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ANALYSING TIME-VARYING INTERRELATIONSHIP AMONG THE BALKAN, DEVELOPED EUROPEAN AND US STOCK MARKETS

Abstract. *This paper explores the dynamic conditional correlations among five Balkan stock markets and the mature markets (the US and EU50), leading to several important findings. First, the dynamic correlations are much higher among the emerging Balkan markets (Romania, Croatia, and Bulgaria). This is also the case when other measures of correlation, such as Spearman's rho, Kendall's tau, and Pearson's r, are applied. In addition, the Balkan markets show lower correlation with the US than with the EU markets. Furthermore, correlation increased during the global financial crisis and it remained high during the European sovereign debt crisis. However, there was no significant increase in correlation during the stock market instability of summer 2015. Lastly, to determine whether the transmission mechanism to the emerging Balkan markets (excluding Greece) works through the EU index and Greece, we first control the role of the EU index and document that there is no significant correlation between the US and almost all the Balkan markets (save for Turkey). Further controlling the role of Greece does not have a major impact on Balkan markets.*

Keywords: *Balkan and developed stock returns, interdependence, DCC-GARCH, Global Financial Crisis, European sovereign debt crisis*.

JEL Classification*:* **C22, G11, G15**.

1. Introduction

How did the correlations among five Balkan economies (Greece, Croatian, Romania, Bulgaria and Turkey) and the mature markets (represented by the USA and the EU50) change during turbulent and tranquil periods? Answering this question is crucial for at least three reasons. First, to the best of our knowledge, there have been no recent studies in this regard and, additionally, only a limited

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number of studies have concentrated on correlation changes and co-movement among the Balkan and developed markets. A few authors have examined the Balkan markets (Dimitoros and Dimitris, 2012; Kenourgious and Samitas 2011; Syriopoulos, 2011; Syriopoulos and Roumpis, 2009), although two such studies did not investigate the correlation behaviour among the Balkan and the developed markets, and their sample does not cover episodes of turbulence. For example, Dimitoros and Dimitris (2012) used cointegration and causality to examine the short- and long-term relationships among the Balkan and developed markets for sample data covering up to 2005. Further, Syriopoulos (2011) used a similar methodology that covered a sample period until 2007. Kenourgious and Samitas (2011) studied correlations between the emerging Balkan markets (Croatia, Romania, Bulgaria and Turkey) by including Serbia in their study. However, their sample period ended in February 2009, which didn't fully cover the 2009 market instability, they also failed to consider correlations among the Balkan markets. Syriopoulos and Roumpis (2009) did study the correlations, but their sample study only covered the period until 2007. Nevertheless, there have been some persuasive studies that examined the stock markets using an advanced econometric method between the developed markets and one or more of the Balkan markets, both with and without non-Balkan economies (Albu et al., 2015; Dajčman, 2014; Kiviaho et al., 2014; Bein and Tuna, 2015; Lupu, 2015). Of these studies, Kiviaho et al. (2014) employed a wavelet coherency approach to investigate the spillover effects from the US and the three largest developed European stock markets to seven European frontier stock markets. They found that the Baltic region is more dependent than the central and south-eastern European stock markets. Lupu (2015) employed a DCC-GARCH and Markov switching analysis to examine contagion into 49 stock market indices, of which three were Balkan markets, while Dajčman (2014) examined return co-movement and contagion between the Croatian stock market and ten European stock markets.

Second, of the Balkan economies, the Greek market experienced several episodes of market instability and so determining the extent to which there has been crisis spillover into the other Balkan economies remains important from a regional perspective. A growing body of literature is focused on the interdependence and correlation changes between the Greek market and other markets. For example, Mink and Haan (2013) examined whether news about the financial bailouts and other news concerning Greece could lead to financial contagion on 48 European banking stock returns. Interestingly, they noted that news about the bailouts had a significant effect on the European Bank returns, whereas the other news only effected local Greek banks. Tamakoshi et al. (2012) studied the correlation among Greece and six developed markets (Germany, France, Ireland, Italy, Spain and the UK) during both the global financial crisis and the sovereign debt crisis. They found a decline in correlation during the sovereign debt crisis. Additionally, the recent turmoil in the USA and European countries has led researchers to investigate the spillover to other countries (e.g., Albu et al., 2016; Bein and Tuna, 2016).

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Third, the Balkan economies, principally the emerging economies, are currently witnessing moderate inflation and a gradual increase in international trade. In addition, Bulgaria, Romania and Turkey are recording positive growth, while almost all the Balkan markets continue to attract foreign direct investment (FDI) (Table 1). It is also worth noting that three of the emerging Balkan economies are already members of the EU, while Turkey is currently going through the accession process. Therefore, there is a potential benefit for international investors who appreciate the advantages of growing markets and portfolio diversification. Indeed, numerous authors have investigated the interrelationships among stock markets with the purpose of portfolio diversification (Amira et al., 2011; Baur, 2012).

