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THE IMPACT OF FINANCIAL CRISES ON THE SHORT-TERM INTERACTION BETWEEN BALKAN STOCK MARKETS

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Abstract
The aim of this study is to examine the impact of financial crises on the short-term interaction between stock market returns of the Macedonian, Serbian and Croatian equity markets. Daily data sample spans from January 4th 2006 to March 31st 2017and based on detected Zivot-Andrews structural break point tests three subsamples are created: Subsample 1- January 4th 2006 to December 31th 2007, the period characterized as period of growth on the three Balkan stock markets, Subsample 2 - January 1st2008 to June 30th 2011, turbulent period for the stock markets and Subsample3 – July 1st2011 to March 31st 2017, after crisis period. Using simple Correlation and Granger-causality tests it is found that three stock markets interacted mostly in the crisis period. A bi-directional pattern of causality is detected for all pairs, except for the relation Macedonia-Serbia. Via variance decomposition and impulse response functions the extent of the interaction within Subsample 2 is analyzed and as a most influential stock market that transmits the changes on the others is the Croatian stock market. From a perspective of Macedonian and Serbian investors, this means that they can benefit following the movement of the Croatian stock market.

Keywords: Dynamic Relationship, Granger Causality, Croatia, Serbia, Macedonia.

Jel Classification: G15; F36; C32

INTRODUCTION

The analysis of the interrelationship between the international stock markets has attracted the interest of the researchers and practitioners - investors and portfolio managers. They are in continuous search in their regional and international investment activities of models that represent the connection and causality between equity markets. This is because such models can provide a better approximation of the equity markets co-movements and enable better evaluation of securities. The research on short-term interaction shows the transfer of the shocks and give explanation how much the stock markets are connected. The focus of this study is three Balkan countries: Macedonia,

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Serbia and Croatia and investigation of the short-term interaction and the impact of the crisis on this interaction. These three Balkan countries used to belong to one common state, former Yugoslavia which like the former Soviet Union and Eastern bloc countries passed the transitional process of moving from a closed to an open market economy. The fact that these three countries used to belong to the same state means that they share almost same mentality, similar language, but not the same economic growth. Even the pattern of the privatization process was not the same in all transitional countries, but the development of capital markets were almost the same just with different timeline. The Balkan capital markets are with short history compared with the other developed countries, but within this short timeline they experienced two financial crises and of course bull and unfortunately bear market. The development started after 2000, first in Slovenia, Croatia and later in the rest of the former Yugoslav countries. The investors from more developed stock exchanges like Croatian and Slovenian were entering the less developed like Serbia, especially Macedonia. The values of the stocks were underestimated through the process of privatization, so the foreign investors that knew what happened in their country were buying stocks in the stock exchanges were the stocks were still underestimated, producing exponential growth of the stock prices. The domestic investors following the trend of raising stock prices produced mostly by foreign investors were buying also stocks raising the bubble that busted 2007–2008. In the following period after the crisis the foreigners became most sellers of the shares contributing to fall of the stock prices. The Macedonian investors as individual investors can buy stocks only in Macedonia. By the Law on foreign exchange operations in Macedonia, the residents, other than authorized banks, may not purchase securities abroad. These mean that Croatian and Serbian investors are buying securities in all three markets and Macedonian investors only through the investment funds that were founded in 2008. Following the previous facts it is interesting to investigate the level of interaction between these stock markets and of course influence of the crises on this interaction.

The goal of this study is to investigate the interrelationships between these three stock markets and explanatory power of each stock market on the other and the impact of the two crises on the bivariate relationships between these markets. The study employs simple bivariate lead–lag relationships between two markets, or standard Granger *F*-tests in a VAR framework to capture short run temporal causality between each two of Macedonian, Croatian and Serbian stock market returns. VAR models can describe the dynamic behavior of stock markets time series and can help for forecasting too. The short run interactions among the each two equity markets were further determined through the application of impulse response analysis and variance decomposition.

1. LITERATURE REVIEW

There is a vast body of literature that studies the co-movement of regional and international stock market indices. The analysis and investigation of the topic of financial integration attracted the researchers since 1960s, but more intensive research on this issue started after 90's (King at al. 1994; Longin and Solnik 1995; Karolyi and Stulz 1996; Forbes and Rigobon 2002; Brooks and Del Negro 2006). Most of these studies have found that the co-movement of stock market indices is not constant over time. Kizys

and Pierdzioch (2009) found evidence of increasing international co-movement of stock returns among the major developed countries since the mid-90s.

