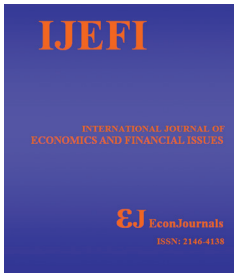

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# Evaluation of the Stock Quote – Stochastic Approach, Market Efficiency and Technical Analysis

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**ABSTRACT**

The paper presents, theoretically and practically, the evaluation of the stock quote using the stochastic technique, market efficiency and the technical analysis, and the object of the study is the stock quote of Electrica SA, listed on the Bucharest stock exchange. One of the current paradigms, in which the stock quote is evaluated, considers this to be a random variable of continuous type. Our developments are subject to this paradigm. We also consider the technical analysis of the stock quote used in the study, complementary to the stochastic calculation. Prior to the technical analysis is carried out a test of the weak-form market efficiency, required to justify such an approach.

**Keywords:** Stochastic Calculation, Market Efficiency, Technical Analysis
**JEL Classifications:** C02, C13, G14, G17

## 1. INTRODUCTION

In the present paper, our objective is to test some theories regarding the evolution of the stock quote, having as object of study the quote of Electrica SA, listed on the Bucharest stock exchange.

Evaluation of the stock quote is one of the most difficult issues in the field of finance and we find the existence of several techniques through which opinions can be based on it. Among the most used techniques we can mention here: Actuarial technique, econometric technique, stochastic technique.

Along with the techniques mentioned above, financial theory also provided to practitioners ways to approach this issue through fundamental analysis and technical analysis.

Having said that, we will continue to make some non-exhaustive references to the research directions that we propose to follow in this study, namely the random behavior of the stock quote, market efficiency and its technical analysis.

Regarding the random behavior, we can say that the valuation approach of stock quote from a stochastic perspective is subject to the current paradigm of its evolution, in which the price of a financial asset is considered to be in the form of a random variable and following a stochastic process.

The most well-known and most widely used model for valuing shares, stock indices and commodities, which is the foundation of financial research, has the following form (Wilmott, 2002. p. 75).

$$dC = \mu Cdt + \sigma CdB$$

The above stochastic differential equation is a mathematical model in continuous time in the form of a Brownian motion with drift and in which, both the drift and the random part, evolve in function of C (the stock quote).

We also remind the properties of a Brownian motion, which are: It is finite; it is continuous; it has the Markov property; it has Martingal property; it is normally distributed, with zero mean and variance dt.

Regarding the market efficiency, we can say that this concept belongs to Eugene Fama and is defined as such (Fama, 1965a. p. 3-4): "An efficient market is defined as a market where there are large numbers of rational profit-maximizers actively-competing, with each trying to predict future market values of individual securities, and where important current information is almost freely available to all participants. In an efficient market, competition among the many intelligent participants leads to a situation where, at any point in time, actual prices of individual securities already reflect the effects of information based both on events that have already occurred and on events which as of now the market expects to take place in the future. In other words, in an efficient market at any point in time the actual price of a security will be a good estimate of its intrinsic value."

Regarding the technical analysis, we can say that this is a method of predicting the future movements of the stock quotes only by observing their history (Wilmott, 2007. p. 628). In other words, the technical analysis is the study of stock quotes, with the stock chart as the basic tool (Brătian et al., 2016. p. 243).

The tools with which the technical analysis operates are the indicators. These can be grouped into several categories, of which the most important are: Trend indicators, oscillators, volatility indicators and volume indicators.

An indicator is a mathematical calculation that can be applied to the price or volume of a financial asset. The result is a value that can be used to predict future movements in the price of the financial asset (Achelis, 2000. p. 26).

Technical analysis is useful as long as the capital market on which the financial asset is traded is not efficient in a weak-form. Therefore, for justification and relevance of the technical analysis, it is imperative, beforehand, to carry out tests of the weak-form market efficiency.

In addition to the above-mentioned works, in the next chapter we will highlight the main literary references that contributed to the methodological development of the three main research directions (stochastic calculation, efficient market hypothesis and technical analysis). Compared with the cited papers, which address each of these themes individually, our work proposes a comprehensive approach to the evaluation of financial assets from the perspective of all three research fields.

## 2. METHODOLOGY

In the following we will describe the main methodological aspects that we consider necessary in the approach of the research, grouped in three directions, namely: Stochastic calculation, testing of the weak-form market efficiency and technical analysis indicators.

A. Regarding the stochastic calculation

When we are dealing with a random behavior of the stock exchange we can do so (Weatherwax, 2008, MIT. p. 8-9).

Let $dC = \mu Cdt+\sigma CdB$ the equation that satisfies C and we use heuristics:

$$dC^2 = \sigma^2C^2dB^2 = \sigma^2C^2dt$$

If we consider a function F defined with the following property:

$$F(C) = \ln(C) \quad (1)$$

Then:
$$\frac{dF}{dC}=\frac{1}{C};\qquad \frac{d^2F}{dC^2}=-\frac{1}{C^2} \quad (2)$$

Where: F(C) follows a logarithmic evolution.