The contributions of this paper are as follow. First, this study investigates the correlation behaviour of the Balkan markets during the global financial crisis, the European sovereign debt crisis and the recent market instability. Second, it is one of the first studies to examine the co-movements and correlation changes among the Balkan economies. Most of the existing research focuses on the spillover from the developed EU markets. Third, the study employs a weekly stock price, which has several advantages, including minimising cross-country difference and weekend effect. Moreover, the spillover from the US to the Balkan markets is limited. Most of the previous studies that focus on the Balkan stock markets and other emerging European markets ignore the role of the US. Fourth, we compare the spillover from the EU index and the US to the Balkan markets.

The findings of this paper are as follow. Importantly, applying a multivariate GARCH–DCC framework and including another method for measuring correlation led to several results. First, the dynamic correlations are much higher among Romania, Croatia and Bulgaria, with the latter two countries having a higher correlation with each other and with Romania than with the US and the EU. Second, the Balkan markets show lower correlation with the US than with the EU. In particular, Romania, Croatia and Bulgaria have a lower correlation with the US market. Third, the dynamic correlations among the Balkan and the mature markets started to increase during the global financial crisis and it remained high during the European sovereign debt crisis. However, there was no significant increase in correlation during the stock market instability of summer 2015. Fourth, there is an important difference between the Greek market and the rest of the Balkan economies, even before the crisis. The correlation with the EU and US markets was higher from the beginning of the sample period and it remained high until the end of the period. Fifth, to determine whether the transmission mechanism to the emerging Balkan economies works through the EU index and Greece, we first controlled for the role of the EU index and documented that there is no significant correlation between the US and almost all of the Balkan markets (except for Turkey). However, we still noticed a statistically significant correlation with the Balkan stock markets. Nonetheless, controlling for Greece does not have a major impact on the level of correlation among the Balkan markets, and it was observed that Greece has only limited influence on the emerging Balkan stock markets.

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The remainder of this paper is organised as follows. Section one discusses the data and methodology of the study, while section two presents the empirical results. Finally, some concluding remarks are offered.

Note: The results are obtained by three-year averaging. BGR=Bulgaria, HRV=Croatia,GRC=Greece, ROM=Romania, and TUR=Turkey. Source: World Bank development indicator.

2. Data and Methodology

2.1 Data and descriptive statistics

To analyse the correlation behaviour among the Balkan and mature markets,

Table 1: Macroeconomic indicators of the Balkan countries

	GDP growth (annual %)				Trade (% of GDP)			
Name	2003-2005	2006-2008	2009-2011	2012-2014	2003-2005	2006-2008	2009-2011	2012-2014
BGR	5.96	6.38	-0.79	1.09	91.58	122.2	111.8	135.
HRV	4.6	4	-3.12	-1.18	84.96	85.44	76.64	85.8
GRC	4.16	2.97	-6.24	-3.23	49.77	56.7	52.97	64.2
ROM	6.19	7.61	-1.81	1.87	78.01	74.32	76.41	83.9
TUR	7.68	4.07	4.37	3.06	47.99	50.77	50.78	58.4
	Inflation, consumer prices (annual %)				FDI, net inflows (% of GDP)			
BGR	4.51	9.34	3.14	3.14	11.4	24.84	5.14	3.37
HRV	2.37	4.06	1.89	3.14	4.14	7.62	2.95	1.69
GRC	3.32	3.41	3.08	3.14	0.61	1.4	0.46	0.93
ROM	12.0	6.42	5.82	3.14	6.18	7.38	2.11	1.76
TUR	15.3	9.6	7.1	3.14	1.12	3.31	1.58	1.59

this study utilises weekly stock price indices for five Balkan economies and two stock price indices for the mature markets. The following indices represent the Balkan countries: SOFIX for Bulgaria, CROBEX for Croatia, ATHEX COMPOSITE for Greece, BET for Romania, and BIST NATIONAL 100 for Turkey. In terms of the mature markets, the S&P 500 COMPOSITE INDEX represents the US and the EUROSTOXX 50 (hereafter EU) serves as a proxy for the developed European markets. All of the stock prices are obtained from Thomson Reuters DataStream. In order to minimise the cross-country differences and capture the weekend effect, the study uses the weekly price from Wednesday to Wednesday, from 5 May 2004 to 7 October 2015. Other researchers have used the weekly stock prices to account for differences in market opening hours and to capture the weekend effect (Beirne et al., 2010).

Table 2 presents descriptive statistics concerning the five Balkan markets and the two mature markets (the US and EU50) using weekly returns. In general, the Balkan markets do have higher positive and negative means (average return) when compared to the mature markets. For example, the Romanian stock market has the

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highest return (0.134), followed by Turkey (0.126), while Greece and Bulgaria have negative returns (-0.23 and -0.029, respectively). High volatility as measured by standard deviation is noticed among the Balkan economies, with the most risky economy being Turkey (5.34), followed by Greece (5.17). Both the US and the EU returns show lower volatility than all of the Balkan economies. Table 2 also shows that the returns are all negatively skewed and, additionally, that all the kurtosis are greater than four, which meets the features of a financial time series. An augmented Dickey-Fuller (ADF) test is carried out first on the level and then on the transformed return. The test on the level fails to reject the null hypothesis that the time series exhibits a unit root against the alternative hypothesis that the series is stationary. However, the ADF test (at lag) on the return series obtained from [$\ln P_t - \ln P_{t-1}$]*100 reveals a rejection of the null hypothesis and an acceptance of the alternative. The Jarque-Bera test is also carried out to test whether the return is normally distributed. The Ljung-Box Q statistics and the Q statistics on the standardised squared residuals at the lag (10) indicate the presence of serial correlation. The return also indicate the presence of autoregressive conditional heteroscedasticity (ARCH) effects, which is confirmed by the statistical significant of the coefficients.

