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POSSIBILITIES OF RISK DIVERSIFICATION IN REGIONAL STOCK EXCHANGES

ABSTRACT

This research investigates diversification possibilities of the four West Balkan capital markets: Sarajevo, Banja Luka, Zagreb and Belgrade Stock Exchanges. Although these markets are highly segmented with different regulations, the capital flow between them is without constraints. By analyzing six main stock market indices in a 34-month period, from 2006 till 2008, we found low to medium positive statistically significant correlation between indices returns pairs. Even though the analyzed period included the second half of 2008, when the ongoing financial and economic crisis became global, the results are encouraging. By Markowitz portfolio selection process, the diversification effect was proven on the analyzed capital markets.

JEL Classification: G11, G32

Keywords: *Risk Diversification, Stock Indices, West Balkan Capital Markets, Markowitz Model*

1. INTRODUCTION

Investors prefer holding portfolios of securities rather than a single security due to risk-reducing effects called diversification. Diversification means spreading out the investments to reduce risk. When investing in capital markets, the fluctuations of single securities returns less affect a diverse portfolio, so it has lower risk than any single security.

Since diversification reduces the portfolio risk, it can consequently reduce portfolio returns. Diversification is often called "the only free lunch in finance".

International diversification of portfolios has always been an area of great interest for investors, researchers and especially international fund managers. There is considerable academic research on the benefits of international diversification.

Investors who buy stocks in domestic as well in foreign markets seek to reduce risk through international diversification. This risk reduction takes place only if the various markets are not perfectly correlated. The increasing correlation among the developed and emerging markets has restricted the scope for international diversification (Srivastava, 2007).

International stock market linkages are the subject of extensive research due to the following reasons: (1) rapid flow of capital among countries due to financial deregulation, [1]

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[1] The ongoing global financial and economic crises has revealed the need for new regulation of financial markets and banks.

(2) information availability, (3) reduction of transaction costs, and (4) potential gains from international diversification of investment portfolios (In, Kim and Yoon, 2002).

Most stock markets in the world tend to move together, in the same direction, implying positive correlation. The regional stock markets (Sarajevo Stock Exchange - SASE, Banja Luka Stock Exchange - BLSE, Zagreb Stock Exchange - ZSE and Belgrade Stock Exchange - BSE) have also shown close connectivity in the past few years. Thus, this paper aims to research if there are any diversification opportunities in the four regional stock markets and among the three neighboring countries (Bosnia and Herzegovina, Croatia and Serbia).

This research attempts to examine the connectivity of the regional stock exchanges in the last few years. It examines the possibility of international diversification on the regional stock exchanges. We have tested the following hypothesis: It is possible to reduce risk by investing in the regional stock exchanges. The hypothesis is being tested by statistical methods and by Markowitz portfolio optimization process (Markowitz, 1991). The research results will allow more efficient securities portfolio management on the capital markets in the region.

This paper is organized in five sections, including introduction. Section 2 shows the theoretical background, Section 3 deals with data and methodology, Section 4 presents the results, and in Section 5 we conclude the study.

2. THEORETICAL BACKGROUND

The integration of global equity markets has been a well-studied topic in the last two decades, particularly since October 1987 stock market crash. Most studies are conducted for the developed markets like the US, West Europe and Japan. The findings were that the degree of international co-movements among stock prices has substantially increased in the post-crash regime (Arshanapalli and Doukas, 1993). After the Asian crisis, the literature started focusing on the emerging Asian markets as well. Co-movement of the West Balkan markets is the subject of this research.

International market integration has several definitions. One states that assets of equal risk provide the same expected returns across integrated markets. This means fewer opportunities for the risk diversification if the markets are integrated. Second definition states that in integrated markets national stock market indices move together over the long run with possibility of short run divergence.

Vizek and Dadić (2005) researched multilateral integration between the emerging markets of Central and Eastern Europe (CEE) and the German equity market, for the period from January 1997 till June 2005. Authors find that equity markets of Croatia and other CEE emerging equity markets, namely of Poland, Czech Republic, Slovenia and Hungary, are multilaterally integrated. Additionally, their results indicate multilateral integration between the CEE equity markets and the German equity market. When analyzing Croatian and German equity markets alone, they find no evidence of bilateral integration.

Within the theoretical context of market integration, international stock market linkages and interdependence form a cornerstone of the modern portfolio theory, especially in relation to asset diversification. This theory suggests that investors diversify their assets across national borders as long as stock returns in other markets are less than perfectly correlated with those of the domestic markets (Masih and Masih, 1997).

Financial integration between equity markets can be assessed by different methodology. Fratzschner (2001) used uncovered interest parity, Korajczyk (1995) used multifactor Arbitrage Pricing Theory, Bekaert and Harvey (1995) and Dumas and Solnik (1995) used Capital Asset Pricing Model. Co-integration analysis is used to test stability of long run relationship across financial markets (Dickinson, 2000, Vizek and Tadić, 2005).

Risk diversification has two basic sources; one concept developed by Markowitz (1952) and another developed by Sharpe (1964). Markowitz revolutionized the finance with his paper "Portfolio Selection," published in Journal of Finance, 1952. He introduced the notion of a (mean-variance) efficient portfolio that (1) provides minimum variance for a given expected return and (2) provides maximum expected return for a given variance.

Diversifying risk by selecting weakly correlated securities implies that decision is made based on information about standard deviation and correlation between securities' returns. This diversification is called Markowitz or efficient diversification, because Markowitz was the first who developed the procedure for calculating efficient portfolios.

Sharpe finds that one can reduce risk of a portfolio just by adding randomly selected securities in a portfolio, in a way that all securities have the same weights. By this procedure, systematic risk is being diversified; unsystematic risk becomes the only risk to be rewarded on the capital market. This approach doesn't explicitly assume that securities' returns are uncorrelated. Sharpe calls this diversification random diversification, essentially because an investor does not have to know information about standard deviation and correlation between securities' returns.

