Vesna Karadzic
PhD (Economics), Associate Professor,
University of Montenegro, Podgorica,
Republic of Montenegro
37 Jovana Tomasevica, Podgorica, 85000, Montenegro
vesnaka@ac.me

UDC 336.7

Julija Cerovic
PhD Candidate (Economics), Teaching Assistant,
University of Montenegro, Podgorica,
Republic of Montenegro
37 Jovana Tomasevica, Podgorica, 85000, Montenegro
julija@ac.me

MARKET RISK OF THE WESTERN BALKANS COUNTRIES DURING THE GLOBAL FINANCIAL CRISIS

Abstract. In this paper, we examine the performance of Value at Risk as a risk measure based at ARMA-GJR GARCH model across emerging countries of Western Balkans by utilizing the unconditional and conditional tests of Kupiec and Christoffersen. In particular, the purpose of the paper is to investigate whether asymmetric GJR GARCH model is appropriate in evaluation of VaR in emerging stock markets of the Western Balkans. Daily returns of stock market indices are analyzed for the period before and during the global financial crisis. The motivation for this research is in the fact that such data structure and time dimension of the sample has not been used in empirical literature so far. Results of ARMA-GARCH GJR modeling show decoupling of Slovenian and Croatian financial markets, on one side, and the rest of the countries of the Western Balkans, on the other side, in terms of asymmetry effect on market risk during the global financial crisis. Our back testing results reveal no evidence of the decoupling of countries in terms of the appropriateness of VaR during the global financial crisis.
Keywords: Value at Risk; ARMA-GJR GARCH model; back testing; Kupiec test; Christoffersen test; decoupling; the Western Balkans.
JEL Classification: C22, C52, G10

Весна Караджич
PhD (екон.), доцент, Університет Чорногорії, Подгориця, Республіка Чорногорія
Юлія Церович
аспірант, викладач, Університет Чорногорії, Подгориця, Республіка Чорногорія
РИНКОВИЙ РИЗИК КРАЇН ЗАХІДНИХ БАЛКАН В УМОВАХ СВІТОВОЇ ФІНАНСОВОЇ КРИЗИ
Анотація. У цій статті на основі моделі ARMA-GJR GARCH (авторегресивне ковзне середнє з умовною дисперсією та генералізована авторегресивна умовна гетероскедастичність) розглядається вартісна міра ризику (Value at Risk – VaR) у країнах, що розвиваються, Західних Балкан. При цьому використовувалися безумовні й умовні тести Купеця (Kupiec) і Кристофферсена (Christoffersen). Метою роботи, зокрема, є дослідження можливості застосування асиметричної моделі GJR GARCH для оцінки вартісної міри ризику при формуванні фондових ринків у країнах Західних Балкан. Авторами проаналізовані щоденні коливання біржових індексів як до, так і під час світової фінансової кризи. Мотивацією для цього дослідження став факт, що в такому розрізі вказана проблема в емпіричній літературі дотепер не розглядалася. Результати ARMA-GARCH GJR моделювання показують припинення кореляційних зв'язків (декаплінг) між словенськими і хорватськими фінансовими ринками – з одного боку, та іншими країнами Західних Балкан – з другого боку, з погляду ефекту асиметрії ринкових ризиків під час світової фінансової кризи. Водночас, результати нашого тестування не виявляють ніякого свідчення припинення кореляційних зв'язків країн з погляду доцільності VaR в умовах світової фінансової кризи.
Ключові слова: VaR; ARMA-GJR GARCH модель; тестування; тест Купеця; тест Кристофферсена; декаплінг; Західні Балкани.

Весна Караджич
PhD (экон.), доцент, Университет Черногории, Подгорица, Республика Черногория
Юлия Церович
аспирант, преподаватель, Университет Черногории, Подгорица, Республика Черногория
РЫНОЧНЫЙ РИСК ДЛЯ СТРАН ЗАПАДНЫХ БАЛКАН В УСЛОВИЯХ МИРОВОГО ФИНАНСОВОГО КРИЗИСА
Аннотация. В этой статье на основе модели ARMA-GJR GARCH (авторегрессионное скользящее среднее с условной дисперсией и генерализированная авторегрессионная условная гетероскедастичность) рассматривается стоимостная мера риска (Value at Risk – VaR) в развивающихся странах Западных Балкан. При этом использовались безусловные и условные тесты Купеца (Kupiec) и Кристофферсена (Christoffersen). Целью работы, в частности, является исследование возможности применения асимметричной модели GJR GARCH для оценки стоимостной меры риска при формировании фондовых рынков в странах Западных Балкан. Авторами проанализированы ежедневные колебания биржевых индексов как до, так и во время мирового финансового кризиса. Мотивацией для данного исследования послужил факт, что в таком разрезе данная проблема до сих пор в эмпирической литературе не рассматривалась. Результаты ARMA-GARCH GJR моделирования показывают прекращение корреляционных связей (декаплинг) между словенскими и хорватскими финансовыми рынками – с одной стороны, и остальными странами Западных Балкан – с другой стороны, с точки зрения эффекта асимметрии рыночных рисков во время мирового финансового кризиса. В тоже время, наши результаты тестирования не обнаруживают никаких свидетельств прекращения корреляционных связей стран с точки зрения целесообразности VaR в условиях мирового финансового кризиса.
Ключевые слова: VaR; ARMA-GJR GARCH модель; тестирование; тест Купеца; тест Кристофферсена; декаплинг; Западные Балканы.

