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# TESTING EFFICIENT MARKET HYPOTHESIS IN DEVELOPING EASTERN EUROPEAN COUNTRIES

## Abstract

This paper analyzes financial markets in four developing countries (Croatia, Serbia, Slovenia, Slovakia) using daily returns of their respective stock market indices from January 1, 2006 till December 31, 2016, timeframe which was rarely analyzed. Analysis was conducted by various statistical tests, more precisely serial correlation test, runs test, Augmented Dickey-Fuller test, unit root test, variance ratio test and test of January effect. Results suggest that all analyzed indices, except BelexLine (Serbia), confirm weak form of efficient market hypothesis, while the results on the index BelexLine are mixed and it can be concluded that it does not follow weak form of efficient market hypothesis. Given these results, it can be said that not only passive approach to portfolio management is more appropriate on all indices, except BelexLine, but also additional test and more complex models are necessary in order to confirm this conclusion.

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## INTRODUCTION

One of the most discussed topics between academics and participants in the financial industry is the one of market efficiency, ever since Fama (1965) laid the foundations of the efficient market hypothesis whose basic premise is that future prices cannot be predicted using only the past prices, or in other words, the changes in the indices are random and gains are equally and evenly distributed.

Even though there were many research papers dedicated to the topic of efficient market hypothesis, where the research was conducted in various capital markets and timeframes, scientific community still can't prove with a fair amount of certainty that the efficient market hypothesis is correct.

Most of the literature accepts the empirical research, which states that the younger and less developed markets are less efficient than the bigger and more established markets, while noting that less efficient markets also have larger transactional costs than their more developed counterparts.

This paper analyzes financial markets in the four developing European states based on the daily returns of their biggest respective indices in the timeframe from January 1, 2006 till December 31, 2016, which is a timeframe, which is not well covered in current research. Paper focuses on financial markets in Croatia, Slovenia, Serbia and Slovakia, which are all transitioning countries in their various states of transition. Because of their developing status, it can be expected, based on the previous literature, that at least some of the analyzed markets will show a certain amount of inefficiencies, i.e. that they will reject efficient market hypothesis.

## 1. EMPIRICAL ANALYSIS: EMPIRICAL LITERATURE OVERVIEW

While the research of the efficient market hypothesis is very well covered in various research papers, this paper will focus on the overview of the empirical literature specific to the financial markets analyzed in this paper. Deželan (1999, p. 25) analyzed Slovenian stock market from 1994 till July 1996 using unit root test, variance ratio test, AR test and market model. The results of the research have suggested that the Slovenian stock market was not efficient, i.e. it rejected efficient market hypothesis in its weak form. Barbić (2010, p. 155) analyzed weak form of the efficient market hypothesis in Croatian stock market, with the results showing that unit root test indicated stationarity in the first difference, while autocorrelation tests up until a certain lag indicated that the market was not following a random walk, which in turn means that the efficient market hypothesis could be rejected.

Njuguna (2016, p. 80) tested efficient market hypothesis of the Nairobi Securities Exchange (NSE) in the time period from January 2001 and January 2015 by applying serial correlation test, unit root test and runs test with the conclusion that the Kenyan market should not be considered weak-form efficient.

Prorok and Radović (2014, p. 62) used Augmented Dickey-Fuller test (ADF), Ljung-Box and Box-Pierce tests of autocorrelation on Serbian indices of Belex15 and BelexLine, concluding that the index Belex15 was not efficient, while index BelexLine turned out to be efficient. They also concluded that, since there were no consistencies in the results, efficient market hypothesis can be rejected, meaning that the Serbian stock market was not following a random walk. The authors noted that the Serbian stock market had a low volume, low number of available stocks, weak regulation and asymmetrical availability of information.

Hawaldar, Rohit, and Pinto (2017) tested weak form of market efficiency of the individual stocks listed on the Bahrain stock market in the period from 2011 to 2015 by applying Kolmogorov-Smirnov goodness of fit test, runs test and serial correlation test. Mixed results obtained from the tests suggest no firm conclusions about market efficiency at the Bahrain stock market.

Šonje, Alajbeg, and Bubaš (2011) have compared Croatian and US stock market from 2002 till 2010, while noting that traditionally serial independence tests often suggested that the markets were inefficient. The authors used daily and monthly returns and concluded that there were some indications of inefficiencies, while suggesting that it could be attributed to the financial crisis of 2008. Monthly returns before the financial crisis suggested that both Croatian and US markets were efficient, while daily returns in Croatian market showed inconclusive results. The authors also added that implementing basic moving averages strategy achieved better returns than the indices CROBEX and S&P500, which in turn signified that the markets were occasionally inefficient, while also noting that using the same strategy in the longer timeframe from 1950 till 2010 on the S&P500 index wouldn't accomplish above average returns. Hančlova and Rublikova (2006, p. 37) analyzed stock markets in the Czech Republic and Slovakia from 2000 till 2004 using various tests, including autocorrelation test and runs tests. They concluded that the Slovakian index SAX30 was not efficient in the timeframe from 2000 till 2002.

