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On Random Walk Hypothesis. A Short Test for the Bucharest Stock Exchange

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Abstract

In this paper we present a short test on the random walk hypothesis, by using as database a sample of companies listed on the Bucharest Stock Exchange, namely the BET companies and the financial companies that form the BET-FI stock index. The analysis uses as entry data stock prices and return series, because both of these indicators encapsulate market evolution. Random walk is a condition for weak informational efficiency, therefore the results may be used in further studies on the Romanian capital market efficiency. They may constitute intermediary results or simply may influence ideas on further testing of market efficiency. Results are discussed at the end of the paper and are included in the conclusion section.

Keywords: informational efficiency, random walk, stock price series, return series, weak form efficiency, market efficiency.

JEL Classification: G19

1. Introduction

The current scientific idea of informational efficiency is one regarding the stock price informativeness, thus referring to how information is included in the stock prices. If all information is contained in stock prices, then the capital market is informationally efficient. This is, of course, the general idea. More specifically, there are three forms of informational efficiency, as defined by the great financial scientist Eugene Fama. There is: weak-form informational efficiency, semi-strong informational efficiency and strong informational efficiency. If the first form of efficiency is not detected for a capital market, then

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the other two need not be tested because they are non-existent in the absence of the first form.

One condition for weak-form informational efficiency is the random walk behaviour of market prices. This is the starting point, in our opinion. Scientific "opinion" may differ from country to country, geographical area to geographical area, or capital market to capital market. And let us not forget that finance is not an exact science. So, according to what we apply in this paper, the random walk characteristic is a fundamental condition that if not met, the entire concept of weak-form informational efficiency will be invalidated, thus no part of the concept of informational efficiency will apply for the capital market.

This paper is a short test of the random walk hypothesis or characteristic of stock price behaviour. The database is rather short, but can be expanded anytime in further studies. The utility of the paper is that of a research in the field of testing market efficiency, and the subsequent results can be used as intermediary results by other authors. One other aspect regarding practical utility of this paper stems from the unanimous idea that on an informationally efficient market, no abnormal profits can be earned by studying the stock price history. Therefore, the results are useful to investors or practitioners that envision earning high returns from the Bucharest Stock Exchange. The paper will offer a straight answer to this respect. It will not provide a mathematical model.

2. Problem Statement

Analyses on informational market efficiency were undertaken in a lot of previous studies. There are also quite a few studies that focus on the Romanian capital market. Our study is merely a short test applied on an updated database. The mathematical, statistical and econometrical methods used in our paper are of basic nature, and can be replicated easily by a large base of potential investors/researchers.

The foundations of the random walk model were laid by Louis Bachelier [1900]. This exceptional author is the one who, for the first time, used statistical analysis in the study of stock exchange prices (Bachelier, 1900). His work showed that past, present and even future events are reflected in the stock market price, but are usually not in visible relationship with price variations. Later, Maurice Kendall [1953] focused on the time series analysis and reached the conclusion that the stock market behaves randomly (Kendall, 1953).

The informational efficiency of the financial market can be expressed by a series of mathematical models. Such models are: the "fair game" model, the submartingale model and the random walk model. The basics for the "fair game" model were put by Fama [1970], when he showed (Fama, 1970) by mathematical equations that the most important consequence of informational efficiency, for a capital market, is the impossibility to obtain abnormal returns relative to the involved risk. The submartingale model states that no active trading strategy can generate a higher return than the passive buy and hold strategy. Finally, the random walk model, which was defined and tested by Fama and Miller [1972], states that

market prices reflect, instantaneously (Fama & Miller, 1972) (and fully), all available information regarding the traded stock; thus, successive variations of market prices are independent of each other, and the same is correct for market returns.

As stated in the previous section of the paper, there are three (Fama, 1965) main forms of informational efficiency for any capital market, according to a taxonomy introduced by the brilliant researcher Eugene Fama. The weak form of informational efficiency is met in the situation in which, on the capital market, asset prices reflect all their past history, fully and instantaneously. The past history includes: the market prices from the past, the variation in the prices, the volume of the transactions, etc. Consequently, there will be no correlation between the past variations and the future variations of the share prices; the price variations will be independent. This also implies that it is impossible to obtain abnormal earnings by studying the market price history.