Introduction. The growing interest of foreign financial investors to invest in emerging financial markets highlights the importance of accurate market risk quantification and prediction. Fundamental difference between emerging and developed markets is reflected in lower liquidity, frequent internal and external shocks as well as higher degree of insider trading which causes the market to be more volatile (Miletic & Miletic, 2013) [1].

During the global financial turmoil risk management is gaining importance in economics. Methodology used for the assessment of financial markets participants' rate of exposition to risk, gives the estimation of value at risk. Value at Risk (VaR) is the maximum loss of financial position over a given time period at a given confidence interval.

Purpose of this paper is to use asymmetric GARCH GJR model (Glosten, Jagannathan, & Runkle, 1993) [2] in evaluating Value at Risk in the stock exchanges of countries of the Western Balkans over long period that includes years of financial crisis. The stock exchanges in the region of the Western Balkans experienced an above-average drop in 2008, according to world indicators. The signs of the recession were evident through the halving of the main stock exchange indices in 2007-2008, almost in the same way in all countries of the region. Market capitalization reduced by 50% on average, somewhat less in the case of Serbia. Losses in stock exchanges in the region were large.

Countries of the western Balkans are Croatia (now an EU Member), Serbia, Bosnia and Herzegovina, Montenegro, Macedonia and Albania. The stock exchange of Albania is still nonexistent, so it was excluded from this analysis. Also, historical data of Macedonian stock exchange index are not available on the official Macedonian stock exchange web site, so we decided to analyze stock indices of four countries of the western Balkans (Croatia, Serbia, Bosnia and Herzegovina and Montenegro) and to compare relative performance of econometric VaR modeling of these countries with Slovenian case. The reason for this is that Slovenia (EU member) was a part of former Yugoslavia together with Macedonia and aforementioned four countries, so it is intended to analyze whether there is decoupling of VaR measuring between Slovenia on one side, and the rest of analyzed countries on the other side.

In particular, we compare the performance of the VaR using both the unconditional and conditional tests of Kupiec and Christoffersen (Kupiec, 1995) [3] in the countries of the Western Balkans, and investigate possible decoupling of the market risk among them. To the best of our knowledge, empirical study with these data and this time frame has not yet been discussed in empirical literature. Similar studies mentioned in the literature review didn't focus on these five countries and their main limitation is that shorter period of the crisis was included. So, our study contributes to the current literature by providing evidence of possible decoupling from the perspective of VaR of countries from the former Yugoslavia.

The paper is organized as follows. A literature review is presented in the next section. The third section reviews the methodology used for modeling market returns and volatility – ARMA-GJR GARCH model. Also, the backtesting procedure is presented. Data and empirical results are presented in fourth section. Finally, conclusions are presented in the fifth section.

Brief Literature Review. Despite the extensive literature and empirical research of estimation of VaR models in the developed financial markets, literature dealing with VaR calculation in emerging financial market is very limited. Such researches conducted Da Silva, Beatriz, and de Melo Mendes (2003) [4], Gencay & Selcuk (2004) [5], Bao, Lee, and Saltoglu (2006) [6], Zikovic (2007) [7], Zikovic and Aktan (2009) [8], Zikovic and Filler (2009) [9], Andjelic, Djakovic, and Radisic (2010) [10], Nikolic-Djoric and Djoric (2011) [11], Mladenovic, Miletic, and Miletic (2012) [12], Bucevska (2012) [13]. The main reason for that was the short historical time-series data (most of the stock markets in these countries were established in the early 1990s) which did not allow performing a reliable econometric analysis (Bucevska, 2012) [13].

