Economics & Economy, Vol. 1, No. 3 (June, 2014), 33-45

MONTENEGRIN CAPITAL MARKET CHARACTERISTICS BASED ON FINANCIAL TIME SERIES ANALYSIS

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JEL Classification G11, G12:
Original Scientific Papaers
Primljeno / Received: *March* 07, 2014
Prihvaćeno / Accepted: May 21, 2014

Abstract
Capital market took the central role in the Economic Reform Agenda for Montenegro. Mass voucher privatization (MVP) has been the initial promoter of the capital market development in Montenegro and it has had a basic impact on the nature of the transition process. Having in mind that Montenegro is a small and developing country, it is no doubt that the establishment of the capital market institutions has been a pillar for the capital market development. The number of transactions on the Montenegrin capital market has been growing rapidly since the period of stock exchange foundation. This phenomenon has had a considerable impact on the transition of Montenegrin citizens' mental blueprint.
Montenegro stock exchange is an important capital market agent. Therefore, data series of its index MONEX20 provide valuable research reference. The main objective of this paper is to undertake econometric analysis of the MONEX20 time series aiming to derive the main characteristics of the Montenegrin capital market. Providing an appropriate Unit root test it will be tried in this paper to find out whether the capital market in Montenegro is an efficient one. It will be tested whether share prices follow a random walk in which case they are nonstationary and hence unpredictable. It is the case when a capital market is indicated as an efficient one. Volatility is another very important characteristic of a capital market. High volatility is a sign of market instability. Participants on capital market are trying to reduce the risk of their investments. Therefore, they try to avoid volatile markets. In order to anticipate a value of volatility of Montenegrin capital market, concept of historical volatility was presented and used to forecast volatility.
The paper is divided in four segments. In the introduction some basic information regarding the analyzed time series are presented. The second part of the paper is dedicated to the methodology of time series analysis. The third part contains the results of the empirical analysis of time series of MONEX20 stock exchange index. The final part of the paper presents conclusions of the analysis.
Key words: capital market, stock exchange index, risk, stationarity, historical volatility.

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1. INTRODUCTION

The actual development of capital market in Montenegro started in 2001. It was the time when the mass voucher privatization of the state-owned companies was still in the process of being completed. The main precondition for capital market development in Montenegro was the foundation of a stock exchange.

Montenegro Stock Exchange was established in June 1993, on the bases of the Law on Money and Capital Market. In July 1995 Montenegro Stock Exchange harmonized its business activities in compliance with the Law on stock exchange, stock exchange activities and agents. Montenegro Stock Exchange obtained founding license from the Federal Ministry of Finance, license for trading with short term securities from Yugoslav Central Bank and license for trading with long term securities from Federal Securities Commission.

Since September 2006 the Montenegro Stock Exchange has been entirely privately owned company due to the fact that the Government of Montenegro sold its 5% stake in Montenegro Stock Exchange by the auction sale on the stock market. For this package, the price was € 1,100.00 per share, or five times more than the nominal value, representing a market capitalization of the Stock Exchange of € 1.4 million.

Even though the first stock exchange in Montenegro was founded in 1993, the first trade with long term securities was realized only after the Parliament passed the Law on Securities in 2002. The Law on Securities regulates the terms and conditions for issuance, public offering and trading of securities, the rights and obligations of participants in the securities market, and the organization, scope and powers of the Securities Commission.

The New Montenegrin Stock Exchange (NEX Montenegro) Podgorica was founded in September, 2001. In November 2001 it was given the authorization for work by the Montenegrin Securities Commission.

Until the end of 2010 Montenegro has had two stock exchanges: Montenegro Stock Exchange and NEX Montenegro Stock Exchange. In January 2010, stockholders in NEX approved a merger with the Montenegro Stock Exchange. The merger consolidated and simplified securities trading in Montenegro.

After the merger NEX Montenegro was established whose principal stock exchange indexes are MONEX20 and MONEXPIF. The starting value of MONEX20 index on January 1st 2011 was 14,522.53 stock market points, and the starting value of MONEXPIF index was 6,595.82 stock market points.