In this paper we adopted Markowitz' methodology to demonstrate the diversification possibilities on the regional capital markets. Efficient frontier of every possible portfolio of stocks, regardless of the number of stocks in the portfolio, lies between the portfolio with minimal standard deviation (also minimum variance) and the portfolio with maximum rate of return (mean). The portfolio with maximum rate of return is the upper, final point of efficient frontier. If the short sales are not allowed, the final portfolio (up on the right) in the efficient frontier will always be represented by only one share with the highest return in the portfolio. In case the short sales are allowed, no share is lying on the efficient frontier. No rational investor will invest in the portfolio which is not on the efficient frontier, because each point outside of the efficient frontier has the lesser efficiency than any point on the efficient frontier.

Markowitz used the technique of quadrate programming for solving the standard portfolio selection problem. To find a portfolio lying on efficient frontier, we are minimizing standard deviation, σ_p, in respect to weights, y_i.

$$(2.1) \quad \sigma_p = \sqrt{\sum_{j=1}^{n}\sum_{i=1}^{n} y_j y_i Cov(R_i, R_j)}$$

where

$$(2.2) \quad \sum_{i=1}^{n} y_i \overline{R}_i = \overline{R}_p^* \text{ and } \sum_{i=1}^{n} y_i = 1$$

The solution to this problem results in weights, y_i, of efficient portfolio. By varying expected return, $\overline{R}_p$, we can find all portfolios lying on efficient line.

Asset risk can be determined as a probability that the expected rate of return on that asset will not be realized (Orsag, 2003). The greater the volatility of expected return, the higher is the risk for the investor. Risk, as a quantified uncertainty or quantified probability of realizing expected return on financial asset investment, encompasses the possibility of anticipating the most probable outcome and, also, measuring dispersion of probability distribution. Besides the danger of loss, the term risk includes dispersion of possible outcomes (results) related to the one most likely to happen.

Total holding period return is measured by the following formula (Bodie, Kane and Marcus, 1996):

$$(2.3) \quad R = \frac{(P_t - P_{t-1}) + D_t}{P_{t-1}}$$

where R is total rate of return, D_t cash dividend for the period "t", P_t price at the end of the period "t" and P_{t-1} price at the beginning of the period "t". Total holding period return is the rate at which the investors' initial funds have grown during the investment period, usually one year. It is represented by the occasional payments during the holding-period increased by the amount of which the price of security has changed during the period. An occasional payment on stocks represents the current income or dividend yield that can be omitted. The positive difference in price changes is called a capital gain, and the negative is called a capital loss. This measure is one of the best *ex-post* measures of the return on an investment for holding periods up to one year. Total rate of return is the sum of dividend yield and capital gain/loss.

A rational investor will try to diversify the risk by combining different securities in his portfolio. The portfolio consists of two and/or more securities into which the investor puts his money, in specific proportions, aimed at reducing the overall risk. Generally, it can be stated that the investor's assets in his portfolio are less risky than the ones he keeps isolated (Orsag, 2003). In the analyses of the portfolio risk, basic parameters of the probability distribution of rates of return in the portfolio need to be determined. Those parameters are the expected rate of return and the variance (i.e. standard deviation).

The expected rate of return of the portfolio is a weighted mean of the expected returns on securities in the portfolio, where the weights are the percentages of the money invested in each individual security:

$$(2.4) \quad \overline{R}_p = \sum_{j=1}^{n} \overline{R}_j w_j$$

where the $\overline{R}_j$ is the expected rate of return of the j security, and w_j is the percentage of money invested in j security.

Portfolio risk is not just the weighted mean of the risk of individual securities, because it does not depend only on the risk of securities in the portfolio, but also on the existing relations between these securities. There are two ways to estimate the standard deviations of the portfolio; the first way is (Van Horne and Wachowicz, 2002, p. 55) by using the following formula:

$$(2.5) \quad \sigma_p = \sqrt{\sum_{i=1}^{n} P_i (R_{i(p)} - \overline{R}_p)^2}$$

where $R_{i(p)}$ is the possible rate of return on portfolio, which is estimated as the weighted mean of rates of return on individual securities in different scenarios (weights are percentages of money invested in individual securities), P_i is the belonging probability of the given scenario, and $\overline{R}_p$ is the expected rate of return of the portfolio. The second way for calculating the standard deviation of the portfolio is (Bodie, Kane and Marcus, 1996, p. 213):

$$(2.6) \quad \sigma_p = \sqrt{\sum_{j=1}^{n} \sum_{i=1}^{n} w_j w_i Cov(R_i, R_j)}$$

where $Cov(R_i, R_j)$ is the covariance between the rate of return of the i and the j security.

The goal of successful diversification is in combining mutually weakly correlated securities, which in turn is measured by the covariance and correlation. Covariance measures the degree to which the two securities go in the same direction. Positive covariance means that return rates are going in the same direction, together. Negative covariance means that return rates are moving inversely and it is the proof of the successful risk diversification according to Markowitz.

$$(2.7) \quad Cov(R_A, R_B) = \sum_{i=1}^{n} P_i (R_{i(A)} - \overline{R}_A)(R_{i(B)} - \overline{R}_B)$$

$$(2.8) \quad Cov(R_A, R_B) = \frac{\sum_{i=1}^{n} (R_{i(A)} - \overline{R}_A)(R_{i(B)} - \overline{R}_B)}{n}$$

$$(2.9) \quad Cov(R_A, R_B) = Cov(R_B, R_A)$$

Even simpler statistical tool for the interpretation is the correlation coefficient (ρ), which takes the value in the interval from –1 (perfect negative correlation) to 1 (perfect positive correlation). Correlation points to the same thing as the covariance does regarding the moving direction of return rates on securities. Correlation coefficient is the quotient of covariance of two securities and its multiplied standard deviations:

$$(2.10) \quad \rho(R_A, R_B) = \frac{Cov(R_A, R_B)}{\sigma_A \sigma_B}$$

Perfect risk diversification according to Markowitz is accomplished if the value of the correlation coefficient is closer to -1.