Andjelic, Djakovic, and Radisic (2010) [10] observed Slovenian, Croatian, Serbian and Hungarian markets and concluded that under stable market conditions, the analyzed models give good forecasts of VaR estimations with 5% level of significance, while under the conditions of market volatility analyzed models give good estimations of VaR parameters with 1% level of significance. Nikolic-Djoric and Djoric (2011) [11] observed the movement of stock-exchange index in Serbian financial market and concluded that GARCH models combined with extreme value theory decrease the mean value of VaR, and that these models are better than RiskMetrics method and IGARCH model. Also, Mladenovic, Miletic, and Miletic (2012) [12] came to conclusion that the methodology of extreme value theory is slightly better than GARCH model regarding the calculation of VaR, based on analysis of stock-exchange indices in Central and Eastern European countries (Bulgaria, Czech Republic, Hungary, Croatia, Romania and Serbia), but general suggestion is to use both approaches for better market risk measuring. Bucevska (2012) [13] showed that the econometric estimation of VaR is related to the chosen GARCH model. The most adequate GARCH family models for estimating volatility in the Macedonian stock market are the asymmetric EGARCH model with Student's t-distribution, the EGARCH model with normal distribution and the GARCH-GJR model. Koksal and Orhan (2013) [14] compared the performance of VaR across a large sample of developed and emerging countries during the global financial crisis. The results showed that VaR performed much more poorly when measuring the risk of developed countries, than of emerging ones, possibly because of the deeper initial impact of the global financial crisis on developed countries. The results also evidenced the decoupling of the market risk of emerging and developed countries during the global financial crisis.

Methodology. Let us assume that we want to determine the level of risk of portfolio value V_t over the period $[t, t+h]$. We mark the random variable of portfolio loss: $L_{t+h} = -(V_{t+h} - V_t) = \Delta V(h)$. Cumulative function of loss distribution is marked as F_L, where $F_L(x) = P(L \le x)$. In this case, VaR at the level of significance α ($\alpha \in (0,1)$ - most often $\alpha=0.01$ or $\alpha=0.05$, i.e. 1% and 5%) is actually α-quintile of distribution function F_L and represents the smallest real number satisfying the equation $F_L(x) \ge \alpha$, i.e.:

$$VaR_\alpha = \inf(x | F_L(x) \ge \alpha). \quad (1)$$

The econometric approach to VaR calculation considers the use of the time series econometric models. Autoregressive moving-average model (ARMA) of orders p and q, ARMA (p, q), is used for estimating a log return series, marked as r_t:

$$r_t = \phi_0 + \sum_{i=1}^{p} \phi_i r_{t-i} + a_t - \sum_{j=1}^{q} \theta_j a_{t-j} \quad (2)$$

$$a_t = \sigma_t \varepsilon_t$$

Parameters of equation (2) representing autoregressive moving-average model (ARMA) of orders p and q, ARMA (p, q), are marked as $\phi_0, \phi_1, ..., \phi_p, \theta_1, ..., \theta_q$. The random member of the model, a_t is the function of ε_t – series of independent and identically distributed random variables having a normal or t-distribution with zero mean and variance equal to 1.

GARCH model that Bollerslev (1986) [15] proposed as a generalization of autoregressive conditional heteroscedasticity model – ARCH (Engle, 1982) [16], is used for modeling volatility. GJR GARCH model was introduced in 1993 (Glosten, Jagannathan, & Runkle, 1993) [2] and it provides an asymmetric approach in volatility modeling. It considers positive and negative shocks not to have the same effect on volatility. In general form it is given by:

$$\sigma_t^2 = \omega + \sum_{i=1}^{p} \alpha_i \varepsilon_{t-i}^2 + \sum_{j=1}^{q} \beta_j \sigma_{t-j}^2 + \gamma_i I_{t-i} \varepsilon_{t-i}^2, \quad (3)$$

where α, β, γ are constant parameters, and I is the indicator function that takes the value zero when ε_{t-i} is positive, and one when ε_{t-i} is negative. So, this dummy variable distinguishes positive and negative shocks, and the asymmetric effects are captured by γ. Thus, positive innovations have an impact of α, while negative innovations have an impact of $\alpha + \gamma$.