The Securities Commission (SCM) is the market regulator in Montenegro. The SCM was founded in 2000 and it took over the jurisdiction from the Yugoslav Federal Commission for Securities and Financial Markets. The SCM has the authority to enact implementing provisions to the Law on Securities, to approve and supervise public offers of securities, to license and supervise securities markets participants, to authorize and regulate collective investment schemes, to regulate the manner and scope of the trading in the securities market and to regulate takeovers.

According to the Securities Law, trading of securities can be performed only at the official stock exchanges; therefore no OTC market exists in Montenegro. The bond market in Montenegro is limited to issuing T-bonds and T-bills by Central Bank of Montenegro and therefore it is undeveloped. Hence, it can be concluded that the capital market in Montenegro is actually the stock market.

2. THE METHODOLOGY

The standard procedure of the time series analysis will be applied to Montenegro stock exchange index. Empirical work based on time series assumes that the underlying time series is stationary. That is why the first step in financial time series analyses is to run the test of stationarity. The stationarity is an essential property in defining a time series process. Stationary time series is the one whose parameters, such as mean, variance, autocorrelation, etc. are all constant over time. Most business and economic time series are far from stationary when expressed in their original units of measurement, and even after deflation or seasonal adjustment they typically still exhibit trends, cycles, random-walk, and other non-stationary behavior. Nonstationarity can have important consequences for regression models and inference. Autoregressive coefficients of non-stationary time series are biased; t-statistics have non-normal distributions even in large samples and regression models of those series are usually spurious regression. Stationarity can be tested by using several tests such as Dickey-Fuller test, augmented Dickey-Fuller test, Phillips-Perron test, Kwiatkowski–Phillips–Schmidt–Shin test and Run-test. In this paper the ADF test and Run-test were used to check the stationary of the stock exchange index MONEX20. If the test indicates that the MONEX20 time series is a stationary one that means that the Montenegrin capital market follows predictable path. This would be a negative sign for one capital market because if the market returns can be predicted than the market is not efficient and transparent.

Volatility is another main characteristic of most financial time series. It means that the expected value of error terms at some times is greater than at others. Moreover, these risky times are not scattered randomly across quarterly or annual data. Instead, there is a certain degree of autocorrelation in the riskiness of financial returns. Market volatility estimation is important for most investors as well as traders. Investors use volatility measure to calculate the risk of their investments. On the other side, traders use information on volatility estimation to anticipate how volatile will be specific stock or market index in a future. There is a strong relationship between volatility and market performance. Volatility tends to decline as the stock market rises and it tands to increase as the stock market falls. When volatility increases, risk increases and returns decrease.

3. EMPIRICAL ANALYSIS

The most important reference for the research was the index data series, MONEX20 attained from the Montenegro stock exchange. The data are given on a

daily level for the period from January 5th 2004 until May 26th 2014. The sample consists of 2702 observations. Empirical analysis focuses on capital market efficiency tests and historical volatility estimation.

3.1. Testing the Montenegrin capital market efficiency

The capital market of Montenegro is a small market. Therefore it has a high response to changes in the business environment, but because of its size revival will neither be quick nor simple. At the beginning of every crisis, investors take out their money from the capital market and the first to feel the pressure are small, emerging markets.

If a capital market is efficient it can attract foreign investments. Since everyone has the same information about a stock, the price of a stock should reflect the knowledge and expectations of all investors. Consequently, an investor should not be able to receive an abnormal return since there is no way that he could know something about a stock that isn't already reflected in the stock's price. This research will present the results of a non-parametric test in an econometric investigation of the capital market efficiency in Montenegro.

The phenomenon such as white noise and random walk are always connected with the idea of market efficiency. Investors react instantaneously to any informational advantages they have and no profit can be made from information based trading.

Random walk theory claims that stock market can be analyzed as random walk according to next three facts:

1) efficient market responds very fast to new information;
2) if share price is a reflection of all available information, it is impossible to use those information for market prediction;
3) it is impossible to predict market movement other than randomly.

There are quite a number of direct and indirect tests as evidence for or against the EMH. Simon Keane (1983) provides some basic explanations of what makes markets inefficient. His very popular idea is called "Gambler's Fallacy". It can be explained as the belief that "what goes up must come down". This phenomenon exhibits itself amongst investors whose stocks' price has risen for a period of time and so is deemed to be "due for a fall". Generally speaking, by knowing the relationship of the current price to recent price movements, one can better estimate the likely direction of future price movements, i.e. historical data on a price movement can be used to predict future prices. This provides credibility to the argument that the market is predictable and inefficient. Therefore, the task is to see whether the stock market is predictable or not by detecting serial dependence of stock returns.

