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CYBERNETICS AND STATISTICS

ABSTRACT

of the doctoral dissertation entitled „MODELING AND PREDICTION OF EMERGING CAPITAL MARKETS"

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A. CONTENTS OF DOCTORAL DISSERTATION

B. KEY WORDS : emerging capital markets, financial modeling, prediction of stock market indices behavior, expected return, volatility, financial investment, international portofolio diversification, financial time series, financial liberalization, heterosckedasticity, globalization, financial contagion, financial integration, cointegration, transmission channels of financial shocks, correlated movements of emerging markets with developed markets, risk management, investment opportunities, time horizon, testing the efficiency of emerging markets, the impact of new information flow on the market.

C. SINTEZA CAPITOLELOR TEZEI DE DOCTORAT

Recently, a major challenge for modern finance was represented by modeling and predicting the behavior of emerging capital market behaviour. Globalization, financial liberalization, information technology, deregulation processes, the volume expansion of securities trading, cross-border financial penetration, investment policy harmonization led to the intensification of financial integration between emerging capital markets in different economies worldwide. The process of financial integration leads to establish a pattern of behavior in terms of expected profitability of international indices. In this respect, it is important to note the inverse dependency relationship between financial integration and the cost of capital.

A key issue in investment activities is represented by the access to information, possibly more complete, recent and with the highest possible accuracy. Beyond the inherent difficulties in accessing and using rapidly the available information in the market, investors must direct financial decision-making in the sense of optimizing informational inflow. Both the surplus of information and informational deficit create imbalances in the structure of investment. Moreover, the very ability to store, compress, organize and access information in an effectively manner provide a privileged area in terms of investment expected profit.

Investor behavior is significantly influenced by instability in emerging capital markets. Despite the fact that emerging markets represent an increasingly attractive financial environment, they are exposed to diverse risks.

In this context, the structure of this Doctoral Dissertation is divided into the following five chapters :

In the first chapter entitled "*Stochastic Processes in Finance*", are discussed various aspects of stochastic modeling, such as : martingale processes, Brownian motion, Lévy processes, Random walk processes, Markov processes, quadratic variation of stochastic processes, stochastic integral, stochastic differential equations, geometric brownian motion and Itô's Lemma.

Stochastic modeling approach holds significant positions in applied financial mathematics based on stock market behaviour, namely on financial derivatives market, including shares, bonds or other financial instruments of trading. The attractiveness of stochastic models has increased considerably in recent decades, both in the area of academic interest and in that of practitioners. The motivation for using this class of models arises from the fact that they allow the inclusion of a stochastic scale that quantifies the influence of certain factors which for some reasons has not been included in the model.

The financial field, especially emerging capital markets represents an extremely fertile area and relatively unexplored in terms of empirical stochastic modeling. Investment implications are significant and reach a broad spectrum of financial activities. Furthermore, one of the most controversial aspects of the recent past is the ability to predict the behavior of capital markets, especially emerging markets in a satisfactory manner. But this is a consequence of the fact that current financial reality reflects a complex reality, globalized, which is constantly changing.

The second first chapter entitled „*Financial engineering, portfolio theory and risk management*" disseminates a number of issues concerning the implications of investment on capital markets, such as: financial derivatives (forward contracts, futures contracts, swap contracts, financial options), risk-neutral measure, the theory of efficient markets and the fractal market theory. It

also presents issues regarding modern portfolio theory, such as : Markowitz model for portfolio diversification, Capital Asset Pricing Model – CAPM, the arbitrage pricing theory (APT), Black–Scholes options pricing model and Cox-Ross-Rubinstein binomial pricing model (CRR). Another important dimension discussed in the second chapter is the international portofolio diversification based on several issues concerning : risk and returns of financial instruments, Value at Risk (VAR) model, Granger causality test, the Error Correction Model (ECM) and cointegration methodology.

Derivatives are classified broadly into the following main categories: forward contracts, futures contracts, swap contracts, financial options. In most cases, derivatives are characterized by high leverage. Derivatives are used extensively in the financial markets for about three decades and recorded continuously developing.