To take a more precise look at the nature of relationship between two securities, it is possible to examine partial correlations between a pair of securities (securities returns), excluding impact of other securities in the observed set of securities.

3. METHODOLOGY AND DATA

Since we adopted previously described Markowitz' methodology to test the hypothesis of whether diversification is possible in the regional stock exchanges, we have to take a closer look at the correlation coefficient between observed capital markets. Rather than selecting single securities from each stock exchange, six stock market indices have been selected and observed in a 34-month period, from 2006 till 2008. The second half of 2008 was included in the analysis regardless the ongoing global financial and economic crisis. In crises, as well as in recovery periods, we expect the stock markets to move in the same direction, but yet we will see if the trends are perfectly positively correlated.

The study investigates the relationship between the four West Balkan markets, represented with six most important stock indices. From SASE, we included two indices following capital market in Federation of BiH: BIFX (following 11 investment funds) and SASX-10 (which includes 10 companies with highest market capitalization).[2] BLSE is represented with BIRS (wide index including 20 companies) and FIRS (following 13 investment funds). CROBEX (wide index including up to 30 companies) is representing ZSE, while BELEX15 (following 15 most liquid stocks) is representing BSE.

Although the analyzed capital markets are highly segmented, even in the same country (BiH itself has two stock exchanges, different regulation etc.), there are no limitations on capital flow between the countries[3] due to financial deregulation, low transaction costs and information availability. Those capital markets are available to international investors like any capital market in the world. This region has attracted attention of many international funds and investors. Some researches have shown that coefficient of relative risk aversion on BiH's capital market is much higher, ranging from 4 to 10 (Zaimović, Babić-Hodović and Arnaut-Berilo, 2006), compared to 2 to 4 on developed capital markets (Bodie, Kane and Marcus, 1996). This implies high risk premium on BiH's capital market. This was recognized as an investment opportunity by the international investors and fund managers, including those from Slovenia and Croatia.

The data sets range from 2[nd] January 2006 till 19[th] November 2008, in total 744 observations. We observed indices in the region on a daily basis. The daily stock price indices were sourced from official websites of the four stock exchanges. The missing data were substituted by the latest data. That day return was signified as zero. The daily indices returns do not include dividend yield on securities. The daily return is calculated as percentage change of daily index value:

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[2] The third index (SASX-30) was introduced recently (March 2009).

[3] Capital flow limitations sometimes exist if an individual investor wants to transfer money abroad (case of BiH). But this obstacle can be easily prevailed by custody banking. Such limitations are not present for companies and institutional investors.

$$(3.1)\quad R_t = \frac{P_t - P_{t-1}}{P_{t-1}}$$

As a first step in the analysis of selected indices movements, we present the basic descriptive statistics of the indices returns (table 1). Only two indices have shown positive daily average return (SASX-10 and CROBEX). However, their returns – although positive – are very close to zero. Standard deviation of all indices returns is high compared to low and negative average returns. SASX-10 has also shown the highest standard deviation of returns.

Table 1

Descriptive statistics of indices returns[4]

Indices returns	Minimum	Maximum	Mean	St. deviation
BIFX	-8,41%	8,03%	-0,0552%	1,46%
SASX-10	-8,46%	9,15%	0,0007%	1,88%
BIRS	-4,89%	7,59%	-0,0168%	1,31%
FIRS	-8,03%	8,27%	-0,0004%	1,74%
CROBEX	-10,20%	15,93%	0,0006%	1,63%
BELEX15	-10,29%	12,93%	-0,0608%	1,76%

Source: Authors' calculations

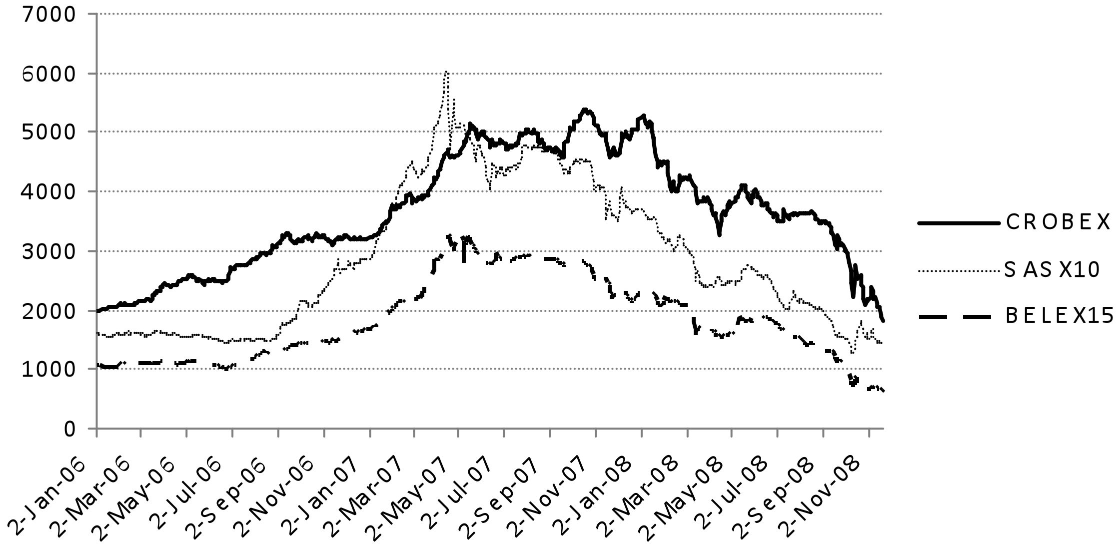
Figures 1 and 2 depict the movements of different stock indices from January 2006 to November 2008. The maximum index value demonstrates FIRS (12,618 on 17th April 2007), followed by BIFX (9,853 on 17th April 2007) and SASX-10 (6,040 on 13th April 2007). All observed BiH's indices had their maximum value in April 2007, when the bullish trend on this market ended. BELEX15 registered maximum value in May 2007 (3,304), while CROBEX had its own maximum in October 2007 (5,392). Shortly after the maximum picks, bearish market started and lasted till the end of observed period, and longer,[5] with short recovery periods.