If the series ε_t is a random variable with standardized normal distribution, the conditional distribution of random variable r_{h+1} for available data with the moment h inclusive, also has a normal distribution with mean $\hat{r}_h(1)$ and variance $\hat{\sigma}_h^2(1)$. Then, 5%-quantile of conditional distribution, representing the estimation of VaR at 95% confidence level and for forecast horizon 1 step ahead, is computed as:

$$\hat{r}_h(1) + 1{,}65\hat{\sigma}_h(1). \quad (4)$$

If random variable ε_t has Student's t distribution, with υ degrees of freedom, then the 5%-quantile of conditional distribution is computed as follows:

$$\hat{r}_h(1) + \frac{t_\upsilon(1-p)}{\sqrt{\frac{\upsilon}{\upsilon-2}}}\hat{\sigma}_h(1), \quad (5)$$

where $t_\upsilon(1-p)$ is the corresponding critical value of $(1\text{-}p)$ quantile from t distribution with υ degrees of freedom.

When a VaR model is estimated it is important to check its reliability and accuracy. Statistical procedure for examining the appropriate estimation of VaR is called backtesting. The aim of backtesting is to estimate if the amount of losses predicted by VaR is correct. That process implements the unconditional or conditional coverage tests for the correct number of violations.

(a) The unconditional test – Kupiec test

Let N be the observed number of violations in the sample over a T period of time when the portfolio loss was larger than VaR estimate (Angelidis, Benos, & Degiannakis, 2004) [17].The failure number follows a binomial distribution where the expected exception frequency is $p = N/T$. The ratio of failures, N, to the trials, T, under the Null hypothesis should be p. The appropriate likelihood ratio statistic is

$$LR_c = 2\ln[(1-\frac{N}{T})^{T-N}(\frac{N}{T})N] - 2\ln[(1-p)^{T-N}p^N]. \quad (6)$$

The Kupiec test has a chi-square distribution, asymptotically, with one degree of freedom. This test can reject a model for both high and low failures but, as stated by Kupiec (Kupiec, 1995) [3], so conditional coverage tests can be used for further examining of VaR model reliability, such as Christoffersen test.

(b) Christoffersen test

The conditional coverage test under the Christoffersen approach detects whether the exceptions occur in clusters or not. A new indicator building on the exception indicator above is calculated which defines n_{ij} to be the amount of days that j (exception) occurred when it was i (no exception) the day before. The probability of state j being observed given that state i was observed the previous day is noted by π_{ij} (Jorion, 2007) [18]. The test statistic testing independence is (Dowd, 2005) [19]:

$$LR_{cc} = -2\ln[(1-p)^{T-N}p^N] + 2\ln[(1-\pi_{01})^{n_{00}}\pi_{01}^{n_{01}}(1-\pi_{11})^{n_{10}}\pi_{11}^{n_{11}}], \quad (7)$$

where the corresponding probabilities are $\pi_{ij} = \frac{n_{ij}}{\sum_j n_{ij}}$, so π_{01} is the probability of a non-exception being followed by an exception, and π_{11} is the probability of an exception being followed by an exception. The absolute probability of a non-exception or exception being followed by exception is denoted by p. The test statistic is distributed as χ^2 with two degrees of freedom.

These two LR tests can be combined, thereby creating a complete test for coverage and independence which also is distributed as χ^2 (2):

$$LR_{cc} = LR_{uc} + LR_{ind}. \quad (8)$$

This is the Christoffersen approach to check the predictive ability and accuracy of a VaR model. Altogether, these tests provide the necessary tools to evaluate and compare the VaR models mentioned above.

Data and empirical results. We collected data from five indices: CROBEX (Croatian), BELEX15 (Serbian), SASX-10 (Bosnian), MONEX20 (Montenegrin) and SBITOP (Slovenian), in order to cover the most representative stocks of each economy. Log daily returns of indices represent the difference between logarithmic levels of prices in two successive days. The data are collected from each the official stock exchange web site[1]. Time series of observed log returns of stock index CROBEX on daily basis consists of 2693 data in total (from 3rd May 2004 to 28th November 2014); there are 2077 data of observed log returns of stock index BELEX15 (from 5th October 2005 to 31st December 2013), 2203 data of SASX-10 (from 8th February 2006 to 28th November 2014), 2508 data of MONEX20 (from 5th January 2004 to 21st February 2014), and 1141 data of SBITOP (from 3rd April 2006 to 17th December 2014). Basic descriptive statistics of data are shown in Table 1, with corresponding p-values in parenthesis.

Significant kurtosis and Jarque-Bera test-statistics (JB) show fat-tail nature of observed logarithmic return series. Further, it is evident that empirical distributions deviate from normal distribution, as Q-Q plots (Figure 1 and Figure 2) show. Namely, the quantiles of empirical distributions are plotted against the quantiles of a normal distribution. Jarque-Bera (JB) normality test shows that the hypothesis of normality of returns can be rejected even when the level of significance is 1%.