Within the context of the European markets, the fact that Central European markets (Poland, Czech Republic, Hungary, Slovakia) tend to display strong linkages with the U.S. and German markets highlights Syriopoulos (2007). With the beginning of the E.U. accession process the interest on the financial linkages between the Central and Eastern European markets and the world markets increased (Syllignakis and Kouretas 2010). Similarly, Li and Majerowska (2008) show limited interactions between the emerging markets (Warsaw and Budapest) and the developed markets (Frankfurt and the U.S). Gilmore et al. (2005) explored the long-run interactions and co-integration between the U.K., German and Central European stock markets (Hungary, Poland, and Czech Republic) and the results were negative. These findings are in line with the study of Egert and Kocenda (2007) who do not find any interactions between the Western European stock markets (France, Germany, and the U.K.) and the stock markets of Central and Eastern Europe (Czech Republic, Hungary and Poland). Voronkova (2004) shows evidence of long-run relationships between the German and Polish stock indices as well as the German and Hungarian indices over the period from 1993 to 2002. Tudor (2011) presents evidence on time-varying interdependencies among six Central and Eastern European stock markets and the U.S. market.

The researches about linkages between Balkan stock markets and their integration with the developed countries are modest taking into considerations that they were established after 2000. Syriopoulos and Roumpis (2009) found that Balkan stock markets exhibit time-varying correlations among themselves, but correlations with the mature markets are modest. Vizek and Dadic (2006) examine the integration between German equity markets, selected CEE equity markets and the Croatian equity market and no evidence of long-term relationship between the Croatian and German stock markets is found. Samitas and Kenourgios (2011) investigate the stock market integration in a number of Balkan countries and compare it to the integration among several developed markets (US, UK, Germany) in 2000-2006. Using several co-integration tests, the results support the existence of long-term relationships among Balkan stock markets and developed markets. International stock market co-movements between Czech Republic, Hungary and Poland, and Croatia, Macedonia and Serbia for the 2006–2011 time period was examined by Horvath and Petrovski (2013) and using time varying co-movement of the volatilities in the time domain show that there is a zero correlation between Western stock markets and Serbian and Macedonian stock markets. Angelovska (2016) using Co-integration analysis and Granger causality tests investigates the bilateral relationship between Macedonian stock exchange and three Yugoslav Republics (Slovenia, Croatia and Serbia), and three world stock exchanges (USA, Germany and UK) for the time period covering January 3rd, 2005, through December 1th, 2009. The only evidence of co-movement of Macedonian stock indices before the 2007 Crisis is found in the relation to Croatian and Slovenian indices. The Macedonian stock market is only the recipient of short-term dynamics. MBI10 is Granger caused by CROBEX, BELEX, DAX, FTSE and DOW and there is no reversibility in the impact, except for CROBEX (Angelovska 2016).

2. METHODOLOGY

The simple linear correlation analysis is used as a start to find out how two variables move in relation to each other. The linear correlation calculated by the Equation (1) shows the strength of the association between dependent and explanatory variables.

$$r=(n\Sigma xy-(\Sigma x)(\Sigma y))/\sqrt{n(\Sigma x^2)-(\Sigma x)^2}\ \sqrt{n(\Sigma y^2)-(\Sigma y)^2} \quad (1)$$

where, X and Y are the random variables. Alternative notation is: $\rho = \sigma_{12} / \sigma_1 \sigma_2$ i.e. unconditional correlation ρ is a number that ranges between +1 and -1. High positive values indicate that returns are moving together in the same direction, and high negative values indicate movement in the opposite direction.

The unit-root property of financial variables has been widely accepted since Nelson and Plosser's (1982), well-known paper. The unit-root property of the variables is first step that is necessary before empirical studies. Unit root test is viewed as mandatory on time series data since these data may possess specific properties like memory, trend and structural break.

In this study three tests are used to detect the unit root property of the stock market indices. The first one is Dickey and Fuller (1979), the Augmented Dickey and Fuller (ADF) test and is generally employed as shown below:

$$\Delta y_t = \propto + \beta_t + (\rho - 1) y_{t-1} + \sum_{i=1}^{k-1} \theta_i \, \Delta y_{t-i} + \alpha_t \quad (2)$$

Where Δ is first difference; y_t is financial variables such as stock price; t is trend variable; and α_t is a white noise term. The null hypothesis is ρ=1 and y_t is said to be unit root if the null failed to reject the null. Beside ADF test nonparametric Phillip-Perron (1988) test is used.

