Preface

In the context of the recent financial crisis that has engulfed the most influential and economically developed countries, there is an increasing interest in research methods that can not only characterize the ongoing processes, but also with a high probability predict the waves of socio-economic development. Over the past 40 years, a language has emerged that could discuss what happens in seemingly random natural systems-for example, weather or financial markets-and can be forecasted. The classical mathematical models used throughout much of the twentieth century usually predict that extreme events with rapid changes could never occur. The cornerstone for calculating the behavior of financial markets and macroeconomic analysis is the modern theory of the portfolio (Markowitz, 1952), which tries to maximize profitability for a given level of risk. The mathematics underlying the theory of the portfolio copes with extreme situations, considering major market shifts that are too unlikely. Indeed, the theory of the portfolio can explain what happens in 95 percent of the cases. But its economic picture of the world does not reflect reality, if we assume that global events are part of the remaining five percent.

Another paradigm of economic and finance theory preoccupied academic and practitioners' world for at least twenty years was the efficient market hypothesis (EMH). After the financial crisis of 2008, additional empirical data analysis on financial markets this paradigm was over (Fox, 2009) and removed by the more effective fractal market hypothesis (FMH). There are phenomena observed in real data collected from trends in concentration of economic activities, financial markets, investment horizons, industrial dynamic etc. that cannot be explained by the traditional economic and finance theories (Farjoun & Levin, 2011; Andronache et al., 2016). Local heterogeneous trends and randomness together with global determination of the economic dynamic fortify the fractal approach positioning.

Since its introduction in 1963, the fractal approach to the analysis of financial markets, in particular, and global economic development as a whole, is still an innovative approach to the study of financial phenomena, the use of chaos theory and quantum theory to characterize and predict market predictability (Mandelbrot, 1963). The Mandelbrot set is a fractal, a term invented by Mandelbrot himself, which has a complex definition, but, in fact, refers to coarse forms that look the same if viewed from a long-range or close-up perspective. This phenomenon is common in nature: for example, broccoli has a fractal shape, mountain ranges, tree branches, and clouds. In each case, a small fragment, when it is enlarged, resembles a larger whole. With the invention of the fractal geometry theory, Mandelbrot expanded the possibilities of mathematical analysis so that it could be applied to complex and simple objects.

The concept of fractals was expanded to all areas of science and technology; however, the concept was born in the field of economics when Mandelbrot studied the changes in prices in the open market.

He empirically discovered that the chart of changes in market prices for cotton looks like another chart with a different time resolution. Such a large-scale invariance can be the key to describing many complex phenomena around us.

More than 40 years have passed since the initial discovery of fractals, and the economy is becoming one of the hottest topics in applying the fractal approach. Fractals, such as the Mandelbrot set, are usually associated with a study of complexity, also known as the fashionable nickname of chaos theory. Fractal analysis of the market reveals and characterizes the order hidden behind seeming random financial events, and determines the probability of future fluctuations.

The defining characteristic of a fractal picture is that it has a repeating pattern in all time frames; that is, smaller components have the same basic shape and structure as larger components. Markets are fractal and look the same. Thus, it is impossible to view the unmarked price schedule and determine whether it is an hourly, monthly or even a 5-minute trading schedule. The main advantage of knowledge of fractal patterns and projections is that they determine specific critical equilibrium points, where the potential energy can be directed to one or another route. It is interesting to note that in the field of fractal analysis, as practiced in financial markets or economic dynamic in general, there are few publications, especially of applied nature (Brenner et al., 1991; Mantegna et al., 1995; Inaoka et al., 2004). This circumstance makes the proposed volume highly relevant.

As a comprehensive collection of cases, the publication represents efforts of experts in applied methods in economics. Authors of the volume cover a variety of issues in the fractal approach implementation, illustrating them with examples of macro-, meso- and micro- level. The aim of the volume is to provide an introduction to the use of fractal approach to describe the logic and trends in several cases within in comparative perspective and to combine discussion of theoretical framework with empirical findings. It gives a balanced and insightful analysis of the scope and limits of the fractal approach.