## 2. METHODOLOGY AND DATA

This paper focuses on the market efficiency in selected countries, specifically testing weak form of efficient market hypothesis on the daily returns of their biggest stock market indices. Since the current literature suggests possible inefficiencies in these markets, research is interested in the possibility of obtaining above average returns.

Research was conducted over daily returns of respective stock markets indices from January 1, 2006 till December 31, 2016. Data were obtained from various reputable sources including stock market websites www.bsse.sk and www.zse.hr using daily data of their respective indices. Data from services www.investing.com and www.quandl.com were used in testing SBITOP index and SAX index. Analysis was conducted using Python programming language with usage of various statistical libraries.

In order to analyze the data, various statistical tests were employed, namely:

- serial (auto) correlation test;
- unit root test;
- runs test;
- variance ratio test;
- January effect.

One of the most direct and intuitive tests of random walk of time series is a test of serial (auto) correlation, that is, the correlation between two observations within the same series over different dates (Campbell & Lo, 1997). If the time series follow a random walk, previous values shouldn't show a significant correlation with future values, which in turn means previous values can't predict future values. Campbell and Lo (1997) concluded that weak form of the efficient market hypothesis assumes that at first difference, there is no correlation at the level of random walk at all lags, which means that it is possible to test null hypothesis in a way that the autocorrelation coefficient values at first difference of different lags are equal to zero.

Unit root test was conducted using Augmented Dickey-Fuller test (ADF). This test is a part of the methodology implemented by Dickey and Fuller (1979, p. 430) as a way of testing stationarity in time series. According to Campbell and Lo (1997), unit root test is constructed in a way that the null hypothesis expects time series to be stationary at first difference, while the alternative hypothesis expects that the time series is stationary in trend. Time series with unit root is non-stationary, which suggests it doesn't follow random walk completely. Since unit root test is a proxy of random walk test, it is also used as a weak form efficient market hypothesis. According to Barbić (2010), rejecting the null hypothesis is a necessary, but not definitive condition of random walk. Because of this, other tests are usually used in combination with unit root, most often autocorrelation test. ADF can be represented with the following equation (Dickey & Fuller, 1979, p. 427):

$$\Delta P_t = \mu + \alpha_1 t + \gamma P_{t-1} + \sum_{i=1}^{q} p_i \Delta P_{t-1} + \varepsilon_t, \quad (1)$$

where $\Delta$ represents the first difference, $P_t$ represents log of index value, $\mu$ is a constant, while $\gamma$ and $p$ are coefficients, which are guessed, $q$ marks the number of lags, $t$ represents trend, while $\alpha_1$ represents trend coefficient and the error term is represented by $\varepsilon_t$ (Chung, 2006, p. 74).

Literature and visual inspection of the indices suggests presence of trend, thus, analysis will be done on the logarithms of the returns using the following equation:

$$r_t = 100\% \cdot \log \frac{p_t}{p_{t-1}}, \quad (2)$$

where $r_t$ represents return at time $t$, $p_t$ represents index value at time $t$ (Brooks, 2008, p. 7).

So-called runs test is a non-parameter test developed by Wolfowitz and Wald (1961). The hypothesis of the test is that the values in test are evenly and identically distributed, meaning that the values in the series are converted into binary values of 1 and 0. The values are assigned in the following way:

$$I_t = \begin{cases} 1, \text{ if } r_t > 0 \\ 0, \text{ if } r_t \leq 0 \end{cases}, \quad (3)$$

where $r_t$ is the daily return, while a run is defined as a sequence of repeating values either ones or zeros (e.g. 11 or 00). Total number of sequences is defined as $N = N + + N\_$, where $N+$ is a count of positive sequences, while $N\_$ is a count of negative sequences. Runs test determines if the oscillation between zeros and ones is too fast or too slow. By definition, if the *p* value is less than 0.01, it can be concluded that a run (time series) is not completely random, while *p* value larger than 0.01 suggests that the run is random (Rukhin et al., 2010). Variance ratio test is used as a random walk test in a way that it expects the returns to be independently and evenly distributed with a constant mean and finite variance, which is a linear function of time (Charles & Darné, 2009, p. 504). This paper uses Wald-Wolfowitz version of the test, while it is equally useful to use Kolmogorov-Smirnov version, these two versions can return different results depending on the input parameters (Magel & Wibowo, 1997, p. 775). Variance ratio test was run on lags 2, 4, 8, 12 and 16 in line with recent literature. Null hypothesis in this type of test defines a time series as random; it is rejected if the test statistic is positive, which suggests a presence of a positive serial correlation in the time series. In order to test the January effect, that is, the possibility to achieve above market returns in January vs. other months, we construct the following regression equation (Heininen & Puttonen, 2010):

$$R_t = \alpha_1 D_{1t} + \alpha_2 D_{2t} + \ldots + \alpha_{12} D_{12t} + e_t, \qquad (4)$$

where $R_t$ is monthly return, while variables $D_{1t}$ do $D_{12t}$ represent dummy variables with January being $D_{1t} = 1$ which gives:

$$R_t = c + \alpha_2 D_{1t} + \alpha_3 D_{2t} + \ldots + \alpha_{12} D_{12t} + e_t. \qquad (5)$$