Even though the ADF test is generally used to detect unit root property of the time series it can fail to reject the null when the sample period includes some major events like crises, shocks etc. This can lead to erroneous conclusions in the case when the null is not rejected. Zivot and Andrews (1992), Perron and Vogelsang (1992), and Perron (1997) have developed unit root test methods which include one unknown structural break. Zivot and Andrews (1992) model is shown in Equation 3.

$$y_t = \alpha + \beta_t + (\rho - 1) y_{t-1} + \gamma DU_t(\lambda) + \sum_{i=1}^{k-1} \theta_i \, \Delta y_{t-i} + \alpha_t \quad (3)$$

Where $DU_t(\lambda) = 1\ if\ t > T\lambda, 0\ otherwise; DU_t(\lambda) 1\ for T > \lambda, otherwise\ DU_t(\lambda) = 0; = \frac{T_B}{T}$ represents the location where the structural break lies; T is sample size; and T_B is the date when the structural break occurred.

Once the statistical property of the variables is established, the Vector Autoregressive Model (VAR) can be performed for exploration of the dynamic effects between variables and random shocks in the system variables. The VAR model has proven to be especially useful for describing the dynamic behavior of economic and financial time series and for forecasting. It often provides superior forecasts to those from univariate time series models and elaborate theory-based simultaneous equations models. The bivariate VAR

model to test the Granger causality is adopted, based on Granger's approach (Granger 1969) to determine the direction of short-term dynamics between the Macedonian, Croatian and Serbian stock indices' returns.

A variable X Granger-causes Y if Y can be better predicted using the histories of both X and Y than it can using the history of Y alone. Beside the notion of causality as misnomer the term "Granger causality" it does not mean that movements in one variable causes movement in the other, but rather causality implies a chronological ordering of movements of the series (Brooks 2002, 355). In this context it means that only past values of X can "cause" Y. Sims (1972) points out that a necessary condition for X to be exogenous of Y is that X fails to Granger-cause Y. Similarly, variables X and Y are only independent if both fail to Granger-cause the other. The Granger causality test is a statistical hypothesis test in order to determine how much of the current Y can be explained by past values of Y and then to see whether adding lagged values of X can improve the explanation.

In order to identify whether there exist causal relations among the time series of the present investigation, bivariate regressions of the following form are employed:

$$\Delta Y_t = a_0 + \sum_{i=1}^{k} a_i \Delta Y_{t-i} + \sum_{i=1}^{k} \beta_i \Delta X_{t-i} + e_t \quad (4)$$

$$\Delta X_t = a_0 + \sum_{i=1}^{k} a_i \Delta X_{t-i} + \sum_{i=1}^{k} \beta_i \Delta Y_{t-i} + u_t \quad (5)$$

for all the possible pairs of (X, Y) series in the group. In these equations, ΔXt and ΔYt are returns on two stock market indices and k is the number of lags. In the first equation it is assumed that the present values of variable Y are a function of its lagged values and the lagged values of variable X. In the second equation, it is assumed that the values of variable X are a function of its lagged values and the lagged values of variable Y. EViews report the Wald statistics for the joint hypothesis:

$$\beta_1 = \beta_2 = \beta_3 = \cdots = \beta_k = 0$$

for each equation. Hence, the null hypothesis is that X does not Granger-cause Y in the first regression and that Y does not Granger-cause X in the second regression.

In addition to the Granger causality analysis, variance decomposition of forecast error analysis is used. Variance decomposition can show the proportion of the movements in a market due to its own shocks versus shocks from other markets. Variance decomposition serves to supplement the findings of Granger causality. In the presence of causality, we expect the shocks of the causing market to be transmitted to the caused market. If the variance of the forecast error of a market is explained mostly by its own shocks and less by shocks of other markets, the market is said to be more segmented than integrated. Decomposition of the variance uses the forecast error of the VAR model in order to determine the extent to which any movement in one market can be explained by the shock to another.

One of the advantages of VAR specifications is that it allows for the computation of Impulse response functions, i.e. functions of the response of any endogenous variables to one standard deviation shock in any other endogenous variable in the system.

The information contained in the variance decomposition can be equivalently represented by graphs of the impulse response functions. Both are obtained from the moving average (MA) representation of the original VAR model. Impulse response functions essentially map out the dynamic response path of a variable due to a one-period standard deviation shock to another variable. The shocks are orthogonalized by using the Choleski decomposition method.

