Bulletin of the Transilvania University of Braşov
Series V: Economic Sciences • Vol. 17(66) No. 2 - 2024
https://doi.org/10.31926/but.es.2024.17.66.2.8

REGIME SHIFTS AND VOLATILITY DYNAMICS IN THE BUCHAREST STOCK MARKET: A MARKOV SWITCHING AND ARCH PERSPECTIVE

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Abstract: *This research examines the changes in volatility and shifts in regimes within the Bucharest Stock Exchange (BSE) by analysing the performance of the BET index. By utilizing both the Markov Switching Model (MSM) and Autoregressive Conditional Heteroskedasticity (ARCH) tests, the study detects two separate market conditions—bullish and bearish—and affirms the existence of volatility clustering in the Romanian market. The analysis of MSM shows a strong level of continuity in both market conditions, leading to important consequences for how investors act, such as excessive reaction, following the crowd, and fear of risk. The ARCH test emphasizes changing volatility over time, showing that market fluctuations are strongly affected by how investors collectively react to market conditions, especially in times of uncertainty or crisis. These results highlight the importance of considering behavioural biases when evaluating risk and making investment choices in emerging markets, such as Romania, for investors and policymakers. The research adds to the body of behavioural finance knowledge by offering an understanding of how investor sentiment impacts volatility and market regime shifts in emerging markets.*

Key words: *BETindex, MSM, ARCHtest, behavioural finance*

1. Introduction

The efficiency of financial markets is commonly believed to involve prices that incorporate all existing information. Nevertheless, in recent years, an increasing amount of research has raised doubts about this idea, emphasizing the impact of psychological elements and behavioural prejudices in causing market irregularities. This area of research, referred to as behavioural finance, questions the conventional efficient market hypothesis (EMH) by proposing that investors are not consistently logical decision-makers and are swayed by cognitive biases, emotions, and societal influences. The objective of this study is to examine the performance of stock returns on the BSE, specifically focusing on returns of the BET index. Through the utilization of various econometric tools, such as the Markov Switching Model (MSM) and the Autoregressive Conditional Heteroskedasticity (ARCH) test,

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this research delves into the identification of volatility regimes and heteroskedasticity in the return series. Furthermore, the analysis includes the incorporation of behavioural finance principles to interpret the market's response to economic and psychological factors, establishing links between market behaviour and underlying investor biases, such as herding, overconfidence, and sentiment-driven trading. Using these models and theories, the study seeks to offer a thorough understanding of the impact of investor psychology on the fluctuation of stock prices and volatility trends within the Romanian stock market. Additionally, it aims to contribute to the scarce collection of research that concentrates on behavioural finance in developing markets, specifically in Eastern Europe. By doing so, this research not only evaluates the practicality of behavioural finance principles, but it also provides valuable insights for investors and policymakers who are seeking to grasp and alleviate irrational market behaviours.

2. Literature review

Several economists and finance researchers have made use of the Markov Switching Models (MSM) and ARCH tests in the study of financial time series, especially in relation to regime switches and volatility clustering characteristic of behavioural finance. In 1989, Hamilton introduced Markov Switching Models (MSM) as a framework for analysing nonstationary time series that transition between various states, such as periods of high and low volatility (Hamilton, 1989). Further research, including work by Ang and Bekaert in 2003, utilized MSM to examine stock market returns, revealing that markets frequently oscillate between bull and bear cycles, each linked to distinct risk-return dynamics. Fractal theory, originally formulated by Benoit Mandelbrot (1977), introduced additional tools to describe the complex nature of financial time series. Drawing from the work of Harold Edwin Hurst on the Nile River's water levels (Hurst, 1956), Mandelbrot adapted the “Hurst exponent” to detect long-term memory and fractal characteristics in time series data. Mandelbrot discovered that there are two effects in a financial time series: the former, “Joseph effects”, after the biblical story about seven good years and seven bad years, as continuous and predictable and, the latter, he termed “Noah effects”, as chaotic and unpredictable (Mandelbrot and Wallis, 1968). He found that these two effects were present in more than flooding of the Nile River, but in everything from the communication lines, to crashes in financial markets. When applied to emerging markets like Romania, MSM has been particularly useful for identifying regime shifts influenced by market inefficiencies, changes in policies, or external disturbances. Researchers such as Krolzig 1997 and 1998), and Cai in 1994, highlighted the model's effectiveness in capturing various market conditions. In addition to MSM models, the Autoregressive Conditional Heteroskedasticity (ARCH) model, developed by Engle in 1982, has become a key method for analysing time-dependent volatility. Engle's research was significant in recognizing volatility clustering, which refers to the occurrence of high volatility periods followed by more high volatility and low volatility periods followed by more low volatility. In markets such as the BSE (Bucharest Stock Exchange), volatility clustering is frequently observed, as supported by various studies on Eastern European and emerging market economies, including work by Garcia et al. in 2014. Manolis and Kouretas (2008) employed the Markov-Switching ARCH