Differential function F, developing in the Taylor series, is:

$$dF = d(\ln C) = \frac{dF}{dC}dC+\frac{1}{2}\frac{d^2F}{dC^2}dC^2 = \frac{1}{C}(\mu Cdt+\sigma CdB)$$
$$+\frac{1}{2}\left(-\frac{1}{C^2}\right)\sigma^2C^2dt = \frac{1}{C}\mu Cdt+\frac{1}{C}\sigma CdB-$$
$$\frac{1}{2C^2}\sigma^2C^2dt = \mu dt+\sigma dB-\frac{1}{2}\sigma^2dt = \left(\mu-\frac{1}{2}\sigma^2\right)dt+$$
$$\sigma dB = \left(\mu-\frac{1}{2}\sigma^2\right)dt+\sigma Z\sqrt{dt} \quad (3)$$

The expression (3) can be integrated and it is obtained the following relations:

$$\int_0^t d(\ln C) = \int_0^t\left(\mu-\frac{1}{2}\sigma^2\right)dt+\int_0^t\sigma dB$$

And the folowing equation of motion:

$$\ln C(t)-\ln C(0) = \left(\mu-\frac{1}{2}\sigma^2\right)t+\sigma(B(t)-B(0)) \quad (4)$$

As a result, the solution for C(t) is:

$$C(t) = C(0)\times e^{\left(\mu-\frac{1}{2}\sigma^2\right)t+\sigma(B(t)-B(0))} \quad (5)$$

Where: B(t) is a Gaussian process; $B(t)-B(0) = Z\sqrt{t}$ ; Z~N(0,1).

That being said, we can determine the range of values at which the stock quote can be, with probabilities of 99%, 90%, thus (Brătian et al., 2016. p. 82-83).

We know that at the beginning, the stock quote is $C_0$, then the profitability for a certain period up to a moment t in the future is given by the following expression: $\ln\frac{C(t)}{C(0)}$ and it will have the following normal distribution:

$$\ln\frac{C(t)}{C(0)} \sim N\left(\left(\mu-\frac{1}{2}\sigma^2\right)t,\sigma\sqrt{t}\right)$$

Where as the logarithm of the stock quote is normally distributed, it can be determined a confidence interval for $C_t$. Thus, with a

probability of 99%, the future value of the stock quote, at time t, varies between the limits:

$$C(0)e^{\left[\left(\mu-\frac{1}{2}\sigma^2\right)t-2.58\sigma\sqrt{t}\right]} \le C(t) \le C(0)e^{\left[\left(\mu-\frac{1}{2}\sigma^2\right)t+2.58\sigma\sqrt{t}\right]}$$

And with a probability of 90%, the future value of the stock quote, at time t, varies between the limits:

$$C(0)e^{\left[\left(\mu-\frac{1}{2}\sigma^2\right)t-1.65\sigma\sqrt{t}\right]} \le C(t) \le C(0)e^{\left[\left(\mu-\frac{1}{2}\sigma^2\right)t+1.65\sigma\sqrt{t}\right]}$$

We can use different sizes of probability. Thus, for a probability of 75% we will have:

$$P\left(\left[\left(\mu-\frac{1}{2}\sigma^2\right)t-1.15\sigma\sqrt{t}\right] \le \frac{\ln(C(t))}{C(0)} \le \left[\left(\mu-\frac{1}{2}\sigma^2\right)t+1.15\sigma\sqrt{t}\right]\right) \rightarrow$$

$$P\left(C(0)e^{\left[\left(\mu-\frac{1}{2}\sigma^2\right)t-1.15\sigma\sqrt{t}\right]} \le C(t) \le C(0)e^{\left[\left(\mu-\frac{1}{2}\sigma^2\right)t-1.15\sigma\sqrt{t}\right]}\right) = 75\%$$

B. Regarding the weak-form market efficiency

The efficient market in a weak form is the market where the course of financial securities at one point fully reflects all the information contained in their history, and as a result, technical analysis is irrelevant.

For this form of efficiency, the testing may involve the use of statistical tests to edify us whether the market is efficient in weak form. The statistical tests used here by us are:

1. Autocorrelation coefficients (Fama, 1965b. p. 69).
2. Augmented Dickey-Fuller test (ADF), used to detect random walk of securities traded on the market. The ADF tests (Brătian et al., 2016. p. 113):
   - For level:
     $\ln C_t = a_0 + a_1 \ln C_{t-1} + \varepsilon_t$
     with $H_0$: $a_1 = 1$
   - For the first difference:
     $\ln C_t - \ln C_{t-1} = a_0 + \gamma \ln C_{t-1} + \varepsilon_t$
     or
     $\Delta \ln C_t = a_0 + \gamma \ln C_{t-1} + \varepsilon_t$
     with $H_0$: $\gamma = 0$

The ADF test is also written in the form in which it can be included a trend variable, which depends on time (φ[t]).

3. Phillips-Perron test (PP), a similar test to the ADF test, but which uses the least squares method in its simple form for estimating the equation, in this case being a t-statistical test for the regression coefficient but adjusted for the removal of some errors (Dragotă et al., 2009. p. 157). In other words, the PP tests the non-autocorrelation of the residual variable values.
4. The Jarque-Bera test (JB) for testing the time series normality. For this test, $H_0$: Errors are normally distributed.