3. DATA

The data used in this study comprised of the daily closing prices (in logs) in three Balkan stock markets for the major stock market index for each country. The high frequency data incorporated here include information on short-run market interactions that may be absent in lower frequency data. The stock market indices of interest are MBI10 of Macedonia, SRXE of Serbia and CROBEX of Croatia. The indices are capitalization-weighted price indices and are made up of the most traded stocks. The data were obtained from national stock exchanges and were adjusted or all the dates were lined up for comparison. This is needed due to the fact that each country had different holidays on which the stock markets are closed. Because most markets are operating in the same time zone, the problem of non-overlapping trading hours does not arise. Also, when a stock exchange is closed due to a national holiday, we use the previous day closing prices. Due to different starting point of the indices under investigation the chosen starting day was on the basis of existence of all three indices. The time frame is period from January 4th 2006 till March 31th 2017. It gives a total of 2931 observations and includes both bull and bear phases, high and low volatility and different market conditions. The indices' movements are presented in Figure 1. All three country indices follow a similar trend of steady growth and then a sharp plunge in 2008. The recovery after the US financial subprime crisis was again followed by decline after 2012 coinciding with the European debt crisis. The index level is stalled in the period after the crisis for all three stock market indices.

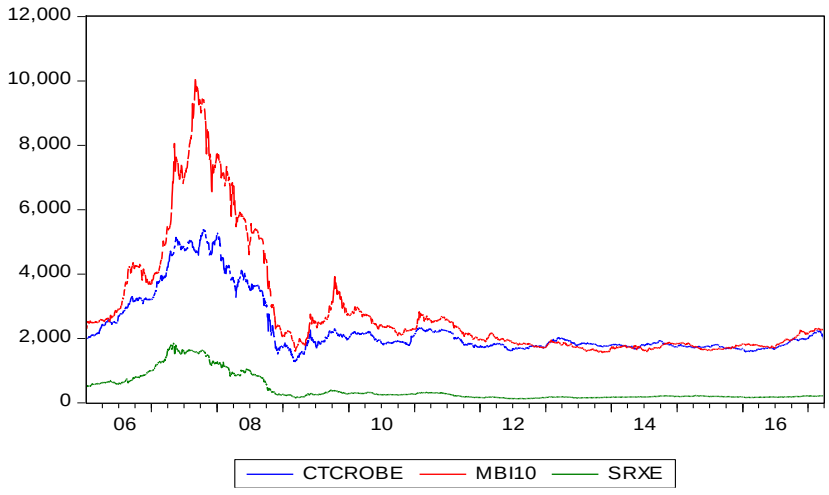

Figure 1. Stock market indices' movement in the period January 4th 2006 till March31th 2017

Descriptive statistics of the stock market returns of the Croatian, Serbian and Macedonian stock market indices for the period January 4th 2006 to March 31th2017 are presented in Table 1 (authors' calculations). The returns are calculated by the Equation 6.

$$rt = \ln(Pt / Pt\text{-}1)*100 \quad (6)$$

The mean return is negative for all three stock market indices and Serbian stock index has highest negative mean return, followed by highest volatility. All stock return series show leptokurtosis and there is evidence of negative skewness for Macedonian and Croatian stock indices returns. Skewness is a particular feature of returns in emerging markets. Significant kurtosis and skewness (long left or right tail) indicate rejection of normality in stock return distributions.

Table 1. Descriptive statistics of the stock returns of Croatia, Macedonia and Serbia in the period January 4th 2006 to March 31th 2017

	Croatia	Macedonia	Serbia
Mean	-0.000127	-0.000760	-0.030901
Median	0.000000	0.000000	0.000000
Maximum	14.77896	6.661235	16.88127
Minimum	-10.76363	-10.28315	-12.90228
Std. Dev.	1.170747	1.197637	1.602592
Skewness	-0.036881	-0.469545	0.349865
Kurtosis	23.18689	14.33499	20.22141
Jarque-Bera	49767.87	15798.57	-90.56996
Probability	0.000000	0.000000	7525.121
Observations	2931	2931	2931

4. EMPIRICAL RESULTS

Granger casualty test can be performed and valid only if the series are stationary. The Augmented Dickey-Fuller (ADF) and the Phillips Peron (PP) tests are designed to capture stationarity with opposite null hypotheses. We expect not to reject the null hypothesis for the level values but to reject for the first differences, which imply that the stock indices are integrated of order one.

The results from ADF unit root test indicate that the null hypothesis of a unit root in the log levels cannot be rejected for all three times series, while a unit root for the returns is rejected at the 1% significance level (Table 2). The PP test results shown in Table 2 support the findings of the previous test. Within the observation period there where two crises: US subprime mortgage crisis and European debt crisis that gave implication in all countries and cause the fall of stock market prices. Figure 1 showed how the three Balkan countries followed these world processes. These facts implied the need to look for the structural break points dates. Zivot-Andrews test was performed to detect the break point dates (Table 2 – authors' calculations). Macedonian stock market reacted first to the US subprime crisis, as detected by the Zivot-Andrews test and had structural break on October 18th 2007, Croatian on January 7th 2008 and Serbian stock market on July 1st 2008. Based on these findings the data were divided in two subsamples. The first subsample according to the detected structural breakpoint is from January 4th 2006 to December 31th 2007 and the second from January 1st 2008 to March 31st 2017.

