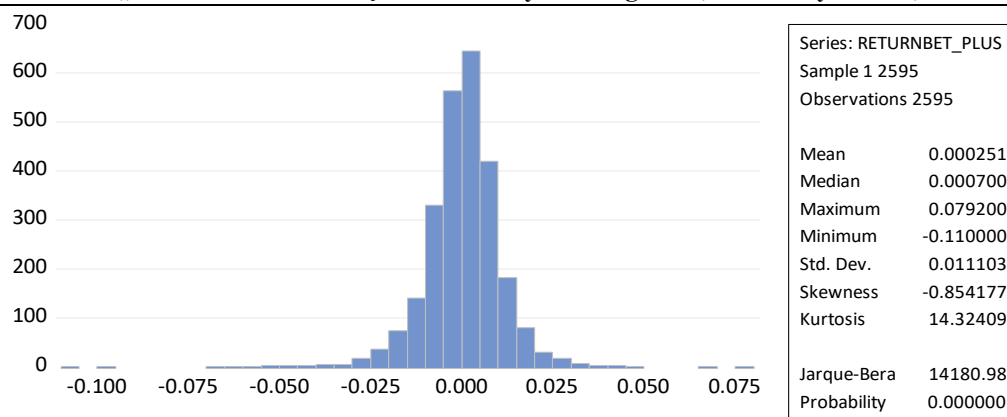


Figure 2: The histogram and the descriptive statistics of the BET Plus index return

The Return BET_Plus distribution is negatively skewed (Skewness = -0.854), with a tendency towards sudden drops. The Kurtosis value is 14.324, which indicates that extreme values (outliers) can appear much more frequently than in a normal distribution. BET Plus returns can be generally stable, but occasionally positive or negative shocks occur.

The verification of the normal distribution was done with the Jarque-Bera test, because it is an asymptotic test, and works best on large samples and the series contain continuous values, expressed as percentage variations.

Table 2. Jarque-Bera test results

Variable	Jarque-Bera statistics	p-value	Conclusion
VIX Change%	2716.6440	0.000000	Non-normal distribution
Return BET Plus	14180.9801	0.000000	Non-normal distribution

Source: Figures 1 and 2

The large value of the statistic and the extremely small p-value indicate the rejection of the normality hypothesis for both the VIX and BET Plus variables.

To establish the direction and measure the intensity of the relationship between the two variables, we used the Spearman coefficient in addition to the Pearson correlation coefficient, because the variables are not normally distributed.

For the two data series, VIX and BET, the Pearson coefficient is -0.199374, indicating a weak negative correlation. The Spearman coefficient of -0.1106 also indicates a weak negative relationship between the VIX change and the BET Plus return, but statistically significant due to the p-value < 0.05 ($p = 1.6322 \cdot 10^{-8}$).

In order to highlight the linearity of the relationship, we created a scatter plot of the pairs of points comprising the daily returns of the BET Plus index and the percentage changes of the VIX, as well as the estimated regression line.

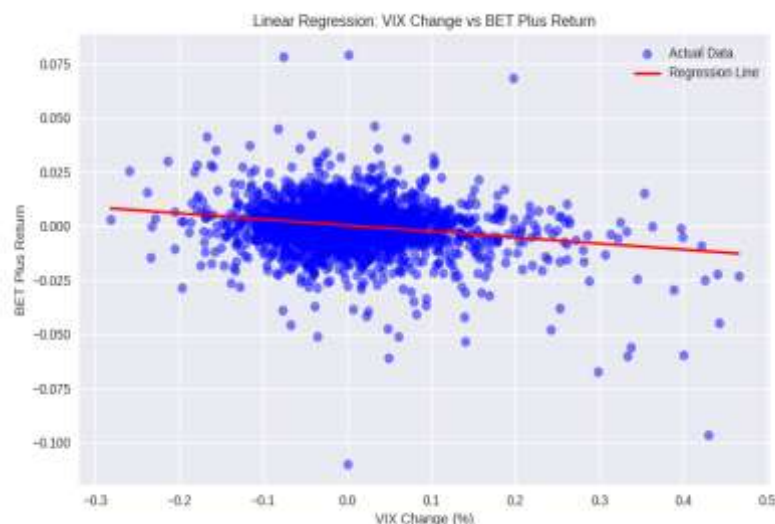


Figure 3 Scatter plot and the estimated regression line

The graph supports the existence of an inverse and linear relationship between the return of the BET Plus index as a dependent variable and the change in the VIX volatility index as an independent (exogenous) variable.

