Zagreb International Review of Economics & Business, Vol. 17, No. 2, pp. 97-116, 2014

ISSN 1331-5609; UDC: 33+65

Pre and Post Crisis Performance Measurement of Croatian Stock Market

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Abstract: Performance evaluation of the stock market has been in investors' focus for many decades. There exist a lot of models, methods and theories that try to provide answers to investors' questions about securities, portfolio and risk management, etc. When making decisions on these topics, investors take into account different micro and macro aspects, which contribute to the stock market movements. Croatian capital market has undergone different phases of its development in the past decade. The financial crisis affected the Zagreb Stock Exchange as well as it did other markets. Since then, investors are even more careful when handling and employing their resources. There has been a lack of domestic papers that deal with different aspects of performance measurement on the Croatian stock market. Thus, the aim of this paper is to perform measures of stock market development, liquidity, MPT (Modern Portfolio Theory) performance measurements and volatility in order to quantify the stock market performance in the period before and after the financial crisis. In this way conclusions can be made based on the results in order to identify opportunities and threats on the Zagreb Stock Exchange.

Keywords: performance measurement, Zagreb Stock Exchange, stock market development, risk-adjusted performance.

JEL Classification: C61, G11, G12

Introduction

Evaluating performance of the stock market, as well as individual securities, has been in the focus of investors for many decades. When making decisions on investing

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and restructuring portfolios, it is important to take into consideration both micro and macro aspects of the stock market movements. There are many factors which influence stock (and other securities) prices and comprehending a good portion of them contributes to the quality of the decisions when structuring portfolios.

There are many aspects of evaluating performance of different stock market concepts. Depending on the investors' needs, different mathematical and statistical measures, models and methods have been developed in order to give the answers to their questions. Nevertheless, finance theory plays an important part when applying different models and methods and in the interpretation of the results. Modern Portfolio Theory (MPT) as the most famous and important part of the finance theory has provided us with many useful concepts of securities evaluation and has given many answers regarding portfolio return and risk. Investors seek to employ their resources in the best possible way on the stock market. Thus, they need to be rational when making investment decisions. This is particularly evident in times of financial crisis like the one that occurred in 2008. The Croatian capital market was affected as well as other markets.

However, there is a lack of studies which have been dealing with the performance gauging of the Zagreb Stock Exchange. A dozen of them have been emerging only in the last couple of years. The issue of the Croatian capital market development was examined by Šohinger and Horvatin (2006), Jošić (2006) and Šestanović (2013). Živković and Pečarić (2010), Arnerić et al (2012), Pervan et al (2011). Živković and Aktan (2009) investigated the issue of risk and volatility on the Croatian capital market, while Vidović et al (2014) dealt with the issue of the illiquidity measurement on stock markets. Some of the major results were the following. Benić and Franić (2008) explored the effect of the turnover on price change. In addition, the authors apply the illiquidity measure on 7 different stock markets – German, Croatian and 5 other CEE stock markets. The observed period is from January 1st 2006 to April 30th 2008. By using 4 different measures of liquidity: market index average daily price change, turnover rate, ratio of market index average daily price change and turnover rate, and illiquidity measure, the authors conclude that the Croatian stock market is more liquid than Serbian and Bulgarian stock market, while less liquid than German, Polish and Hungarian stock market, and at the same level of liquidity as Slovenian market.

Vidović (2013) questioned whether there exists the illiquidity premium on stock markets in Central and South East Europe. The analysis was made on 8 stock markets, and in each of them, portfolios based on liquidity were made. The period from the beginning of November 2009 to the end of October 2011 was observed. It is concluded that the Amihud's ILLIQ measure of illiquidity is not the appropriate measure of illiquidity on CEE stock markets and that the illiquidity premium does not exist there. Minović (2012) examined the liquidity of Croatian stock market by using zero rates return, price pressure of non-trading and turnover as measures of liquidity.

The data used were the prices of all the stocks at ZSE in the observing period from 2005 to 2009. The results showed that the least illiquid year was 2007 and the most illiquid year was 2009. Although the whole Croatian stock market is described by the very low level of liquidity, it is still more liquid than the Serbian stock market. The paper also showed that the level of illiquidity increased in the post-crises period. Erjavec and Cota (2010) had the objective to model short-term volatility at the ZSE and to investigate whether American or European stock market has greater influence on Croatian stock market. By using GARCH models authors examine the hypotheses that volatility in the short run depends on the volume of traded stocks and that volatility at the ZSE is mainly influenced by the situation at the foreign stock markets. The data for this paper was collected from daily quotations of the four indices: CROBEX, DAX30, FTSE100 and DJIA for the period from January 4th 2000 to December 31st 2004. The results showed that the CROBEX volatility follows the one from DAX30 and FTSE100. Moreover, DJIA movement is reflected in CROBEX with a one day lag.