3. Aims of the Research

Overall, this paper is about studying the weak form of informational efficiency on the Romanian market. Previous studies in this area show the Romanian capital market is not characterized by weak-form efficiency. This means that our market also lacks the other two forms of informational efficiency: the semi-strong (also called semi-weak) and strong form.

In our opinion, the pivotal study undertaken on the Romanian capital market is that of Dragotă and Mitrică [2003]. This paper uses standard econometric testing methodology and shows (Dragotă & Mitrică, 2003), at the end, that the Romanian capital market does not cumulate the conditions necessary for weak form informational efficiency. However, transaction costs and temporary lack of liquidity do not allow investors to gain abnormal returns.

Another important study (Todea, 2002) is one that tested the hypothesis of informational efficiency in the weak form, and was undertaken by Todea [2002]. The author used a sample of 10 BET index companies, listed on the BSE. The sample comprised 800 recordings from between the years 1997-2000. For 8 shares, the analysis confirmed that stochastic modelling is feasible. Thus, weak-form informational efficiency hypothesis is rejected.

Ten years later, Stănculescu and Mitrică [2012] studied the weak-form informational efficiency of the Romanian capital market and showed that market prices do not "walk" according to the random walk model (Stănculescu & Mitrică, 2012). Thus, the market lacks informational efficiency. The study sample includes the daily share prices of the 10 most liquid companies traded on the BSE regulated market. Present paper methodology is based mainly on this article.

However, a complex research (Dragotă et al., 2009) by Dragotă et al. [2009] concluded that the weak-form EMH cannot be rejected for the Romanian capital market. That is because for most of the stock prices, the random walk hypothesis could not be rejected. This study was based on multiple variance ratio test, assuming both homoskedasticity and heteroskedasticity.

There is more research undertaken on the Romanian market, but we finish our short survey with a recent study that is relevant to our paper's approach. Pașca [2015] tested the Romanian capital market efficiency by assessing basic statistical properties of market prices (Pașca, 2015). Ten of the most liquid stocks listed on the BSE were assessed. The conclusion was that weak-form informational efficiency cannot be generalized to the entire market, although some stocks had shown signs of informational efficiency.

4. Research Methods

The *database* of this study is not large. As stated in the paper title, this study is a "short" one. Nevertheless, we recommend the analysis to be continued and expanded with as many sample recordings as possible. To state a general idea, which in fact is a problem that hinders domestic scientific research, there is no public database, with a complete stock market history, available to the average investor or researcher. Gathering data is still a major issue today. One might wonder why an exhaustive stock price history is not available for immediate free download on the website of the Bucharest Stock Exchange. It's just a question.

To move on, we will explain how data was gathered for this study. We used the data[3] provided by investing.com website. By signing up for free, any online user is granted access to downloading the stock price history for any stock that is listed on the Romanian capital market[4]. Of course, other international capital markets may be accessed, too. The price history is not exhaustive, but it covers a lot of years and it generally starts with chronological recordings from around 2010. There is an average ten year period for data availability.

We chose to test random walk on the stock prices of the companies included in the BET index and the BET-FI (Bucharest SIF) index. The first index is comprised of 16 stocks and the second index includes 6 stocks. Therefore, a total number of 22 stocks, parted on two market indexes, are used in this analysis. As stated before, this study can be expanded. We encourage and recommend this endeavour.

For each of the analysed stock, a complete market recorded history (as provided by investing.com) consisting of daily prices, is gathered in a chronological fashion.

The research methodology is similar to the one described in Stănculescu and Mitrică [2012]. The starting point is the random walk model:

$$P_t = \rho \times P_{t-1} + \varepsilon_t \quad (1)$$

The elements of this relationship have the following significance: P is the stock price; t, t -1 are two successive moments in time; $\rho = 1$; ε_t is a regression error. P_t is a time series and ε_t is a random series (Stănculescu & Mitrică, 2012).

[3] www.investing.com - Markets – Stocks – Europe – Romania.

[4] We don't guarantee data availability, we are just describing how we accessed data on our own. Websites might restrict access anytime, according to their rules and policies.