Box-Ljung test-statistic is next in Table 1. Null hypothesis in this test implies that the first m autocorrelation coefficients of residuals are zero and it is rejected here. Value m is chosen in several ways and in practice the best form is $m \sim \ln(T)$ where T is the number of data of the observed variable (Tsay, 2010) [20]. In our case, for m this value is 8. To determine the existence of time-changing variability, the same Box-Ljung test-statistic is used, but for squared residual series (Tsay, 2010) [20].

After analysis of the data, we estimated model GJR GARCH(1,1) with Student's t-distribution for volatility movement. The appropriate model for modeling logarithmic return series is ARMA(1,1) for all stock indices, except SASX-10, which data are best fit to ARMA(0,1) and SBITOP which are best fit to ARMA(1,0). The estimated parameters with p-values are given in Table 2.

The coefficient γ is statistically significant at level of significance of 2% in the case of SBITOP and 8% in the case of CROBEX. So it indicates there is asymmetry effect on these two financial markets, that are best developed among analyzed markets, and its positive value implies presence of «the leverage effect». The same coefficient is not statistically significant for the rest of indices, so it clearly reveals decoupling here of Slovenian and Croatian financial markets, on one side, and the rest of the countries of the western Balkans, on the other side, in terms of asymmetry effect on market risk during the global financial crisis.

Our backtesting and forecasting methodology is such that we analyze the following approach of a sliding window of approximately four years' daily returns data. In the estimation of parameters of model, as the daily

Tab. 1: **Basic descriptive statistics of five stock exchange indices**

Statistic	CROBEX	BELEX15	SASX-10	MONEX20	SBITOP
N	2693	2077	2203	2508	2173
Mean	0.000157	-0.00028	-0.000371	0.086433	-0.000131
St. deviation	0.012754	0.014634	0.013492	1.693898	0.012278
Skewness	0.042591	0.150709	0.157725	0.686277	-0.432675
Kurtosis	15.688	12.192882	7.514655	6.536753	6.448707
JB	27665.8704 (<2.2e-16)	12904.6251 (<2.2e-16)	5205.8126 (<2.2e-16)	4672.7013 (<2.2e-16)	3843.3126 (<2.2e-16)
Box-Ljung	75.1649 (4.572e-13)	280.6493 (<2.2e-16)	269.9217 (<2.2e-16)	219.6358 (<2.2e-16)	66.1602 (2.844e-11)
Box-Ljung (a_t^2)	1609.696 ((<2.2e-16)	709.8107 (<2.2e-16)	1345.778 (<2.2e-16)	1003.793 (<2.2e-16)	1080.834 (<2.2e-16)

Source: Authors' calculation

[1] Historical data of Slovenian stock exchange index SBITOP are not available online, but upon request.