C. Regarding the technical analysis indicators

Technical analysis indicators of the stock quote considered in our analysis are:

1. Trend indicators, respectively: Simple moving average (SMA); exponential moving average (EMA); moving average convergence-divergence (MACD).

Moving average indicator is among the simplest and commonly used indicators in technical analysis and among its first users are Donochian R. and JM Hurst (Elder, 2014. p. 74). This indicator identifies existing trends and their reversals.

The MACD indicator, built by Gerald Appel, signals trend changes and indicates trend direction (Reuters, 2000. p. 141).

2. Oscillators, respectively: Relative strength index (RSI); momentum.

The RSI indicator is one of the most well-known indicators of technical analysis developed by Wilder in the paper New Concepts in Technical Trading Systems (1978), on the basis of which the sell and buy signals can be anticipated.

The momentum indicator is useful in measuring the rate of change of the rate of growth or decrease of the course, in order to identify its cyclic phases.

3. Volatility indicator Bollinger Bands.

This indicator may indicate whether the stock quote is relatively high or low, if the trend continues or reverses or the market where the stock is traded is more or less volatile (Achelis, 2000. p. 57).

4. Volume indicators, respectively: On balance volum (OBV); accumulation/distribution (A/D).

The OBV indicator is a momentum indicator but correlates volume with price variations.

The A/D indicator makes an association of stock quote variations with volume variations, assuming that a price movement is representative if it is correlated with a higher trading volume (Achelis, 2000. p. 44).

## 3. THE RANDOM BEHAVIOR OF ELECTRICA SA SHARES

Based on the above mentioned methodology, regarding the random behavior of the quote of Electrica SA, we will determine (with probability of 99%, 90% and 75%) the range of values in that can be found at the following moments:

- 1 week after the analysis period – January 09, 2017;
- 1 month after the analysis period – January 30, 2017;
- 3 months after the analysis period – March 29, 2017.

The stock quotes of Electrica SA used in the analysis are daily values (closing prices), from the Bucharest stock exchange, for the period 04.01.2016-28.12.2016, 1 year.

Required data obtained from the stock quote analysis during the above mentioned period:

- Daily average: 0.000355503
- Standard deviation: 0.010194337

- Time step: 0.003968254
- Drift (annual average): 0.089586636
- Volatility (annual standard deviation): 0.161830084.

That being said, the value ranges of the SC Electrica SA stock quote, with probabilities of 99%, 90% and 75%, are:

a. on January 9th, 2017, t = 0.02777777

- For probability of 99%:

$$C(0)e^{\left[\left(\mu-\frac{1}{2}\sigma^2\right)t-2.58\sigma\sqrt{t}\right]} \le C(t) \le C(0)e^{\left[\left(\mu-\frac{1}{2}\sigma^2\right)t+2.58\sigma\sqrt{t}\right]} =$$

$$13.12\, e^{-0.0674628} \le C(t) \le 13.12e^{0.0717072} \rightarrow 12.26 \le C(t) \le 14.09$$

- For probability of 90%:

$$C(0)e^{\left[\left(\mu-\frac{1}{2}\sigma^2\right)t-1.65\sigma\sqrt{t}\right]} \le C(t) \le C(0)e^{\left[\left(\mu-\frac{1}{2}\sigma^2\right)t+1.65\sigma\sqrt{t}\right]} =$$

$$13.12\, e^{-0.0423784} \le C(t) \le 13.12e^{0.0466279} \rightarrow 12.57 \le C(t) \le 13.74$$

- For probability of 75%:

$$C(0)e^{\left[\left(\mu-\frac{1}{2}\sigma^2\right)t-1.15\sigma\sqrt{t}\right]} \le C(t) \le C(0)e^{\left[\left(\mu-\frac{1}{2}\sigma^2\right)t+1.15\sigma\sqrt{t}\right]} =$$

$$13.12\, e^{-0.0288925} \le C(t) \le 13.12e^{0.0331421} \rightarrow 12.74 \le C(t) \le 13.56$$

b. 1 month after the analysis period (on January 30th, 2017), t = 0.0833333

- For probability of 99%:

$$C(0)e^{\left[\left(\mu-\frac{1}{2}\sigma^2\right)t-2.58\sigma\sqrt{t}\right]} \le C(t) \le C(0)e^{\left[\left(\mu-\frac{1}{2}\sigma^2\right)t+2.58\sigma\sqrt{t}\right]} =$$

$$13.12\, e^{-0.0707075} \le C(t) \le 13.12\, e^{0.0834562} \rightarrow 12.22 \le C(t) \le 14.26$$

- For probability of 90%:

$$C(0)e^{\left[\left(\mu-\frac{1}{2}\sigma^2\right)t-1.65\sigma\sqrt{t}\right]} \le C(t) \le C(0)e^{\left[\left(\mu-\frac{1}{2}\sigma^2\right)t+1.65\sigma\sqrt{t}\right]} =$$

$$13.12\, e^{-0.0707075} \le C(t) \le 13.12\, e^{0.0834562} \rightarrow 12.22 \le C(t) \le 14.26$$