The Montenegrin capital market is considered as an emerging capital market. Therefore, only weak form of market efficiency[3] will be tested. We test whether

[3] American economist, Eugene Fama, has proposed three types of efficiency: weak form, semi-strong form and strong efficiency. Weak form efficiency claims that all past prices of a stock are reflected in

share prices follow a random walk. If analyzed time series follow random walk they are nonstationary so it could be concluded that they are unpredictable. In that case capital market is indicated as an efficient one.

Three very popular tests of market efficiency are applied in this paper – Augmented Dickey-Fuller (ADF) test, Run test and Autocorrelation Function (ACF) test. Augmented Dickey–Fuller (ADF) test is the most popular stationary test.. ADF test is used to test the unit root hypothesis. If a time series has unit root than it is nonstationary and it follows random walk. The test is based on two possible equations:

$$Y_t = \rho Y_{t-1} + u_t \tag{1}$$

After subtraction of Yt-1 from the left and the right side of equation, the equation can be written in the next form:

$$Y_t - Y_{t-1} = \rho Y_{t-1} - Y_{t-1} + u_t \rightarrow \Delta Yt = (\rho - 1)Y_{t-1} + u_t \rightarrow \Delta Yt = \delta Y_{t-1} + u_t \tag{2}$$

where null hypothesis can be defined on two ways: H0: δ=0 or H0: ρ=1. But the basic assumption of ADF test is that the error term ut is a white noise.

To test whether ADF test can be applied to return on MONEX20 we estimated the following model:

$$RTMONEX20_t = \rho RTMONEX20_{t-1} + u_t \tag{3}$$

where RTMONEX20 represents the return on stock market index MONEX 20. Return on stock market index was calculated by using the following formula:

$$RTMONEX20t = \ln(\frac{MONEX20_t}{MONEX20_{t-1}}) \cdot 100 \tag{4}$$

In order to test weather error term is a white noise, the first step in ADF test application is to estimate equation (1). The results of estimation are given in the following table:

Table 1: The random walk model of return on stock market index MONEX20

Dependent Variable: RTMONEX20 Method: Least Squares Included observations: 2702 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
RTMONEX20 (-1)	0.216642	0.018789	11.53024	0.0000

today's stock price. Therefore, technical analysis cannot be used to predict and beat a market. Semi-strong efficiency implies that all public information is calculated into a stock's current share price, i.e. meaning that neither fundamental nor technical analysis can be used to achieve superior gains. Strong form efficiency is the strongest version of market efficiency. It states that all information in a market, whether public or private, is accounted for in a stock price. Not even insider information could give an investor the advantage.

R-squared	0.045196	Mean dependent var	0.000713
Adjusted R-squared	0.045196	S.D. dependent var	0.016799
S.E. of regression	0.016415	Akaike info criterion	-5.380818
Sum squared resid	0.727830	Schwarz criterion	-5.378634
Log likelihood	7270.485	Hannan-Quinn criter.	-5.380028
Durbin-Watson stat	2.001778		

The coefficient next to lagged RTMONEX20 variable is significantly different from 1 which is the first sign that the analyzed series doesn't have a unit root and hence, it is stationary. Next step is to test for serial correlation of residual in the previously estimated model.

Table 2: Breusch-Godfrey Serial Correlation LM Test

Breusch-Godfrey Serial Correlation LM Test:			
F-statistic	0.009337	Prob. F(2,2699)	0.9907
Obs*R-squared	0.000000	Prob. Chi-Square(2)	1.0000

Test Equation:
Dependent Variable: RESID
Method: Least Squares
Included observations: 2702
Presample and interior missing value lagged residuals set to zero.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
RTMONEX20(-1)	0.017477	0.396116	0.044120	0.9648
RESID(-1)	-0.018043	0.396625	-0.045491	0.9637
RESID(-2)	-0.001360	0.087935	-0.015470	0.9877

R-squared	-0.001148	Mean dependent var	0.000557
Adjusted R-squared	-0.001890	S.D. dependent var	0.016406
S.E. of regression	0.016421	Akaike info criterion	-5.379345
Sum squared resid	0.727825	Schwarz criterion	-5.372792
Log likelihood	7270.495	Hannan-Quinn criter.	-5.376975
Durbin-Watson stat	2.000702		

The Breusch–Godfrey **serial correlation LM** test as a test for autocorrelation in the errors in a regression model shows that the serial correlation is not present. According to the results of this test we fail to reject the null hypothesis of no serial correlation with the probability of aproximately 100%. Therefore ADF test is appropriate for the investigation of RTMONEX20 time series stationarity.