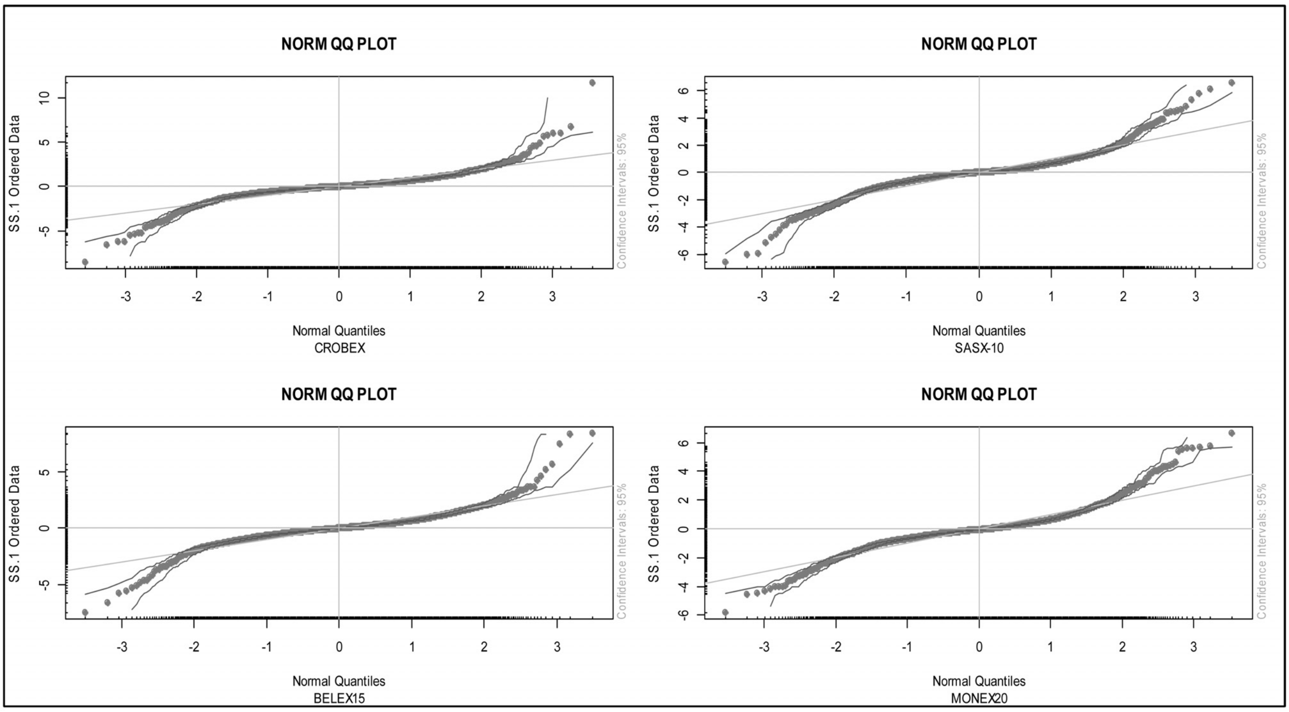

Fig. 1: **Q-Q plots of stock indices CROBEX, BELEX15, SASX-10 and MONEX20**
Source: Authors' calculation

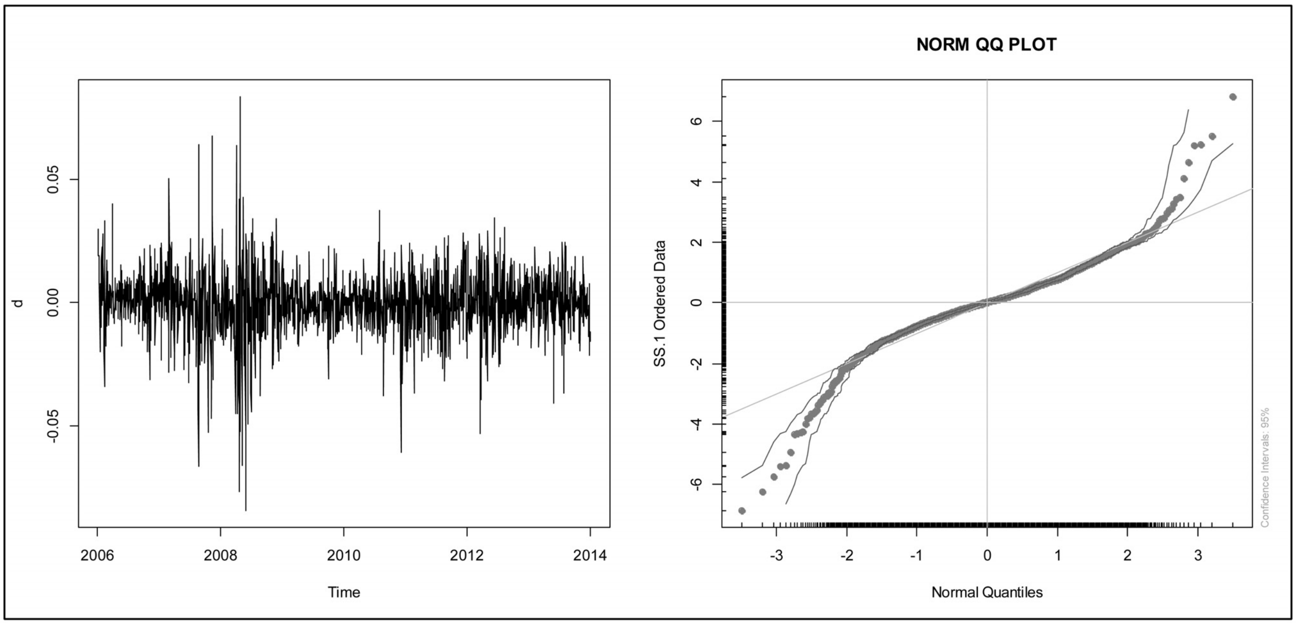

Fig. 2: **Daily log returns and Q-Q plot of stock index SBITOP**
Source: Authors' calculation

Tab. 2: **The estimated parameters of ARMA(1,1)-GJR GARCH(1,1) models for CROBEX, BELEX15 and MONEX20, ARMA(0,1)-GJR GARCH(1,1) for SASX-10, and ARMA(1,0)-GJR GARCH(1,1) model for SBITOP**