- For probability of 75%:

$$C(0)e^{\left[\left(\mu-\frac{1}{2}\sigma^2\right)t-1.15\sigma\sqrt{t}\right]} \le C(t) \le C(0)e^{\left[\left(\mu-\frac{1}{2}\sigma^2\right)t+1.15\sigma\sqrt{t}\right]} =$$

$$13.12\, e^{-0.0473493} \le C(t) \le 13.12\, e^{0.060098} \rightarrow 12.51 \le C(t) \le 13.93$$

c. 3 months after the analysis period (on March 29th, 2017), t = 0.25

- For probability of 99%:

$$C(0)e^{\left[\left(\mu-\frac{1}{2}\sigma^2\right)t-2.58\sigma\sqrt{t}\right]} \le C(t) \le C(0)e^{\left[\left(\mu-\frac{1}{2}\sigma^2\right)t+2.58\sigma\sqrt{t}\right]} =$$

$$13.12\, e^{-0.1896376} \le C(t) \le 13.12\, e^{0.2278837} \rightarrow 10.85 \le C(t) \le 16.47$$

- For probability of 90%:

$$C(0)e^{\left[\left(\mu-\frac{1}{2}\sigma^2\right)t-1.65\,\sigma\sqrt{t}\right]} \le C(t) \le C(0)e^{\left[\left(\mu-\frac{1}{2}\sigma^2\right)t+1.65\sigma\sqrt{t}\right]} =$$

$$13.12\, e^{-0.1143867} \le C(t) \le 13.12\, e^{0.1526327} \rightarrow 11.70 \le C(t) \le 15.28$$

- For probability of 75%:

$$C(0)e^{\left[\left(\mu-\frac{1}{2}\sigma^2\right)t-1.15\sigma\sqrt{t}\right]} \le C(t) \le C(0)e^{\left[\left(\mu-\frac{1}{2}\sigma^2\right)t+1,15\sigma\sqrt{t}\right]} =$$

$$13.12\, e^{-0.0739292} \le C(t) \le 13.12\, e^{0.1121752} \rightarrow 12.18 \le C(t) \le 14.67$$

## 4. TESTING THE WEAK-FORM MARKET EFFICIENCY OF THE CAPITAL MARKET IN ROMANIA

Next, we will test the weak-form market efficiency of the Romanian capital market using the previously described methodology, using the BET-NG stock index. The values of the BET-NG stock index used in the analysis are its daily values (close), between 04/01/2010 and 30/12/2016 (1799 observations).

The above mentioned index is chosen by us because it is specific to the energy companies listed on the Bucharest stock exchange, which includes Electrica shares.

We recall that an efficient market in a weak form is the market where the course of financial securities at one point reflects (fully) all the information contained in their history. If, following testing, the market is informational efficient in a weak form, then the technical analysis is irrelevant in estimating the stock quote.

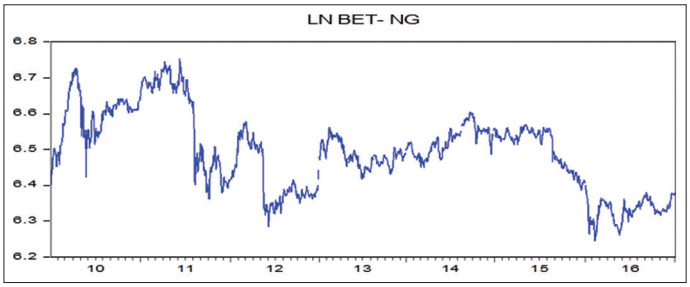
The evolution of the BET-NG stock index during the above mentioned analysis period is as follows (Chart 1).

The logarithmic evolution of the BET-NG stock index over the above mentioned period is as follows (Chart 2).