Table 3: ADF Unit Root test for return rate on index MONEX20

Null Hypothesis: RTMONEX20 has a unit root Exogenous: None Lag Length: 0 (Automatic - based on SIC, maxlag=27)			
		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-41.69231	0.0000
Test critical values:	1% level	-2.565818	
	5% level	-1.940941	
	10% level	-1.616621	
*MacKinnon (1996) one-sided p-values.			

The value of ADF test statistics is -41.69231 and it is significantly smaller than the critical test statistics values at 1%, 5% and 10% significance level. Hence, we reject the Null hypothesis. Time series RTMONEX20 is stationary and it doesn't have a unit rot. Accordingly we reject the hypothesis of weak form efficiency for the capital market in Montenegro.

This results testify that the capital market in Montenegro is not transparent, i.e. not all relevant information are reflected in the stock price and there are participants who can gain the abnormal profit by having more information than others.

The Run test, also known as Geary test, is a non-parametric statistical test whereby the number of sequences of consecutive positive and negative returns is tabulated and compared against its sampling distribution under the random walk hypothesis. A run is defined as the repeated occurrence of the same value or category of a variable. It is indexed by two parameters, which are the type of the run and the length. Regarding the type stock price runs can be positive, negative, or have no change, while the length defines how often a run type occurs in succession. Under the null hypothesis that successive outcomes are independent, the total expected number of runs is distributed as normal with the following mean:

$$E(R) = \frac{n + 2n_A n_B}{n} \tag{5}$$

and the following standard deviation:

$$\sigma_R = \sqrt{\frac{2n_A n_B (2n_A n_B - n)}{n^2 (n-1)}} \tag{6}$$

where n is the total number of observations, nA is the number of the first run cycle, and nB is the number of the second run cycle. Number of runs is marked with R. If the number of observations is large its distribution is almost equal to normal

distribution. The test for serial dependence is carried out by comparing the actual number of runs, ar in the price series, to the expected number μ.

The formula for standard score is:

$$Z = \frac{R - E(R)}{\sigma_R} \tag{7}$$

If calculated Z value is greater than critical value with appropriate significance level, than we can reject Null hypothesis and conclude that analyzed MONEX20 stock index cannot be predicted. In that case capital market of Montenegro will satisfy weak form of market efficiency.

Table 4: Run test applied to return on index MONEX20

God.	*nA*	*nB*	*n*	*R*	*E(R)*	*σR*	*Z*	*Zα=0.01*	*Hypothesis*
2004	102	157	259	126	124.66	7.67	0.17	±2.58	*H0*
2005	112	148	260	129	128.51	7.89	0.06	±2.58	*H0*
2006	119	141	260	104	130.07	7.99	-3.26	±2.58	*Reject H0*
2007	107	148	255	73	125.20	7.76	-6.73	±2.58	*Reject H0*
2008	130	133	263	102	132.48	8.09	-3.77	±2.58	*Reject H0*
2009	105	156	261	103	126.52	7.75	-3.03	±2.58	*Reject H0*
2010	138	141	279	139	140.48	8.34	-0.18	±2.58	*H0*
2011	125	135	260	123	130.81	8.03	-0.97	±2.58	*H0*
2012	124	129	253	131	127.45	7.93	0.45	±2.58	*H0*
2013	104	122	226	129	113.28	7.45	2.11	±2.58	*H0*
2014	57	47	104	48	52.52	5.03	-0.90	±2.59	*H0*

According to our results capital market of Montenegro is weak-form efficient in 4 out of 11 analyzed years. Capital market of Montenegro is inefficient in the first two and the last five years of analysis.

It is reasonable to assume that recent financial crisis has had grate impact on capital market efficiency. This is why we aply Run test for two sub-periods: pre-crisis and crisis period.