Null hypothesis of the previous equation is that coefficients of all dummy variables are equal to zero, meaning no month is significantly different than the others. If this hypothesis is rejected, then, time series show monthly seasonality (Marrett & Worthington, 2011, p. 118). January effect can be tested via Bartlett's test, the purpose of which is to test if two samples have equal variances, i.e. if the variances are homogenous. Bartlett's test (Bartlett, 1937, p. 281) is defined as follows:

$$H_0:\ \sigma_1^2 = \sigma_2^2 = \ldots = \sigma_k^2,$$

$$H_a = \sigma_1^2 \neq \sigma_2^2.$$

Null hypothesis in Bartlett's test, which was a used as a proxy for testing the January effect assumes that variances of the test groups are equal, while test itself returns a test statistic and a critical value. Null hypothesis is rejected at the level of significance of 0.05 if the test statistic is larger than the critical value.

# 3. RESULTS AND DISCUSSION

## 3.1. Serial correlation test results

Serial (auto) correlation test was applied to daily returns with 30 lags with results shown in Figures 1 to 4 for each individual index. All daily returns are shown as a continuous log of returns, which decreases trend influence in results. By definition, lag 0 has an autocorrelation coefficient equal to 1, which is visible in the previously mentioned figures, thus, it should be disregarded from the analysis. As in other tests, analysis was done on 2725 observations. Barbić (2010, p. 169) observed that "according to the literature, most of the indices in developed countries show a correlation coefficient in the first lag less than 0.2 while statistically significant autocorrelation coefficient larger than 0.2 is found in the first lag in developing countries (Chile, Columbia, Mexico, Pakistan, Philippines, Portugal, Turkey and Venezuela)".

Given different stages of transition in the analyzed countries and their respective financial markets, it is expected to notice autocorrelation coefficients larger than 0.2. Figure 5 shows that the Croatian index CROBEX has a biggest coefficient on the first lag in the amount of 0.111156, which can be confirmed in Table 1.

Test results on the Serbian index BelexLine show significant autocorrelation coefficients at lag 1 with the value of 0.342121 and on lag 2 with the value of 0.173774, as shown in Figure 5 and Table 1. These coefficients suggest that it is possible that the market is inefficient in the short term, which suggests a possibility of above average returns.

Slovenian index SBITOP shows an autocorrelation coefficient with the amount of 1.52050 at lag 1, while other coefficients are relatively low and do not show significant inefficiencies. Slovakian index SAX shows a negative autocorrelation coefficient at lag 1 with the amount of –0.108943. Simple visual inspection of the results indicates that the coefficients at all lags are very low, which suggests more efficient market compared to the other three indices.

All of the results of the autocorrelation test are in line with recent literature like Dragotă and Țilică

Source: Author's calculation (2018).