**Chart 1:** BET-NG evolution in the period 04/01/2010-30/12/2016


Source: Own calculations in Eviews

**Chart 2:** Logarithmic evolution of the BET-NG stock index in the period 04/01/2010-30/12/2016



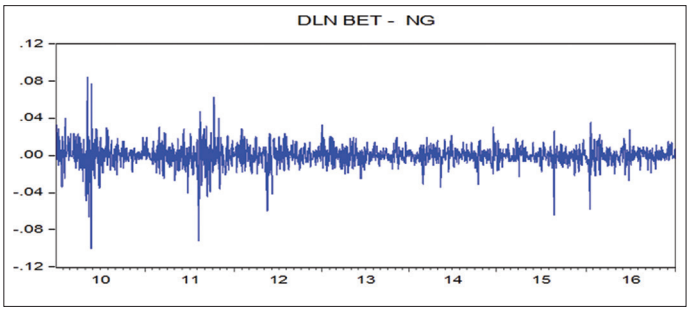

Source: Own calculations in Eviews

**Table 1: ADF for level**

| Null hypothesis: LN_BETNG has a unit root | | | |
|---|---|---|---|
| Exogenous: Constant, linear trend | | | |
| Lag length: 0 (automatic - based on SIC, maxlag=24) | | | |
| **ADF test statistic** | | **t-statistic** | **P*** |
| Test critical values | | −3.182971 | 0.0881 |
| 1% level | | −3.963155 | |
| 5% level | | −3.412310 | |
| 10% level | | −3.128090 | |
| *MacKinnon (1996) one-sided P-values | | | |
| ADF test equation | | | |
| Dependent variable: D(LN_BETNG) | | | |
| Method: Least squares | | | |
| Sample (adjusted): 1/05/2010 12/30/2016 | | | |
| Included observations: 1798 after adjustments | | | |
| **Variable** | **Coefficient** | **Standard error** | **t-statistic** | **P** |
| LN_BETNG(−1) | −0.009620 | 0.003022 | −3.182971 | 0.0015 |
| C | 0.063834 | 0.019959 | 3.198284 | 0.0014 |
| @TREND("1/04/2010") | −1.55E-06 | 6.37E-07 | −2.429231 | 0.0152 |
| $R^2$ | 0.005907 | Mean dependent variable | | −1.42E-05 |
| Adjusted $R^2$ | 0.004800 | SD dependent variable | | 0.011503 |
| SE of regression | 0.011475 | Akaike info criterion | | −6.095638 |
| Sum squared resid | 0.236355 | Schwarz criterion | | −6.086471 |
| Log likelihood | 5482.979 | Hannan-Quinn criter | | −6.092254 |
| F-statistic | 5.333364 | Durbin-Watson stat | | 1.952176 |
| P (F-statistic) | 0.004905 | | | |

Source: Own calculations in Eviews. ADF: Augmented Dickey-Fuller

**Chart 3:** Evolution of the logarithmic return of the BET-NG stock index in the period 04/01/2010-30/12/2016




Source: Own calculations in Eviews

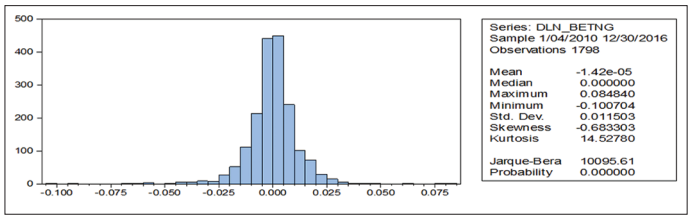
The evolution of the logarithmic return of the BET-NG stock index over the above mentioned period is as follows (Chart 3).

## 4.1. Augmented Dickey-Fuller Test (ADF) (Tables 1 and 2)

As a result of the results obtained by applying the ADF test (for level and first difference), we can say the following:

- Forlevel is confirmed the weak-form efficiency of the capital market, analyzed on the basis of the BET-NG stock index (the result of the ADF test is higher than the critical values for significance thresholds, 1%, 5% and less for 10% for t-statistic, but we notice that it is very close to its values);
- For the first difference, the weak-form efficiency of the capital market is not confirmed, based on the BET_NG stock index (the result of the ADF test is well below the critical values for significance thresholds of 1%, 5%, 10% for t-statistic);
- According to the results obtained in the ADF test, we consider that the Romanian capital market is not efficient in a weak-form.

**Figure 1:** Jarque Bera test




Source: Own calculations in Eviews

## 4.2. Phillips-Perron Test (PP) (Tables 3 and 4)

As a result of the results obtained by applying the PP test (for level and first difference), we can say the following:

- For level is confirmed the weak-form efficiency of the capital market, analyzed on the basis of the BET-NG stock index (the result of the PP test is higher than the critical values related to the significance thresholds, 1%, 5% and less for 10% for t-statistic, but we notice that it is very close to its values);
- For the first difference, the weak-form efficiency of the capital market is not confirmed, analyzed on the basis of the BET_NG stock index (the result of the PP test is well below the critical values for significance thresholds of 1%, 5%, 10%, for t-statistic);
- According to the results of the PP test, we consider that the Romanian capital market is not efficient in a weak form.

## 4.3. The Jarque-Bera Test (JB) (Figure 1)

As a result of the results obtained by applying the JB test, we can say the following:

- The distribution of logarithmic returns of the BET-NG stock index is suspected of not being subject to the normality assumption;

**Table 2: ADF for the first difference**

| Null Hypothesis: D(LN_BETNG) has a unit root | | | | |
|---|---|---|---|---|
| Exogenous: Constant, linear trend | | | | |
| Lag Length: 0 (automatic - based on SIC, maxlag =24) | | | | |
| **ADF test statistic** | | | **t-statistic** | **P*** |
| Test critical values | | | −41.70227 | 0.0000 |
| 1% level | | | −3.963157 | |
| 5% level | | | −3.412311 | |
| 10% level | | | −3.128091 | |
| *MacKinnon (1996) one-sided P-values | | | | |
| ADF test equation | | | | |
| Dependent variable: D(LN_BETNG,2) | | | | |
| Method: Least squares | | | | |
| Sample (adjusted): 1/06/2010 12/30/2016 | | | | |
| Included observations: 1797 after adjustments | | | | |
| **Variable** | **Coefficient** | **Standard error** | **t-statistic** | **P** |
| D(LN_BETNG(−1)) | −0.982247 | 0.023554 | −41.70227 | 0.0000 |
| C | 0.000251 | 0.000543 | 0.462393 | 0.6439 |
| @TREND("1/04/2010") | −3.14E-07 | 5.22E-07 | −0.602164 | 0.5471 |
| $R^2$ | 0.492229 | Mean dependent variable | | −2.01E-05 |
| Adjusted $R^2$ | 0.491663 | SD dependent variable | | 0.016106 |
| SE of regression | 0.011483 | Akaike info criterion | | −6.094221 |
| Sum squared resid | 0.236558 | Schwarz criterion | | −6.085050 |
| Log likelihood | 5478.658 | Hannan-Quinn criter | | −6.090835 |
| F-statistic | 869.5450 | Durbin-Watson stat | | 1.999553 |
| P (F-statistic) | 0.000000 | | | |