Emerging capital markets, however, are considerably less efficient than developed markets, due to the numerous failures applied to areas such as functional, structural, organizational, legal, logistical and institutional level. Moreover, a significant issue regarding the efficient market theory suggests that it is impossible to overcome the stock market return over long term horizont. Practically, in the context of emerging capital markets, the access to information is delayed, distorted, difficult, incomplete and restricted, ie there are no free access, unconditionally and fair for all investors.

Fractal market theory is an alternative to the efficient market theory. In this theory, the interest is not represented by market efficiency , but its stability . The market is considered stable when it is liquid, the trading volume is solid and investment horizon implies a significant impact on investor behavior. In other words , the stock market is considered to be stable when transactional activity is generated by a large number of investors who have different time horizons. In general, it is considered that the market is liquid when the market price is close to the correct price. However, in financial practice, the prices obtained on a relatively short investment horizon very seldom will be treated as a fair price. Regarding

financial markets, correlations do not implicitly assume the existence of causality, there is a multitude of correlations unjustifiable, pointless.

Cointegration occurs naturally in quantitative finance, is most often associated with the idea of equilibrium relationship among time series analysis. Deviations from this equilibrium relationship will be corrected over time because economic forces tend to push relevant variables back to steady state. Thus, cointegration can be represented by a high-frequency relationship justified by measures based on financial arbitration, or rather the low-frequency relationship. According to the law of one price, financial assets with similar characteristics should be traded at the same price in order to avoid arbitrage opportunities, ie determining the existence of cointegration between identical assets traded in different capital markets. In this respect, financial arbitrage implies the existence of cointegration between prices of various derivatives, spot and futures, spot and forwards, in the case of buying or selling. The data series which is cointegrated never deviates too much from each other, the trend is continuously maintaining an equilibrium relation. However, the cointegration relationship between certain variables is not constant in time, because is influenced by a number of disturbances or shocks in the short term, so that equilibrium relationship can be influenced.

The third chapter entitled „Models for financial time series analysis" disseminates a number of issues concerning methods used in capital markets modeling, such as : Box-Jenkins methodology, autoregressive processes (AR), moving average processes (MA), ARMA processes, ARIMA processes, Autocorrelation (ACF) and partial autocorrelation (PACF) functions. Moreover, the following issues are discussed : diagnostic tests for detecting heteroscedasticity, tests for detecting nonlinearity (nonparametric tests and parametric tests) and aspects regarding volatility modeling based on heteroscedastic models, such as : ARCH model, GARCH model, IGARCH model, GARCH-M model, EGARCH model and TGARCH model. In this chapter are presented time series models based on computational intelligence, such as : Artificial Neural Networks, neural architectures, Feed-Forward Neural Networks,

Error Back Propagation Algorithm, fuzzy systems, hybrid neuro-fuzzy systems and ANFIS architecture.

Time series analysis performed using Box-Jenkins methodology implies several successive stages whose objective is to predict the evolution of the studied phenomenon. The final aspect of this analysis involves identifying the stochastic process that generated the time series. In financial time series modeling it is assumed that certain features of the past will be reflected in the future. Under these conditions, time series analysis must satisfy the first condition of stationarity. If this assumption is not satisfied, it is very easy to transform the time series.

Neural networks are nonlinear systems of information processing, based on simple processing units called neurons and they are interconnected, ie form a communications channel that propagate numerical information and operate in parallel. This structure works along the same principle as the biological neuronal systems. Artificial neural network function is similar to organic functions and is determined by the connections between elements. The weights of each connection or perceprons are those that store information based on neural network learning processes.

The fundamental characteristic of a fuzzy system is derived from the fact that can simultaneously control numerical data and lexical knowledge based on a nonlinear transformation of the input data. In general, fuzzy set theory contribute to the adjustment of qualitative arguments based on knowledge obtain from quantitative mathematical expressions. Moreover, knowledge can be objective, reflected in the quantitative, mathematical, or can be subjective, ie the linguistic side of information processing that can not be quantified or expressed numerically. Hybrid neuro-fuzzy systems is based on the principle of extending the standard model of artificial neural networks so as to be able to process information represented by fuzzy sets. Fuzzy systems and neural networks are dynamic systems characterized by the ability of providing very high accuracy results in terms of imprecise or noisy decision spaces. Moreover, these hybrid systems develops bidirectional relationships, given that they can be trained with numerical data, but also with linguistic data.