The purpose of the paper Bogdan et al (2012) is to find out which the key variables in decision-making process of investing in stocks are, i.e. which variables affect the market liquidity the most. The data for 196 stocks from ZSE are used. The observation period is from January 1st 2010 until January 1st 2011. Amihud's liquidity ratio, which shows the amount of capital sufficient to change price by 1%, was used as a measure of liquidity. The paper showed that liquidity ratio depends positively on market capitalization, number of issued stocks and achieved volume. Perković (2011) raised a question whether beta from CAPM can be trusted as a decision-making tool in investment activities. In his research, the author used monthly stock prices on ZSE from January 1st 2005 to December 31st 2009. As a proxy for portfolio, the author used CROBEX index. According to the results, the paper rejects the validity of CAPM on ZSE and it denies the relationship between beta and return. The paper also showed that portfolio which resembles the index CROBEX is not the efficient portfolio. The paper of Džaja and Aljinović (2013) examines if CAPM is valid on 9 Central and South-eastern European stock markets and whether these markets are efficient. The data used were monthly stock return for the period from January 2006 to December 2010. The findings showed that beta is not a valid measure of risk in the aforementioned markets. Furthermore, it is found that stock market indices do not represent the efficient portfolios on the corresponding markets.

As it can be seen, the risk of index CROBEX is mostly modelled throughout the research and authors mostly use basic risk and return measures to get insights of the Croatian capital market. Thus, the purpose of this paper is to provide several aspects of the stock market analysis and performance evaluation. The aim is to employ measures of stock market development, liquidity, MPT performance measurements and volatility in order to quantify the stock market performance in the period before and after the financial crisis. Each of the aforementioned topics will be calculated throughout several years so that a comparative analysis can be made. Therefore, conclusions can be made based on the results in order to identify opportunities and threats on the Zagreb Stock Exchange. Most of the focus will be aimed at the stocks because they constitute the biggest part in volume and turnover trade.

Methodology

This paper employs several approaches of measuring different aspects of Croatian capital market. Previous domestic research has separately analyzed some of the approaches, which will be mentioned here. By comprehending several different aspects of analyzing the stock market, a better insight of the market characteristics can be obtained as well as their comparison through time can be carried out. When making important decisions on investing or handling existing portfolios, (potential) investors usually take into account a lot of information on individual securities, as well as the whole market. Here, we briefly describe several groups of measures which can give useful information on stock market performance.

First approach is measuring stock market development and liquidity. This first group of measures gives us a glance at basic changes of the stock market size and importance in the economy. Some basic measures include the turnover, market capitalization and number of active securities. Turnover represents the total money amount which is used in all of the transactions during a year. The total number of transactions represents the number of market transactions, i.e. stocks bought and sold during a year. Furthermore, here we include the turnover ratio, *TR*, which is calculated as:

$$TR = \frac{\text{total value of shares}}{\text{market capitalization}}, \tag{1}$$

and market capitalization ratio (or sometimes called value traded ratio), *MC*, is calculated as following:

$$MC = \frac{\text{total value of shares}}{\text{GDP}}, \tag{2}$$

Turnover ratio measures the efficiency, while market capitalization ratio measures the activity of the stock market. High turnovers are often interpreted as indicators of low transaction costs. Moreover, it is useful to observe turnover and market capitalization ratio together because turnover ratio measures relative importance of trading with regard to the stock market size, while market capitalization ratio measures relative importance of trading regard to the size of the economy.

Dermirguç-Kunt and Levine (1995) explain that measuring market development in terms of market capitalization is significant, due to the positive correlation between the ability to mobilize capital and diversify risk. Moreover, they develop an index of stock market development, named INDEX-1, which is calculated as follows. For each period demeaned market capitalization, total value share in GDP and turnover ratio are calculated. A demeaned value of each of the variable, X_t, is calculated as:

$$\tilde{X}_t = \frac{X_t - \bar{X}}{\left|\bar{X}\right|}, \tag{3}$$

where X_t represents the value of the variable in the period t and $\bar{X}$ the mean value of the variable. Then, the index is calculated as a simple average of the demeaned values.

Furthermore, stock market performance measures will be calculated as a second approach. They refer to usual market measures, which investors can take into account when analyzing stocks they plan to invest in. When calculating these measures, stock return and risk are being used so in that way we get a glance of risks and awards on the stock market. These measures are important concepts in the Modern portfolio theory, so we give a brief description of them. Beta coefficient measures the intensity of a change in excess stock return to a change in the excess return of the whole market[1] (Orsag, 2003). It is calculated according to the following formula:

$$\beta_i = \frac{\mathrm{cov}(r_i, r_m)}{\sigma_m^2}, \tag{4}$$

where r_i represents the excess return on the stock i, r_m is the excess return on the relevant market index and σ_m^2 is the market return variance. Usually, we estimate the market return using a relevant stock market index. Beta is useful to divide stocks into high or low risk groups and in that way investors can form more aggressive or conservative portfolios.

Sharpe ratio (Sharpe, 1966) measures the excess return on stock above some benchmark return standardized by a risk measure. It is calculated according to the following formula:

$$SR_i = \frac{R_i - R_f}{\sigma_i}, \tag{5}$$

where R_i is the expected return on the stock i, R_f is the expected return on some risk-free asset (expected return on the market index can also be used) and σ_i is the standard deviation of the stock i. Similar measure to the Sharpe ratio is the Treynor ratio

(Treynor, 1965). Instead of using the standard deviation of the stock as a measure of risk, it uses beta, which represents the systematic risk. Treynor ratio for stock i, T_i, is calculated according to the following formula:

$$T_i = \frac{R_i - R_f}{\beta_i}. \tag{6}$$

RAPA (Modigliani & Modigliani, 1997) is a risk-adjusted performance measure, which is based solely on excess returns. It uses Sharpe ratio as the base for calculation:

$$RAPA(i) = \sigma_m \cdot SR_i, \tag{7}$$

and measures risk-adjusted abnormal performance. Since it is based on the Sharpe ratio, it will equally rank observed securities as the mentioned ratio.