Source: Own calculations in Eviews. ADF: Augmented Dickey-Fuller

**Table 3: PP for the level**

| Null Hypothesis: LN_BETNG has a unit root | | | | |
|---|---|---|---|---|
| Exogenous: Constant, Linear Trend | | | | |
| Bandwidth: 4 (Newey-West automatic) using Bartlett kernel | | | | |
| **PP test statistic** | | | **Adjusted t-statistics** | **P*** |
| Test critical values | | | −3.244287 | 0.0762 |
| 1% level | | | −3.963155 | |
| 5% level | | | −3.412310 | |
| 10% level | | | −3.128090 | |
| *MacKinnon (1996) one-sided P-values | | | | |
| Residual variance (no correction) | | | | 0.000131 |
| HAC corrected variance (Bartlett kernel) | | | | 0.000139 |
| PP test equation | | | | |
| Dependent variable: D(LN_BETNG) | | | | |
| Method: Least squares | | | | |
| Sample (adjusted): 1/05/2010 12/30/2016 | | | | |
| Included observations: 1798 after adjustments | | | | |
| **Variable** | **Coefficient** | **Standard error** | **t-statistic** | **P** |
| LN_BETNG(−1) | −0.009620 | 0.003022 | −3.182971 | 0.0015 |
| C | 0.063834 | 0.019959 | 3.198284 | 0.0014 |
| @TREND("1/04/2010") | −1.55E-06 | 6.37E-07 | −2.429231 | 0.0152 |
| $R^2$ | 0.005907 | Mean dependent variable | | −1.42E-05 |
| Adjusted $R^2$ | 0.004800 | SD dependent variable | | 0.011503 |
| SE of regression | 0.011475 | Akaike info criterion | | −6.095638 |
| Sum squared resid | 0.236355 | Schwarz criterion | | −6.086471 |
| Log likelihood | 5482.979 | Hannan-Quinn criter | | −6.092254 |
| F-statistic | 5.333364 | Durbin-Watson stat | | 1.952176 |
| P (F-statistic) | 0.004905 | | | |

Source: Own calculations in Eviews. PP: Phillips-Perron

- The series of logarithmic returns of the BET-NG stock index is left asymmetric (Skewness is negative) and leptocurtotic (Kurtosis >3);
- The capital market in Romania is, in terms of probabilities, fragile, in the sense of Taleb (Taleb, 2014. p. 451);
- The null hypothesis is not accepted and, as a result, we

**Table 4: PP for the first difference**

| Null hypothesis: D(LN_BETNG) has a unit root | | | |
|---|---|---|---|
| Exogenous: Constant, linear trend | | | |
| Bandwidth: 9 (Newey-West automatic) using Bartlett kernel | | | |
| **PP test statistic** | | **Adjusted t-statistics** | **P*** |
| Test critical values | | −41.69872 | 0.0000 |
| 1% level | | −3.963157 | |
| 5% level | | −3.412311 | |
| 10% level | | −3.128091 | |
| *MacKinnon (1996) one-sided P-values | | | |
| Residual variance (no correction) | | | 0.000132 |
| HAC corrected variance (Bartlett kernel) | | | 0.000129 |
| PP test equation | | | |
| Dependent variable: D(LN_BETNG,2) | | | |
| Method: Least squares | | | |
| Sample (adjusted): 1/06/2010 12/30/2016 | | | |
| Included observations: 1797 after adjustments | | | |
| **Variable** | **Coefficient** | **Standard error** | **t-statistic** | **P** |
| D(LN_BETNG(−1)) | −0.982247 | 0.023554 | −41.70227 | 0.0000 |
| C | 0.000251 | 0.000543 | 0.462393 | 0.6439 |
| @TREND("1/04/2010") | −3.14E-07 | 5.22E-07 | −0.602164 | 0.5471 |
| $R^2$ | 0.492229 | Mean dependent variable | | −2.01E-05 |
| Adjusted $R^2$ | 0.491663 | SD dependent variable | | 0.016106 |
| SE of regression | 0.011483 | Akaike info criterion | | −6.094221 |
| Sum squared resid | 0.236558 | Schwarz criterion | | −6.085050 |
| Log likelihood | 5478.658 | Hannan-Quinn criter | | −6.090835 |
| F-statistic | 869.5450 | Durbin-Watson stat | | 1.999553 |
| P (F-statistic) | 0.000000 | | | |

Source: Own calculations in Eviews. PP: Phillips-Perron

conclude that the Romanian capital market is not effective in a weak form.

