Comparative Analysis of the Financial Market Performance Theories

Murad R. Taghiyev
Baku State University

Abstract

This study compares two theories of financial market efficiency. In this regard, we have proposed parameters for assessing the state of the market, depending on the speed of absorption of this information received. Further, we have determined the specific boundaries of application of the presented theories. It is proposed to determine the degree of stability of a particular financial market using the maximal Lyapunov exponent.

Keywords: stock market, financial instruments, martingale.

Introduction

Financial markets represent key elements of the economic system. The dynamics of the markets' behaviors are directly connected to the problems of investments and concentration of capital.

The mechanism of transformation of savings into investments is conducted through financial markets. In addition, the participation of the population in the activities of financial markets fills with the reality of the right of individuals to have the means of production (Taghiyev, Gasanov, 2017, pp. 298–301). Thus, the dynamics of the behavior of financial markets are related to the problems of investment and, accordingly, economic growth. In addition, according to the behavior of financial markets, certain forecasts can be made, predicting economic crises, as well as determining the degree of integration of the local economy into the global world economy. In this regard, the issue of the effectiveness of the functioning of financial markets is relevant.

The efficient-market hypothesis introduced by Louis Bachelier and further developed by Eugene Fama proceeds from the existence of the multiple accidental factors influencing market price of the financial instruments and the assumption to use first differences or increments of the financial instruments in the formation of the statistical arrays as opposite to the prices of the financial instruments (Taghiyev, Gasanov, 2017, pp. 298–301). In my opinion, this is the main factor that represents the "longevity" of this hypothesis.

The first differences suppress significant deviations from the average values bringing temporary arrays closer to the stationary ones. Let's consider some definitions to analyze the dynamics of market efficiency. The perfectly efficient market is the market where the price of every security is always equal to its investment cost (Taghiyev, Gasanov, 2017, pp. 298–301). The investment cost represents the current cost of the security with the allowance for an expected profit. There is no financial formula explicitly determining the future price of the financial instrument and accounting for the current price. In the absence of the determined calculation formula, the methods of stochastic analysis shall be applied. In such case, tomorrow's price of the financial instrument is to be considered as the current market price fluctuating within a certain range. The nature of such fluctuation is random, but it is fluctuating within the mathematical expectancy (average) value.

All the foregoing factors are described in the probability theory and mathematical statistics. The theory of probability describes processes with a zero mathematical expectancy as the martingale or "game with zero-sum" or "fair game."

Therefore, the market is efficient if it quickly adapts to new information. A quick reflection on the price of the financial instrument determines the level of market efficiency. The investor operating by such market rules cannot expect excessive profits and accepts only the average market profitability. Market efficiency is evaluated as weak, average, or strong, depending on the level and speed to absorb information. The weak efficiency form means that the cost of the market asset includes all historical information, whereas the same cost comprises full market information in the case with the strong efficiency form. The full information is understood as the accumulation of historical, current, and insider data. The insider data includes information accessible by the narrow circles related to the particular project. The average market efficiency stands between the weak and the strong forms. In this case, all public information related to the market is fully reflected in prices, and hence, there is no chance of getting additional profit.

The efficient-market hypothesis, as well as other mathematical methods based on this hypothesis, fails in the economic globalization environment. The recent cascade of world economic crises doubts the normality of the probabilistic distribution of the financial instruments' prices. Most methods of technical analysis are acceptable in the existence of the obvious market trend. With the change of the stationary character of the temporary arrays in the prices of the financial instruments, the need appears to sum and analyze only those sections of the temporary arrays, which have stable elements of mathematical expectancy and dispersion, hence bringing these temporary arrays closer to the stationary type arrays. However, the accuracy of such calculation is negatively affected. The longer the temporary array, the less the forecast precision.

While stochastic approaches question the normality of the price distribution of the financial instruments in the absence of stationarity, the modeling of quick and spasmodic profitability changes of the financial instruments in the determined cases does not accept the linear paradigm in the analysis of securities. This does not imply a full inconsistency of the efficient-market theory, it just outlines boundaries for its application. In my view, the classical methods of stock markets analysis based on the efficient market theory shall be used for the developed and stable markets. However, in the long-term conditions of the unstable markets, caused by both internal and external problems, as well as in the global economic crisis environment, the application of models based on the efficient-market theory is not rational. Then the fractal market theory can be used as an alternative to the efficient market theory.

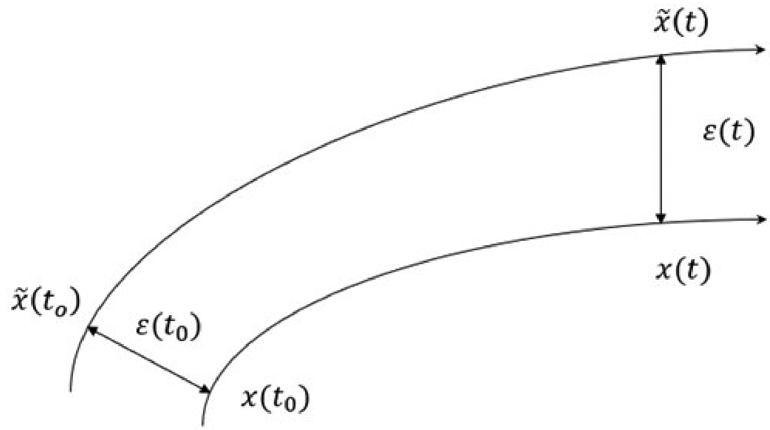
B. Mandelbrot's hypothesis about the dependency of the prices of the financial instruments at the current markets upon the previous day's prices has become a crucial point in changing the paradigms in the analysis of the financial markets. It has introduced the notion of the financial markets' memory. B. Mandelbrot has identified that the prices at the financial markets can be persistent and anti-persistent. Persistency means market memory. It means that the current auctions start from the prices of the previous day's auctions, and today's events at the market cannot be considered in isolation from yesterday's events. The anti-persistent markets do not have this capability.