[4] The results are generated by SPSS 17.0, ©SPSS Inc., 2008.

[5] The stock prices and indices values continued to fall till spring 2009.

Figure 1

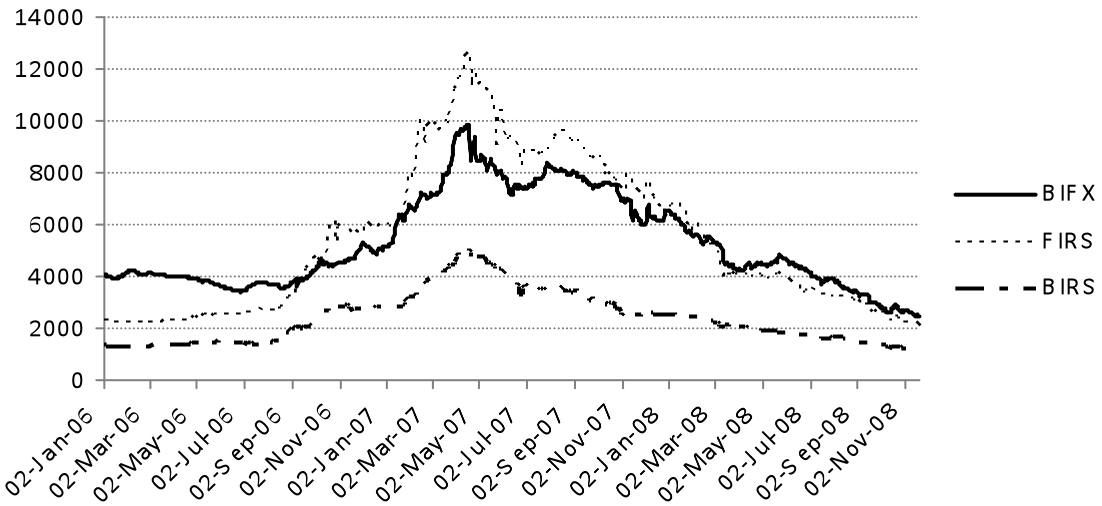
Daily indices movement of CROBEX, SASX-10 and BELEX15[6]



Source: Authors' work

Figure 2

Daily indices movement of BIFX, FIRS and BIRS



Source: Authors' work

Bearish trend that started on BiH's capital market in April 2007 spreaded out on the neighboring capital markets. It has been deepened by ongoing global crises. The ending values of all six indices are lower than the starting values of January 2006, which implies that the stock prices in indices were in November 2008 similar to prices before January 2006. In November 2008, markets in general fell to the prices of 2005 and 2004.

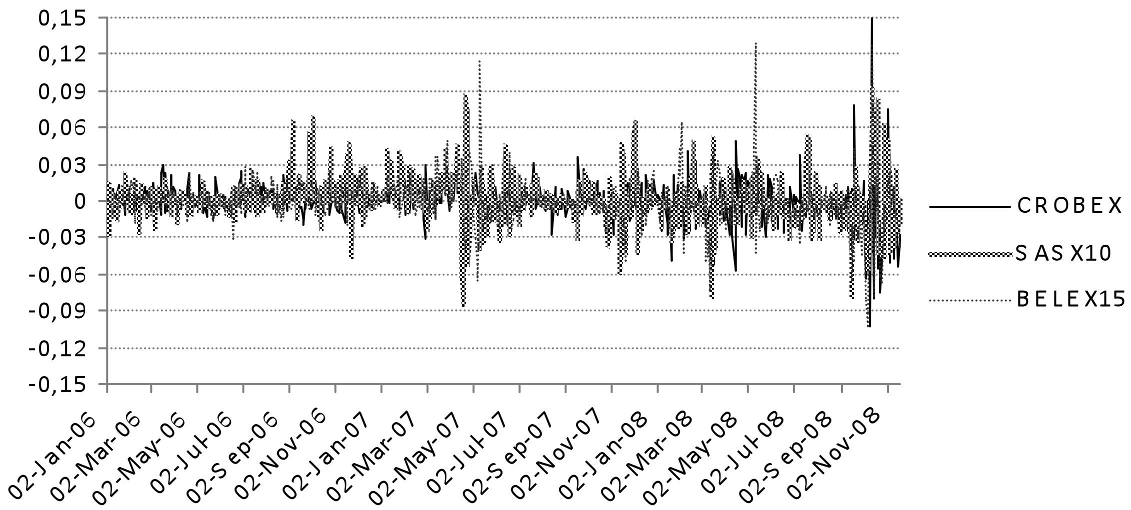
The following figures (3 and 4) show the daily returns oscillations. CROBEX and BELEX15 have shown higher amplitudes in daily returns movements, especially in October 2008, while other four indices returns move in range of +/-10%, daily. SAXS10 also had the highest daily positive change in October 2008. In figures 1 and 2 we can observe that

[6] Figures 1, 2, 3 and 4 are generated by MS Excel. Data obtained by Zagreb Stock Exchange, Sarajevo Stock Exchange, Banja Luka Stock Exchange and Belgrade Stock Exchange.

indices' returns are stationary, while indices' values were not mean reverting (figures 1 and 2).