Table 2. ADF and PP unit root tests for the period January 4th 2006 to March 31th 2017. Null Hypothesis: has a unit root and ZA unit root test. Null has a unit root with structural break

	ADF test*		PP test*		Zivot-Andrews test**	
	Level	Return	Level	Return	Level	breakpoint dates
Macedonia	-0.92	-33.36	-1.07	-36.37	-4.14	10/18/2007
Croatia	-1.13	-27.99	-1.31	-50.87	-5.12	1/07/2008
Serbia	-0.87	-33.19	-0.93	-47.45	-4.71	7/01/2008

Note: *ADF - Augmented Dickey-Fuller test; MacKinnon critical values for rejection of hypothesis: 1%Critical value -3,436749, 5% Critical value -2,864254, 10% Critical value -2,568267
** Zivot-Andrews test statistic: 1% Critical value -5.57, 5% Critical value -5.08, 10% Critical value -4.82.

The Figure 2 shows graphically the structural breakpoint dates of the Croatian, Macedonian and Serbian stock indices' returns in the period January 4th 2006 to March 31th 2017.

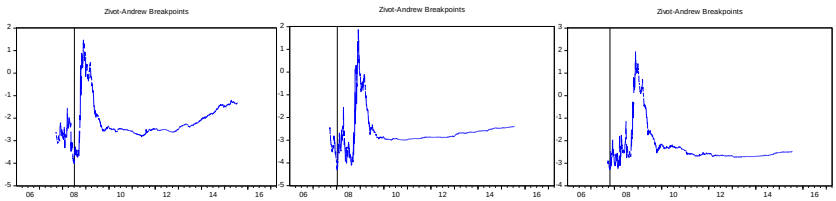

Figure 2. Zivot-Andrews break points dates for SRXE, CROBEX and MBI10 for the period January 4th 2006 to March 31th 2017.

The unit root tests are performed on the second subsample from January 4th 2009 to March 31st 2017 and the results are presented in Table 3. Unit root in the log levels cannot be rejected for the three stock indices, while a unit root for the returns is rejected at the 1% significance level. The European sovereign debt crisis started from 2009 and Zivot-Andrews test was performed to investigate the structural break point dates to detect if there is structural break point within this period for the three stock market indices. The structural break point dates indicated that the impact of the European debt crisis was in the middle of 2011 (Table 3 – authors' calculations).

Table 3. ADF and PP unit root tests for the period January 4th 2008 to March 31th 2017. Null Hypothesis: has a unit root and ZA unit root test. Null has a unit root with structural break

	ADF test*		PP test*		Zivot-Andrews test**	
	Level	Return	Level	Return	Level	breakpoint dates
Macedonia	-2.88	-31.09	-2.80	-35.57	-3.37	6/16/2011
Croatia	-2.35	-28.78	-2.49	-46.21	-4.26	7/25/2011
Serbia	-2.95	-30.06	-3.02	-44.86	-3.60	5/31/2011

Note: *ADF - Augmented Dickey-Fuller test; MacKinnon critical values for rejection of hypothesis: 1%Critical value -3,436749, 5% Critical value -2,864254, 10% Critical value -2,568267 ** Zivot-Andrews test statistic: 1%Critical value -5.57, 5% Critical value -5.08, 10% Critical value -4.82.

Based on the results of Zivot-Andrews structural breakpoint test, the three subsample are created:

Subsample 1 – January 4th 2006 to December 31th 2007
Subsample 2 – January 1st 2008 to June 30th 2011
Subsample 3 – July 1st 2011 to March 31st 2017

ADF and PP Unit root test is performed to validate the stationarity in the return time series in the Subsample 1, 2 and 3 as a precondition for Granger causality test (Table 4 – authors' calculations).