The chapters provide provoking and comprehensive overview of academic thinking and practical cases. Therefore, some chapters would be interesting for researchers working in the relatively new areas of econophysics, neuro-linguistic programming, behavioral economics and neural networking. Some researchers and practitioners would find interesting case-studies with comparative inter-state or in-state perspectives. Finally, there is a group of specifically practice-oriented chapters focusing on development of economic phenomena, like taxpaying, pension system, creditworthiness, banking, and so forth.

The volume is unique not only by its wide scope but also its balance between theory and practice. It has an added-value bringing an innovative theory with relevant empirical evidences coming from the real-world experience. Authors write from the grassroots' perspective to reflect current realities of global and country-based economic development. The volume covers different and diverse topics related to challenges and opportunities of the fractal analysis implications to complex social and economic phenomena.

In Chapter 1, Cem Cagri-Donmez introduces the econophysics approach to analysis of uncertainty in dynamics of complex market structural models. As it comes from the idea of predictability of extrapolative fluctuations in the capital markets, the chapter presents a specific methodological approach design. Since the results of experimental work could be validated through comparative studies of historic data, the new and alternative indicators could be added to the ordinary technical analysis in Econophysics. Market indicators could be exploited within the context action-reaction mechanisms reliable and open to experimentation, in which laws of energy are also applicable, and wherein indicators changes (other than those pertaining to data numbers) can occur from one country to another, from one market to another, and even from one financial instrument to another within the same market. The dynamic phenomena

of the econophysical architecture presented by modeling form the degree of its applicability to the markets and provide empirical data collected from high-frequency futures data corresponding to different futures assets. It demonstrates the effect of a trade order on the underlying price, which depends on the duration of mutual trade by examining the volatility and clustering of stock fluctuations. The author, focusing on the temporary progress of financial assets, is considering the possibility of parallel forecasts of the proposed model with a relatively rich ensemble of historical implementations. The presentation of financial time series in the clustering of volatility can be modeled and evaluated using a model for a particular market with a given risk factor. Although it seems that prices are formed under external influences, this fact indicates that internal market events determine prices, and external dynamics are indicated as a cause only after events have occurred.

In Chapter 2 as it is explained by Inna Nekrasova, Oxana Karnaukhova and Oleg Sviridov the index of fractality is used for the traditional analysis in the fractal structure of time series. With the same amount of data, the index (μ) is determined several times more accurately than the Hearst index (H). In this case, the minimum scale necessary for determining μ with a reasonable accuracy is several tens of points, whereas for the determination of H, several thousand data are needed. This fact makes it possible to use μ as a local fractal index in the analysis of time series. Financial time series demonstrate the behavior in which fluctuations in the fractal structure lead to a change in the type of behavior of the series. The research demonstrates that for the time series of prices in financial assets the value of μ is related to the stability of the series. In this case, the larger the value of μ is, the more stable the series behavior.

Chapter 3 attempts to investigate the impact of the long memory property on the market risk across two sub-periods based on four country-specific events (Tunisian revolution; Egyptian revolution; assassination of Prime Minister Rafik El Hariri and series of suicide bomber in Morocco). Salim Ben Sassi and Azza Bejaoui use the modified R/S test and the GPH test to demonstrate long-range dependence behavior, which changes over time. The focus is on the process, where the long memory property in returns and volatility tend to be significant in the pre-crisis period for all emerging markets. The study reveals that the long memory property in the post-crisis period seems to be as significant as in the pre-crisis period. As authors state, "market thinness and nonsynchronous trading, among others, as well as the country-specific circumstances can be considered as factors responsible for such behavior of long memory property before and after political events". The empirical results also show that long memory models maybe useful for depicting cyclical fluctuations in index returns, namely: the information from "today" is not instantaneously absorbed by the price in the stock market and also investors react with delay to information. So this leads to re-examining the concept of informational efficiency in the Middle East and North Africa (MENA) markets during the specific-country events.