(SWARCH) model and discovered that the high volatility in stock returns of EU emerging markets is linked to financial crises, while a shift to a lower volatility regime occurs as these markets approach EU accession. Other studies, including those by L. Badea et al. (2019), apply methods such as conditional volatility estimation and dynamic conditional correlation using EGARCH and DCC MV-GARCH models, alongside regime shifts identified through Markov Regime Switching models. These studies suggest that, for investors, a diversified portfolio of funds can remain resilient during temporary unfavourable market conditions.

3. Data

The Bucharest Stock Exchange was categorized as a frontier market until September 26, 2019, when it was reclassified as an emerging market by the FTSE Russell global index provider. Our research used data from January 17, 2000, to January 19, 2024, consisting of 8769 records for the BET Index (BET). Most of the data refers to the period when the exchange was considered a frontier market, with the transition to an emerging market occurring in September 2019. We analysed the stationary series using BETr, which represents the log return of the BET index calculated using the formula:

$$BETr = \ln\left(\frac{BETt}{BETt-1}\right)$$

This resulted in 8768 records. The dataset was sourced from www.investing.com and processed to include only working days, excluding weekends and legal holidays in Romania, using STATA 18. It includes daily closing data over a span of approximately 24 years.

4. Methodology

4.1. Augmented Dickey-Fuller (ADF) Test

To determine the stationarity of the BET index and its log returns (BETr), the Augmented Dickey-Fuller (ADF) test was applied(David A. Dickey and Wayne A. Fuller, 1979). Stationarity is crucial for analysing financial time series, as non-stationary data can lead to spurious results in econometric modelling. The ADF test was conducted with the null hypothesis that the series contains a unit root (i.e., it is non-stationary). By applying this test, we assessed whether the BET series and BETr were stationary, with particular attention to the p-values to either accept or reject the null hypothesis. The test was performed at common significance levels of 1%, 5%, and 10%.

4.2. Markov Switching Model (MSM)

The Markov Switching Model (MSM) was employed to capture regime shifts in the behaviour of the BETr series. This model allows for the identification of different states (e.g., bullish and bearish market conditions) within the time series. MSM is particularly suitable for financial time series because it recognizes that markets can switch between different regimes, each characterized by distinct return and volatility patterns (Hamilton, 1989). The MSM model assumes two distinct states for BETr: a bearish state (State 1) characterized by negative returns and a bullish state (State 2) characterized by positive returns. Transition probabilities between these states were estimated to capture the likelihood of moving from one market regime to another. The model was fitted using maximum likelihood estimation (MLE), and the performance was evaluated based on the log-likelihood function and information criteria such as AIC, HQIC, and SBIC. The Markov Switching Model (MSM) is a useful tool for identifying changes in financial market regimes, especially shifts between high and low volatility, or bullish and bearish market conditions. Investor sentiment often leads to regime changes, influenced by concepts from behavioural finance like overreaction, herding, and loss aversion. The MSM model identifies different market environments by recognizing the shifts between them, which correspond to changes in investor psychology. In bullish states, exaggerated reactions can result in sustained high returns, whereas in bearish states, following the crowd can lead to dramatic and prolonged downturns. These patterns of behaviour make the market switch back and forth between the two states, which can be accurately represented by MSM by assigning probabilities to the chances of remaining in or moving between states. By identifying these patterns, the MSM not only reveals how markets transition between high and low volatility, but also uncovers underlying behavioural biases that drive these changes.