The most famous notion in MPT theory is the Markowitz model (Markowitz 1952), which helps in choosing the optimal portfolio in the conditions of uncertainty and risk (Šego, 2011:136-138). The goal of the model is to minimize the portfolio risk given the expected portfolio return or to maximize the expected return given the risk. This model is very fameous, so we give a brief overview of it. Let us assume that an investor has data on stock prices, $P_{i,t}$, for $i \in \{1,2,...,N\}$ stocks and T periods. Stock returns are calculated as:

$$r_{i,t} = \ln\left(\frac{P_{i,t}}{P_{i,t-1}}\right). \tag{8}$$

Expected return of i-th stock is calculated as:

$$E(r_i) = \frac{1}{T}\sum_{t=1}^{T} r_{i,t}, \tag{9}$$

while stock risk is calculated as the variance σ_i^2 :

$$\sigma_i^2 = \frac{1}{T}\sum_{t=1}^{T}\left(r_{i,t} - E(r_i)\right)^2. \tag{10}$$

Furthermore, a crucial part of the model is the co-movement between the returns of each pair of stocks, due to the advantages of diversification Markowitz first realized. Thus, we need to calculate the covariance between returns on stocks i and j as:

$$\sigma_{ij} = \frac{1}{T}\sum_{t=1}^{T}\left(r_{i,t} - E\left(r_i\right)\right)\left(r_{j,t} - E\left(r_j\right)\right). \tag{11}$$

Since portfolio return and risk is calculated based on the individual stock returns and risks, the expected portfolio return is calculated as:

$$E\left(\pi\right) = \sum_{i=1}^{N} w_i E\left(r_i\right) \tag{12}$$

and the portfolio risk is calculated as follows:

$$\sigma_{\pi}^{2} = \sum_{i=1}^{N}\sum_{j=1}^{N} w_i w_j \sigma_{ij}, \tag{13}$$

where w_i, $i \in \left\{1, 2, \ldots, N\right\}$ represents the share of each stock in portfolio. The model can now be expressed in the usual form:

$$\left.\begin{aligned} &\max_{w_i} \quad E\left(r_{\pi}\right) = \sum_{i=1}^{N} w_i E\left(r_i\right) \\ &\text{subject to} \\ &\sigma_{\pi}^{2} = \sum_{i=1}^{N}\sum_{j=1}^{N} w_i w_j \sigma_{ij} \le c \\ &\sum_{i=1}^{N} w_i = 1 \\ &w_i \ge 0, \quad i \in \{1,\ 2,\ ..,\ N\}. \end{aligned}\right\} \tag{M}$$

c represents the maximal level of risk an investor is willing to accept. By varying the constant *c* and optimizing the model (*M*), we obtain efficient portfolios, which lie on the efficient frontier. That means that these portfolios have the maximum expected return given the risk level *c*. By calculating efficient portfolios in each analyzed period it can be seen how the efficient frontier shifts over time and this allows us to examine efficiency over time.

Risk (volatility) is an important factor when considering potential securities to invest in or when handling portfolios, since it can be defined as the uncertainty of future events. Thus, the third aspect of stock market examination is the risk, although it is already considered in measures given in (4)-(7) and in the Markowitz model. There are many risk measures today created for different types of securities. Here, we focus on the standard deviation, historical volatility and a basic EMWA (Exponentially Weighted Moving Average) model. Standard deviation is probably the most commonly used risk measures despite its flaws. Historical volatility, $\hat{\sigma}_t^2$, tries to model securities volatility based on previous n observations of security return:

$$\hat{\sigma}_t^2 = \frac{1}{n}\sum_{j=1}^{n} r_{t-j}^2, \tag{14}$$

while EMWA model expands the historical volatility model in a way that observations from the recent past have bigger impact on volatility today. This impact is given through the smoothing factor λ. The bigger the λ is, the bigger ponder is given to previous observations. Thus, it is a more realistic model. The EMWA model is calculated as:

$$\hat{\sigma}_t^2 = \left(1-\lambda\right) r_{t-j}^2 + \lambda \hat{\sigma}_{t-1}^2, \tag{15}$$

where the first summand is the intensity factor, which measures the intensity of the reaction to the stock market movements, and the second is the persistency factor, which does not depend on the stock market movements. The bigger the λ is, the smaller the reaction to the stock market movements is.

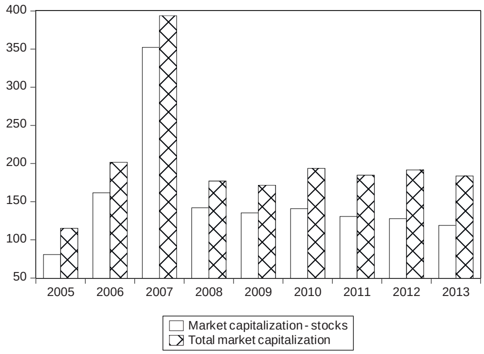
Empirical Analysis

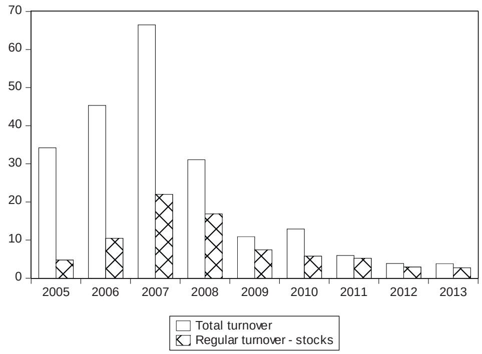
Stock Market Development and Liquidity

In order to comprehend the characteristics of the Croatian capital market, price data on index CROBEX and 24 most liquid stocks that constitute the mentioned index has been gathered from January 1st 2005 to December 31st 2013 (data were gathered from ZSE (2014)), as well as data on Treasury bill interest rates from the Ministry of Finance (2014). Stock returns were calculated using the formula (8) and the excess returns were calculated by subtracting Treasury bill interest rates from the original returns. Furthermore, data on market capitalization, turnover and number of active securities was collected from the ZSE yearly trade overview (ZSE 2005-2013) and yearly data on GDP[2] was collected form the Eurostat website.