Table 4. ADF and PP unit root tests for the Subsample 1, 2 and 3 in first differences. Null Hypothesis: has a unit root

	ADF test	PP test	ADF test	PP test	ADF test	PP test
Macedonia	-14.01	-12.31	-19.45	-21.39	-31.08	-31.16
Croatia	-18.8	-19.06	-15.65	-27.94	-35.37	-35.64
Serbia	-17.34	-17.29	-25.06	-25.41	-39.21	-39.26

Note: ADF - Augmented Dickey-Fuller test; MacKinnon critical values for rejection of hypothesis: 1% Critical value -3,436749, 5% Critical value -2,864254, 10% Critical value -2,568267

Descriptive statistics of the three subsamples are presented in Table 5 (authors' calculations), indicating that the highest mean returns in all countries under investigation are achieved in the first period (Subsample 1) or the period before the financial subprime crisis. The highest returns are noticed in Macedonia and Serbia followed by high volatility. This period is characterized as period of growth. The worst period is within Subsample 2 in the period 2008–2011. The highest negative mean returns in this period are noticed in Serbia and Macedonia followed by highest volatility. This is the most turbulent time for the Balkan stock markets. The period covered by the Subsample 3 is stable with almost equal negative mean return in the stock markets followed by the smallest standard deviation or this after crisis period is characterized as most stable period.

Table 5. Descriptive statistics of the stock returns in the Subsample 1, 2 and 3

	Subsample 1			Subsample 2			Subsample 3		
	Croatia	Maced.	Serbia	Croatia	Maced.	Serbia	Croatia	Maced.	Serbia
Mean	0.16	0.23	0.17	-0.09	-0.12	-0.17	-0.01	-0.01	-0.02
Median	0.11	0.16	0.10	0.00	-0.04	-0.09	0.00	0.00	0.00
Maximum	3.52	6.66	11.85	14.78	6.67	16.88	3.39	3.39	11.64
Minimum	-3.57	-6.57	-8.32	-10.76	-10.28	-12.90	-4.68	-4.48	-8.66
Std. Dev.	0.93	1.40	1.62	1.81	1.68	2.21	0.61	0.62	1.06
Skewness	0.05	0.076	0.04	0.11	-0.51	0.47	-0.57	-0.14	0.24
Kurtosis	4.59	6.93	10.87	12.77	9.62	14.68	8.23	6.88	18.68
Jarque-Bera	54.9	334.76	1338.	3630.73	1709.37	5223.75	1786.49	946.49	15359
Probability	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Observations	519	519	519	913	913	913	1497	1497	1497

The simple correlation method prior to econometric analysis is carried out between the Croatian, Macedonian and Serbian stock market returns, as a preliminary insight into the existence of relationship or co-movement among the time series variables. Table 6 (authors' calculations) displays the correlation coefficients between the three stock-market returns in the three periods of investigation. The coefficients are highest in the turbulent period of the Subsample 2. The correlation coefficient between Croatia and Macedonia is 0.26, Croatia and Serbia 0.28 and Serbia and Macedonia 0.29. Similar low correlation coefficients are detected in the first period of growth and last stable period, Subsample 1 and 3.

Table 6. Correlation matrix between the stock market returns for Subsample 1, 2 and 3

	Subsample1			Subsample 2			Subsample 3		
	Croatia	Maced.	Serbia	Croatia	Maced.	Serbia	Croatia	Maced.	Serbia
Croatia	1.00			1.00			1.00		
Macedonia	0.07	1.00		0.26	1.00		0.09	1.00	
Serbia	0.09	0.03	1.00	0.28	0.29	1.00	0.12	0.03	1.00

To understand the nature of linkages between two markets – whether one market is influencing or causing the other market or whether the two markets are causing each other Granger causality method is performed. The VAR estimates are computed taking each one of them once as the dependent variable and the other variables as the independent variables. The computing is done for each subsample. The results of the Granger's causality tests are presented in Table 7 (authors' calculations) based on F-statistic. The indication of the correlation results are confirmed in the pairwise causality test, meaning that 5 bidirectional relations of full causality are found between Croatian, Macedonian and Serbian stock markets in the second subsample or the turbulent crises period. The Granger causality is found for all pairs, except for the relation Macedonia-Serbia. This means that changes in the prices at Croatian stock market predict changes in the prices at Macedonian and Serbian stock markets and vice versa except Macedonian stock market does not predict changes in Serbian stock market. The causality in the Subsample 1 is found only in the relation Croatia – Serbia at 5% significance level. In the period classified as subsample 3 or stable period four causality relations are found. Croatian stock price changes influence only Macedonian stock prices. Serbian stock market causes Croatian and Macedonian stock market and the relation with Macedonian is vice versa