Figure 3

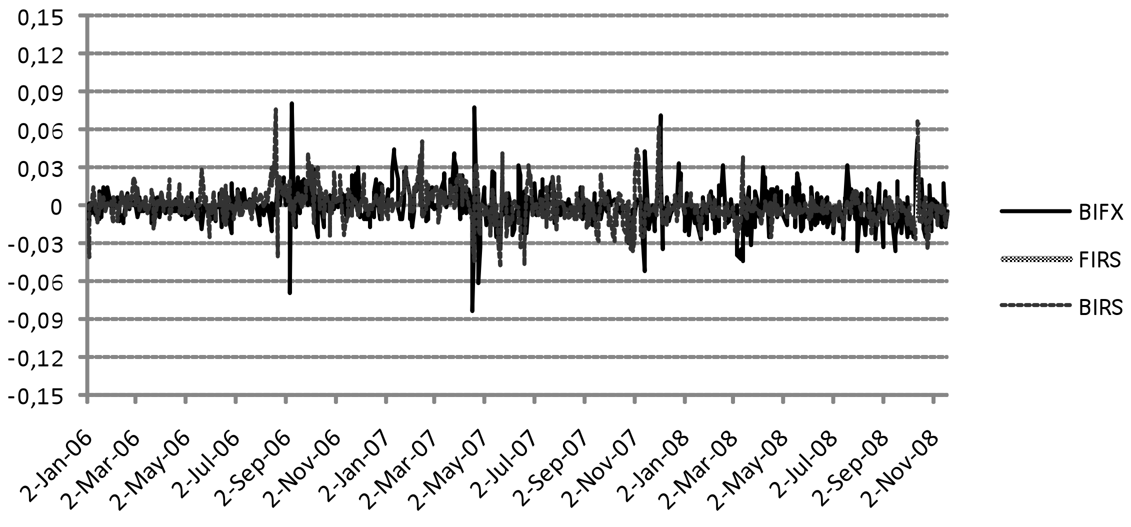
Daily indices return movement of CROBEX, SASX-10 and BELEX15



Source: Compiled and processed by the authors

Figure 4

Daily indices return movement of BIFX, FIRS and BIRS



Source: Compiled and processed by the authors

4. RESULTS

Correlation analysis was applied on: (1) indices values, and (2) indices daily returns. Indices daily returns were also analyzed by the partial correlation procedure. Partial correlation analysis helps find correlation between a pair of indices returns after removing the effects of other indices returns. This analysis aims to reveal hidden correlations, correlation masked by the effect of other included variables. All calculated coefficients were tested on their statistical significance.

In table 2 we show the correlation matrix of indices values. As shown on figures 1 and 2, the indices movements have the same direction. We measure the intensity of the connectivity between analyzed indices.

Table 2

Correlation matrix of indices[7]

		BIFX	SASX-10	BIRS	FIRS	CROBEX	BELEX15
BIFX	Pearson Correlation	1	0,978(**)	0,930(**)	0,965(**)	0,807(**)	0,953(**)
	Sig. (2-tailed)		0,000	0,000	0,000	0,000	0,000
SASX-10	Pearson Correlation	0,978(**)	1	0,928(**)	0,973(**)	0,871(**)	0,968(**)
	Sig. (2-tailed)	0,000		0,000	0,000	0,000	0,000
BIRS	Pearson Correlation	0,930(**)	0,928(**)	1	0,979(**)	0,724(**)	0,878(**)
	Sig. (2-tailed)	0,000	0,000		0,000	0,000	0,000
FIRS	Pearson Correlation	0,965(**)	0,973(**)	0,979(**)	1	0,803(**)	0,928(**)
	Sig. (2-tailed)	0,000	0,000	0,000		0,000	0,000
CROBEX	Pearson Correlation	0,807(**)	0,871(**)	0,724(**)	0,803(**)	1	0,922(**)
	Sig. (2-tailed)	0,000	0,000	0,000	0,000		0,000
BELEX15	Pearson Correlation	0,953(**)	0,968(**)	0,878(**)	0,928(**)	0,922(**)	1
	Sig. (2-tailed)	0,000	0,000	0,000	0,000	0,000	

** Correlation is significant at the 0,01 level (2-tailed).
Source: Authors' calculations

All correlation coefficients between pairs of analyzed indices are high, positive and statistically significant on 1% level of risk. Their values are in the 0,724 – 0,979 range, which indicates a strong and direct relationship between all indices pairs. CROBEX has the lowest correlation coefficient to other indices, ranging from 0,724 to 0,922. Yet, it does not mean that the indices returns are also so highly positively correlated. Otherwise, there would be a small possibility of risk diversification due to high positive co-movements.

Correlation coefficients between a pair of indices returns (table 3) are obviously smaller compared to correlation coefficients between indices, and they are all statistically significant. Two lowest correlation coefficients between indices returns are 0,096 (between CROBEX and BIFX returns) and 0,128 (between CROBEX and FIRS returns). There is a very weak to weak relationship between indices returns from different stock exchanges ranging from 0,096 (between CROBEX and BIFX returns) to 0,298 (between BIFX and FIRS).

Two highest correlation coefficients are 0,593 (between SASX and BIFX returns) and 0,548 (between BIRS and FIRS returns). The results are not surprising, since SASX and BIFX are indices from the same stock exchange, as well as BIRS and FIRS. It is interesting to point out that these stock indices represent different segments of these markets; companies and investment fund segment on every stock exchange. Yet there is a moderate positive correlation between these two segments on each stock exchange.

We can conclude that although the correlations between indices returns are positive (from weak to moderate positive correlation), there are significant diversification opportunities on those markets, since correlation is much lower than 1. There was no evidence of negative correlation between indices returns nor indices value, which proves the assumption that those markets move together.

[7] The results in tables 2, 3 and 4 are generated by SPSS 17.0, ©SPSS Inc., 2008.