First, we will examine the development and liquidity of the stock market. Figure 1 demonstrates the movement of the total market capitalization (left), as well as the stock capitalization. As it can be seen, both capitalizations grew until the year 2008, in which the financial crisis affected the Croatian market. Ever since, the total market capitalization is cut in half and it is stagnating, while the stock capitalization shows a negative trend. This negative trend is partly a result of introducing new securities in 2012 (structured securities) and partly of the investors' prudence, which is guiding them to invest into bonds. Figure 1 (right) shows also the consequences of the crisis. In the last several of years, the trade is stagnating and the market is “dying”.

Figure 1. Market capitalization of stocks and total market capitalization, in billions of HRK (left) and Total turnover and regular stock turnover, in billions of HRK (right)

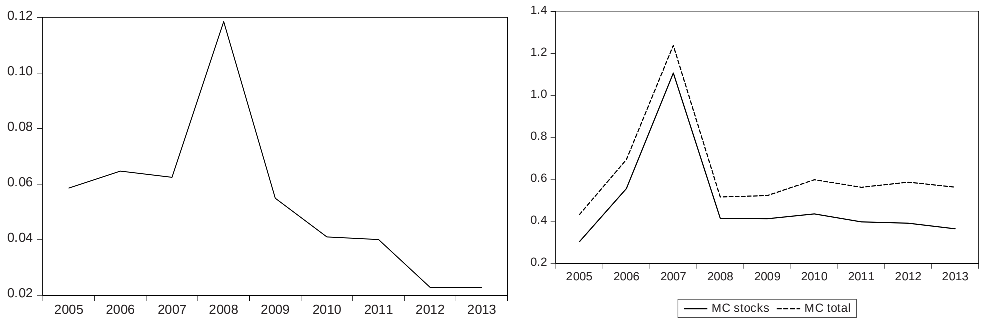




Source: authors’ calculations based on ZSE (2005-2013)

Since absolute values of the market capitalization and turnover cannot give us a full insight of the stock market, two relative measures have been calculated: turnover ratio and market capitalization ratio. Turnover ratio is shown on the left side of figure 2. As it can be seen, the turnover ratio is very small for the whole analyzed period. It peaked in the year 2008, which indicates that investors have increased their trading when the market was collapsing. In that year, there was a 50% increase of individual trading compared to the previous year. After 2008 there is a decreasing trend of the turnover ratio, and now it has fallen below 3%. The liquidity of the Croatian stock market has always been a problem, and the present situation is even worse. By observing the market capitalization ratio on the right side of figure 3, one can conclude that the relative importance of the stock market in the economy is somewhat better when compared to the turnover ratio. Of course, there is an increasing trend before the year 2008, in which the total stock market value surpassed 120% of the GDP value. Moreover, total value of stocks had the biggest share of the total market value. After the mentioned year, we can see a disparity of the total market capitalization ratio and the stock capitalization ratio. Now, the stocks make 50% of the total market value. The reason lies in the investors’ prudence and carefulness, as well as in new types of securities introduced in the past couple of years.

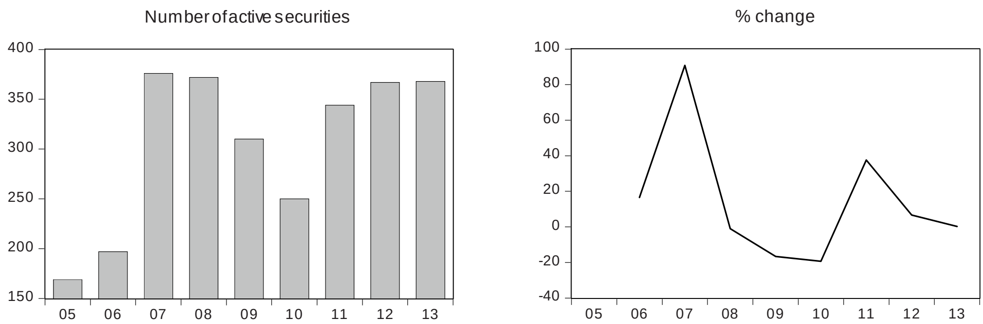
Figure 2. Turnover ratio (left) and market capitalization ratio for total market and stocks (right)



Source: authors' calculations based on ZSE (2005-2013)