Based on the aforementioned elements, using the EvIEWS software package, the parameters of the regression model were estimated using the ordinary least squares method, being found in Table 3.

Table 3 Characteristics of the regression model

Dependent Variable: RETURNBET_PLUS

Method: Least Squares

Date: 02/08/25 Time: 16:55

Sample: 1 2595

Included observations: 2595

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.000312	0.000214	1.460597	0.1442
VIX_CHANGE_	-0.027931	0.002696	-10.36039	0.0000
R-squared	0.039750	Mean dependent var		0.000251
Adjusted R-squared	0.039379	S.D. dependent var		0.011103
S.E. of regression	0.010882	Akaike info criterion		-6.202640
Sum squared resid	0.307059	Schwarz criterion		-6.198123
Log likelihood	8049.925	Hannan-Quinn criter.		-6.201003
F-statistic	107.3377	Durbin-Watson stat		1.982962
Prob(F-statistic)	0.000000			

The probability associated with the F-statistic test is 0 and implicitly lower than the significance level, which means that the null hypothesis (all coefficients except the intercept are 0) is rejected, resulting in the model being significant.

For the exogenous (independent) variable, the probability associated with the t-Statistic test is 0, so the coefficient is statistically significant. The same cannot be said about the constant, for which the probability associated with the t-Statistic test is $> 10\%$. For the constant, the p-value is

0.1442, which means it is not statistically significant at the 10% or 5% level. However, we will keep the intercept in the model to avoid distorting the estimates.

The regression function is therefore:

$$\text{Return BET Plus } t = 0.000312 + (-0.02793) * \text{Change VIX}_t + \varepsilon_t \quad (2)$$

The small coefficient of determination ($R^2 = 0.03975$) suggests that only about 4% of the variation in the BET Plus return is explained by the VIX change, indicating a weak relationship.

The negative regression coefficient indicates that a 1% increase in VIX leads to an estimated decrease of about 0.028 percentage points in the BET Plus return.

We generated the residual plot to check the homoscedasticity of the errors, which assumes that the errors (residuals) of the regression model have constant variability throughout the range of predicted values. This is an essential condition for the validity of linear regression.

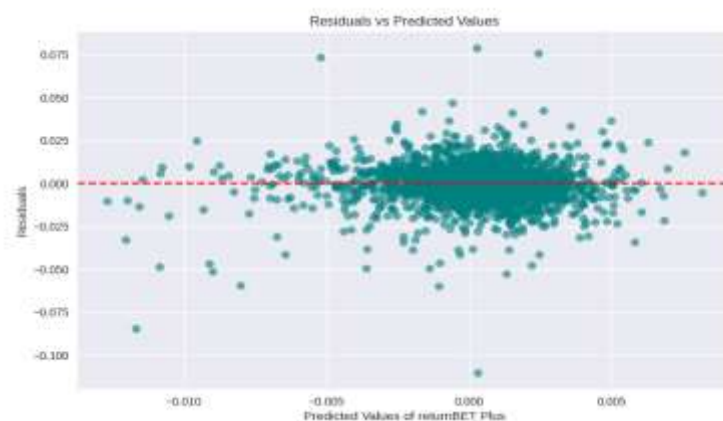


Figure 4. Residual plot –dependent variable

Figure 4 demonstrates that the points are distributed relatively uniformly around the zero line, without a clear pattern or a systematic increase in dispersion as a function of predicted values, which means the errors are homoscedastic. Visually, the linear regression model complies with the condition of constant error variance, which supports the validity of the obtained estimates.

To check the normal distribution of the errors, in Figure 5 we generated the histogram of the residuals.

