THE IMPLICATIONS OF CHAOS THEORY ON BUCHAREST STOCK EXCHANGE

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Abstract:
Chaos theory has generated a conceptual revolution regarding the analysis of capital markets. In general, capital market is an exciting and suitable field to apply chaos theory. Through its fundamental characteristics, an emerging capital market such as Bucharest Stock Exchange is even more appropriate. A chaotic system, as it is an emerging capital market presents certain characteristics such as : unpredictability, instability, disorder, noise and multiple vulnerabilities. By its very complex structure, an emerging capital market is a chaotic system.
Chaos represents a state of complex, unpredictable, nonlinear dynamics. A chaotic system appears to be random when in fact is an evolved form of order. Chaos theory provides an explanation for the fact that complex and unpredictable results occur in dynamic systems behaviour due to seemingly insignificant changes in initial conditions.

Key words: *chaos theory, random, determinism, initial conditions, chaotic time series, emerging capital markets*

JEL classification: *C58, G11, G14*

1. Introduction

Emerging capital market is characterized by a very complex and unpredictable behavior, particularly in turbulent financial and economic conditions. The current global financial crisis that erupted with the U.S subprime credit crisis in mid-2007 highlights certain features of capital markets.

Chaos theory portrays a new perspective, deeply rooted in reality and practical certainties. In fact, this mathematized and at the same time bohemian paradigm provides a thorough and reasoned criticism of efficient market hypothesis.

The inadequacies and limitations of this classical theory lead to inaccurate results in capital markets analysis. Accordingly, applying an inappropriate model leads to obtaining inaccurate results, useless for financial investors.

The complexity of capital markets behavior is in fact the transition to chaotic system condition. Interesting is that chaos theory applies to nonlinear dynamic system that appears to be random, but are just a superior class of order. A fundamental dimension of chaos theory is fractal market analysis, which has profound implications in the context of capital market.

Insignificant variations of the initial condition of a nonlinear dynamical system may produce very sharp variations in the long term behavior of the analyzed system, namely the emerging capital market. Chaos theory provides an effective alternative to traditional models and especially to Efficient Market Hypothesis.

2. Chaos theory and fractal dimension of capital market

Capital market is a nonlinear dynamic system, but in its essence is a conglomerate that certifies that local randomness and global determinism can coexist allowing a certain degree of predictability. A particular feature of chaotic systems is their fractal dimension and its quantitative implications.

In the literature, the concept of chaos achieve multiple meanings and interpretations. Different visions of the authors create a more pronounced theoretically mysticism around this abstract concept.

According to Maxwell (1873) : "When the state of things is such that an infinitely small variation of the present state will alter only by an infinitely small quantity the state at some future rime, the condition of the system, whether it is at rest or in motion, is said to be stable; but when an infinitely small variation in the present state may bring about a finite difference in the state of the system in a finite time, the condition of the system is said to be unstable".

Flake (1998) perceives the concept of chaos as an "irregular motion of a dynamical system that is deterministic, sensitive to initial conditions, and impossible to predict in the long term with anything less than an infinite and perfect representation of analog values". Williams (1997) reveals that : "Chaos is sustained and disorderly-looking long-term evolution that satisfies certain special mathematical criteria and that occurs in a deterministic non-linear system."

At the same time, some reviews suggest that a system whose long term behaviour is unpredictable, tiny changes in the accuracy of the starting value rapidly diverge to anywhere in its possible state space. There can however be a finite number of available states, so statistical prediction can still be useful.

On the other hand, Beckerman (2000) highlights the fact that : "Chaotic systems are ordered and deterministic, but appear to have an infinite number of potentially stable states. However, they never settle down to any of these and never repeat their path between them. They are by nature unpredictable and appear to be uncontrollable. Small inputs can lead to very large outputs, resulting in a runaway system or avalanche effect" (CALRESCO, 2006).

A fundamental characteristic of chaotic behavior is that the system trajectory will vary eventually, no matter how insignifiant the initial differences are. A chaotic system develops a behavior completely explained by the past evolution. However, any seemingly insignificant change in the initial conditions determines a thoroughly different and deeply unpredictable behavior of the system. In other words, a chaotic system such as the capital market is extremely sensitive to variations of the parameters describing the initial state.

Capital market is characterized by complex nonlinear dynamics which does not converge to a known purpose, a result that may be anticipated or influenced, or at least to a limit cycle. In this context, even the concept of financial investment rationality reaches a completely different meaning. Thus, limited rationality replaces rational expectations.

In another train of thoughts, the central idea of the efficient market theory is that any information is available to all investors or market participants, so stock prices always incorporate and reflect all relevant information. Due to this issue, the price of a stock should reflect the knowledge and expectations of all investors or market participants. Because of that, except for long-term investment trends, future stock prices are difficult, if not impossible, to predict. In other words, an investment strategy based on past stock prices cannot preview future prices, no matter how complex and deep would be (Birău, 2011a).