Table 2: Descriptive statistics of the weekly returns

	USA	EU50	BGR	HRV	GRC	ROM	TUR
Mean	0.0967	0.0096	-0.029	0.042	-0.232	0.134	0.126
Std. Dev.	2.299	3.495	3.7534	3.366	5.177	4.556	5.34
Skewness	-1.171	-0.648	-1.469	-0.257	-0.337	-0.668	-1.05
Kurtosis	10.41	5.932	15.240	6.504	4.671	6.047	6.46
Jarque-Bera	150^{***}	25^{***}	393^{***}	31^{***}	80^{***}	275^{***}	40^{***}
ARCH(5)	12.49^{***}	22.2^{***}	21.9^{***}	51.9^{***}	8.15^{***}	15.7^{***}	21.7^{***}
Q(10)	20.2^{***}	33.14^{***}	121.6^{***}	66.3^{***}	11.8	50.0^{***}	37^{***}
Q^2(10)	135***	230.4^{***}	213.2^{***}	632.4^{***}	85.9^{***}	157.5^{***}	180^{***}
ADF	-9.08^{***}	-8.74^{***}	-6.81^{***}	-7.78^{***}	-8.8^{***}	-7.89^{***}	-8.9^{***}

Note: ***, **, and * are statistically significant at 1%, 5%, and 10%, respectively.

2.2 Methodology

The generalised autoregressive conditional heteroscedasticity (GARCH) model remains one of the most popular methods for modelling volatility and contagion across and within markets. This study aims to capture the time variance in the correlations by making use of the dynamic conditional correlation (DCC)-GARCH model proposed by Engle (2002). In recent years, this model has been used by several researchers (Antonakakis et al., 2013; Celik, 2012) due to the advantages it has over other models. For example, Forbes and Rigobon (2002) argued that the correlation analysis model does not take into account the problems of

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heteroscedasticity, endogeneity and omitted variable bias. Antonakakis et al. (2013) stressed that models such as the rolling window that are used to capture time variability suffer from the ghost feature. However, the DCC-GARCH model of Engle (2002) overcomes all such problems (Antonakakis et al., 2013).The DDC model of Engle (2002) can be expressed as

$$Y_t = K_t S_t K_t \quad (1)$$

where Y_t is the conditional covariance matrix, which is decomposed into conditional standard deviations, $K_t = diag(y_{1,1,t}^{1/2},.....,y_{N,N,t}^{1/2})$, in which $y_{i,i,t}$ is any univariate GARCH process, and S_t, the time dependent conditional correlations matrix specified as:

$$S_t = diag(m_{11,t}^{-1/2},....,m_{NN,t}^{-1/2})M_t(m_{11,t}^{-1/2},.....,m_{NN,t}^{-1/2}) \quad (2)$$

where Q_t is a symmetric positive definite matrix for the dynamic orrelation structure expressed as:

$$M_t = (1-\alpha-\beta)\overline{M} + \alpha w_{t-1}w_{t-1}^{'} + \beta M_{t-1} \quad (3)$$

Where w_t is a vector of the standardised residuals, $\overline{M}$ is an unconditional variance matrix of w_t, and 'α' and 'ß' are non-negative one-period lagged autoregressive and correlation coefficients satisfying α+ß<1. In addition, the parameter α shows the volatility and ß shows the persistence on DCC. Since we use weekly stock return series which deviate from normality,we use the quasi-maximum likelihood (QML) estimation method using Student's *t*-distribution for most of the estimations. The estimation of Engle's (2002) DCC-GARCH model comprises two steps. First, the estimation of the univariate GARCH model for the stock returns and, second, the estimation of the conditional correlations that varies over time.

3. Empirical Results

Table 3 presents a different measure of the correlation among the Balkan and mature markets (the US and EU indices) for the whole sample period. In Table 3, Panel A is the Pearson correlation and according to this measure, the Balkan markets show relatively lower correlation with the US than with the EU index. For example, considering the Balkan markets and the US, the highest correlation is noticed with Turkey (57%) and the lowest is with Bulgaria (39%). In terms of the EU, the highest correlation is with Greece (67%) and the lowest is with Bulgaria (49%). Further, the Pearson correlation of Romania and Turkey with the EU is around 63%. Considering the correlation among the Balkan economies, it is observed that a higher correlation exists among the emerging Balkan markets (Bulgaria, Croatia and Romania). For instance, the correlation between Romania and Bulgaria (55%) is much higher than that between Bulgaria and Greece and Bulgaria and the mature markets (the US and EU markets), while it is also high