B. Malbrot's hypothesis has replaced the efficient-market hypothesis of L. Bachelier and is based on specific principles. These principles lie in that the financial market consists of investors with different investment prospects. The difference creates demand for various assets and determines their liquidity. When the proportion of investors with long and short-term investment prospects changes in favor of short-term investors, the market starts losing its stability. Other important statements of B. Mandelbrot are about the lack of a correlation between the liquidity of the financial market and the volume of sales of the financial instruments. The level of importance of the information obtained by the market can be evaluated based on the change in the lengths of investors' prospects. Investors react differently to the information obtained from the market.

It should not be disregarded that each investor evaluates the information obtained as a result of the purchase and sale in his own way. This is what is called the irrationality of the investor's behavior. If all investors made the same conclusions based on the received information, their actions would be mono-directional. And the market would have lost its liquidity.

The non-stationarity in the dynamics arrays, the sensitivity to the initial conditions, the irregularity of the temporary arrays - all these are the pre-conditions making the application of the traditional linear principles in the modeling of the financial markets based on the efficient-market theory inefficient. The theory of non-linear dynamics, laying the basis for the determined chaos theory, successfully resolves many problems related to the complexity of the financial markets' behaviors. The stability of the financial markets' behaviors depends on the sensitivity to the initial conditions. It means that the two close points of the phase space have trajectories significantly diverging in the course of time. In the process of such movement, even the minimum difference in the initial conditions may lead to the exponential recession of these trajectories in the course of time. Identifying the speed of such exponential recession is the important goal of the analysis. I believe that the application of the Lyapunov exponent is convenient in the identification of the speed of the trajectories exponential recession and further detection of the system stability.

Consider the point $x(t_0)$ defining the status of the system in the initial point of time (t_0). Let's define some positive number $\varepsilon(t_0)$ at the system attractor, where there is a point $\tilde{x}(t_0)$ in accordance with the following correlation $|\tilde{x}(t_0)-x(t_0)| = \varepsilon(t_0)$. After time Δt points $x(t_0)$ and $\tilde{x}(t_0)$ move to points x(t) and $\tilde{x}$(t) accordingly, and let's define the distance between them as $\varepsilon(t)$, where $t=t_0+\Delta t$.



$\varepsilon(t)=\varepsilon(t_0)e^{\lambda\Delta t}$. This translates into the maximal Lyapunov exponent $\lambda = \frac{1}{\Delta t}\ln\frac{\varepsilon(t)}{\varepsilon(t_0)}$ (Sharp, 2012, pp. 108-109).

It would be necessary to apply some restrictions while analyzing technical systems, for example, to introduce certain correlations between the parameters and diameter of the attractor. However, this is not critical for the economic analysis due to the small diameters of the attractor.

There are several Lyapunov exponents. We are interested in the exponent which is, being positive, reflects chaotic processes. In my opinion, it is not reasonable to model based on the efficient-market hypothesis with the positive value of the maximal Lyapunov's exponent. It is necessary to apply fractal analysis of the financial market based on the B. Mandelbrot's hypothesis.

Conclusion

The article presents comparative analysis of the two theories describing efficiency of the financial markets. These theories are efficient-market theory by L.Bachelier and more recent theory of fractal market by B.Mandelbrot. Fractality lies in the fact that the movement of financial markets (using the example of the Dow Jones indices), where even the shortest section of the charts is self-similar (or close to self-similarity) with the longest sections. As stated by B. Mandelbrot:

> *A fractal is a geometric shape that can be separated into parts, each of which is a reduced-scale version of the whole. 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. An observer then cannot tell which of the data concern prices that change from week to week, day to day or hour to hour* (Mandelbrot, 1999).

The results of the comparative analysis testify that neither of the theories can be rejected. However, the boundaries should be introduced to apply each of them. The author proposes to use maximal Lyapunov's exponent as a criterion of selection. If the exponent is positive, the application should include models based on the fractal theory. In case of negative exponent, the choice is for models, based on the efficient-market hypothesis.

References

Benoit Mandelbrot *(February 1999)*. "How Fractals Can Explain What's Wrong with Wall Street". *Scientific American.*

Golovko V.A. (2005). Lectures in Neuroinformatics. INFRA-M.

Sharp U.F. (2012). Alexander G. Investments, INFRA-M, pp. 108, 109

Taghiyev M.R., Gasanov A. - The place of the bond market in the country's economy. Strategic economic reforms. Materials of the international conference. Baku, pp. 298–301.