According to Fama: "In an efficient market, competition among the many intelligent participants leads to a situation where, at any point in time, actual prices of individual securities already reflect the effects of information based both on events that have already occurred and on events which, as of now, the market expects to take place in the future. In other words, in an efficient market at any point in time the actual price of a security will be a good estimate of its intrinsic value."

Accordingly, is obvious the conceptual difference between efficient market hypothesis and chaos theory.

In addition, chaos theory is based on on the concept of fractal. Benoit Mandelbrot, which is considered to be the father of fractal geometry, derived the term "fractal" from the Latin verb "frangere", meaning to break or fragment. Fractals are entities characterized by an irregular and fragmented geometric shape. In general, fractals exhibit a self-similarity pattern in that minuscule aspects of its structure observed at any scale repeat details of the original pattern.

In finance, this concept is not a rootless abstraction but a theoretical reformulation of a down-to-earth bit of market folklore - namely, that movements of a stock or currency all look alike when a market chart is enlarged or reduced so that it fits the same time and price scale (Mandelbrot, 2008).

Chaos theory analyzes complex motion and the dynamics of sensitive systems, such as the stock market. In addition, chaos theory is an attempt to demonstrate that order does exist in apparent randomness.

For a long time there was the perception that events are either random and completely unpredictable, or deterministic and perfectly predictable. Chaos theory does not involve the identification of a pattern from the past and applying it to the future. The centre of interests is current stock market behavior, which is generated by the individual fractal behaviour of investors (Birău, 2011b).

3. Empirical results

An emerging capital market, like Bucharest Stock Exchange, is characterized by deep functional, structural and institutional dysfunctions. In other words, we can identify certain particularities such as : high volatility, the existence of bubbles, panic, speculation, anomalies, high-risk investment opportunities, a low level of liquidity, reduced capitalization, strong correlation with developed capital markets, reduced number of transactions, insufficient development of financial instruments, exchange rate instability and many others also. (Birău, 2011c)

In terms of Bucharest Stock Exchange, a chaotic behavior can be observed especially in the context of the current financial crisis.

The empirical study highlighted in this article is based on the use of a time series representing daily price of Bucharest Stock Exchange most representative indices : BET, BET-C and BET-FI during the period of January 2007 to January 2012.

I specifically chose this time interval to cover both Romania's Integration in the European Union on January 1st 2007 and the entire period from the beginning of the global financial crisis until now.

The global financial crisis that was caused by U.S. subprime crisis affected all the capital markets in the world, including Bucharest Stock Exchange.

The evolution of Bucharest Stock Exchange indices reflected in the analyzed period a sharp downward trend, as it can be seen in the following figures :
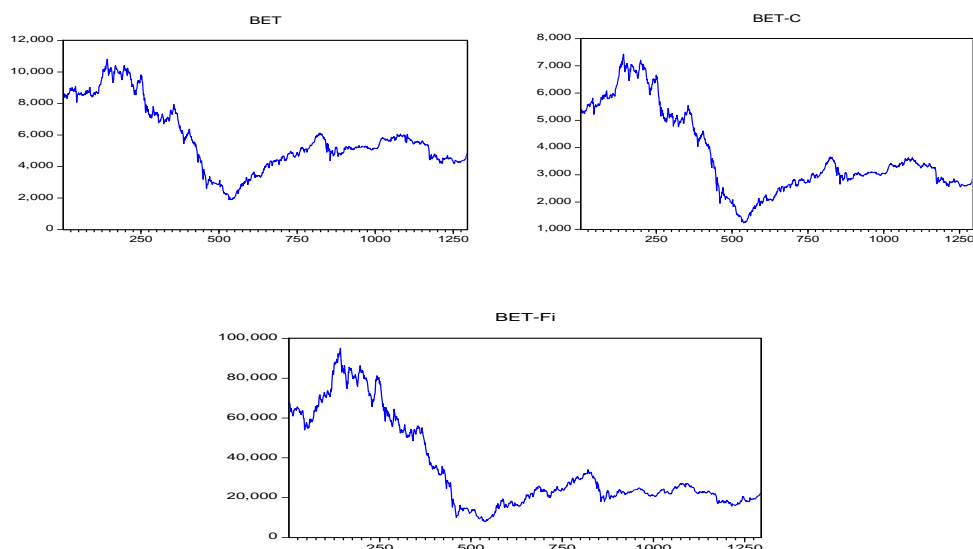
Figure no.1 The trend of BET, BET-C and BET–FI

The daily returns were calculated using the log-difference of the Bucharest Stock Exchange indices, namely BET, BET-C and BET–FI, as follows :

$$r_t = \ln\left(\frac{p_t}{p_{t-1}}\right) \times 100$$

where p was the closing price.