Table 3

Correlation matrix of indices returns

		BIFX	SASX-10	BIRS	FIRS	CROBEX	BELEX15
BIFX	Pearson Correlation	1	0,593(**)	0,239(**)	0,298(**)	0,159(**)	0,223(**)
	Sig. (2-tailed)		0,000	0,000	0,000	0,000	0,000
SASX-10	Pearson Correlation	0,593(**)	1	0,279(**)	0,282(**)	0,253(**)	0,261(**)
	Sig. (2-tailed)	0,000		0,000	0,000	0,000	0,000
BIRS	Pearson Correlation	0,239(**)	0,279(**)	1	0,548(**)	0,096(**)	0,155(**)
	Sig. (2-tailed)	0,000	0,000		0,000	0,008	0,000
FIRS	Pearson Correlation	0,298(**)	0,282(**)	0,548(**)	1	0,128(**)	0,215(**)
	Sig. (2-tailed)	0,000	0,000	0,000		0,000	0,000
CROBEX	Pearson Correlation	0,159(**)	0,253(**)	0,096(**)	0,128(**)	1	0,271(**)
	Sig. (2-tailed)	0,000	0,000	0,008	0,000		0,000
BELEX15	Pearson Correlation	0,223(**)	0,261(**)	0,155(**)	0,215(**)	0,271(**)	1
	Sig. (2-tailed)	0,000	0,000	0,000	0,000	0,000	

** Correlation is significant at the 0,01 level (2-tailed).
Source: Authors' calculations

Considering the strong and direct relationship between the analyzed indices and low to moderate positive correlation between indices return, it is interesting to investigate the relationship between a pair of indices returns excluding the indirect influence of other indices returns. To eliminate this indirect impact, partial correlation coefficients were calculated between pairs of indices returns (table 4). In most cases, partial correlation coefficients between indices returns are significantly smaller than the corresponding correlation coefficients. Moreover, most of them are more than twice smaller than the corresponding correlation coefficients.

Table 4

Partial correlation matrix of indices returns

		BIFX	SASX	BIRS	FIRS	CROBEX	BELEX15
BIFX	Partial Correlation	1	0,530(**)	0,009	0,133(**)	-0,013	0,065
	Sig. (2-tailed)		0,000	0,802	0,000	0,725	0,077
SASX-10	Partial Correlation	0,530(**)	1	0,120(**)	0,032	0,162(**)	0,103(**)
	Sig. (2-tailed)	0,000		0,001	0,388	0,000	0,005
BIRS	Partial Correlation	0,009	0,120(**)	1	0,498(**)	-0,007	0,013
	Sig. (2-tailed)	0,802	0,001		0,000	0,857	0,721
FIRS	Partial Correlation	0,133(**)	0,032	0,498(**)	1	0,030	0,107(**)
	Sig. (2-tailed)	0,000	0,388	0,000		0,416	0,004
CROBEX	Partial Correlation	-0,013	0,162(**)	-0,007	0,030	1	0,214(**)
	Sig. (2-tailed)	0,725	0,000	0,857	0,416		0,000
BELEX15	Partial Correlation	0,065	0,103(**)	0,013	0,107(**)	0,214(**)	1
	Sig. (2-tailed)	0,077	0,005	0,721	0,004	0,000	

** Correlation is significant at the 0,01 level (2-tailed).
Source: Authors' calculations

Seven partial correlations are not statistically significant, so we cannot reject the null hypothesis that these partial correlations are different from null. The following pairs of indices returns have no direct impact on each other: BIFX and BIRS, BIFX and CROBEX, BIFX and BELEX15, SASX and FIRS, BIRS and CROBEX, BIRS and BELEX15, FIRS and CROBEX. Their co-movement is due to impact of other indices returns co-movements.

Minor low direct relationship exists between returns on BIFX and FIRS (0,133), SASX-10 and BIRS (0,120), SASX-10 and CROBEX (0,162), SASX-10 and BELEX15 (0,103), FIRS and BELEX15 (0,107), CROBEX and BELEX15 (0,214). All of them are statistically significant on the 1% level of risk. We can conclude that positive correlation (although low) between these pairs of indices returns is partly due to their own connectivity and partly to the impact of other indices returns co-movements.

The moderate partial correlation between returns on BIFX and SASX (0,530) and between BIRS and FIRS (0,498) implies that other analyzed indices returns have not significant influence on their relationship. Their moderate co-movements are due to their own connectivity.

Aiming to demonstrate diversification effects on regional stock exchanges, we have to create stock portfolios. Assume the existence of six index funds which are tracking analyzed indices and replicating the movements of these indices. For a portfolio of these six funds stocks, the portfolio risk would be influenced by stocks' (i.e. indices) own variances as well as by covariance between stock returns pairs. The portfolio variance is the sum of the variance-covariance matrix, as shown in table 5, where all stocks are equally weighted. As the number of stocks increases, the covariance members are dominating over the variance members in this matrix. In a portfolio of 6 stocks, there are 6 variance members and 30 covariance members.

Table 5

Variance-covariance matrix[8]

$$\begin{bmatrix} 5{,}941\text{E-06} & 4{,}533\text{E-06} & 1{,}271\text{E-06} & 2{,}109\text{E-06} & 1{,}051\text{E-06} & 1{,}597\text{E-06} \\ 4{,}533\text{E-06} & 9{,}826\text{E-06} & 1{,}907\text{E-06} & 2{,}560\text{E-06} & 2{,}151\text{E-06} & 2{,}399\text{E-06} \\ 1{,}271\text{E-06} & 1{,}907\text{E-06} & 4{,}769\text{E-06} & 3{,}472\text{E-06} & 5{,}720\text{E-07} & 9{,}932\text{E-07} \\ 2{,}109\text{E-06} & 2{,}560\text{E-06} & 3{,}472\text{E-06} & 8{,}411\text{E-06} & 1{,}011\text{E-06} & 1{,}694\text{E-06} \\ 1{,}051\text{E-06} & 2{,}151\text{E-06} & 5{,}720\text{E-07} & 1{,}011\text{E-06} & 7{,}369\text{E-06} & 2{,}162\text{E-06} \\ 1{,}597\text{E-06} & 2{,}399\text{E-06} & 9{,}932\text{E-07} & 1{,}694\text{E-06} & 2{,}162\text{E-06} & 8{,}621\text{E-06} \end{bmatrix}$$

Source: Authors' calculation

We will assume that the indices mean is their expected return. We show in table 6 that the coefficient of variation (CV) of indices with a positive mean is extremely high; $CV_{SASX\text{-}10}$=2,691 and CV_{CROBEX}=2,846. CV of other indices returns is not meaningful since their mean is negative. So, the created equally weighted portfolio of all six indices also has a negative mean of -0,022% and standard deviation of 1,019%. The created portfolio has the lowest standard deviation of all the observed indices; the diminishing standard deviation is a proof of risk diversification in these four markets.