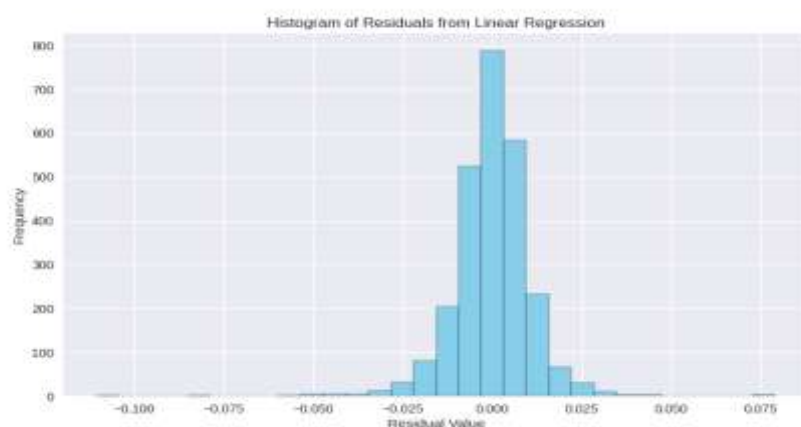


Figure 5 Histogram of the residuals

The generated histogram is symmetric, with a concentration of values around the mean (zero), having a bell-like shape, which supports the normality hypothesis.

To ensure that the errors (residuals) of the model are independent, we applied the Durbin-Watson and Breusch-Godfrey tests.

The Durbin-Watson test result is 1.9830 (from Table 3 Characteristics of the regression model), which indicates that there is no significant serial autocorrelation of the errors and the model respects this important condition for the validity of the regression.

The Breusch-Godfrey test results are found in Table 4.

Tabel 4 Breusch-Godfrey Serial Correlation LM Test

Breusch-Godfrey Serial Correlation LM Test:

Null hypothesis: No serial correlation at up to 1 lag

F-statistic	0.190456	Prob. F(1,2592)	0.6626
Obs*R-squared	0.190662	Prob. Chi-Square(1)	0.6624

Test Equation:

Dependent Variable: RESID

Method: Least Squares

Date: 06/07/25 Time: 20:48

Sample: 1 2595

Included observations: 2595

Presample missing value lagged residuals set to zero.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-4.54E-07	0.000214	-0.002123	0.9983
VIX_CHANGE_	0.000206	0.002737	0.075159	0.9401
RESID(-1)	0.008702	0.019939	0.436412	0.6626
R-squared	0.000073	Mean dependent var	-6.06E-19	
Adjusted R-squared	-0.000698	S.D. dependent var	0.010880	
S.E. of regression	0.010884	Akaike info criterion	-6.201943	
Sum squared resid	0.307036	Schwarz criterion	-6.195167	
Log likelihood	8050.021	Hannan-Quinn criter.	-6.199487	
F-statistic	0.095228	Durbin-Watson stat	2.000946	
Prob(F-statistic)	0.909169			

The most important part of the Breusch-Godfrey test output is the one that presents the two tests, F-Statistic and R-squared, and their associated probabilities.

The null hypothesis of the test is that there is no serial correlation of the errors of the regression equation up to the specified lag. Since the probability associated with the two tests is higher than the working significance level ($0.66 > 0.05$), then the null hypothesis is accepted, so there is no serial correlation, this being consistent with the Durbin Watson test.

5. Conclusions

This paper examines the relationship between the Romanian stock market return, measured by the BET Plus index and the fluctuation of the fear index (VIX). The importance of this analysis lies in the fact that international capital flows react to global risk, even though Romania is a small emerging market. When the VIX rises sharply, investors tend to reduce exposure to risky assets, including in Romania.

We analyzed daily frequency time series for the period between June 23, 2014, and December 30, 2024, from which we excluded those days with no activity at the Bucharest Stock Exchange and we found that the increase in VIX has a negative but weak effect ($R^2 = 4\%$) on the BET Plus return. Episodes of amplified volatility in the US market lead on average to declines in

the Romanian market, this being typical for contagion or volatility transmission between markets. The effect is a forecasted decrease of approximately 0.028 percentage points in the BET Plus return for a 1% increase in VIX, while the reduction in the level of the explanatory variable determines the appreciation of the stock index, considered a benchmark in evaluating the returns of the most liquid traded stocks. The statistical test results support the validity of the linear regression model.

The limitation of this study derives from the fact that there are other factors that can influence the BET Plus index return and therefore the model can be improved; however, for investors, monitoring the VIX is a useful tool to anticipate the movements of the Romanian stock market.

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