Chapter 2
Fractal Properties of Financial Assets and Forecasting Financial Crisis

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ABSTRACT

The chapter is aimed at identification of criteria to select financial assets for investment; observing price fluctuations at small time intervals (up to one week) as possible predictors of the future of a significant increase in the price fluctuations amplitude; determining a fractal dimension of the financial markets on the basis of R/S-analysis; constructing a fractal index indicator to identify a bifurcation point, which gives birth to a possibility of crisis phenomena in economy. Therefore, the practical significance of the chapter lies in the idea of equipping academics and practitioners with new methods and tools for analysis and forecasting future development and dynamics of the financial markets.

INTRODUCTION

Despite the considerable research already conducted on measuring the market efficiency the problem is still under investigation. There is no common methodology, results of measuring differ one over another, some aspects are underestimated etc. For example, the behavior of the market efficiency during a crisis in general and from the position of countries’ differences is not clear even nowadays.

The aim of this study is a synthesis of the Efficient Market Hypothesis (EMH) and Fractal Market Hypothesis (FMH) hypotheses to predict the financial crisis and investment decision-making. On the one hand, following the FMH, interpretation of price fluctuations based on the description of the mar-
Market agents’ behavior can be changed significantly at different time intervals. For instance, for intraday transactions, where more than a half of the stock exchange transactions performed by robots (in the US markets), the behavior of agents is very close to the rational. On the other hand, for time intervals from few days to few months, social psyche plays a significant role and always contains an irrational element. Meanwhile, the unchanging nature of vibrations (according to the EMH) with the most common mode of a random walk takes place at all-time intervals, starting from the smallest. This suggests that the basis of these price oscillations is the common mechanism of delay. This delay mechanism is an important element of the decision-making for agents in the stock market.

However, despite the frequent lengthy local deviations, the prices tend to go back to the effective behavior, which describes the random walk model. Based on the foregoing, the following positions are formulated:

- Identifying criteria to select financial assets for investment;
- Observing price fluctuations at small time intervals (up to one week) as possible to predict the future of a significant increase in the price fluctuations amplitude;
- Determining a fractal dimension of the financial markets on the basis of R/S-analysis;
- Constructing a fractal index to identify a bifurcation point, which gives birth to a possibility of crisis phenomena in economy.

Therefore, the practical significance of the chapter lies in the idea to equip academics and practitioners with new methods and tools for analysis and forecasting future development and dynamic of the financial markets.

**THEORETICAL FRAMEWORK**

One of the most important objectives in finance is modeling and forecasting price fluctuations in risky assets. For analysts and policy makers volatility is a key variable for understanding market fluctuations. Analysts need accurate forecasts of volatility as an indispensable input for tasks such as risk management, portfolio allocation, value-at-risk assessment, and option and futures pricing. In financial markets volatility is a fluctuations measure of the financial instrument price over time. It cannot be directly observed, but has to be estimated via appropriate measures or as a component of a stochastic asset pricing model.

An important contribution in studying financial markets persistence has been done by Los (2003), who analyzed the existing methodology quite carefully. According to his research, one of the key indicators of the persistence level is the so called Hurst exponent. The Hurst exponent was created by hydrologist Hurst (1951). For current study there are quite important works of Kristoufek (2013), Roch (2011), Vacha et al. (2013), which who investigated signals of market crashes.

For a long time the study of financial time series has been developed in the form of two unrelated directions, and only recently a tendency towards their convergence appeared. The first direction, which can be called statistical, originates from the work of Bachelier (1900), where the researcher five years before Einstein proposed the first model of Brownian motion (random walk model) and applied it to describe fluctuations in share prices on the stock-market.

Strictly mathematically this model was justified in the early 1920s by Norbert Wiener and for a long time was developed exclusively in the academic environment. The latter is due to the fact that in accor-
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