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between Romania and Croatia (59%) and between Croatia and Bulgaria (53%). Among the emerging Balkan markets, Bulgaria has the lowest correlation with Turkey and Greece. For instance, the correlation between Bulgaria and Turkey is 37%, Bulgaria and Greece 40%. In Table 3, Panel B shows Kendall's tau correlation among the Balkan markets and the mature markets. In general, using this method provides a much lower correlation than using Pearson's r or Spearman's rho correlation (Panel C). For example, between the Balkan economies and the US, the highest correlation is observed with Turkey (33%) and the lowest with Bulgaria (around 20%). Kendall's tau correlation between the EU and the Balkan economies still shows higher correlation than with the US, the highest being with Greece (50%) and lowest being with Bulgaria (around 32%). The Kendall's tau correlation among the emerging Balkan markets is much greater than with Greece and the mature markets (the US and EU indices). Again, Turkey shows lower correlation with the emerging Balkan economies. Finally, Panel C presents the Spearman's rho correlation among the Balkan and mature markets, using a method of correlation that is higher than using Kendall's tau correlation but lower than Pearson's r correlation. Again, among the Balkan economies, Turkey has higher correlation with the US and lower correlation with the emerging Balkan markets, the lowest being with Bulgaria (around 22%). It is observed that the correlation with the EU is greater than that with the US, the highest being with Greece (around 67%) and lowest with Bulgaria (46%). As was the case with Pearson's r and Kendall's tau, the correlations are higher among the emerging Balkan markets than with the mature markets and Greece.

Table 3: Correlation between the Balkan and mature markets (the US and EU indices)

Panel A Pearson's r

	USA	EU50	BGR	HRV	GRC	ROM	TUR
USA	1						
EU50	.777**	1					
BGR	.389**	.487**	1				
HRV	.450**	.599**	.538**	1			
GRC	.493**	.671**	.402**	.511**	1		
ROM	.489**	.633**	.559**	.592**	.558**	1	
TUR	.573**	.630**	.368**	.466**	.511**	.512**	1

Panel B Kendall's tau

	USA	EU50	BGR	HRV	GRC	ROM	TUR
USA	1						
EU50	.551**	1					

DOI: 10.24818/18423264/52.2.18.18

BGR	.205**	.320**	1				
HRV	.250**	.363**	.337**	1			
GRC	.326**	.500**	.273**	.345**	1		
ROM	.292**	.426**	.323**	.391**	.376**	1	
TUR	.331**	.404**	.177**	.279**	.341**	.329**	1
Panel C Spearman's rho							
	USA	EU50	BGR	HRV	GRC	ROM	TUR
USA	1						
EU50	.737**	1					
BGR	.297**	.456**	1				
HRV	.359**	.517**	.472**	1			
GRC	.469**	.676**	.393**	.501**	1		
ROM	.417**	.592**	.454**	.542**	.538**	1	
TUR	.478**	.570**	.255**	.403**	.491**	.470**	1

Note:. ***, **, and * are statistically significant at 1%, 5%, and 10%, respectively

Table 4 shows the univariate estimation for the Balkan stock markets and the two mature markets (the US and EU indices). The GJR(1,1) model was found to be appropriate for the US, the EU and Greece, and its leverage effect coefficients (γ) are statistically significant at 5% or better, meaning that negative events (news) persist more than positive. Moreover, the GARCH coefficients for all the markets are highly statistically significant or else all at 1%, and the ARCH coefficients are also statically significant for most of them. The significant GARCH and ARCH coefficients mean that yesterday's information about returns and volatility reflects on today's stock market returns.

Note: The numbers given in ( ) are standard errors. ***, **, and * are statistically significant at 1%, 5%, and 10%, respectively.

Table 4: Univariate estimations using weekly returns							
	USA	EU50	BGR	HRV	GRC	ROM	TUR
	GJR (1,1)	GJR (1,1)	GARCH (1,1)	GARCH (1,1)	GJR (1,1)	GARCH (1,1)	GARCH (1,1)
μ	0.0504	0.014	0.1764	0.082	0.121	0.275**	0.2450
	(0.073)	(0.108)	(0.121)	(0.107)	(0.168)	(0.136)	(0.196)
ω	0.299*	0.487**	0.498	0.164	0.381*	0.240	1.771**
	(0.164)	(0.220)	(0.322)	(0.362)	(0.208)	(0.231)	(0.816)
ARCH	-0.049	0.023	0.208***	0.108	0.066**	0.097**	0.074***
	(0.047)	(0.033)	(0.079)	(0.088)	(0.033)	(0.039)	(0.024)
GARCH	0.8051***	0.805***	0.768***	0.876***	0.868***	0.893***	0.859***
	(0.103)	(0.053)	(0.078)	(0.121)	(0.035)	(0.045)	(0.035)
GJR	0.359***	0.253***			0.108**		
	(0.121)	(0.093)			(0.048)		