4.3. Autoregressive Conditional Heteroskedasticity (ARCH) Test

To detect volatility clustering within the BETr series, we applied the ARCH model. This method identifies time-varying volatility by examining whether large changes in stock returns tend to cluster together (Engle, 1982). The statistical representation provided by the ARCH test shows how market volatility is influenced by investors' behaviour through the detection of volatility clustering. Frequent spikes in volatility are typically caused by fear, uncertainty, and following the crowd, whereas minimal volatility is associated with confidence and stability. The ARCH test helps in illustrating how market volatility cycles mirror investor psychology. The ARCH test was conducted in two steps:

4.3.1. *Initial Regression:*

A simple regression was performed on the BETr series to capture any underlying patterns. The residuals from this regression were used to perform the ARCH test.

4.3.2. Engle's ARCH LM Test:

The residuals were subjected to Engle's ARCH LM test to identify the presence of autoregressive conditional heteroskedasticity (ARCH). This test evaluates whether there is time-varying volatility in the residuals, which is an indicator of volatility clustering.

The null hypothesis of no ARCH effects was tested, with a significant result suggesting the presence of ARCH effects, meaning that periods of high volatility tend to follow each other in the BETr series.

5. Results

5.1. ADF Tests

For the BET Index (Tabel 1), the p-value of 0.9819 exceeds typical significance levels like 0.05 or 0.01, leading us not to reject the null hypothesis. This indicates that the BET series is not constant. The p-value (0.0000) for BET Log return is significantly below 0.05 or 0.01, leading us to reject the null hypothesis and conclude that the BETr series is stationary.

Table 1

ADF test for non-stationarity for BET and log-return BETr 17 Jan 2000- 19 Jan 2024

ADF test/Variable	BET	BETr
Test-statistic	0.411	-81.335
p-value	0.9819	0.0000
Critical values		
1%	-3.430	-3.430
5%	-2.860	-2.860
10%	-2.570	-2.570

5.2. MSM Test

The value of the likelihood function (Log Likelihood: 27.482.609) with high values generally indicates a better fit, and, in combination with lower values of information criteria [AIC (-6.2677), HQIC (-6.2663), and SBIC (-6.2637)], it suggests a better model fit (Table 2).

Table 2

Markov Switching Dynamic Regression (MSM) model with two states for the return of the Bucharest Exchange Trade index (BETr)

Performing EM optimization:
Performing gradient-based optimization:

Iteration	0:	log	likelihood	=	26838.783	(not concave)
Iteration	1:	log	likelihood	=	26838.783	(not concave)
Iteration	2:	log	likelihood	=	26842.67	(not concave)
Iteration	3:	log	likelihood	=	26848.409	(not concave)
Iteration	4:	log	likelihood	=	26853.019	(not concave)
Iteration	5:	log	likelihood	=	26856.288	(not concave)
Iteration	6:	log	likelihood	=	26885.351	(not concave)
Iteration	7:	log	likelihood	=	26927.065	(not concave)
Iteration	8:	log	likelihood	=	27310.473	(not concave)
Iteration	9:	log	likelihood	=	27402.857	(not concave)
Iteration	10:	log	likelihood	=	27467.646	(not concave)
Iteration	11:	log	likelihood	=	27482.536	(not concave)
Iteration	12:	log	likelihood	=	27482.609	(not concave)
Iteration	13:	log	likelihood	=	27482.609	(not concave)

Markov-switching dynamic regression

Sample: 18jan2000 thru 19jan2024 Number of obs = 8,768
Number of states = 2 AIC = -6.2677
Unconditional probabilities: transition HQIC = -6.2663
SBIC = -6.2637

Loglikelihood=27.482.609

BETr	Coefficient	Std. err.	z	P>z	[95% conf. interval]	
State1 _cons	-.0431373	.0012968	-33.26	0.000	-.045679	-.0405956
State2 _cons	.0010764	.0001101	9.77	0.000	.0008605	.0012922
sigma	.0099095	.0000808			.0097524	.010069
p11	.3237532	.0457317			.2412251	.4189273
p11	.0108215	.0012904			.0085638	.0136661

Markov Switching Dynamic Regression (MSM) model with two states for the return of the Bucharest Exchange Trade index (BETr)

The average return to State 1 (Constant (_cons): -0.0431373) is interpreted as a bearish market or lower growth period. The negative value means that, in this state, the BETr returns tend to be negative. With P-value (< 0.001), we have indication that the result is statistically highly significant. A value of p11 (0.324) means that, if the market is in State 1 (bearish state), there's about a 32.4% chance it will stay in that state in the next period. A very small value of p21 (0.011) means that the market rarely switches from the bullish state to the bearish state, indicating a high level of persistence in the bullish state. A small value of sigma (0.010) suggests low volatility in the residuals, indicating that the model explains much of the variation in the BETr returns. The model has identified two distinct states for BETr: State 1 which is a bearish state with negative returns (indicated by a negative constant -0.043) and State 2 a bullish state with positive returns (as indicated by the positive constant: 0.001). In the context of a Markov Switching Model (MSM), "states" refer to different regimes or phases, distinct periods of behaviour, indicating that the BETr returns time series can transition between different states.