Parameter	CROBEX	BELEX15	SASX-10	MONEX20	SBITOP
ar1	0.923818 (0)	0.651395 (0)	-	0.940526 (0)	0.191074 (0)
ma1	-0.883124 (0)	-0.441623 (0)	0.145206 (0)	-0.876555 (0)	-
omega	0.000001 (0.001861)	0.000007 (0.000474)	0.000006 (0.023123)	0.000014 (0.000014)	0.000009 (0.000007)
alpha1	0.078996 (0)	0.289878 (0)	0.216002 (0.000163)	0.325224 (0)	0.169414 (0.000001)
beta1	0.902083 (0)	0.708096 (0)	0.790971 (0)	0.709950 (0)	0.719056 (0)
gamma1	0.031496 (0.074718)	-0.013738 (0.781524)	-0.015746 (0.671778)	-0.071228 (0.146870)	0.100782 (0.010741)

Source: Authors' calculation

returns of the following day were added, the oldest daily returns were cast out from the observed window. This sliding window has 1000 days as a basis for model estimation. For example, with a window size of 1000, the window is placed between the 1st and the 1000th data points, the model is estimated, and the return forecast is obtained for the 1001st day at different quantiles. Next, the window is moved one day ahead to the 2nd and 1001st data points to obtain a forecast of the 1002nd day return with updated parameters from this new sample.

In case of no-convergence in some of all the windows, there is mark NA (not applicable, due to insufficient number of convergences). Non-convergence here (all empirical results expressed in this paper are calculated using R program package) implies both a failure of the solver to converge to a solution (global failure), or a failure to invert the resulting Hessian (local failure). For example, backtesting CROBEX resulted in insufficient number of convergences, so the backtesting of VaR was not possible with this rolling window size.

Table 3 reports the results from the Kupiec and the Christoffersen test for all five countries. Namely, there are test statistics for these two tests, for 1% and 5% significance levels, as well as the proportion of violation. The ideal situation would be with the proportion of violations approximately 0.05, and 0.01 for VaR at 95% and 99% confidence levels, respectively. Surprisingly, that is just the case. VaR, based on ARMA-GJR GARCH model, was a good measure of risk for all five countries of the Western Balkans. The critical values for the Kupiec test for 1% and 5% significance levels of the chi-square distribution with 1 degree of freedom are 6.64, and 3.84, respectively, so the null hypothesis wasn't rejected at both significance levels for five stock indices. In the case of the Christoffersen test, the critical values for 1% and 5% significance levels of the chi-square distribution with 2 degrees of freedom are 9.21, and 5.99, respectively, and the test results show the appropriateness of VaR for all 5 indices (in the case the test performance was applicable).

Tab. 3: **Kupiec test and Christoffersen test results**

Country	VaR	Kupiec Statistic	F/N	Christoffersen test
Slovenia	95	0.51	0.055	0.831
	99	2.189	0.015	NA
Serbia	95	3.294	0.038	3.459
	99	3.094	0.005	NA
Croatia	95	NA	NA	NA
	99	NA	NA	NA
Bosnia and Herzegovina	95	0.989	0.057	NA
	99	1.016	0.007	NA
Montenegro	95	2.747	0.039	2.938
	99	0.105	0.009	NA

Notes: NA = not applicable + insufficient number of convergences; F/N is the proportion of violations.

Source: Authors' calculation

Conclusions. This paper examines the performance of VaR as a risk measure based at GJR GARCH model across emerging countries of Western Balkans by utilizing the unconditional and conditional tests of Kupiec and Christoffersen. There are two main conclusions from our study. Firstly, ARMA-GARCH GJR modeling shows decoupling of Slovenian and Croatian financial markets, on one side, and the rest of the countries of the western Balkans, on the other side, in terms of asymmetry effect on market risk during the global financial crisis. Secondly, our results reveal no evidence of the decoupling of countries in terms of the appropriateness of VaR during the global financial crisis. Finally, it would be interesting to see whether our conclusions continue to hold when other measures of risk are implemented with different methodological choices.