[8] The results in table 5 and 6 are calculated using MS Excel.

Table 6

Descriptive statistics of indices returns and portfolios returns

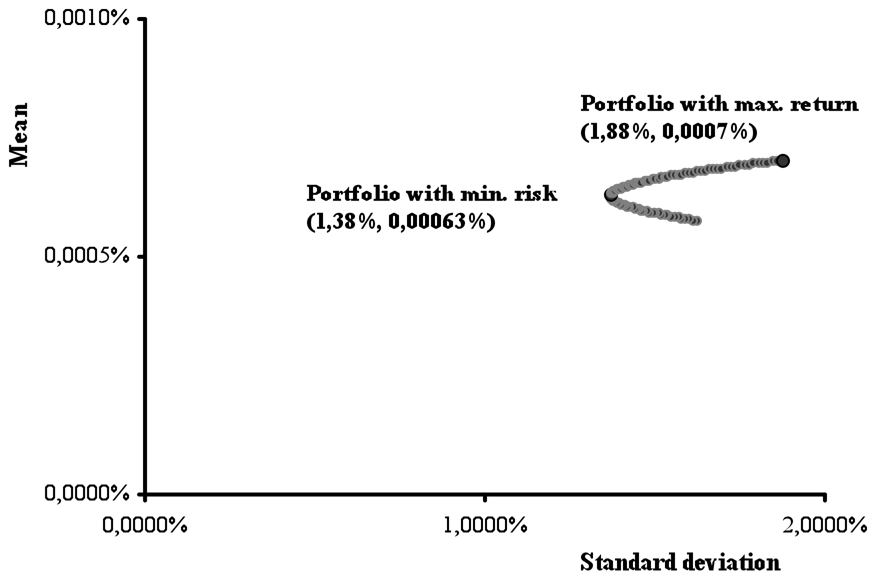
Indices returns	Mean	Variance	St. deviation	Coefficient of variation
BIFX	-0,0005517	0,0002139	0,0146251	-
SASX	0,0000070	0,0003538	0,0188083	2,691
BIRS	-0,0001682	0,0001717	0,0131021	-
FIRS	-0,0000045	0,0003028	0,0174012	-
CROBEX	0,0000057	0,0002653	0,0162878	2,846
BELEX15	-0,0006077	0,0003104	0,0176174	-
Portfolio of six indices	-0,0002199	0,0001039	0,0101932	-
Portfolio of SASX-10 and CROBEX	0,0000064	0,0001935	0,0139099	2,188

Source: Authors' calculation

To demonstrate diversification effect on regional stock exchanges we will create portfolio of two indices, those with a positive mean. Equally weighted portfolio of SASX-10 and CROBEX indices/fund stocks has lower risk than any single index, i.e., its standard deviation is 1,39%. Portfolio return is 0,00064%. The benefits of diversification are more visible through coefficient of variation of 2,188, which implies that this portfolio has the lowest standard deviation over mean, i.e., this portfolio has the best risk/return relationship of all analyzed indices. This diversification effect is due to a relatively low correlation coefficient between SASX-10 and CROBEX returns of 0,253.

Figure 5

All possible portfolios of SASX-10 and CROBEX indices[9]



Source: Compiled and processed by the authors

The diversification effect is better visible in figure 5. Diversification is the curvature of the line of all possible portfolios between the two indices regarding the straight line that connects the two ending portfolios. We can see that the minimum risk portfolio is the left portfolio with standard deviation of 1,38%, where expected return is 0,00063%. This

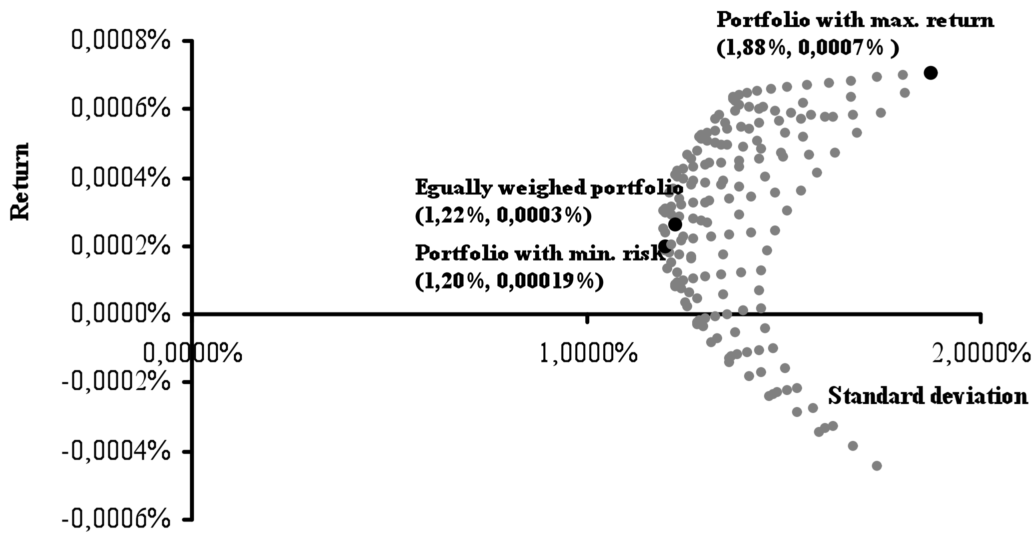
[9] This possible portfolios set is result of simulation method using MS Excel.

portfolio consists of 40,47% of SASX-10 and 59,53% of CROBEX. Equally weighted portfolio has standard deviation of 1,39% and expected return of 0,00064%. It means that this portfolio is very close to minimum standard deviation portfolio and it is lying on efficient frontier.