Table 5: Run test applied to return on index MONEX20 before and during the world financial crisis

	nA	nB	N	R	E(R)	σR	Z	Zα=0.01	Hipothesis
2004-2007	440	594	1034	431	506.53	15.71	-8.37	±2.58	Reject H0
2008-2014	884	783	1667	770	831.44	20.33	1.85	±2.58	H0

The results of Run-test suggest that the Montenegrin capital market was efficient before the world financial crisis. The efficiency was not achieved in the period of the crisis which is expected by the theory. On the other hand, efficiency in the period from 2004 to 2007 can be explained by the process of privatization in Montenegro which was identified as well organized and transparent one. In fact, almost all state-owned companies were privatized in this specific period. In the 2004-2007 period total value of stock-exchange market turnover was 1,343,958,943.8870 € and total number of transaction was 504,892. In the crisis period, from 2008 until the end of analized period, the value of market turnover was 712,066,321.2584 and the number of transaction was 187,291. Comparing the values of market capitalization in these two sub-periods one can conclude that this value was significantly higher in the pre-crisis period. Significant difference in statistics of capital market in Montenegro in the period before and after 2008 can be explained by the lack of transparency on capital market in the period marked as inefficient and with the abnormal profits gained by some of the participants on the market.

The autocorrelation function (ACF) test is examined to identify the degree of autocorrelation in a time series. It measures the correlation between the current and lagged observations of the time series of stock returns.

If time series has unit root, than the autocorrelation function slowly decreases starting from the value of one and the partial correlation function has only first value which differs from zero. If one time series has two unit roots, ACF act the same way as for the one unit root series, but the PACF has only first two nonzero values. Based on the results of correlogram, ACF and PACF statistics we conclude that the return on MONEX20 index represent stationary time series. The correlogram as well as the values of ACF and PACF decrease slowly with very small ACF and PACF values which all implies that the analyzed series is stationary. Stationary goes hand in hand with inefficiency of Montenegrin capital market.

3.2 Volatility measure

In finance, volatility is a measure of variation of price of a financial instrument over time. It is usually measured by the standard deviation from the expectation. Any price movement up or down from its expectation is the volatility. Historically, the volatility of a stock market is roughly 20% a year and 5.8% a month, but volatility keeps on changing, so we go through periods of high volatility and periods of low volatility. The biggest driver of volatility is a drop in the market. Volatility implies high risk of market and it can scare investors and cause the collapse of financial market.

In theory two types of volatility are recognized: historical volatility and implied volatility.

Implied volatility is what the market expects for a stock's price movement. If implied volatility is high, the market expects the high range of stock price movement. On the other hand, low implied volatility suggests smoother stock price movements within a limited price range.

Table 6: Correlogram for time series return on index

Sample: 1/05/2004 5/26/2014
Included observations: 2705

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
|** |	|** |	1	0.215	0.215	125.30	0.000
| |	| |	2	0.048	0.002	131.61	0.000
| |	| |	3	0.013	0.002	132.03	0.000
| |	| |	4	0.071	0.072	145.86	0.000
|* |	| |	5	0.088	0.061	166.98	0.000
| |	| |	6	0.036	0.001	170.43	0.000
| |	| |	7	0.022	0.012	171.69	0.000
| |	| |	8	0.053	0.045	179.28	0.000
|* |	| |	9	0.088	0.062	200.53	0.000
| |	| |	10	0.056	0.017	209.13	0.000
| |	| |	11	0.023	0.002	210.51	0.000
| |	| |	12	0.046	0.036	216.19	0.000
| |	| |	13	0.020	-0.011	217.25	0.000
| |	| |	14	0.067	0.052	229.52	0.000
| |	| |	15	0.061	0.032	239.62	0.000
| |	| |	16	0.060	0.033	249.42	0.000
| |	| |	17	0.009	-0.022	249.66	0.000
| |	| |	18	-0.013	-0.027	250.12	0.000
| |	| |	19	0.029	0.023	252.37	0.000
| |	| |	20	0.051	0.027	259.44	0.000
| |	| |	21	0.032	0.003	262.18	0.000
| |	| |	22	0.010	-0.002	262.46	0.000
| |	| |	23	0.030	0.020	264.88	0.000
| |	| |	24	0.042	0.014	269.63	0.000
| |	| |	25	0.025	-0.002	271.33	0.000
| |	| |	26	-0.005	-0.018	271.41	0.000
| |	| |	27	0.007	0.009	271.53	0.000
| |	| |	28	0.024	0.008	273.16	0.000
| |	| |	29	-0.004	-0.028	273.20	0.000
| |	| |	30	0.011	0.009	273.56	0.000
| |	| |	31	0.034	0.028	276.78	0.000
| |	| |	32	0.025	0.004	278.52	0.000
| |	| |	33	0.054	0.044	286.62	0.000
| |	| |	34	0.029	0.008	288.99	0.000
| |	| |	35	0.027	0.009	290.95	0.000
| |	| |	36	0.014	-0.005	291.50	0.000