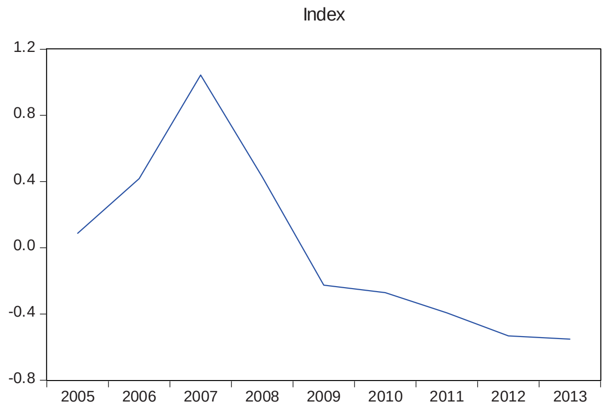
It is useful to include the number of active securities on the stock market in this part of the analysis because it also gives us information on the stock market development. Zagreb Stock Exchange is a small market and the number of active securities has never been bigger than 400. Figure 3 shows the movement of this number, as well as the percentage change in each year. After the explosion of the number of securities in the year 2007, there is a downward trend until the year 2010 because many of the firms had to withdraw the trading of their stocks. In the past three years there has been a rise in the number due to the new securities introduced on the market.

Figure 3. Number of active securities and yearly percentage change



Source: authors' calculations based on ZSE (2005-2013)

Figure 4. INDEX-1 (Dermirguç-Kunt and Levine (1995) methodology) for the ZSE



Source: authors' calculations based on ZSE (2005-2013)

Figure 4 shows the development of INDEX-1 throughout the observed period. It is not surprising that the index had a rising trend until the year 2008, and ever since a negative trend is present. It even has a negative value in the last few years, which means that the observed variables are lower than the average values for the analyzed period.

By observing this first group of measures, it can be concluded that the financial crisis had a heavy blow on the trading volume, turnover and general development of the market, as well as liquidity. Zagreb Stock Exchange, and its most popular index, CROBEX, rose exponentially till 2008, the first year of the crisis. This could be easily seen by observing the turnover, market capitalization to GDP ratio and total number of transactions. These measures hit the peak in 2007 and 2008 respectively. The lag in the total number of transactions shows that crisis was not observed by the traders. "Buying cheap and selling high", they still tried to accomplish positive returns. The aforementioned measures dropped drastically after 2007 and 2008.

Descriptive Statistics

After analyzing the general measures of stock development and liquidity, descriptive statistics on return on CROBEX was calculated for each year. In that way the general information on stock movements can be obtained. The results are given in table 1. Only in years 2008 and 2011 has the average return been negative. The 2008 is the year of the biggest impacts of the crisis, whilst the 2011 negative return was generated due to the negative trends in the second part of the year. In all other years, investors could have realized positive gains. Median is a measure that is useful when the data is not normally distributed. Since the Jarque-Bera test resulted in rejecting the hypothesis of normality of data for each year, the median is preferable to use compared to the mean.

Now it is obvious that five years have a negative value of the median, which is not favorable for the investors at all. Comparing standard deviations, the most risky years were 2007 and 2008 when there was the explosion of prices on the market. The period after the crisis is less risky compared to the years before the crisis. The market is less volatile, which is a result of the investors' passiveness.

Table 1: Descriptive statistics for CROBEX, 2005-2013

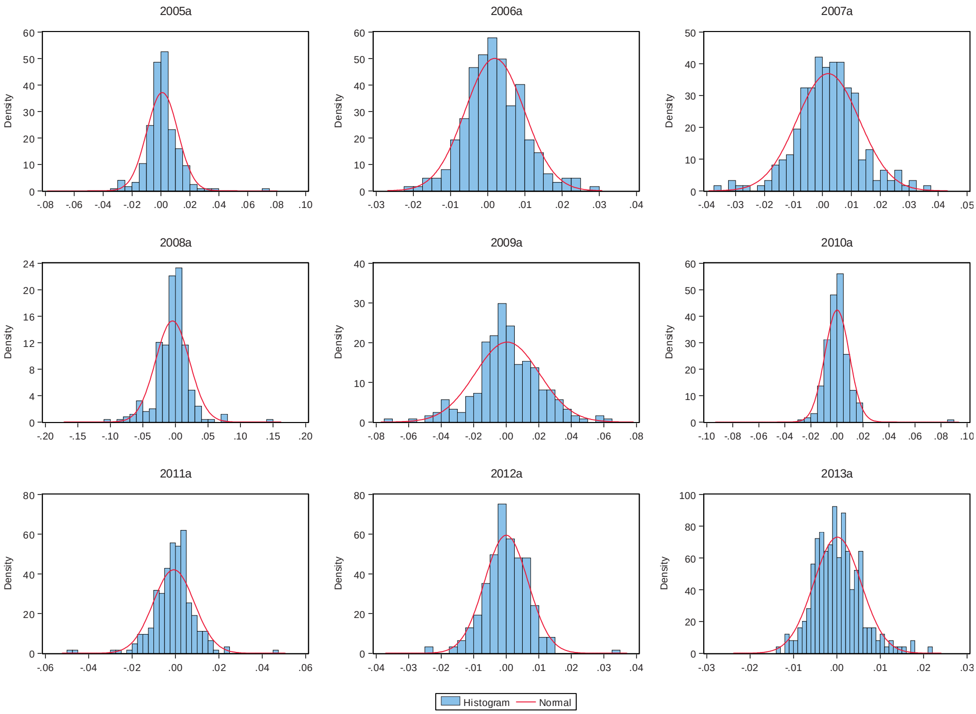
Statistics	2005	2006	2007	2008	2009	2010	2011	2012	2013
Mean	0,000939	0,001904	0,001984	-0,004468	0,000611	0,000208	-0,000766	4,14E-07	0,000122
Median	0,000262	0,001193	0,001828	-0,00187	-0,000444	5,77E-05	-0,000269	-0,000111	-0,000294
Maximum	0,073547	0,028235	0,035209	0,14779	0,062737	0,085629	0,045249	0,033894	0,021995
Minimum	-0,033394	-0,020289	-0,035684	-0,107636	-0,070203	-0,025044	-0,047763	-0,024328	-0,013834
Std. Dev.	0,010742	0,007971	0,010806	0,026114	0,019812	0,00943	0,009488	0,006715	0,005458
Skewness	1,159397	0,279037	-0,107977	0,320813	-0,082115	2,846612	-0,567397	0,051914	0,614762
Kurtosis	11,78497	3,55032	4,25291	9,01765	3,99373	28,63000	8,80027	5,75695	4,25342
Jarque-Bera	863,361	6,37337	16,63575	379,97140	10,48291	7.180,30800	366,77490	79,28670	31,98399
Probability	0,000000	0,041309	0,000244	0,000000	0,005293	0,000000	0,000000	0,000000	0,000000
No trading days	251	249	247	249	248	250	252	250	249