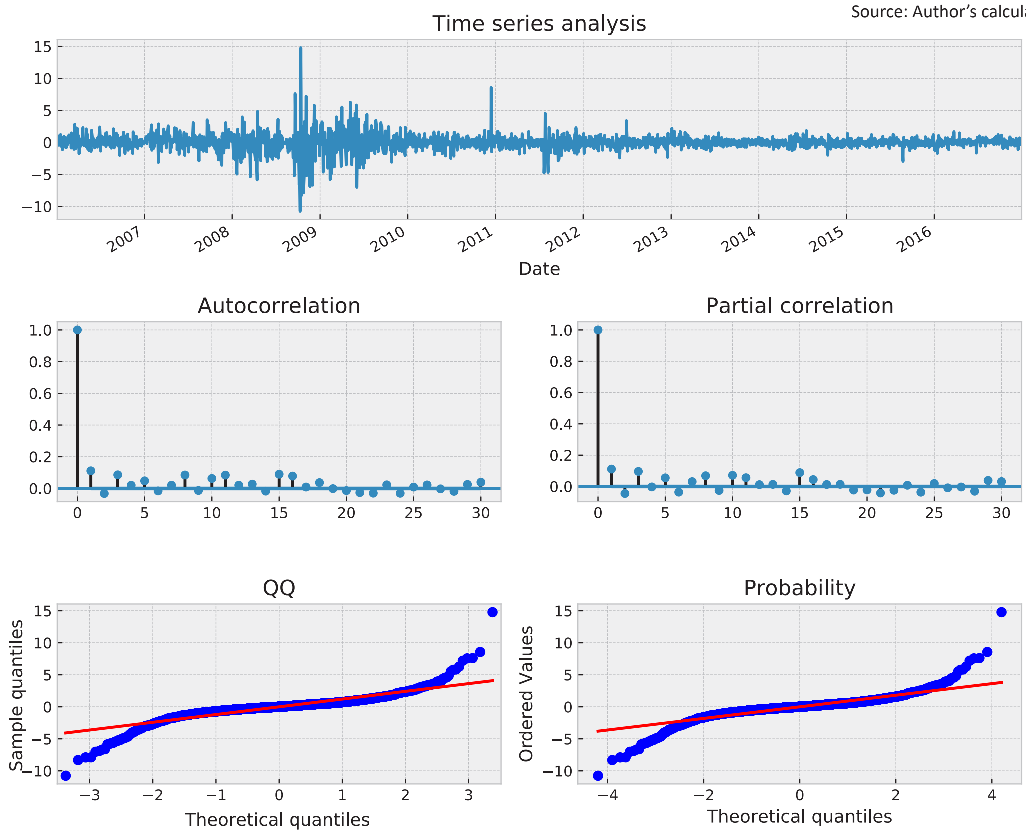


**Figure 1.** CROBEX autocorrelation test results

Source: Author's calculation (2018).

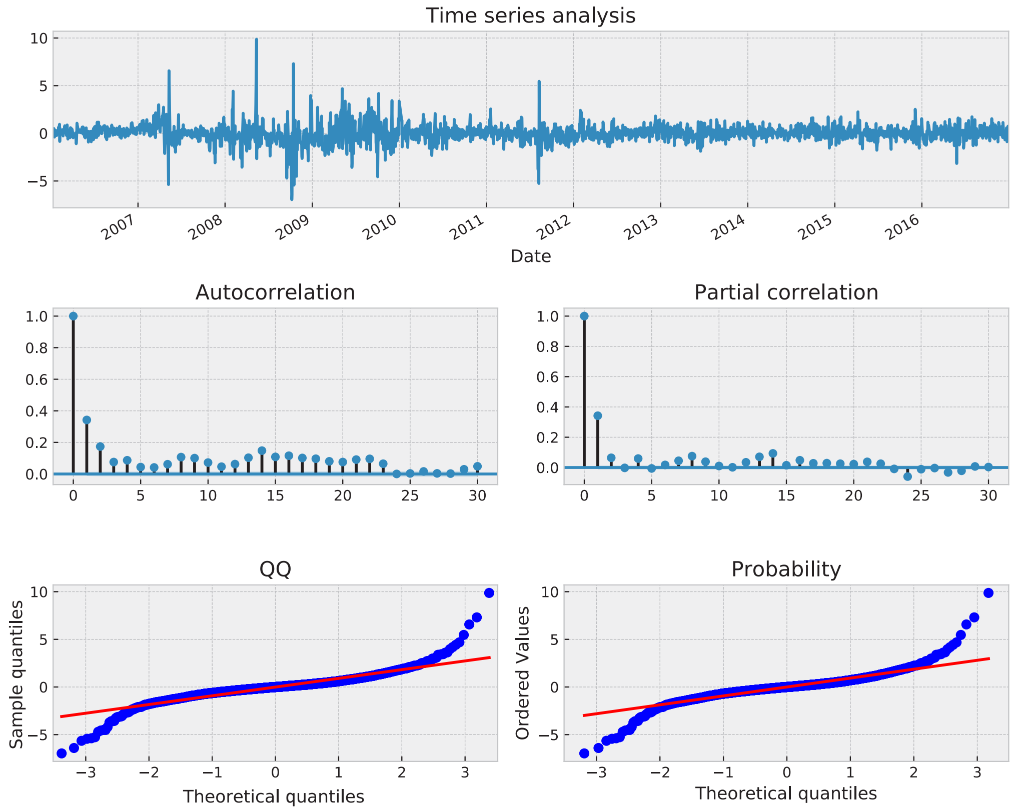


**Figure 2.** BelexLine autocorrelation test results

Source: Author's calculation (2018).