The Log-return calculated for BET, BET-C and BET–FI during January 2007 to January 2012 is is evidenced in the figures below :
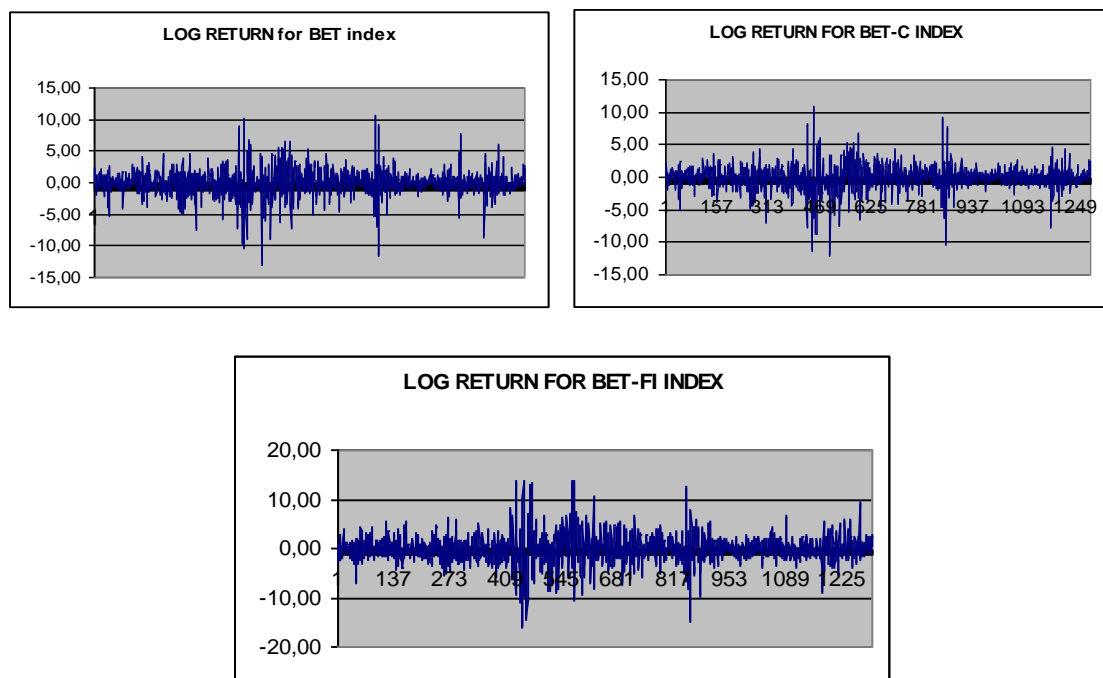

Figure no.2 The Log-return calculated for BET, BET-C and BET–FI

Bucharest Stock Exchange capitalization during January 2005 to January 2012 is is evidenced in the figure below :
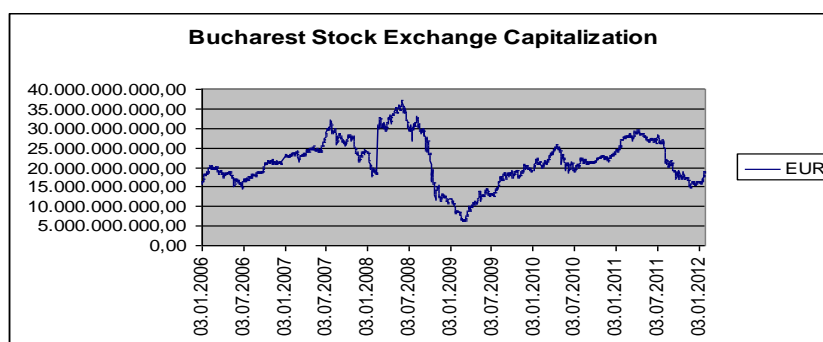

Figure no.3 Bucharest Stock Exchange capitalization

4. Conclusions

The global financial crisis that was caused by U.S. subprime mortgage crisis affected all the capital markets in the world. However, its impact was more pronounced in the case of emerging capital markets, such as Bucharest Stock Exchange.

Capital markets are nonlinear dynamical systems. Classical financial theory cannot provide solutions for specific issues. In this respect, certain anomalies identified in capital markets behavior, and especially emerging capital markets such as Bucharest Stock Exchange can not be explained on the basis of equilibrium models, such as efficient market hypothesis.

Beyond its unconventional and fascinating dimension, Chaos theory represents a significant progress in understanding a dynamic, complex, unpredictable, nonlinear systems such as the capital market. Chaos theory contradicts in a reasoned and sophisticated manner the conventional principles of traditional finance, such as the efficient market theory.

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