Table 7. Pairwise Granger Causality Tests

	Subsample 1		Subsample 2		Subsample 3	
Null Hypothesis:	F-Stat.	Prob.	F-Stat.	Prob.	F-Stat.	Prob.
MB10 does not Granger Cause CTCROBE	2.52	0.08	4.47	0.01*	1.70	0.18
CROBE does not Granger CauseMB10	1.19	0.30	43.93	0.00*	8.72	0.00*
SRXE does not Granger Cause CTCROBE	1.57	0.21	8.42	0.00*	15.96	0.00*
CROBE does not Granger Cause SRXE	3.03	0.05*	29.84	0.00*	2.17	0.11
SRXE does not Granger Cause MB10	1.93	0.14	9.68	0.00*	17.03	0.00*
MB10 does not Granger Cause SRXE	0.47	0.62	1.05	0.35	3.21	0.04**

The Granger causality tests only indicate the most significant direct causal relationship. To investigate further the extent to which these stock markets could be explained by changes in other markets, variance decomposition of forecast error is performed. Variance decomposition shows the percentage of forecast error that is attributable to its own and other country shock. Table 8 (authors' calculations) shows the results of variance decomposition analysis for a 6 days forecast period for the Subsample 2, because this is turbulent period when the strongest interaction between the three Balkan stock markets are detected by the correlation and Granger causality method. It can be seen that the Macedonian stock market 92.6 per cent of the forecast error can be explained by its own variance. Croatian stock market influences the Macedonian stock market by 7.4 per cent after the first day and 20 per cent after the third day. Serbian stock market 90.6 per cent of the forecast error can be explained by its own variance. Croatian stock market influences the Serbian stock market by 7.1 per cent after the first day and 14 per cent after the third day.

Table 8. Variance Decomposition of CROBE, MBI10 and SRXE

Per.	S.E	CROB	MB10	SRX	S.E.	CROB	MB10	SRX	S.E.	CROB	MB10	SRX
1	1.78	100.0	0.00	0.00	1.51	7.39	92.60	0.00	2.10	7.09	2.32	90.59
2	1.79	99.93	0.06	0.00	1.65	17.64	82.12	0.23	2.19	14.05	2.18	83.76
3	1.81	98.11	0.66	1.23	1.68	20.19	79.17	0.64	2.21	14.18	2.42	83.40
4	1.81	98.04	0.67	1.29	1.68	20.15	78.98	0.86	2.21	14.14	2.56	83.30
5	1.81	98.03	0.67	1.29	1.68	20.14	78.93	0.93	2.21	14.19	2.56	83.24
6	1.81	98.03	0.67	1.29	1.68	20.15	78.92	0.93	2.21	14.21	2.56	83.23

To address the question of how rapidly events in one variable are transmitted to the others, impulse–response function was utilized. Impulse response functions are computed to give an indication of the system's dynamic behaviour. The shocks are orthogonalized by using the Choleski decomposition method. Impulse response function analysis can be seen in Figure 3. Response of series when representing one standard deviation shock for each series is presented in the graphs. It shows the effect of one standard deviation shock that comes to one of the random errors of the current and future values of the endogenous variables. Responses of the Macedonian, Croatian and Serbian stock market to Cholesky one standard deviation shock of the Croatian, Serbian and Macedonian stock market is shown in Figure 3 (authors' calculation).