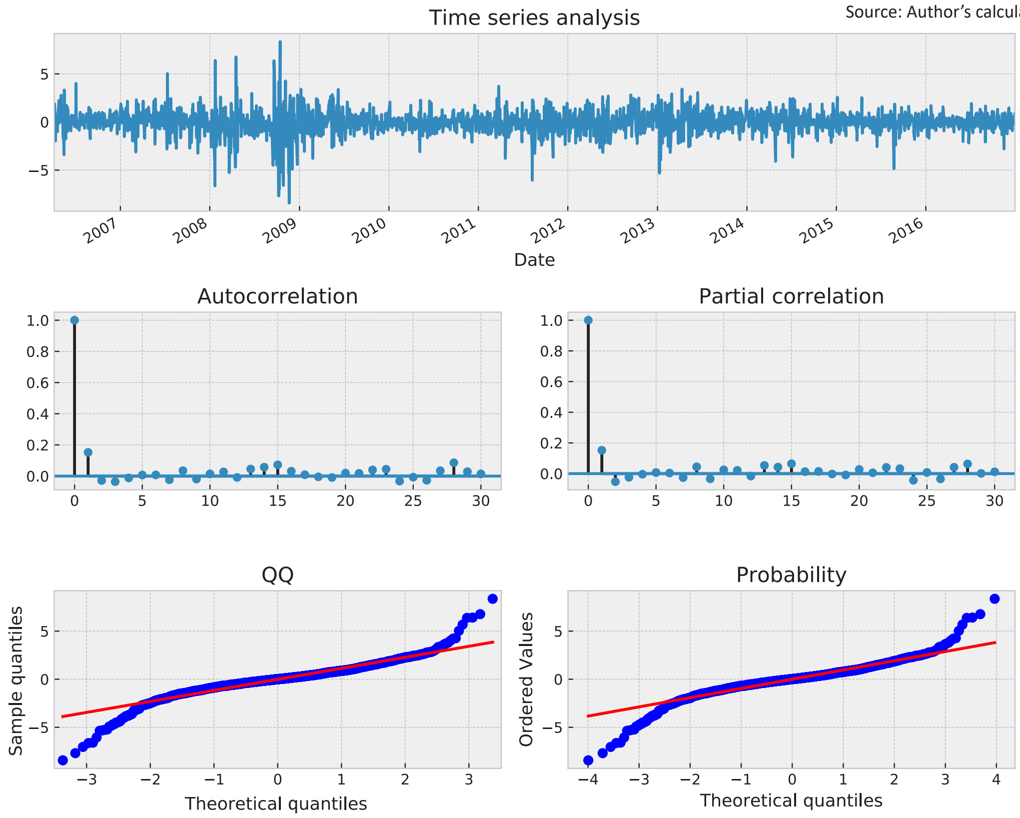


**Figure 3.** SBITOP autocorrelation test results

Source: Author's calculation (2018).

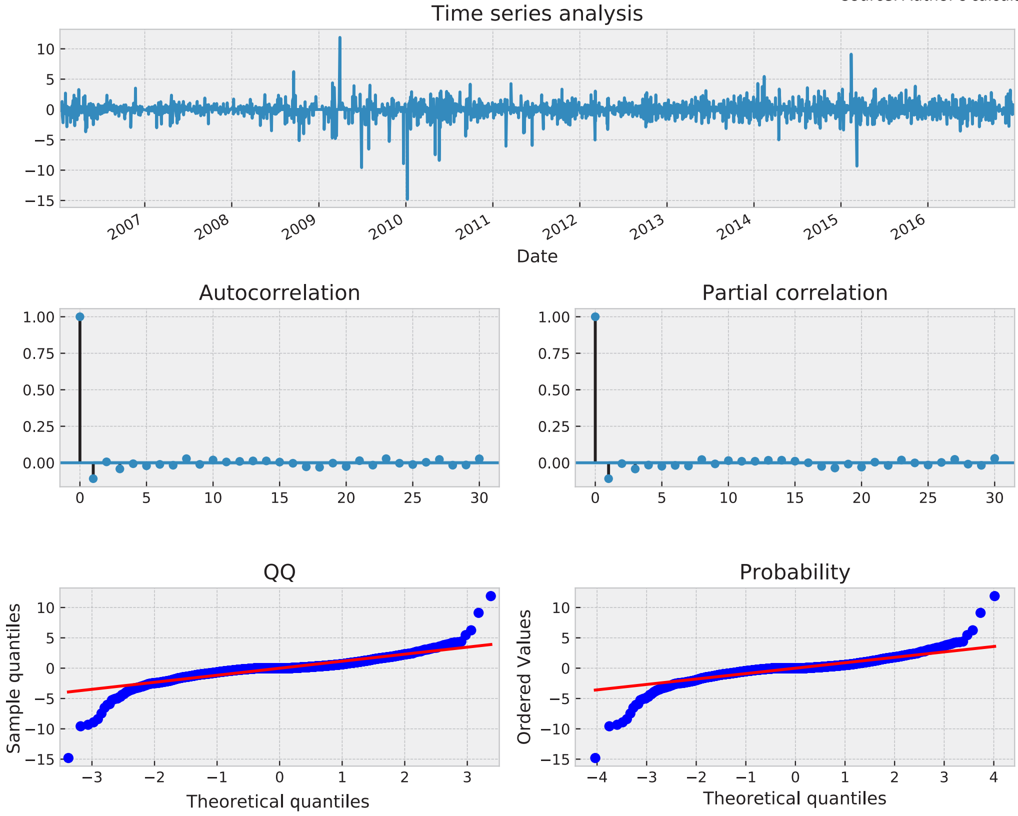


**Figure 4.** SAX autocorrelation test results

**Table 1.** Correlation coefficients in serial correlation test

Source: Author's calculation (2018).