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Table 5 presents the DCC-GARCH generated from Table 4. Considering the weighted correlations between the US and the Balkan markets in Table 5, in Panel A it can be observed that Bulgaria and Croatia have the lowest correlation with 0.19 and 0.23, respectively. On the other hand, the highest correlation is with Greece (0.434) and Turkey (0.431). In Table 5, Panel B offers the weighted correlations between the EU index and the Balkan markets and, as expected, the weighted correlations are much higher. For example, the correlation is around 70% with Greece, while the lowest is with Bulgaria (around 44%). Among the emerging Balkan economies, Romania has the highest correlation with the EU index (58%). Panel C of Table 5 presents the weighted condition correlations among Greece and the rest of the Balkan stock markets. In general, the conditional correlations between Greece and the emerging Balkan markets are lower than with the EU index, the highest being with Romania (51%) and the lowest being with Turkey (37%). However, taking into account the correlation among the emerging Balkan economies (Bulgaria, Croatia and Romania), the correlation is much higher than that with Greece and the EU index. For example, consider the weighted correlation between Romania and Bulgaria (47%), Romania and Croatia (55%), and Croatia and Bulgaria (51%). Lastly, looking at the weighted correlation between Turkey and the emerging Balkan economies, it is observed that the correlation is much lower than with the EU index and the US, and that the lowest is with Bulgaria (around 27%). Moreover, Table 5 confirms that the pairs of stock markets satisfy the condition that $\alpha+ß<1$and that the correlations are non-negative for all the markets (between the US and Balkan markets, the Balkan and EU index, and among the Balkan markets). Additionally, the coefficient 'ß' is statistically significant at 1% for all the markets, and most of the 'a' coefficients are also statistically significant. Table 5 also reports Student's t-distribution (df) for all the pairs of markets and it can be seen that the coefficients are highly statistically significant at 1%, confirming the appropriateness of choosing df in the modelling.

Table 5: Dynamic conditional correlations among the Balkan, EU and US markets

	BGR	HRV	GRC	ROM	TUR	
Panel A Generated DCC between the Balkan and US markets						
ρ	0.19231	0.2908**	0.4348***	0.338***	0.43[1]***	
	(0.159)	(0.1183)	(0.0534)	(0.1396)	(0.0661)	
α	0.013**	0.0325*	0.04994**	0.0386	0.0318	
	(0.0060)	(0.0195)	(0.02065)	(0.0485)	(0.0220)	
ß	0.980***	0.951***	0.8789***	0.935***	0.933***	

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	(0.008)	(0.0343)	(0.0397)	(0.1108)	(0.0478)	
df	6.810***	7.540***	8.5419***	5.856***	6.863***	
	(0.984)	(1.193)	(1.648)	(0.804)	(1.042)	
Panel B Generated DCC between the Balkan and EU markets						
	BGR	HRV	GRC	ROM	TUR	
ρ	0.447***	0.490***	0.7004***	0.582***	0.5767***	
	(0.077)	(0.1002)	(0.0293)	(0.0416)	(0.0529)	
α	0.0137**	0.022***	0.0960**	0.0593**	0.0630**	
	(0.0061)	(0.0071)	(0.0486)	(0.0300)	(0.0289)	
ß	0.977***	0.970***	0.7159***	0.851***	0.8747***	
	(0.0073)	(0.0113)	(0.206)	(0.0764)	(0.0480)	
df	8.057***	10.66***	8.003***	6.494***	7.4190***	
	(1.4799)	(2.486)	(1.497)	(1.012)	(1.257)	
Panel C Generated DCC between the emerging Balkan markets and Greece						
	BGR	HRV	ROM	TUR		
ρ	0.418***	0.456***	0.515***	0.369		
	(0.0464)	(0.0902)	(0.0469)	(0.328)		
α	0.00660	0.025***	0.0793	0.034***		
	(0.0088)	(0.0082)	(0.0737)	(0.0104)		
ß	0.977***	0.962***	0.809***	0.961***		
	(0.0268)	(0.0116)	(0.2710)	(0.0171)		
df	8.212***	9.227***	7.345***	7.222***		
	(1.448)	(1.823)	(1.299)	(1.261)		
Panel D Generated DCC among the emerging Balkan markets						
	DCC with Romania			DCC with HRV		DCC with BGR
	BGR	HRV	TUR	BGR	TUR	TUR
ρ	0.470***	0.552***	0.391**	0.511***	0.392**	0.269***
	(0.052)	(0.118)	(0.163)	(0.056)	(0.079)	(0.066)
α	0.0178	0.034***	0.018*	0.036*	0.013**	0.020
	(0.011)	(0.012)	(0.009)	(0.019)	(0.005)	(0.026)
ß	0.950***	0.955***	0.975***	0.926***	0.98***	0.944***

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	(0.034)	(0.019)	(0.016)	(0.046)	(0.008)	(0.108)
df	5.66***	7.181***	5.911***	7.405***	7.71***	6.278***
	(0.72)	(1.10)	(0.805)	(1.122)	(1.342)	(0.902)

Note: The numbers given in ( ) are standard errors. ***, **, and * are statistically significant at 1%, 5%, and 10%, respectively.