Although standard deviation is decreasing by adding one more index in the previous portfolio (now consisting of SASX-10, CROBEX and FIRS), minimal $\sigma_p = 1{,}20\%$, the coefficient of variation is increasing, CV of the least risky portfolio is 6,341.[10] The minimum standard deviation portfolio has the following weights: 20% SASX-10, 40% (CROBEX) and 40% (FIRS). The significant increase of CV is due to the negative mean of the added index returns. However, the diversification effect is being proved by sliding the possible portfolio set to the left, regardless of the negative mean of added index returns, which is the result of low correlation between the selected index returns, 0,282 (SASX-10 and FIRS), 0,128 (CROBEX and FIRS) and 0,253 (SASX-10 and CROBEX). Yet, a certain number of portfolios are located in the fourth quadrant, due to a negative mean of the third added index (FIRS) and these portfolios are ones that no one would like to have.

Figure 6

All possible portfolios of SASX-10, CROBEX and FIRS[11]



Source: Compiled and processed by the authors

It is crucial to remark that the equally weighted portfolio of three fund stocks, formed like three stock indices in the region, is very close to the efficient frontier. This portfolio has standard deviation of 1,22% and a mean of 0,0003%. Assuming the existence of these index funds stocks, we observe following:

- ❖ Equally weighed portfolio of fund stocks in the region has a very good standard deviation – mean trade off, compared to other possible portfolios of these three fund stocks, almost lying on efficient frontier.
- ❖ This is argument for passive portfolio management, since we simplify portfolio optimization process by avoiding calculating the efficient portfolios. It reduces portfolio management costs.

[10] FIRS is chosen as the third index in the portfolio because of the minimal negative return.

[11] This possible portfolios set is a result of simulation method in MS Excel. The graph shows more than 200 possible portfolios of these three indices/funds stocks. The number of all possible portfolios between two, three or more stocks is unlimited. In this simulation, short sells are not considered.

- ❖ We can suggest that portfolios of more index funds stock (four, five and more) would make this standard deviation – mean trade off of equally weighed portfolio even more efficient, actually lying on the efficient frontier.
  Creation of such funds would improve portfolio management in the region.

5. CONCLUSION

The analysis of indices values has shown that all six indices are highly positively correlated. The correlation coefficients between pairs of indices ranged from 0,724 (between CROBEX and BIRS) to 0,979 (between BIRS and FIRS). All correlation coefficients were statistically significant at 99%.

The correlation analysis of indices returns gave interesting results. Correlation coefficients between indices returns are low and moderate, ranging from 0,096 (between CROBEX and BIRS) to 0,593 (between SASX-10 and BIFX), and all of them are statistically significant at 99%. We conclude that there is significant diversification effect if investing in portfolios formed like stock indices in the region, due to correlation coefficients different than 1.

Analysis of partial correlation coefficient provided a more detailed explanation of co-movements between indices returns. Partial correlation coefficients between seven different pairs of indices returns (excluding influence of other four indices) are not statistically significant, and we cannot reject the null hypothesis that the partial correlation between these pairs is different than null. The co-movements of these pairs of indices returns are explainable with other indices returns co-movements.

Indices returns from BLSE and SASE have shown a moderate partial correlation (0,498 and 0,530, respectively), significant at 99%. These values slightly differ from the simple correlation coefficient of 0,548 and 0,593, which brings us to the conclusion that there is no significant influence of other indices on co-movements of these pairs of indices returns. All other partial correlation coefficients are low, ranging from 0,103 to 0,214, and all of them are statistically significant at 99%.

Correlation coefficients between indices returns are much lower than the correlation analysis of indices values would indicate. It means that even though the indices tend to move in tandem, their percentage changes are not highly positively correlated. It proves possible to diversify risk by investing in regional stock exchanges.

To show diversification, we assume the existence of index funds replicating stock indices analyzed in this paper. Diversification effect on the regional stock markets was shown on the example of two and three index fund stocks portfolios, formed like indices SASX-10, CROBEX and FIRS. Standard deviation is diminishing by adding one more index fund stock in the portfolio, which is a proof of diversification. Diversification is also visible on graphical demonstration. In most of the period, the markets were bearish, resulting in a negative mean in four of six cases. The low and moderate correlation coefficients between indices pairs indicate diversification possibilities on all the analyzed markets. We could have obtained much "nicer" results if we had adjusted the period, excluding the second half of 2008. All of the indices would have a positive mean, and diversification effects would be more visible.

One of the most important results of this research is that equally weighted portfolio of three index fund stocks would have very good standard deviation – mean trade off, lying almost on efficient portfolios. This encourages creation of such index funds, whereby the portfolio management in the region would be improved. This also speaks for passive portfolio management. It also implies that such portfolio could be used as a proxy for market portfolio in tests of Sharpe's CAPM. In CAPM tests market portfolio efficiency is required.

Since the observed markets tend to move together, it will be interesting to track the co-movements of analyzed markets in the recovery period, after the ongoing global financial and economic crisis.

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MOGUĆNOSTI DIVERZIFIKACIJE RIZIKA NA REGIONALNIM BURZAMA

SAŽETAK

Ovaj rad istražuje mogućnosti diverzifikacije na četiri tržišta kapitala Zapadnog Balkana: Sarajevske, Banjalučke, Zagrebačke i Beogradske burze. Iako su posmatrana tržišta visoko segmentirana sa različitom regulativom, kretanje kapitala na ovim tržištima je bez ograničenja. Analizirajući šest najvažnijih dioničkih indeksa u periodu od 34 mjeseca, od 2006. do 2008., našli smo nisku do umjerenu pozitivnu statistički signifikantnu korelaciju između parova prinosa na indekse. Mada je analizirani period obuhvatao drugu polovinu 2008. godine, kada je tekuća financijska i ekonomska kriza postala globalna, rezultati studije ohrabljuju. Koristeći Markowitzev metod portfolio selekcije dokazan je efekat diverzifikacije na analiziranim tržištima.

JEL Classification: G11, G32

Keywords: *diverzifikacija rizika, dionički indeksi, tržišta kapitala Zapadnog Balkana, Markowitzev model*