### 4.4. Autocorrelation Coefficients (Table 5)

As a result of the results obtained for the coefficients of autocorrelation, we can say the following:

- The coefficients of autocorrelation for the logarithmic returns of the BET_NG Stock Index are insignificant (close to zero) and consequently, on their account, we can conclude that the Romanian capital market is efficient in a weak form;
- The test is one of the simplest tests to assess the weak-form efficiency of the financial market and we are not sure that the market is subject to this form of efficiency, given the results of theabove complementary tests for stationarity and normality.

## 5. TECHNICAL ANALYSIS OF ELECTRICA SA SHARES

Whereas, following tests on the weak form efficiency in the market, we found that the market on which Electrica SA shares are traded, is inefficient in weak form, we believe that technical analysis can be justified.

Therefore, in the following we will calculate the values of the technical analysis indicators, mentioned in the methodology used in the paper, and we will conclude the obtained results.

**Chart 4:** Simple moving average (9)


Source: Own analysis using the platform tradingview.com

**Chart 5:** Exponential moving average (9)


Source: Own analysis using the platform tradingview.com

The data used for this analysis refers to the share price of Electica SA (daily data, closing prices), from the Bucharest stock exchange, for the period 04.01.2016-28.12.2016, and the charts were generated and customized using the platform of technical analysis, available at the web address: www.tradingview.com.

## 5.1. Trend Indicators

- SMA (Chart 4)
- EMA (Chart 5).

At the end of 2016, the two charts do not give us a clear buy/sell signal, the quote being slightly below the moving average. The indication would be that in the short term the downward trend of the quote will continue until a downward intersection of the moving average occurs by the quote of Electrica SA share.

- MACD (Chart 6).

As a consequence, in the case of the Electrica SA share, the MACD indicator is below both the signal line and below 0. This suggests that in the short term the downward trend of the Electrica quote will continue, at least until MACD crosses the signal line or will exceed level 0.

**Table 5: Corelogram of logarithmic return of the BET-NG stock index**

| Correlogram DLN BET-NG | | | | | |
|---|---|---|---|---|---|
| Sample: 1/04/2010 12/30/2016 | | | | | |
| Included observations: 1798 | | | | | |
| Autocorrelation | Partial correlation | AC | PAC | Q-statistics | P |
| \|\| | \|\| | 0.018 | 0.018 | 0.5830 | 0.445 |
| \|\| | \|\| | 0.034 | 0.034 | 2.6989 | 0.259 |
| \|\| | \|\| | −0.043 | −0.044 | 6.0633 | 0.109 |
| \|\| | \|\| | 0.010 | 0.011 | 6.2470 | 0.181 |
| \|\| | \|\| | −0.033 | −0.030 | 8.1664 | 0.147 |
| \|\| | \|\| | 0.052 | 0.050 | 12.986 | 0.043 |
| \|\| | \|\| | −0.051 | −0.051 | 17.767 | 0.013 |
| \|\| | \|\| | 0.016 | 0.012 | 18.244 | 0.019 |
| \|\| | \|\| | 0.014 | 0.022 | 18.610 | 0.029 |
| \|\| | \|\| | 0.060 | 0.053 | 25.103 | 0.005 |
| \|\| | \|\| | −0.048 | −0.047 | 29.304 | 0.002 |
| \|\| | \|\| | −0.006 | −0.012 | 29.360 | 0.003 |
| \|\| | \|\| | −0.012 | 0.002 | 29.609 | 0.005 |
| \|\| | \|\| | 0.055 | 0.049 | 35.099 | 0.001 |
| \|\| | \|\| | 0.018 | 0.019 | 35.690 | 0.002 |
| \|\| | \|\| | −0.015 | −0.027 | 36.108 | 0.003 |
| \|\| | \|\| | −0.021 | −0.008 | 36.883 | 0.003 |
| \|\| | \|\| | 0.007 | 0.005 | 36.976 | 0.005 |
| \|\| | \|\| | −0.034 | −0.034 | 39.058 | 0.004 |
| \|\| | \|\| | 0.038 | 0.033 | 41.708 | 0.003 |
| \|\| | \|\| | −0.036 | −0.028 | 44.043 | 0.002 |
| \|\| | \|\| | −0.027 | −0.030 | 45.353 | 0.002 |
| \|\| | \|\| | 0.021 | 0.025 | 46.160 | 0.003 |
| \|\| | \|\| | −0.016 | −0.029 | 46.640 | 0.004 |
| \|\| | \|\| | 0.002 | 0.009 | 46.645 | 0.005 |
| \|\| | \|\| | 0.001 | 0.001 | 46.646 | 0.008 |
| \|\| | \|\| | 0.032 | 0.037 | 48.548 | 0.007 |
| \|\| | \|\| | −0.015 | −0.019 | 48.939 | 0.008 |
| \|\| | \|\| | 0.018 | 0.012 | 49.561 | 0.010 |
| \|\| | \|\| | 0.005 | 0.009 | 49.611 | 0.014 |
| \|\| | \|\| | −0.011 | −0.008 | 49.841 | 0.017 |
| \|\| | \|\| | 0.000 | 0.004 | 49.841 | 0.023 |
| \|\| | \|\| | 0.005 | −0.000 | 49.893 | 0.030 |
| \|\| | \|\| | −0.033 | −0.027 | 51.831 | 0.026 |
| \|\| | \|\| | −0.005 | −0.009 | 51.877 | 0.033 |
| \|\| | \|\| | −0.029 | −0.023 | 53.389 | 0.031 |