Table 6 illustrates the partial correlations in the Balkan markets after controlling for the role of the EU, Greece, and both. Table 6 Panel A shows a partial correlation after controlling for the European developed market. Considering the correlation between the US and Balkan markets, it is observed that there is no statistically significant correlation with almost all the Balkan markets, except with Turkey (0.17). Looking at the partial correlation among the Balkan markets, and especially with Greece, it is observed that the correlation is very low, even though there is a statistically significant partial correlation. For example, the partial correlation between Greece and Bulgaria is 0.116, while the highest correlation is with Romania (0.231). However, the partial correlations among the emerging Balkan economies (Bulgaria, Croatia and Romania) are greater than those with Greece. For example, the correlation between Romania and Bulgaria is 0.37, while between Romania and Croatia it is 0.34, and between Croatia and Bulgaria it is 0.35. Interestingly, although the partial correlations between Turkey and the other Balkan markets are statistically significant, they are very low, the lowest being with Bulgaria (0.09) and the highest being with Romania (0.187). In Table 6, Panel B reports the partial correlations after controlling for the Greece market and allowing for the effect of EU50. The partial correlations significantly increased among the Balkan equity markets. For instance, the correlation between Romania and Bulgaria is 0.44, between Romania and Croatia it is 0.43, and between Croatia and Bulgaria it is 0.422. In general, the partial correlation with Turkey increased, the highest being with Romania (0.318). Finally, in Table 6 Panel C we controlled for the role of the EU50 and the Greek markets, and it can be observed that very little changes when compared with Panel A (when controlling for only the EU). For example, the correlation is only reduced by 0.015, 0.029, and 0.015 between Romania and Bulgaria, Romania and Croatia, and Croatia and Bulgaria, respectively.

Table 6: Partial correlations when controlling for the EU, Greece and both					
Panel C Controlling for the EU					
	BGR	HRV	GRC	ROM	TUR
USA	0.02	-0.031	-0.06	-0.005	0.17***
GRC	0.116***	0.183***		0.231***	0.152***
ROM	0.37***	0.343***			0.187***
HRV	0.352***				0.143***

DOI: 10.24818/18423264/52.2.18.18

BGR					0.09**
Panel B Controlling for the Greek market					
	HRV	ROM	TUR		
BGR	0.422***	0.44***	0.206***		
HRV		0.43***	0.278***		
ROM			0.318***		
Panel C Controlling for the EU and Greek markets					
	HRV	ROM	TUR		
BGR	0.338***	0.355***	0.073***		
HRV		0.314***	0.118***		
ROM			0.158***		

Note: ***, **, and * are statistically significant at 1%, 5%, and 10%, respectively.

Figure 1 shows the dynamic conditional correlation evaluation between the Balkan and US markets from 5 May 2004 to 7 October 2015. Almost all of the emerging Balkan stock markets display the same pattern and trend, for example, starting from 2008 they experienced a sudden increase in correlation and this stayed high during the European debt crisis, even though during the first quarter of 2011 the correlation in these markets experienced a sudden decline and then a sharp rise. The reason for the decline is because in February 2011 the European finance minister announced the establishment of a European stability mechanism (EFM) to provide financial assistance to EU countries that were hit by the sovereign debt crisis. The increased correlation (during the crisis) was substantial. For example, for Bulgaria it was 45% during 2009 and the beginning of 2013, and in almost the same period for Croatia and Romania it reached nearly 60% and for Turkey around 70%. However, the correlation between Greece and the US looks very different. For instance, from the beginning of the sample period the correlation was high, starting around 45% and remaining high until the end of the period, even though there was a sudden decline and a sharp rise during 2011. Interestingly the correlation reaction to the stock market instability during summer 2015 is minimal, except in the Greek market. Figure 2 shows the dynamic conditional correlation evaluation between the Balkan markets and the EU index. Looking at the correlation between the EU index and Croatia and Bulgaria, it can be observed that the correlation displays the same pattern, starting to increase from 2008 and continuing to remain high during the European sovereign debt crisis. During this period, the correlation with Bulgaria reached around 60% and for Croatia it was around 70%. It is also worth noting that from 2014 these markets experienced a calming in terms of the correlation. The correlation with Greece, Romania and Turkey, however, looks different to that with the other Balkan markets. For example, the correlations were high from the start of the initial

DOI: 10.24818/18423264/52.2.18.18

sample period and they stayed high for the remaining years, particularly in the case of Greece, which started at 70% and remained the same until the end of the sample. Romania started at 55% and reached almost 80% during the crisis period, while Turkey started at 60% and reached 80% during the crisis period. Interestingly, three of these markets briefly experienced a sharp increase at the beginning of 2011 and 2013. Figure 3 shows the dynamic evaluation between Greece and the emerging Balkan markets. Starting from 2008, the correlation with Croatia and Bulgaria experienced a sudden increase and it remained high during the crisis, reaching around 45% with Bulgaria and 65% with Croatia. In addition, two of these markets started to decline from 2014. Looking at the correlation with Turkey again, there is a sudden increase starting from 2006 until 2011. During these years, the correlation ranged between 45% and 70%, while after 2011 the correlation began to decline until the end of the sample period. Finally, the correlation with Romania has been very volatile, reaching as high as 70% during the crisis year. Figure 4 Panels A-C shows the dynamic evaluation among the emerging Balkan markets. Figure 4 Panel A concerns Romania and three emerging Balkan markets, and it shows almost the same pattern and trend. This is especially true with Croatia and Bulgaria, since starting from 2008 a sharp increase was noticed. It remained high during the European debt crisis, reaching its highest with Bulgaria (around 65%) and with Croatia (80%). However, from the beginning of 2013, the correlation started to decline until the end of the sample period. Moreover, considering the correlation with Turkey, from 2007 the correlation began to increase and it stayed high during the crisis period, reaching as high as 65%. Figure 4 Panel B shows the dynamic conditional correlation between Croatia and two emerging Balkan economies (Bulgaria and Turkey). The correlations were low during the initial period of the sample, but from 2008 they started to increase and stayed high during the crisis period, reaching as high as 70% with Bulgaria and 55% with Turkey. A gradual decline in correlation can be noticed between Croatia and Turkey starting from the end of 2012, while with Bulgaria it continues to be high until the end of the sample period, even though the correlation briefly declines during 2014. Finally, Figure 4 Panel C shows the dynamic correlation between Turkey and Bulgaria. From 2007, the correlation suddenly increases and it remained high during the two crises, reaching as high as 45%. Yet, starting from 2013 the correlation sharply declined and continued to be lower until the end of the sample period.