5.3. Arch test

5.3.1. Regression

The coefficient for the constant term in the regression is 0, with a p-value of 0.002, which is highly significant (p < 0.01). The R-squared value of 0.000 indicates that this regression model is not particularly useful for explaining the variations in BETr, but the low value of R-squared is not unusual in financial time series data, where individual lags often explain little of the variance in returns and stock returns are notoriously difficult to predict due to their random nature (Table 3). We can consider the ARCH test.

Table 1

Regression for the return of the Bucharest Exchange Trade index (BETr)

BETr	Coef.	St.Err.	t-value	p-value	[95%	Interval]	Sig
Constant	0	0	3.14	.002	0	.001	***

Mean dependent var	0.000	SD dependent var	0.011
R-squared	0.000	Number of obs	8768
F-test	0.000	Prob > F	.
Akaike crit. (AIC)	-53672.803	Bayesian crit. (BIC)	-53665.724

**** p<.01, ** p<.05, * p<.1*

5.3.2. ARCH Test

The goal of the ARCH test (Engle's ARCH LM test) (Table 4) is to identify autoregressive conditional heteroscedasticity in the residuals of a time series regression. If the test demonstrates notable findings, it indicates the presence of time-varying volatility within the series. The LM test indicates highly significant results for autoregressive conditional heteroskedasticity (ARCH) with a Chi-squared value of 77.143, 1 degree of freedom, and a p-value of 0.000. This indicates that we can reject the null hypothesis that there are no ARCH effects present in the residuals of the regression. To conclude, the ARCH test results indicate the existence of ARCH effects, specifically time-varying volatility, in the BETr series.

Table 2

Engle's ARCH LM test for the return of the Bucharest Exchange Trade index (BETr)

LM test for autoregressive conditional heteroskedasticity (ARCH) chi2	df	Prob>Chi2
77.143	1	0.000

H0: no ARCH effects vs. H1: ARCH(p) disturbance

6. Conclusion

This research examines the changes in volatility and shifts in regimes on the Bucharest Stock Exchange (BSE), with a specific focus on the performance of the BET index. The MSM and ARCH tests together provide insides into market structural changes and volatility clustering, revealing how investor actions influence market behaviour. The MSM findings revealed two separate market conditions: State 1 being bearish with negative returns, and State 2 being bullish with positive returns. The elevated chance (32.4%) of staying in the bear market indicates that, when investors become pessimistic or fearful, they are inclined to maintain cautious behaviour, leading to extended periods of low profits. On the other hand, the small chance of shifting from a positive to a negative market state (p21 = 0.011) shows a strong continuity in favourable market conditions, implying that, in times of positivity, investors may be hesitant to respond to negative indicators, displaying a leaning towards excessive confidence and following trends during bullish periods. Additionally, the ARCH test outcomes validate the existence of volatility clustering, which is supported by the substantial LM test findings (Chi-squared = 77.143, p-value = 0.000). This suggests that times of increased volatility are frequently succeeded by further volatility, demonstrating the increased uncertainty and fear-driven actions of investors during market declines or crises. On the other hand, times of low volatility, which are typically linked with market stability, tend to continue, supporting the notion that in times of stability, investors showcase increased confidence and a preference for taking risks, resulting in prolonged periods of minimal market fluctuations. This study enhances the understanding of stock market behaviour in Romania, examining the intricate volatility dynamics that arise from the conjunction of market structure and investor psychology. For investors and policymakers, these findings emphasize the importance of considering behavioural factors in risk management and investment strategies, particularly in emerging markets where behavioural biases can exacerbate market instability.

Acknowledgments

I would like to express my deepest gratitude to Prof. dr. Monica Szeles Răileanu, whose invaluable guidance and support made this research possible. Their insightful feedback and encouragement throughout the process have been instrumental in shaping this work. I am also grateful to Transilvania University of Brasov for providing the resources and environment necessary for completing this study.

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