Source: authors' calculations based on ZSE (2005-2013)

By observing the coefficients of skewness and kurtosis, a familiar property of financial series can be seen: in each year, index CROBEX is skewed and leptokurtic. Surprisngly, the positive skewness of the index in most of the years was present, which means that there were more abnormal returns realised than abnormal losses. The kurtosis is very big for every year, which has for a consequence fat tails of the return distribution (the probabilities of extreme events are bigger compared to the normal distribution).

Figure 5 displays the histogram and comparison to the normal distribution for each year return on CROBEX. The mentioned skewness and kurtosis can be now more easily seen, as well as the probabilities of extreme event occurrences.

Figure 5. Histograms of CROBEX, 2005-2013



Source: authors' calculations based on ZSE (2005-2013)

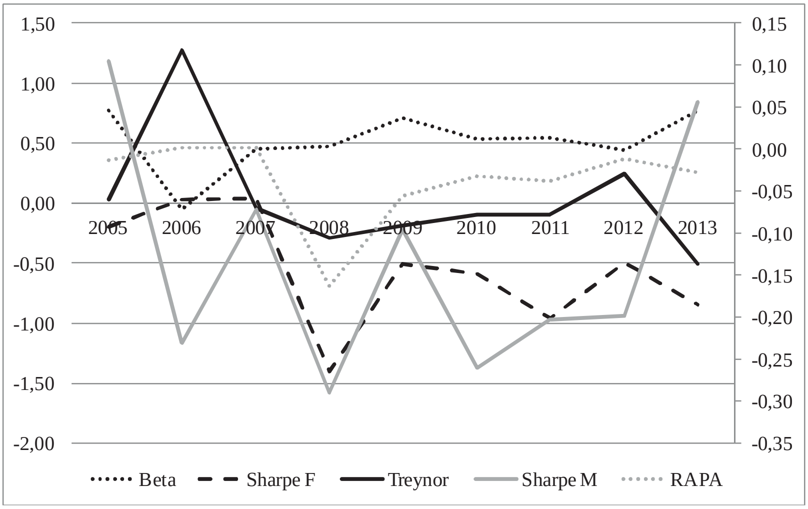
Measuring Stock Market Performance

In order to examine stock performance on the market, a sample of 24 most liquid stocks that constitute index CROBEX was obtained. Data on each stock price was used to calculate returns and several performance measures for each year: beta, Sharpe ratio, Treynor ratio and RAPA. As a benchmark of the Sharpe ratio both the average return on market index and the average annual risk-free interest rate – the interest rate on the T-bills of the Ministry of Finance (2014) were used.

Figure 6 shows all of the calculated measures for each year. By looking at beta, it can be seen that it fluctuated at value of one through the most of the observed period. This means that stocks that formed CROBEX are not aggressive at all, but they moved in the market direction to some extent. The exception is the year 2006 when beta was around zero. It means that these stocks did not move in the same direction as market at all (due to the fact that not all of these stocks formed the index in the mentioned year). Investors could have though time using beta as a measure of risk when forming portfolios on ZSE.

On average, the 24 analyzed stocks yielded positive standardized excess return (Sharpe M) above the return on market only in 2005 and 2013. In all the other observed years Sharpe M ratio was negative on average. This suggests that it was more profitable for investor to invest in the market index than in any of the analyzed stocks on average. Sharpe F ratio suggests that it was more profitable to invest in risk-free T-bills than in analyzed stocks throughout the observed period. The standardized excess of return above the return on risk-free securities was constantly around zero until 2008. Since then, it dropped and stayed beyond -0.5 standard deviation of return on stock. Treynor ratio rose along with the market until the crisis. It amounted higher than one in 2006 because of the low beta. After 2007 Treynor ratio became negative and it moved similar to Sharpe F ratio, still not so noticeable. The exception is the year 2012 when stock PTKM-R-A drove the average Treynor ratio higher compared to other years. Risk-adjusted performance measure (RAPA) was constantly negative since 2008, just like Sharpe F ratio. This suggests that Croatian capital market has not recovered since 2008. The stability of the aforementioned measures suggests that the market stagnates.