Predicting financial crisis is also the focus of the Chapter 4 with an application to the case of Turkey. Dr. Asli Yuksel Mermod, Ülkü Yüksel and Catherine Sutton-Brady consider several incidents to highlight fundamental causes of financial crises, such as The Great Depression of 1929 - early 1940s, the 1997 Asian Financial Crises, the 1998 Russian Financial Crisis, and the Liquidity Crisis of 2008, and make a comparison among them and their various outcomes. This case study specifically analyses the Turkish Banking System that was restructured after the enormous financial crises in Turkey in 2001, which caused many Turkish banks to collapse. However, the precautions taken in the aftermath of the financial turmoil allowed them to survive the liquidity crises in 2008. The study specifies the cues that emerge in the financial system that may help governments predict upcoming financial crises through early warning signals.

In the aftermath of the global financial crisis, the author of the Chapter 5, Andrea Quintiliani aims to shed light on the determinants of the financial distress costs between Italian and Germany small and medium enterprises (SMEs). The author proposes an innovative formulation of the expected costs arising from the financial crisis, expressed as a result of the expected likelihood of a financial disaster multiplied by the total financial cost of the disaster, if such a situation occurs. The model is estimated using the panel data methodology for samples from Italy and Germany as two European countries. The obtained results show that the amount of expenses related to posts depends on the use of derivative financial instruments, the use of intangible assets and relations with local banks (small local banks, rather than large banking groups). It is emphasized that current work limits the scope of its research to several variables without completely affecting other elements of uncertainty that could adversely affect the likelihood of financial shocks and the value of SMEs.

In Chapter 6, Dmitry Shevchenko and Ellah Igoche Godwin demonstrate the effects of behavioral factors on the creditworthiness of small scale enterprises to increase access of SMEs to credit facilities. Authors remark that the inability of several small businesses to secure loans cannot be overemphasized. Heuristics affecting entrepreneurs are explained in this paper and a regression model showing the dependence of creditworthiness on behavioral factors is proposed. If banks consider using psychometric tools in testing for creditworthiness of small scale entrepreneurs, access to credit facilities will be significantly increased and businesses will flourish. Regression models may be imbedded in psychometric tools to enhance creditworthiness testing and improve the quality of loans that banks give.

The task of Chapter 7 by Larisa Yakimova is to assess relationship of nonlinear dynamics in pension systems and economic cycles, and to develop a descriptive evolutionary model of pension systems. The author applies the Hodrick-Prescott filter to determine cycles in the pension system and economic dynamics. An empirical study shows that the evolution of pension systems depends on cyclicality in the national and global economy. The point of bifurcation is associated with the large Kondratieff cycles, while the fluctuations in indicators in pension systems correlate with the medium-term Yoglar cycles. A comparative study of the OECD countries indicates the countercyclicity of growth in public spending on pension provision and the relativity of the coincident indicators in the global business cycle in 13 countries from 21 analyzed. The size and volatility of public pension spending depends on the basic pension model and have higher values in the countries of the Bismarck model.

Summing up the potential results of the measures in financial and economic security of BRICS countries examined in Chapter 8, Elena V. Fomicheva and Marina S. Shikun state that they reinforce the claims of five states for their wider representation in international financial institutions and, in general, in the management of the world economy. The creation of a joint financial infrastructure within the BRICS group will give an important impetus to the real sector of the economy. The use of national currencies in mutual settlements and lending will reduce the association's dependence on the conjuncture in traditional centers of the world economy. The development of measures to manage financial globalization in the face of increasing threats and challenges is necessary to ensure the financial and economic security of the BRICS group. Looking at the near future, there are serious reasons to discuss the trend of further strengthening and stability of all BRICS currencies. They are associated with strengthening the positions of countries within the group's closer economic alliance, creating their own "financial security cushion" in the form of a banking and a pool (in the future, it is possible to create an analogue of SWIFT and a joint aggregate currency) and a more intensive shift in world trade in CHN and rubles. The forecast for the future of currencies has good reasons.