| No | Tau CROBEX | Q CROBEX | Tau BELEX | Q BELEX | Tau SBITOP | Q SBITOP | Tau SAX | Q SAX |
|---|---|---|---|---|---|---|---|---|
| 1 | 0.111156 | 33.915992 | 0.342121 | 324.688707 | 0.152050 | 62.144117 | –0.108943 | 32.365478 |
| 2 | –0.032268 | 36.775190 | 0.173774 | 408.486923 | –0.028343 | 64.304231 | 0.006195 | 32.470175 |
| 3 | 0.085816 | 57.005150 | 0.075543 | 424.328701 | –0.036033 | 67.796958 | –0.042021 | 37.288932 |
| 4 | 0.019954 | 58.099298 | 0.086756 | 445.230146 | –0.011883 | 68.176930 | –0.006476 | 37.403422 |
| 5 | 0.047794 | 64.378782 | 0.043754 | 450.548371 | 0.007002 | 68.308907 | –0.020798 | 38.584766 |
| 6 | –0.015797 | 65.065031 | 0.041356 | 455.301397 | 0.007481 | 68.459619 | –0.011188 | 38.926736 |
| 7 | 0.020264 | 66.194733 | 0.061654 | 465.868834 | –0.023751 | 69.979321 | –0.017101 | 39.725989 |
| 8 | 0.084701 | 85.938505 | 0.106876 | 497.635064 | 0.034743 | 73.232338 | 0.028005 | 41.870263 |
| 9 | –0.013169 | 86.415955 | 0.100514 | 525.742361 | –0.019264 | 74.232874 | –0.011108 | 42.207756 |
| 10 | 0.062852 | 97.295374 | 0.072298 | 540.289519 | 0.014092 | 74.768437 | 0.018899 | 43.184999 |
| 11 | 0.083991 | 116.730687 | 0.046191 | 546.229714 | 0.026813 | 76.708176 | 0.005556 | 43.269486 |
| 12 | 0.020354 | 117.872523 | 0.062587 | 557.139079 | –0.008809 | 76.917601 | 0.009417 | 43.512297 |
| 13 | 0.027147 | 119.904408 | 0.102980 | 586.684999 | 0.045179 | 82.428717 | 0.012712 | 43.954907 |
| 14 | –0.017059 | 120.707065 | 0.147865 | 647.621893 | 0.057206 | 91.268188 | 0.012713 | 44.397731 |
| 15 | 0.089689 | 142.901470 | 0.108221 | 680.275373 | 0.072395 | 105.429987 | 0.004809 | 44.461132 |
| 16 | 0.077956 | 159.675076 | 0.115685 | 717.602166 | 0.031309 | 108.079695 | –0.003427 | 44.493337 |
| 17 | 0.008777 | 159.887788 | 0.101489 | 746.340378 | 0.008857 | 108.291803 | –0.027667 | 46.593030 |
| 18 | 0.036645 | 163.596973 | 0.096609 | 772.390921 | –0.004752 | 108.352885 | –0.030726 | 49.183731 |
| 19 | –0.001415 | 163.602503 | 0.080117 | 790.313131 | –0.009246 | 108.584224 | –0.002504 | 49.200936 |
| 20 | –0.013898 | 164.136426 | 0.075608 | 806.280536 | 0.019030 | 109.564628 | –0.025533 | 50.991186 |
| 21 | –0.026464 | 166.073021 | 0.091116 | 829.478163 | 0.017693 | 110.412385 | 0.014365 | 51.558068 |
| 22 | –0.029977 | 168.558784 | 0.095898 | 855.183759 | 0.039472 | 114.633444 | –0.016362 | 52.293805 |
| 23 | 0.022609 | 169.973354 | 0.065002 | 866.998599 | 0.043834 | 119.840924 | 0.027980 | 54.446045 |
| 24 | –0.030644 | 172.572945 | 0.000266 | 866.998797 | –0.032451 | 122.696030 | –0.003120 | 54.472816 |
| 25 | 0.008707 | 172.782892 | 0.003375 | 867.030676 | –0.007003 | 122.829055 | –0.012091 | 54.875010 |
| 26 | 0.022050 | 174.129846 | 0.016052 | 867.751947 | –0.027066 | 124.816716 | 0.003446 | 54.907689 |
| 27 | –0.002820 | 174.151885 | 0.003811 | 867.792620 | 0.034331 | 128.015878 | 0.022681 | 56.324073 |
| 28 | –0.018395 | 175.089944 | 0.002497 | 867.810084 | 0.085767 | 147.989767 | –0.016667 | 57.089173 |
| 29 | 0.025208 | 176.852201 | 0.029707 | 870.283133 | 0.028072 | 150.130271 | –0.015315 | 57.735430 |
| 30 | 0.039270 | 181.130709 | 0.048376 | 876.843686 | 0.014157 | 150.674879 | 0.027260 | 59.783651 |

(2014), where the general conclusion is that indices CROBEX, SAX and SBITOP are efficient, while index BelexLine might be inefficient. Results obtained on the index BelexLine are in partial agreement with results in Prorok and Radović (2014, p. 60) who rejected null hypothesis of the efficient market hypothesis and concluded that, while index BelexLine is efficient, its smaller index BELEX15 was not efficient. While our data do not's agree with the assessment of the index BelexLine, we agree on the conclusion that, in general, it can be concluded that the stock market in Serbia was not efficient.

## 3.2. Unit root test

Table 1 displays the results of the Augmented Dickey-Fuller test (ADF), which was run like the other tests on 2725 observations. Results show that on each index, there is a unit root at level, while first differences are stationary at all indices at the 1% level of significance, which is in line with recent literature. Since the timeframe in the analysis wraps recent financial crisis of 2008, the presence of the trend is noticeable from the visual analysis, which further implies that all indices will be non-stationary at level.