References

1. Miletic, M., & Miletic, S. (2013). Measuring value at risk on emerging markets: Empirical evidence from Serbian stock exchange. *Facta Universitatis, Series: Economics and Organization, 10*(1), 25-37. Retrieved from http://facta.junis.ni.ac.rs/eao/eao.html
2. Glosten, L. R., Jagannathan, R., & Runkle, D. E. (1993). On the Relation Between the Expected Value and the Volatility of the Nominal Excess Return on Stocks. *Journal of Finance, 48*(5), 1779-1801. doi: 10.1111/j.1540-6261.tb05128.x
3. Kupiec, P. H. (1995). Techniques for verifying the accuracy of risk measurement models. *The Journal of Derivatives, 3*(2), 73-84. doi: 10.3905/jod.1995.407942
4. Da Silva, A., Beatriz, V., & de Melo Mendes, B. (2003). Value-at-Risk and Extreme Returns in Asian Stock markets. *International Journal of Business, 8*(1), 17-40. Retrieved from http://www.craig.csufresno.edu/ijb/index.htm
5. Gencay, R., & Selcuk, F. (2004). Extreme Value Theory and Value-at-Risk: Relative Performance in Emerging Markets. *International Journal of Forecasting, 20*(2), 287-303. doi: 10.1016/j.ijforecast.2003.09.005
6. Bao, Y., Lee, T., & Saltoglu, B. (2006). Evaluating Predictive Performance of Value-at-Risk Models in Emerging Markets: A Reality Check. *Journal of Forecasting, 25*(2), 101-128. doi: 10.1002/for.977
7. Zikovic, S. (2007, June). *Measuring Market Risk in EU New Member States.* Paper presented at the 13th Dubrovnik Economic Conference of Croatian National Bank, Dubrovnik. Croatian National Bank, Dubrovnik, Croatia.
8. Zikovic, S., & Aktan, B. (2009). Global financial crisis and VaR performance in emerging markets: A case of EU candidate state – Turkey and Croatia. *Proceedings of Rijeka Faculty of Economics, 27*(1), 145-170. Retrieved from http://www.efri.uniri.hr/en/proceedings
9. Zikovic, S., & Filler, R. K. (2009). *Hybrid Historical Simulation VAR and ES: Performance in Developed and Emerging Markets* [unpublished working paper]. Retrieved from CESifo Working paper Series: http://www.cesifogroup.de/portal/page/portal/DocBase_Content/WP/WPCESifo_Working_Papers/wpcesifo-2009/wp-cesifo-2009-10/cesifo1_wp2820.pdf
10. Andjelic, G., Djakovic, V., & Radisic, S. (2010). Application of VaR in Emerging markets: A Case of Selected Central and Eastern European Countries. *African Journal of Business Management, 4*(17), 3666-3680. Retrieved from http://www.academicjournals.org/ajbm/
11. Nikolic-Djoric, E., & Djoric, D. (2011). Dynamic Value at Risk Estimation for BELEX15. *Metodoloski zvezki, 8*(1), 79-98. Retrieved from http://www.stat-d.si/mz/
12. Mladenovic, Z., Miletic, M., & Miletic, S. (2012, September). *Value at Risk in European emerging economies: An empirical assessment of financial crisis period.* Paper presented at the conference From Global Crisis to Economic Growth. Which Way to Take? Belgrade, University of Belgrade, Faculty of Economics.
13. Bucevska, V. (2012). An Empirical Evaluation of GARCH Models in Value-at-Risk Estimation: Evidence from the Macedonian Stock Exchange. *Business Systems Research, 4*(1), 49-64. doi: 10.2478/bsrj-2013-0005
14. Koksal, B., & Orhan, M. (2013). Market Risk of Developed and Emerging Countries during the Global Financial Crisis. *Emerging Markets Finance & Trade, 49*(3), 20–34. doi: 10.2753/REE1540-496x490302
15. Bollerslev, T. (1986). Generalized autoregressive conditional heteroskedasticity. *Journal of Econometrics, 31*(3), 307-327. doi: 10.1016/0304-4076(86)90063-1
16. Engle, R. F. (1982). Autoregressive Conditional Heteroscedasticity with Estimates of the Variance of United Kingdom inflation. *Econometrica, 50*(4), 987-1007. doi: 10.2307/1912773
17. Angelidis, T., Benos, A., & Degiannakis, S. (2004). The use of GARCH models in VaR estimation. *Statistical Methodology, 1*(1-2), 105-128. doi: 10.1016/j.stamet.2004.08.004
18. Jorion, P. (2007). *Value at Risk: The New Benchmark for Managing Financial Risk* (third edition). New York: McGraw-Hill.
19. Dowd, K. (2005). *Measuring Market Risk* (second edition). Chichester: John Wiley & Sons.
20. Tsay, R. S. (2010). *Analysis of Financial Time Series* (third edition). Hoboken: John Wiley & Sons, Inc.

Received 07.11.2014