The fourth chapter entitled „Statistical research on emerging capital markets behaviour in the context of international portfolio diversification" highlights a series of empirical studies on the analysis of emerging capital markets behavior. Financial time series are characterized by a complex behavior that can be understood only if one takes into account several key issues. In the case of emerging capital markets, however, the difference is even more significant and focuses in particular on clusters of volatility, non-stationarity, leverage effects, gaps in the normal distribution, heteroskedastic returns, „fat-tailed" distributions (non -Gaussian or leptokurtic). Moreover, these distinguishing features of the time series related to capital markets are known in the literature as "stylized facts" and synthesize the econometric motivation of using nonlinear models.

In this chapter were originally discussed issues concerning conceptual perspective of emerging capital markets. There eere presented and analyzed the following the empirical results of statistical research :

a) Comparative statistical study based on emerging capital markets of Hungary and Romania

b) Statistical study on emerging capital markets of Slovenia, Slovakia and Russia

c) Analysis of the phenomena of causality and cointegration for emerging capital markets

c_1) Case study: BRIC emerging capital markets

c_2) A comparative case study regarding the frontier capital market in Romania and developed capital markets of France, Germany and Greece

c_3) A comparative case study regarding the advanced capital market in Poland and developed markets of USA, Japan and UK

c_4) Empirical analysis of a strongly diversified international portfolio

The applied research presented in this chapter focuses on the following categories of emerging capital markets, ie advanced (Brazil, Hungary, Poland), secondary (China, India, Russia) and frontier (Romania, Slovakia, Slovenia). Also was analyzed the behavior of emerging capital markets based on the evolution of

the following mature capital markets : U.S., Japan, UK, Greece, France and Germany.

Empirical analysis was focused on certain lines of research, such as international portfolio diversification opportunity, financial contagion, integration, cointegration, transmission channels of financial shocks, correlated movements of emerging capital markets with developed capital markets, the impact of internal / external factors on decision-making process, risk management strategies, investment opportunities in the short term versus long-term, emerging markets volatility modeling, prediction of stock indices behavior, emerging markets efficiency and the impact of the inflow of new information on the capital market.

The fifth chapter entitled „Applied research on modeling and prediction of emerging capital markets" presents a series of empirical studies applied in the context of emerging capital markets. In this chapter were highlighted issues regarding the estimation of emerging capital market volatility. The results of the following applied research are also presented and analyzed regarding modeling and predicting emerging capital markets behavior :

a) Modeling volatility of BRIC emerging capital markets

b) Estimation and prediction of long-term volatility for emerging capital market in Poland

c) Modeling volatility of the JURI capital markets group, ie Japan, UK, Romania and India

d) Investigating correlated movements of emerging capital markets

e) Predicting transmission channels of financial shocks and spillover effects on emerging capital markets

f) Financial contagion implications on emerging capital markets

g) International transmission patterns of financial assets price volatility

h) The estimation of BET-C index behaviour using neuro-fuzzy methods (ANFIS)

In terms of volatility clustering, it is a representative feature of financial assets return since the price changes recorded periods of high amplitude alternating with periods of low amplitude. Emerging capital markets are extremely volatile,

significant price variations are perceived as a very attractive speculative opportunity for potential investors. Modeling and predicting volatility is a matter of particular concern in terms of risk management and financial portfolio. In fact, a very interesting dilemma regarding this area of research is how certain structural abnormalities are transformed into portfolio opportunities and informational efficiency in the turbulent context of the current global financial crisis.

The financial integration process is a causal circumstance under which financial shocks that occur in a particular market capital rapidly transmitted to other markets. As a consequence, the diffusion of information degenerates into spillover effects with implications for international portfolio dynamics and the type relationship linkage between emerging capital markets. Basically, contagion is defined as a significant increase in the interdependence of capital markets during the financial convulsion. Moreover, the propagation of shocks has significant implications on financial stability, international portfolio optimization, risk management and financial option pricing.