DOI: 10.24818/18423264/52.2.18.18

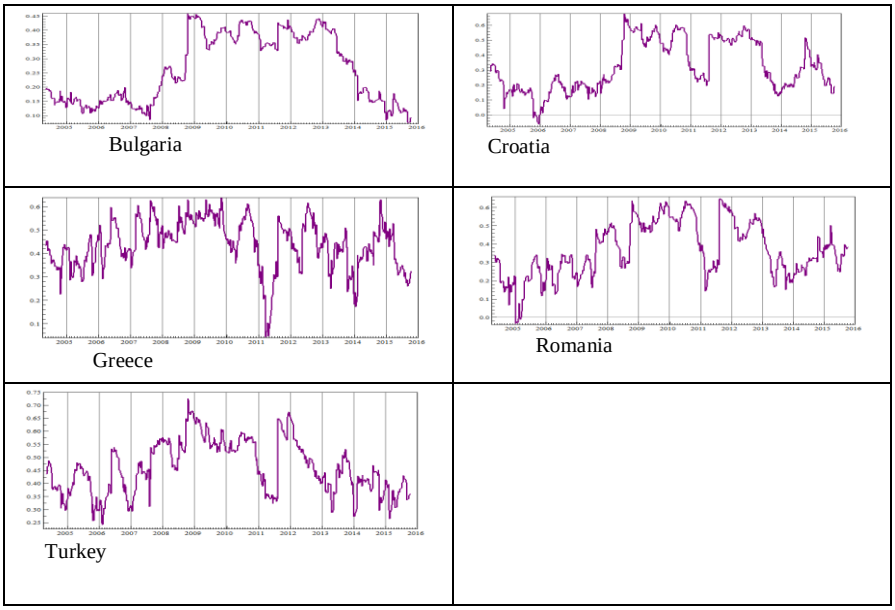

Figure 1: Dynamic conditional correlations between the Balkan and US markets

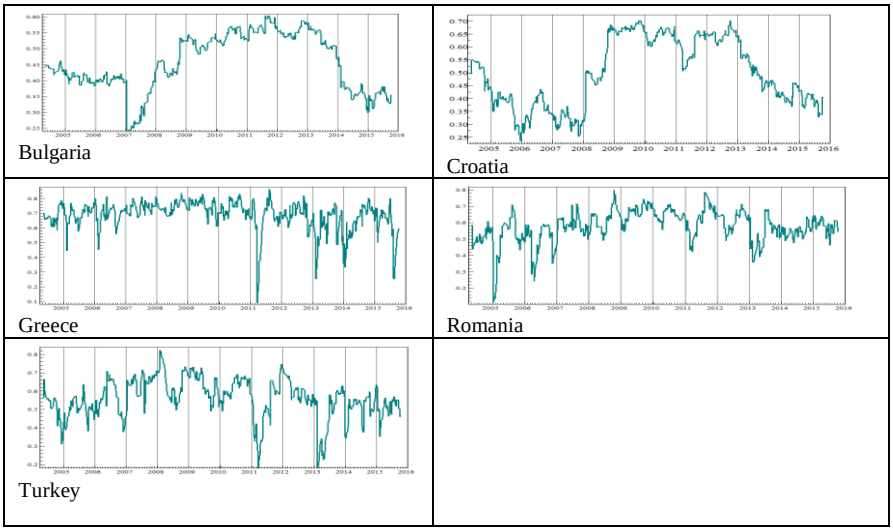

Figure 2: Dynamic conditional correlations between the Balkan and EU markets

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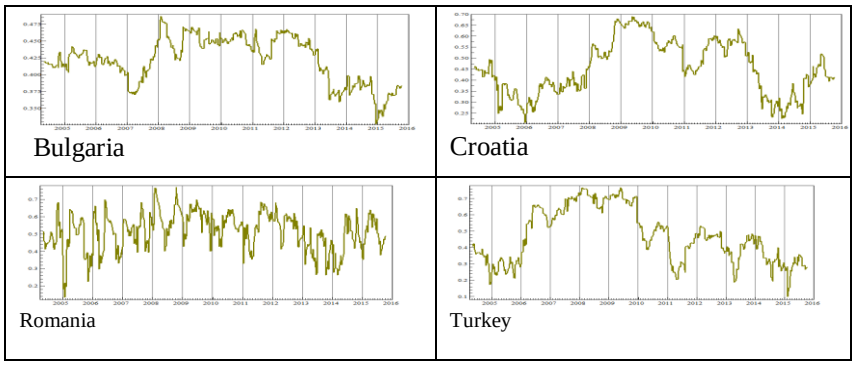