Figure 6: Beta, Sharpe and Treynor ratios, RAPA measure



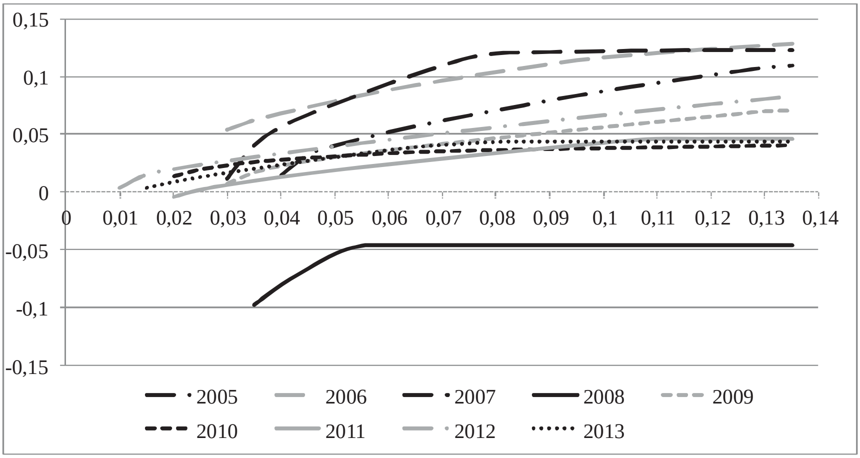
Note: Beta, Treynor, Sharpe F – left axis, Sharpe M and RAPA – right axis. Sharpe F denotes that the Sharpe ratio was calculated based on the risk free rate and Sharpe M denotes the calculation of the Sharpe ratio using the market rate.

Source: authors' calculations based on ZSE (2005-2013)

If stock performance measures are compared with characteristic market measures it is noticeable that stagnation of beta comes along with the stagnation of the market capitalization to GDP ratio. A possible explanation of the drop of the market capitalization is that corporate financing through bank loans is easier than raising funds through capital market or "going public". Furthermore, higher return on risk-free securities discouraged investors in investing in capital market. According to that, turnover, total number of transactions and market capitalization in GDP ratio movements should not be surprising. However, our analysis shows that there is no reason for investors to run away from capital markets. This analysis is presented below.

After this preliminary performance measurement, a Markowitz portfolio problem was solved for each year, by optimizing the model (M). In each year, 24 mentioned stocks are used in order to find efficient portfolios. Figure 7 shows the results from the optimization.

Figure 7: Efficient frontiers, 2005-2013



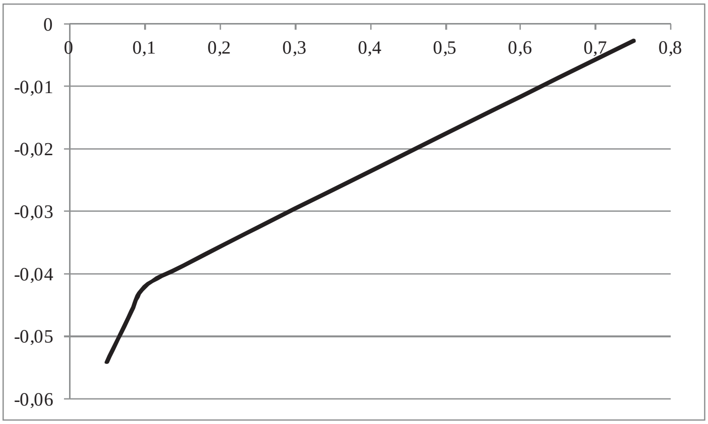
Source: Author's calculations

It is easily noticed from the figure that investors could earn a positive return by combining the stocks from the index CROBEX throughout the whole observed period, except in the year 2008 when positive return could not be accomplished. In 2005, both a conservative and aggressive investor could earn a positive return. In the year after returns rose sharply for both of the investors. But, in 2007, returns for the most conservative and the most aggressive investors could not achieve higher returns than in the previous years, although other investors could. As it was mentioned earlier, it was not possible to achieve a positive return on the efficient portfolio in 2008.

Although it seems as if the return in 2008 is stabilized at around -5% above the 5% of risk, when taking a closer look, it can be observed that at higher levels of risk, the return converges to zero. This can be seen on figure 8: the portfolio risk is much bigger compared to all other years. It is not surprising and it is in accordance with the CROBEX risk analyzed earlier.

The surprising fact is that positive returns could be achieved already in 2009. This fact may have been a sign of the market recovery (by observing only these results). Moreover, in 2009 investors could have achieved higher return than in 2005 at the lower levels of risk, but at the higher levels of risk the return was lower than in each pre-crisis year. Taking too much risk was not profitable in 2010 either. Above the 5% level of risk, returns were lower than in the year before, but below that level, returns were higher. An entirely different situation is observed if we compare returns in 2011 to returns in 2010. Below the level of risk of 9%, returns in 2011 were lower than in 2010, but above that level they were higher. To sum up, it was profitable for investors to be prone to risk.

Figure 8: Efficient frontier, 2008



Source: Author’s calculations

In 2012 investors could anticipate that the market was recovering because the returns were higher than in 2011 for each level of risk. It is interesting that the stock with the highest Treynor ratio in 2012, PTKM, did not form the optimal portfolio, even at the lowest levels of risk. Unfortunately, the decline in return in 2013 confirmed the conclusion drawn from the analysis of movement of the characteristic measures of the Croatian capital market, the conclusion that the Croatian capital market has been stagnating since 2009.