The same idea applies for stock returns, which are in fact stock price variations. The distribution of the return variable, conditioned by the I_t information set, is identical to the unconditioned distribution of the same variable. Therefore, returns (return rates), same as price variations, manifest a random evolution in time (Dragotă et al., 2003), as the density function f ($R_{j,t+1}$) is the same, irrespective of the value taken by t:

$$f(R_{j,t+1} \mid I_t) = f(R_{j,t+1}) \quad (2)$$

To be precise, we will use two random walk tests: the Augmented Dickey-Fuller test and the Phillips-Perron test. They are generally called *unit root tests*.

The ADF test is based on assuming that the series of natural logarithms of daily share prices follow an AR (1) stochastic process, order 1 autoregressive:

$$\Delta \ln(P_t) = \mu + \varphi\, t + \gamma \times \ln(P_{t-1}) + \varepsilon_t \quad (3)$$

This is, in fact, a modified relationship, in which $\gamma = 1 - \rho$. The ADF involves performing a t-statistic test on the γ coefficient. The test results are to be compared with the critical values available for different levels of significance. Essentially, what is tested is the null hypothesis stating the stochastic series has a unit root:

$$H_0 \rightarrow \gamma = 0 \quad \Rightarrow\!\!> \quad \rho = 1 \quad (4)$$

The PP test provides an alternative to the ADF testing. It is a t-statistic for the coefficient of regression. It is in fact adjusted to remove errors (Stănculescu & Mitrică, 2012).

For both tests, computed numerical results are to be compared (Stănculescu & Mitrică, 2012) to the critical values obtained for the significance levels: 1%, 5%, and 10%. If the resulting values are higher than the critical values, for all significance levels, then the series would have a unit root. This will imply that the stock prices follow a random walk process.

The two tests are performed on the natural logarithms series of the stock prices recorded for the BET companies and the BET-FI companies. The results are synthesized in the next part of the paper.

5. Findings

The results performed by using the ***ADF procedure***, for the *BET indexed companies*, are presented in the following table:

Table 1. Augmented Dickey-Fuller testing for BET stocks

Share	ADF BET	1% critical value	5% critical value	10% critical value
ALR	-18.4657847556	-3.43389247529	-2.86299139357	-2.56758988872
TLV	-22.6740156472	-3.43340753751	-2.86277695834	-2.56747482236
BRD	-26.5258608073	-3.43193405813	-2.86212517502	-2.56712502501
BVB	-23.0847853231	-3.4328912795	-2.86254863358	-2.56735229402
TEL	-21.380801724	-3.433428591	-2.86278626877	-2.5674798185
COTE	-20.1483456189	-3.43440914542	-2.86321982052	-2.56771245431
DIGI	-16.1823411984	-3.43988141472	-2.86563666854	-2.56900869497
EL	-19.8551090521	-3.43486533872	-2.86342147559	-2.5678206476
FP	-19.0391558803	-3.43335218901	-2.86275248142	-2.56746168744
WINE	-11.4661680377	-3.44412819835	-2.86750913931	-2.57001227826
M	-14.9773242155	-3.43881901235	-2.86516781263	-2.56875730966
SNP	-22.0810034382	-3.43339951254	-2.86277340947	-2.56747291795
SNN	-18.3124345824	-3.43438988933	-2.86321130789	-2.56770788689
SNG	-16.3503405011	-3.43440914542	-2.86321982052	-2.56771245431
TGN	-21.262819315	-3.43340914731	-2.86277767025	-2.56747520439
SFG	-15.7767750794	-3.44267334751	-2.86686797977	-2.56966870494

Source: own processing

As one can notice, the ADF value is smaller than all critical values, for any level of significance: 1%, 5% and 10%. Thus, the test rejects the null hypothesis which states the natural logarithms stock price series has a unit root. This proves the series does not follow any random walk sort of stochastic process.