Chapter 9 by Galina Artemenko describes the use of fractal analysis in assessing the reliability of taxpayer's information. The analysis concerns economic and mathematical tools aimed at creating information systems for decision support in complex interactions between tax authorities and taxpayers. For the purposes of strategic planning (forecasting) of economic indicators in the behavior of taxpayers, the author recommends a model of preliminary forecasting. This model came from the R / S analysis algorithm and phase analysis. Comparative analysis of the series of the dynamics of tax revenues and the corresponding series of the tax base dynamics reveals regularities and similar trends in the dynamics of time series of the taxation and indicators of accounting reporting of taxpayers. The practical significance of the study lies in the substantial applicability of automated information systems in any department and satisfaction of the need for tax control with a reduction in the resource costs carried by governments.

Chapter 10 written by Dmitry Averchenko and Artem Aldyrev is based on the results of applying neural networks for modeling of financial assets. According to the authors, neural networks as a distinguished statistical method of multidimensional classification is based on the parallel processing of information and possesses the ability to conduct self-learning. This means the neural networks allow to obtain a valid result based on data that was not encountered in the learning process. The ability to model nonlinear processes, adaptability and work with noisy data could apply neural networks to solve a wide class of financial problems.

Chapter 11 written by Mamed Babaev and Oxana Savenko applies neuro-linguistic programming based modeling to stock markets. Authors note that "in real life, many decisions do not entirely correspond to the rational part of the human intelligence and therefore LAB profiling may play the role of a rectifier that makes it possible to "weaponise" the concept of the Nash equilibrium within the framework of stock trading". It is recognised that not all the NLP modeling techniques are fruitful due to their intrinsic peculiarities, therefore the results of NLP implications are highly experimental and debatable. And yet, the astonishing success of the proponent of the reflexivity theory George Soros has already demonstrated an innovative character and possible implications of NLP to financial market analysis and forecasting.

The volatility spillover during crises is the main focus of Chapter 12 by Rıfat Karakuş, Şeyma Yılmaz Küçük, and İbrahim Bozkurt. It compares developed and developing markets in the situation of crises and questions possible changes in volatility spillover. The analysis demonstrates that volatility spillover from the developed markets to the developing markets is not valid in crisis periods, while commencing again in the post-crisis period. Moreover, the volatility spillover from developing to developed markets being limited in the crisis period increases in the post-crisis period. The promising idea come from the study is that despite the prejudice the developing markets constitute an important alternative for investors during the crisis.

Chapter 13 on Riesz Potential in Generalized Hölder Spaces by Boris Vakulov, Galina Kostetskaya, and Yuri Drobotov provides an overview of the advanced studies of the multidimensional Riesz potential operator in the generalized Hölder spaces. While the interest is represented by mathematical modeling in economics, theoretical physics and other fields of knowledge, the Riesz potential plays a significant role in the analysis of fractal sets, and this aspect is briefly described. The generalized Holder spaces provide convenient terminology for the formalization of the concept of "smoothness", which is described here. Operators of potentials of constant and variable order are considered, including a two-pole spherical potential. As a sphere, in a sense, a convenient set for analysis, there are two results, proved in detail: conditions for spherical fractional integration of a variable order for being bounded in generalized Holder

spaces that the local continuity of the module occupies the dominant that can vary from point to point, and the ones, for a constant order of two-pole spherical potential type of operator.

Financial markets and even economic systems should be studied as chaotic, non-linear systems, but only some study them. But over the next few years, this will certainly change. We hope these chapters will generate ideas for future research and for the development of relevant policies that will influence global as well as national prosperity and will help to predict future crises. Fractal analysis pushes the still unexplored border of economic thought, but we believe that in 10 years the fractal analysis will assume its well-defined place.

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