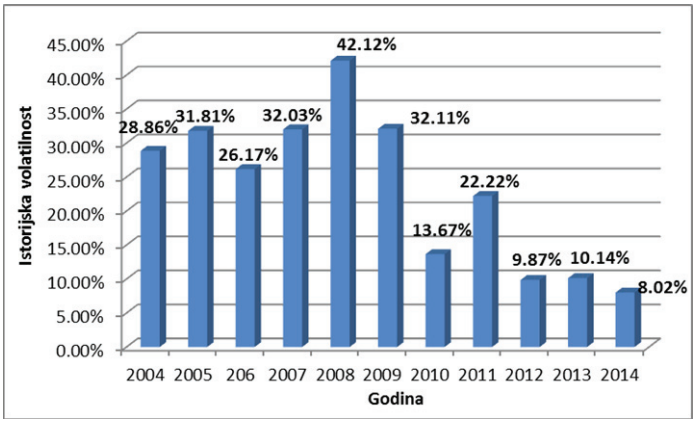
Historical volatility measures the stock price changes in the market and translates it into a statistical measure of variance. Historical data of stock prices are used to calculate volatility.

In this paper we use historical volatility concept. Historical volatility calculation is based on the time series representing the return on stock market index MONEX20. We calculated its average day-to-day changes (Rm) over a specific period. Than historical volatility is the average variance of return on stock market index MONEX20 from the mean, and can be estimated as:

$$HV = \sqrt{\frac{\sum (RTMONEX20 - Rm)^2}{n-1}} \tag{8}$$

To annualize the historical volatility, the above result is multiplied by the square root of 252 because this is the average number of trading days in a year.

Graph 1: Results of annual historical volatility for analyzed period



Analysis of the historical volatility data indicates that volatility of capital market in Montenegro rose from year to year in the period 2004 to 2008 and the highest value was reached in the year of 2008. However, in the crises period volatility declined which is connected to market stability and previously proven market efficiency.

If we analyze the last value of historical volatility we can conclude that the return on stock market index MONEX20 in the first part of 2014 will increase or decrease for 8.02% from the annual average rate of return. The average annual rate of return on MONEX20 stock index for the last year of this analysis is -0.00781%. If we consider calculated historical volatility for the year of 2014it can be expected that the rate of return on index MONEX20 will have value from -0.0072% to -0.0084%.

Even though the expected future rate of return is negative, the stability will be the main characteristics of capital market and that is a good signal to attract investors and investments.

4. CONCLUSION

The goal of this paper was to examine main characteristics of capital market in Montenegro. To do that we employed tests for market efficiency as well as volatility estimation.

Efficient-Market Hypothesis is a cornerstone of modern financial theory. Researches in this field of economy have significantly contributed to the understanding of the stock market, although the present state of understanding the issue, especially in the emerging financial markets, is far from being conclusive.

Our research focused only to tests of weak-form efficiency. Despite the fact that Montenegrin capital market was inefficient in the period before the world financial crisis, ADF and Run test approved that in the past few years there was a weak form of efficiency on the capital market in Montenegro. Even though it is generally assumed that the emerging markets are less efficient than the developed ones it ca be concluded from our test results, that the capital market in Montenegro has becomed more developed, transparent and therefore efficient. That should be a good signal for investors and investment attraction.

The other good characteristic of the Montenegrin capital market, indicated by our results, is a low volatility which assumes that in a near future capital market in Montenegro will be stable one with the low level of risk for participants' investments.

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