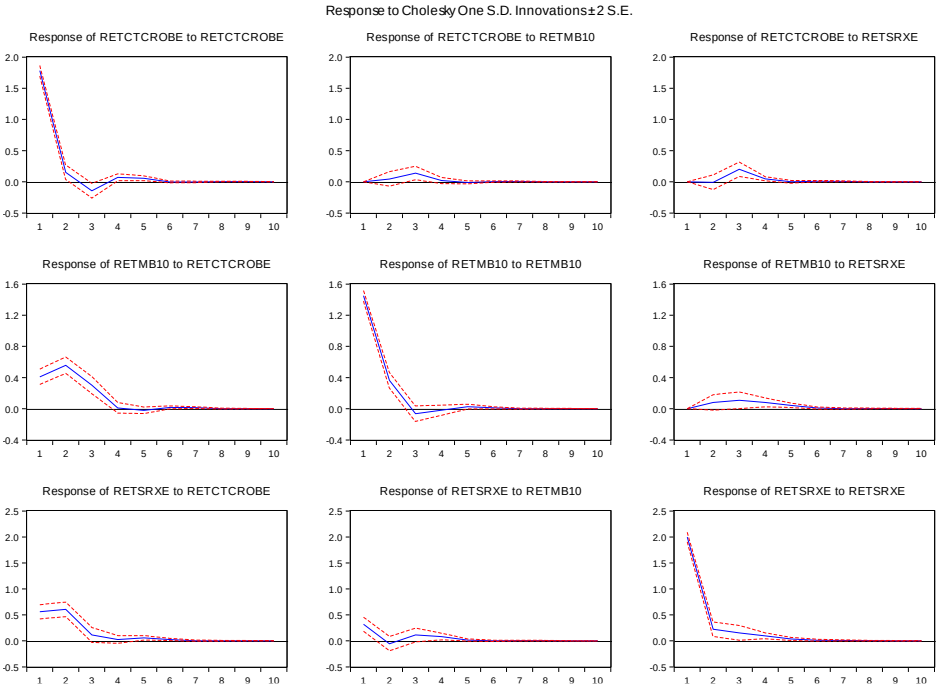

Figure 3. Impulse Responses Analysis

Generalized impulse responses from one standard deviation shock to MBI10, CROBE and SRXE (*x*-axis represents days elapsed after shock; *y*-axis represents standard deviations; dashed lines refer to 90% confidence bands).

The response of the Macedonian stock market to one standard deviation shock of the Croatian capital market is 0.4% with a delay of one day and 0.55% with two days delay

at 5 per cent level of significance. The response of the Macedonian stock market to one standard deviation shock of the Serbian stock market is 0.07% with a delay of two days at 5 per cent level of significance. The response of the Serbian and Croatian stock market to one standard deviation shock of the Serbian, Croatian and Macedonian stock market is insignificant at 5 per cent level of significance.

CONCLUSION

This study investigates the impact of the two financial crises: US subprime and European debt crisis on patterns of dynamic bidirectional causal linkages among Macedonian, Croatian and Serbian stock markets in the period January 4th 2006 to March 31th 2017. Based on Zivot-Andrews unit root test that can detect structural break point dates, three sub-sample periods are constructed: Subsample 1 – January 4th 2006 to December 31th 2007, the period characterized as period of growth on the three Balkan stock markets, Subsample 2 – January 1st2008 to June 30th 2011, turbulent period for the stock markets and Subsample 3 – July 1st2011 to March 31st 2017, after crisis period when the prices are stalled on low level with low volatility as well. The simple correlation method prior to econometric analysis is carried out between the Croatian, Macedonian and Serbian stock market returns, and the coefficients are highest in the turbulent period of the Subsample 2. Using a Granger *F*-tests in a VAR framework, short run temporal bi-causality between Macedonian, Croatian and Serbian stock returns is examined for all three subsamples. It seems that the stock markets are mostly interconnected or depend on each other's movement in the turbulent crisis period within the subsample 2. The Granger causality is found for all pairs, except for the relation Macedonia-Serbia. The causality in the Subsample 1 is found only in the relation Croatia – Serbia at 5% significance level. In the period classified as subsample 3 or stable period four causality relations are found. Croatian stock price changes influence only Macedonian stock prices. Serbian stock market causes Croatian and Macedonian stock market and the relation with Macedonian is vice versa. The turbulent crisis period made three Balkan stock markets to be mostly interrelated meaning that in the period with highest negative returns and highest volatility the shock from one stock exchange was transferred to another. To investigate further the extent to which these stock markets could be explained by changes in other markets, variance decomposition of forecast error is performed in the period of the subsample 2. When variance decomposition values were analyzed after the resolution of VAR model, it was noticed that stock market returns have especially been affected by its own past values in variance decomposition. For the Macedonian stock market 92.6 per cent of the forecast error can be explained by its own variance. Croatian stock market influences the Macedonian stock market by 7.4 per cent after the first day and 20 per cent after the third day. For the Serbian stock market 90.6 per cent of the forecast error can be explained by its own variance. Croatian stock market influences the Serbian stock market by 7.1 per cent after the first day and 14 per cent after the third day. To address the question of how rapidly events in one variable are transmitted to the others, impulse–response function was utilized. The response of the Macedonian stock market to one standard deviation shock of the Croatian capital market is 0.4% with a delay of one day and 0.55% with two days delay at 5 per cent level of significance. The response of the Macedonian stock market to one standard deviation

shock of the Serbian stock market is 0.07% with a delay of two days at 5 per cent level of significance. The response of the Serbian and Croatian stock market to one standard deviation shock of the Serbian, Croatian and Macedonian stock market is insignificant at 5 per cent level of significance.

This suggests that changes in the Croatian stock market have a significant effect on the Macedonian and Serbian stock market in the crisis period. The Macedonian and Serbian stock market responds quickly to changes in the Croatian market or the Macedonian stock market tends to follow the directions taken by the Croatian stock market and that the impact on Macedonian market is significant. From a perspective of Macedonian and Serbian investors, this means that they can benefit following the movement of the Croatian stock market in turbulent crisis period.

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