The results performed by using the ***ADF procedure***, for the *BET-FI indexed companies*, are included in the following table:

Table 2. Augmented Dickey-Fuller testing for BET-FI stocks

Share	ADF BET-FI	1% critical value	5% critical value	10% critical value
FP	-19.0391558803	-3.43335218901	-2.86275248142	-2.56746168744
SIF3	-22.8336283178	-3.43192133436	-2.86211954529	-2.5671220033
SIF4	-18.0354522978	-3.43343022188	-2.86278698999	-2.56748020553
SIF2	-20.2523010113	-3.43342696174	-2.86278554828	-2.56747943187
SIF5	-18.232297777	-3.43341722047	-2.86278124043	-2.5674771202
SIF1	-17.5027088492	-3.43343022188	-2.86278698999	-2.56748020553

Source: own processing

As it may be noticed, the ADF value is smaller than all critical values, for any level of significance: 1%, 5% and 10%. This implies that the test rejects the null hypothesis which states that the natural logarithms stock price series has a unit root. This proves the series does not follow any random walk sort of stochastic process.

The results performed by using the ***PP procedure***, for the *BET indexed companies*, are included in the following table:

Table 3. Phillips-Perron testing for BET stocks

Share	PP BET	1% critical value	5% critical value	10% critical value
ALR	-47.1216884796	-3.43385662876	-2.86297554379	-2.56758138399
TLV	-44.1423933143	-3.43338675533	-2.86276776784	-2.56746989049
BRD	-56.7756762931	-3.43192602526	-2.86212162081	-2.56712311736
BVB	-50.1642489184	-3.43287548013	-2.86254164537	-2.56734854372
TEL	-42.9539991017	-3.43340432272	-2.86277553668	-2.56747405946
COTE	-45.2772907755	-3.43437624204	-2.86320527472	-2.56770464987
DIGI	-26.3409302548	-3.43976639667	-2.86558591744	-2.5689814857
EL	-40.8184131732	-3.43482498395	-2.86340363851	-2.56781107778
FP	-45.7440866863	-3.43332140588	-2.8627388679	-2.5674543821
WINE	-26.7134297219	-3.44377635142	-2.86735410785	-2.56992920914
M	-35.4028895063	-3.43869394286	-2.86511260607	-2.56872770722
SNP	-46.5692564885	-3.43337883332	-2.86276426447	-2.56746801054
SNN	-36.2274676845	-3.43434921133	-2.86319332496	-2.56769823821
SNG	-39.5155886951	-3.43435458956	-2.86319570259	-2.56769951394
TGN	-42.9619221037	-3.43338834445	-2.8627684706	-2.5674702676
SFG	-24.1538165605	-3.44253021898	-2.86680488518	-2.56963489116

Source: own processing

As one can notice, the PP value is smaller than all critical values, for any level of significance: 1%, 5% and 10%. As a consequence, the test rejects the null hypothesis which states that the natural logarithms stock price series has a unit root. This proves the series does not follow any random walk stochastic process.

The results performed by using the ***PP procedure***, for the *BET-FI indexed companies,* are included in the following table:

Table 4. Phillips-Perron testing for BET-FI stocks

Share	PP BET-FI	1% critical value	5% critical value	10% critical value
FP	-45.7440866863	-3.43332140588	-2.8627388679	-2.5674543821
SIF3	-55.6580242885	-3.4319111027	-2.86211501818	-2.5671195735
SIF4	-45.7403456618	-3.43339791234	-2.86277270181	-2.5674725382
SIF2	-49.249743147	-3.43339152741	-2.86276987821	-2.56747102299
SIF5	-44.0450480466	-3.43338199742	-2.86276566374	-2.56746876144
SIF1	-44.3787762392	-3.4333947167	-2.86277128861	-2.56747177984

Source: own processing

As it may be noticed, the PP value is smaller than all critical values, for any significance level: 1%, 5% and 10%. This implies the test will reject the null hypothesis which states the natural logarithms stock price series has a unit root. This shows the series does not follow any random walk stochastic process.

6. Conclusions

In conclusion, the capital market is non-efficient in the weak form. Of course, this is an extrapolation. We did not test all stocks traded on the Bucharest Stock Exchange. But for the ones that we did test, the random walk hypothesis was rejected. Thus, no random walk, no weak-form informational efficiency. It is quite relevant that for 22 listed companies, the stock prices do not follow a random walk stochastic process. Therefore, without providing any mathematical prediction model, we cannot exclude the fact, as proven by this paper, that abnormal returns can be gained by means of studying the stock price history, at the BSE.

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