Since all analyzed indices show stationarity at first difference, it can be concluded that they follow random walk, while taking into account that random walk solely doesn't imply that all of the changes in the index are completely random, thus, ADF test results should not be considered as an absolute truth regarding the efficiency in its weak form. As the literature suggests, further statistical analysis is necessary in order to obtain more degrees of certainty.

**Table 2.** ADF test results

Source: Author's calculation (2018).

| Index | Level [t-value, p-value] | Trend [t-value, p-value] | First difference [t-value, p-value] |
|---|---|---|---|
| CROBEX | [–1.2098, 0.6693] | [–0.4845, 0.5025] | [–10.0846, 0.0000] |
| BelexLine | [–1.6656, 0.4489] | [–0.9573, 0.3053] | [–6.8972, 0.0000] |
| SBITOP | [–1.2270, 0.6619] | [–0.8639, 0.3438] | [–7.2194, 0.0000] |
| SAX | [–1.3598, 0.6014] | [–0.9684, 0.3009] | [–32.1639, 0.0000] |

## 3.3. Runs test

**Table 3.** Runs test results

Source: Author's calculation (2018).

| Index | Observed runs | Expected runs | p value |
|---|---|---|---|
| CROBEX | 1296.00 | 1372.00 | 0.0041 |
| BelexLine | 1210.00 | 1386.50 | 0.0000 |
| SBITOP | 1188.00 | 1343.50 | 0.0000 |
| SAX | – | – | 0.0000 |

Table 3 shows the test results on the four indices, where it can be noted that index CROBEX has a critical value larger than 0.01 suggesting that its run is random, while indices BelexLine and SBITOP show critical values less than 0.01 suggesting that their runs are not completely random. Slovakian index SAX is showing a special type of inefficiency in the way that it doesn't comply with the first step of the runs test, i.e. it is failing Monobit test, which is a prerequisite for applying runs test. Monobit test checks the proportionality of zeros and ones in a run, where the expected distribution is proportional. If the distribution was not proportional, it can be concluded that the run is not random. Considering that the index SAX fails Monobit test, we can conclude that considering this type of statistical analysis it is not completely efficient. These results are in line with similar testing done in "Market efficiency of the Post-Communist East European stock markets" by Dragotă and Ţilică (2014).

## 3.4. Variance ratio test

Table 4 shows results of the test on all four indices, where it can be observed that all indices on all lags return a negative test statistic, meaning that all-time series display characteristics of a random walk. The results are a bit different than the ones in the recent literature (Dragotă & Ţilică, 2014, p. 20), where indices BelexLine and SBITOP displayed positive test statistics, i.e. non-random behavior. The difference can be explained by the different time frames used mainly by using newer data, so it can be speculated that indices are maturing, thus, displaying more level of efficiency as expected.

## 3.5. January effect

**Table 5.** January effect test results

Source: Author's calculation (2018).

| Index | Test statistic | p-value |
|---|---|---|
| CROBEX | 0.49130102 | 0.48334752 |
| BelexLine | 1.06451487 | 0.30218770 |
| SBITOP | 0.12055499 | 0.72843334 |
| SAX | 0.16730867 | 0.68251484 |

Table 5 shows results of the Bartlett's test, where it can be observed that indices SBITOP and SAX do not show signs of the January effect, while index CROBEX show only slightly bigger test statistic providing an inconclusive result. Index BelexLine

**Table 4.** Variance ratio test results

Source: Author's calculation (2018).

| Index | Crobex | BelexLine | SBITOP | SAX |
|---|---|---|---|---|
| 2 | –15.273281 | –13.424887 | –16.985410 | –21.862624 |
| 4 | –13.121734 | –14.117262 | –16.739049 | –19.472650 |
| 8 | –10.530818 | –13.168826 | –14.177264 | –17.665490 |
| 12 | –9.230789 | –12.101342 | –12.588565 | –16.066551 |
| 16 | –8.495282 | –11.456342 | –11.597560 | –14.774003 |

**Table 6.** All test result matrix

| Index | Autocorrelation test | Unit root test | Runs test | Variance ratio test | January effect |
|---|---|---|---|---|---|
| CROBEX | + | + | + | + | + |
| BelexLine | – | + | – | + | – |
| SBITOP | + | + | – | + | + |
| SAX | + | + | + | + | + |

has a significantly larger test statistic than its critical value and it can be concluded that there is also a significant difference in returns in January vs. all other months, thus, the market is not completely efficient.

### 3.6. Complete results matrix

Table 6 shows a matrix of all test results across all four analyzed indices. Plus sign marks efficient market, while minus sign shows inefficient market, i.e. accepted or rejected efficient market hypothesis in its weak form. Results are mostly in line with the current literature, although some of the tests show different results. These can be explained by much larger and newer data in the time series.