The analysis of the Croatian capital market using the Markowitz model showed that the movement of the market capitalization to GDP ratio after 2008 is similar to the movement in return on the optimal portfolio formed from the CROBEX stocks. Both experienced a sharp rise until 2008 and a dramatic fall and stagnation after 2008. Nevertheless, there are opportunities to gain positive returns on the ZSE.

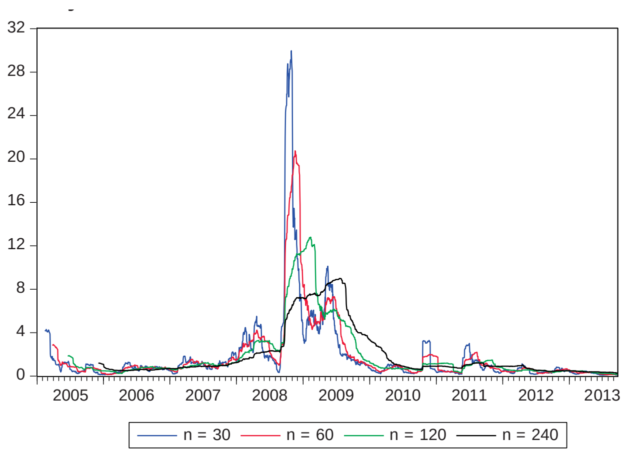
Stock Market Risk and Volatility

Finally, some basic measures of risk were examined, to accompany the standard deviation and beta, which were used earlier. Since the distribution of stock returns is not normal, standard deviation is not somewhat useful, although it gives us first insights of the risk. As it was mentioned previously, beta was also questioned as a measure of risk. Thus, we include the historical volatility and EMWA model to observe the changes of the risk of CROBEX to estimate the risk of the whole market.

Figure 9 shows the historical volatility by using last 30, 60, 120 and 240 days. Therefore, a general observation of historical volatility can be made. It had a positive trend up until the end of 2008. It means that the risk of the market was getting bigger due to the rises of prices, which resulted in big returns. This should have been a warning for the investors. Moreover, an explosion of the volatility occurred in the period of the crisis, which is not surprising. It was more than 20 times greater when compared to the beginning of the analyzed period. It settled in 2010, and afterwards it is very low. This is in accordance with the first set of measures. The volatility is very low in the last three years, and by combining these results with the results from Markowitz optimization of possibilities of gaining positive returns, it should be an invite for the investors to engage in the market activities more.

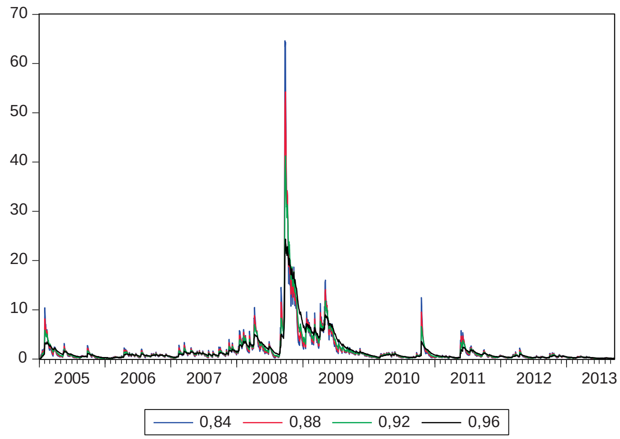
Figure 10 displays the EMWA model for the CROBEX, with the same conclusions made from the historical volatility model.

Figure 9: Historical volatility for CROBEX, 2005-2013



Source: Author’s calculations

Figure 10: EMWA model for CROBEX, 2005-2013



Source: Author's calculations

Conclusion

When making decisions on investing, investors (should) usually observe macro and micro aspects of the stock market. It is not always an easy task to grasp different information, although it is important to analyze as many factors that influence stock market movements as possible. In that way, the risk of the portfolio can be minimized. The Croatian capital market is relatively young and it is not yet sufficiently examined. Although there have been some researches of the Zagreb Stock Exchange, authors mostly focus on one aspect of the market. Thus, we wanted to give a broader picture of the stock market movements.

In that way, this paper deals with several aspects of the stock market in Croatia: stock market development and liquidity, stock market performance, risk and volatility and descriptive statistics have been employed. Since previous works have not observed the impacts of the financial crisis, this research tries to include a comment on the period before and in the crisis. Some of the activities that have contributed to the development of the market in total and to the rise of the prices were euphoria before the crisis, as well as initial public offerings of PLIVA and INA in 2006 and HT and MAGMA in 2007. In 2008 when the crisis hit, there was an increase of almost 50% of the individual transactions on the market, but the value of these transactions was smaller than before. Afterwards, the liquidity drastically fell, with a small cluster of liquid stocks on the market (such as HT, ATLN, IGH and DLKV). Although new types of securities and short selling were introduced on the market in the last couple of years, investors are still careful and inactive. The accession of Croatia to the European Union was reflected in the first half of the year 2013, but it was not substantially enough reflected in the year as a whole.

Furthermore, the general results imply that the Croatian capital market is illiquid, shallow and investors are prudent and inactive. Although, there are possibilities of gaining positive returns with low risk, the investors are not motivated enough. Further research could include the analysis of investors' opinions on the stock market movements in order to identify the reasons of their inactiveness. Therefore, more work needs to be done. However, this research includes many different aspects of the market, so we hope to contribute to the investment literature.

NOTES

[1] It is a measure of the sensitivity of an asset's excess return to changes in market's excess return.

[2] At current prices.

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