Figure 3: Dynamic conditional correlations between the emerging Balkan markets and Greece

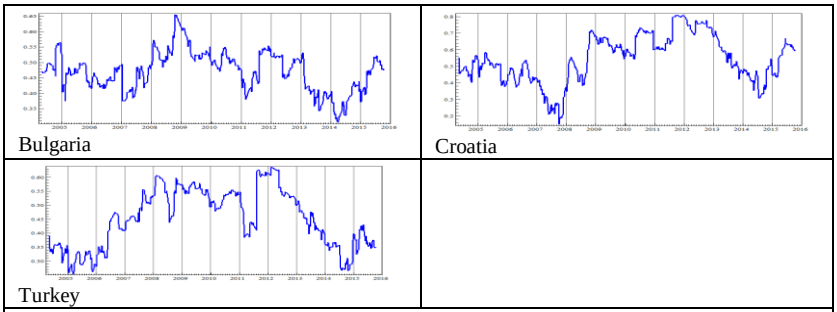

Figure 4 Panel A: Dynamic conditional correlations between the emerging Balkan markets and Romania

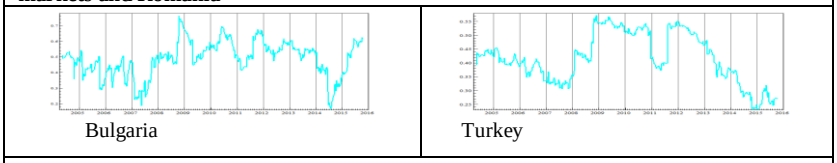

Figure 4 Panel B: Dynamic conditional correlations between Croatia and Bulgaria and Turkey

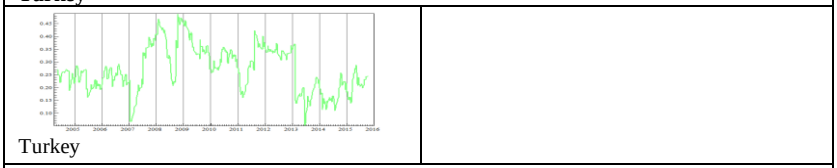

Figure 4 Panel C: Dynamic conditional correlation between Bulgaria and Turkey

Figure 4: Dynamic conditional correlations among the Emerging Balkan markets

Robustness check

We have carried out the estimation by splitting the data into three (pre-crisis period, Global financial crisis period (GFC), Eurozone sovereign debt crisis period (ESDC)) and observed that during the crisis period (GFC and ESDC) correlation have significantly increased which is line with dynamic evaluation findings.

DOI: 10.24818/18423264/52.2.18.18

4. Conclusion

This article investigates the correlation behaviour among select Balkan and mature markets (the US and EU indices) during periods of stability and turmoil. Weekly stock prices (in dollar denominations) from Wednesday to Wednesday are used to minimise cross-country difference and to account for the weekend effect. The sample period covers 5 May 2004 to 7 October 2015.

Due to employing the multivariate DCC-GARCH model of Engle (2002), this paper has several key findings. First, the dynamic correlations are much higher among Romania, Croatia and Bulgaria, with the latter two countries in particular having a higher correlation with each other and with Romania than with the US and EU. In addition, among the emerging Balkan markets, Romania has a higher correlation with the EU index and Greece, followed by Turkey with EU. This is also the case when other measures of correlation, such as Pearson's r, Kendall's tau, Spearman's rho, are applied. Second, the Balkan markets show lower correlation with the US than with the EU. In particular, Romania, Croatia and Bulgaria have a lower correlation with the US market. Third, we observe that the dynamic correlations among the Balkan and mature markets started to rise during the global financial crisis and that they stayed higher during the European debt crisis. However, during the first quarter of 2011, we observe a shape calming down (decline) in the correlation following the announcement by the European Finance Minister of the establishment of the EFM. In addition, we did not observe a significant increase in correlation during the stock market instability of summer 2015. Fourth, there is an important difference between the Greek market and the rest of the Balkan economies, even before the crisis. The correlation with the EU and US was higher from the beginning of the sample period and it remained high until the end of the sample period. Fifth, to determine whether the transmission mechanism to the emerging Balkan economies works through the EU index and Greece, we first controlled for the role of the EU index and documented that there is no significant correlation between the US and almost all the Balkan markets, except for with Turkey. However, a statistically significant correlation among the Balkan economies was still noticed. Furthermore, controlling for the role of Greece does not have a major impact on the level of correlation among the Balkan economies, which means that the Greek stock market has only limited ability to transmit the crisis from other countries. Additionally, the emerging Balkan stock markets may not be directly affected by volatility and instability in the Greek stock market.

Overall, our findings suggest that there is currently a great opportunity for international investors who would like to benefit from portfolio diversification, particularly as Bulgaria, Croatia and Romania have very low correlation with the US market, which means an investor can invest in the US as well as one of the three Balkan markets. In addition, these economies are experiencing low inflation and moderate growth. Therefore, there are potential benefits for investors who want to take advantages of growing markets. Policy makers in these countries

DOI: 10.24818/18423264/52.2.18.18

(including Turkey and Greece) should encourage investors to make long-term investments in their economies.

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