Source: Own calculations in Eviews

## 5.2. Oscillators

- RSI (Chart 7)

For Electrica SA share, we do not have a strong signal of reversing the slightly downward trend, so that until the appearance of new elements, strictly according to this indicator of technical analysis, we consider inappropriate the entry into the market at purchasing positions.

- Momentum (Chart 8)

Similar to previous indicators, momentum oscillator evolution suggests an uncertain state without a strong trend (regardless of

**Chart 6:** Moving average convergence-divergence (MACD) is Histogram MACD


Source: Own analysis using the platform tradingview.com

**Chart 7:** Relative strength index


Source: Own analysis using the platform tradingview.com

**Chart 8:** Momentum


Source: Own analysis using the platform tradingview.com

**Chart 9:** Bollinger bands


Source: Own analysis using the platform tradingview.com

**Chart 10:** On balance volume


Source: Own analysis using the platform tradingview.com

**Chart 11:** Accumulation/distribution


Source: Own analysis using the platform tradingview.com

direction). In these conditions, we expect a slight downward trend to continue in the short term.

### 5.3. Volatility Indicators

- Bollinger bands (Chart 9)

From the analysis of the Boolinger Bands we notice that the volatility of the Electrica SA share has been declining lately, with fewer fluctuations from 1 day to the next. By the time the quote will not come out of the Boolinger bands, we do not expect a significant trend backward, so that in the near future the trend will continue to be slightly downward.

### 5.4. Volume Indicators

- OBV (Chart 10)

From the analysis of the OBV indicator for the quote of Electrica SA (EL), we can see a relatively constant evolution with a slight downward trend lately, which confirms once again that the quote of the EL share will not register significant developments in the near future.

- A/D (Chart 11)

Similar to the OBV, A/D indicator suggests a period without an obvious trend, which implies a possible period of evolution similar to the last trading days, i.e., slight declines without significant variations.

## 6. CONCLUSIONS

- In the present paper, our objective was to test some theories regarding the evolution of the stock quote, having as object of study the quote of Electrica SA, listed on the Bucharest stock exchange. Having said that, we proposed to follow in this study the random behavior of the stock quote, testing the weak-form market efficiency and technical analysis of the selected share.
- Regarding the random behavior of the quote of Electrica SA, we determined (with probability of 99%, 90% and 75%) the range of values in that can be found the quote: January 09, 2017; 1 month after the analysis period, January 30, 2017; 3 months after the analysis period, March 29, 2017. Comparing the results obtained from our analyzes with the price observed at the Bucharest stock exchange of Electrica SA, we find that, in all cases, the value ranges, with the probable probabilities, integrate these courses. For January 9, 2017, the observed quote is 13.4 Ron; for January 30, 2017, the observed quote is 13.70 Ron; for March 29, 2017, the observed quote is 14.20 Ron.
- The distribution used by us in this paper is the log-normal distribution. This is also confirmed in the natural sciences. For example, at a macrocosmic level, the spectrum (intensity distribution by frequency) of microwave background cosmic radiation takes the form of a log-normal function (Hawking, 2006. p. 38); at the microcosmic (quantum) level, the electron wave function around the nucleus is log-normal (Baggott, 2015. p. 21);
- Regarding the testing the weak-form efficiency of the Romanian capital market, we used the following statistical tests: ADF, PP, JB and calculation of Autocorrelation Coefficients done by Eugene Fama;
- We recall that an efficient market in a weak form is the market where the course of financial securities reflects (fully) all the information contained in their history. Whereas, following tests on the weak form efficiency in the market, we found that the market on which Electrica SA shares are traded, is inefficient in weak form; so, we believe that technical analysis can be justified;
- The capital market in Romania is, in terms of probabilities, fragile, in the sense of Taleb.
  If the distribution has a short tail to the right and a long tail to the left, the result is fragile. "Almost always we can detect anti-fragility or fragility using a simple asymmetry test: Everything that has more advantages than the disadvantages of random events (or certain shocks) is antifragil, the inverse being fragile" (Taleb, 2014. p. 16). This can be observed by interpreting the skewness indicator in our analysis, which indicates asymmetry to the left. By fragile we understand that the shocks in the economy cause more and more damage as their intensity increases (technically, non-linearly concave).
- By applying these technical analysis indicators, we can conclude that we can see a relatively constant evolution with a slight downward trend lately, which implies a possible period of evolution similar to the last trading days, ie slight declines without significant variations.

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