## 4. DISCUSSION

Market efficiency was analyzed through various statistical tests, which test weak form of the efficient market hypothesis. Obtained results suggest that analyzed markets do not reject weak form of efficient market hypothesis with an exception of the index BelexLine. We have observed some of the differences in the analyzed markets, where index BelexLine rejects null hypothesis of the efficient market hypothesis during autocorrelation test, runs test and January effect test. Slovakian index SBITOP also rejects the null hypothesis during runs test, while it does not reject the hypothesis in all other tests. CROBEX and SBITOP do not reject the hypothesis in either test. Obtaining above market returns is possible if the two conditions are met, markets is not efficient and transactional costs including the amount of slippage are low enough to allow to exploit market inefficiencies.

Literature suggests that financial markets in developing countries have larger transactional costs compared to their more developed counterparts. Less developed markets also show low market capitalization, low volume and low number of available share, bad regulations, isolation from other markets (Prorok & Radović, 2014, p. 62). More developed markets, on the other hand, display high liquidity, large market capitalization, which, in turn, makes them much more efficient, as witnessed by the recent literature. Although this paper analyzed efficiency of the markets and detected inefficient properties in one of them, further research that should include transactional costs is necessary in order to determine with a more degree of certainty if it is possible to exploit these inefficiencies.

Applying active or passive approach to portfolio management depends on the efficiency of the market, if the market is efficient, passive approach is more appropriate, while active portfolio management is more appropriate in the less efficient markets. All of the analyzed markets could be considered efficient with regard to the analysis in this paper, with the exception of the index BelexLine.

While it can be concluded that the passive approach is the correct option in all of the markets, except BelexLine, it should be considered that there are special cases as the recent literature suggests. For example, the case of Croatian index CROBEX is considered highly intriguing by the recent literature, where it is concluded that: "The case of Croatia is also interesting. We have not found a suitable test for highlighting a strategy for obtaining systematic abnormal earnings based on indices, but EMH was rejected for 92.31% of the stocks. This (apparent) contradictory result can be attributed to the trade-off between opposite evolutions of some assets from the market index. Thus, the index shows the average evolution of the market and does not capture the complex situation presented by analyzing a number of stocks individually. The results suggest the possibility of reaching systematic abnormal earnings through decisions that can be made based on past information available on the market. Each of the evidences of market inefficiency can be a suggestion for a managerial strategy. Thus, an active portfolio management seems to be suitable" (Dragotă & Ţilică, 2014, p. 330). Previous paradox is a clear example of any weak form efficient form hypothesis analysis should not be accepted as an absolute conclusion about the market efficiency, especially if the timeframe under consideration is relatively short.

## CONCLUSION

Exploiting market inefficiencies has been a goal of every professional investor ever since the financial markets have been created. Various researches during the last couple of decades tried to confirm or reject efficiency of the markets using different statistical analysis tests. Modern research papers suggest that the more developed markets, which usually have a larger market capitalization, are very efficient, thus, it is not possible to achieve above market return rates. Similarly, it is believed that newer markets with lower market capitalization are often inefficient and at least partially reject efficient market hypothesis in its weak form, which suggests that it is possible to achieve above market returns if the transaction costs and slippage allow to exploit these inefficiencies. Research papers often ignore transactional costs, which results doesn't allow for fully accepting the premise that it is possible to create a market strategy, which would achieve returns above the market rate.

Most of the research papers focus solely on the weak form of the efficient market hypothesis, mainly, because the data necessary for testing semi-strong and strong forms of the hypothesis are often unavailable. This paper also focused on the weak form of the efficient market hypothesis using daily index returns in four developing European countries, specifically Croatia, Slovenia, Serbia and Slovakia. The hypothesis was tested using various statistical tests used in other research, namely serial correlation test, unit root test, runs test, variance ratio test and January effect. All of the tests were applied to daily index returns in the timeframe from January 1, 2006 till December 31, 2016.

Although countries analyzed in this paper are in their various stages of transition, the test results show no major differences with the exception of the Serbian index BelexLine, where mixed results were obtained, which, in turn, suggests that in some tests, efficient market hypothesis could be rejected in its weak form. In addition to the daily returns, the current literature suggests running the same tests against weekly and monthly returns and also using different timeframes within the currently tested timeframe.

Furthermore, it is suggested that various individual stocks should be analyzed because of the possible discrepancies between the index as a whole and individual companies. Although some of the obtained results are in contrast with the currently available research papers, it should be noted that the timeframe used in this paper is much longer and newer and also it should be noted that there isn't much research done on the analyzed markets.

Taking into account only the results obtained in this paper, it can be concluded that the passive approach to portfolio management is more appropriate in these markets with an expectation in the index BelexLine, which is in line with the current literature. Also, considering the results of the previous research, individual stocks in Croatian index CROBEX should be analyzed, since the research suggests possible discrepancies, i.e. it suggests that some of the stocks are not efficient even though the index generally is.

Given the use of the newer timeframe in this paper, it can be concluded that the research presented here adds value to the total research of this topic. It can also be concluded that it is not possible to obtain above market returns solely based on the previous prices with a noted exception of the index BelexLine. It should be noted that further research is necessary in order to obtain a conclusion with more degree of certainty.

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