Differences among Volatility Patterns of Visegrad Countries' Stock Markets

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Abstract
Current study focuses on returns of representative Morgan Stanley Capital International (MSCI) stock indices of selected Visegrad countries and the analysis of its volatility relations. We compare it with volatility relations of representative MSCI stock index returns formed from markets' data of those countries, as well. The aim of the paper is to estimate differences in volatility relations among selected MSCI stock indices in crises times. We paid our attention to the global financial crisis period and the sovereign debt crisis in the European Monetary Union (EMU), too. As the major estimation method it is deployed GARCH (1,1) and TARCH (1,1) models. We obtained data in daily frequency for period from June 2002 till June 2015. Whereas within the stock returns of MSCI CEE index its previous day volatility is significant, it does not remain in selected Visegrad countries. We also prove what affects its volatility more, whether the increase or decrease of stock returns. Otherwise, the effect of higher volatility affected by increase of those stock returns is the strongest in times before the global financial crisis, whereas it is weaker in times of the sovereign debt crisis in the EMU.

Keywords: volatility patterns, crises times, Visegrad countries, GARCH and TARCH model
JEL codes: C58, G01, G15

1. Introduction

The revival of stock markets in the Visegrad countries took place in the early nineties. Totally first that was put back in operation, the Budapest Stock Exchange (BSE), which opened in June 1990. The first trading on the Warsaw Stock Exchange (WSE) took place in April 1991. The Slovak stock exchange in Bratislava (SSE) was founded in August 1991 then. And finally, the trading was initiated on the Prague Stock Exchange (PSE) in April 1993. Stock markets in these countries exhibit the characteristics of a newly emerging markets (Kulhánek and Šoltés, 2010), but within their development can be seen also many differences. Heryán and Kulhánek (2015) argue some differences of BSE, especially. Moreover, our paper focuses on the comparison of selected Morgan Stanley Capital International (MSCI) stock index and MSCI stock indices of Visegrad countries, included in this index. Therefore we have excluded Slovak representative stock index from our analysis.

Not only global financial crisis affected price' volatility on financial markets. The sovereign debt crisis in the EMU and financial instability has impacted even on volatility of the oil prices (see Heryán, 2015). Therefore, both crises could even affected the volatility relations among prices of representative stock indices in selected non-Eurozone countries. In general, changes among volatility relations of financial instruments' prices in crises times, it motivates current paper. The aim of the paper is to estimate differences in volatility relations among selected MSCI stock indices in crises times.

The paper is structured as follows. After the Introduction there is the second section where are related recent studies reviewed very briefly. In the third section we describe our data and methods used in current paper. Then we discuss our empirical results for crisis as well as for pre-crisis period. Finally, the fifth section concludes.

2. Literature Review

Cakan et al. (2015) examine the impact of surprises about U.S. macroeconomic news announcements on the conditional volatility of stock returns in twelve emerging economies. They use current daily data, that spans several financial crises and captures recent reactions of emerging stock markets and analyze a large in comparison to previous studies group of countries. They argue, analyzing the results about the relationship between stock returns and time-varying volatility from a GJR-GARCH (1,1) model, incorporating macroeconomic news surprises, indicates that the GARCH parameters are highly significant for all of the examined emerging stock markets. Moreover, they are able to reject the hypothesis of no asymmetric effect, a result that emerges with high level of significance. They find good economic news about US unemployment on the conditional volatility of Polish market. But they do not investigated any other Visegrad country in the study.

Golosnoy et al. (2015) find that the crisis leads to a significant reduction of the general persistence of volatility shocks in international stock markets. Hence, it appears that during the turmoil of the subprime crisis news generating volatility become outdated more quickly than before the crisis. They focus on the analysis of short-run volatility transmission patterns where they pay special attention to the impact of the recent subprime crisis on this transmission pattern. Their results appear that the link between the US and Germany is significantly tighter than the links of Japan to the US and German market.

Adcock et al. (2014) use data on 27 European stock indices over the period from January 2007 to December 2012 to investigate the relationship between innovations and the market reaction to negative news during the financial crisis. They show that index prices of countries in the high (low) innovation groups experience significantly positive (negative) abnormal returns on and following the negative news announcement dates. They argue that if innovations enhance investors' confidence, one would expect a positive association between innovation measures and event day abnormal returns, as recessions may have less adverse effect on the competitiveness and profitability of firms in innovation intensive economies. To investigate whether these findings are unique to the crisis period, the analysis is also carried out for the period from January 2001 till December 2006. A study of the pre-crisis period using the same methods, indicates that investors value innovation more during difficult times.

Horvath and Petrovski (2013) examine the international stock market co-movements between Visegrad countries (Czech Republic, Hungary and Poland) and South Eastern Europe (Croatia, Macedonia and Serbia) using multivariate GARCH models in the period 2006–2011. They argue, although the financial systems in Central European and South Eastern European countries are largely bank-based, an analysis of stock market developments can still provide useful insights. Their results show that the degree of stock market integration of Central Europe against Western Europe is much higher than integration of South Eastern Europe against Western Europe on the other hand. All stock markets fall strongly at the beginning of the global financial crisis. Nonetheless, they do not find that the crisis altered the degree of stock market integration between these groups of countries.

3. Data and Methods

We obtained daily data from Morgan Stanley Capital International (MSCI) online statistical database. Estimated period is from June 2002 till June 2015. We include three MSCI indices for three Visegrad countries CZ/HU/PL and MSCI index for FM from Central and Eastern Europe + CIS, into which those three countries are listed. The period is divided into two sub-periods, into the pre-crisis period and the crises period due to the start of the sovereign debt crisis in the EMU (21st April 2010 Greece officially asked the IMF for the first financial help). The period after the start of the global financial crisis till the start of sovereign debt crisis (GFC has been reflect in the full with bankruptcy of Leman Brothers 15th September 2008) was excluded due to small no of observations.

We deploy two estimation methods GARCH (1,1) and TARCH (1,1) models to show differences within selected stock prices volatility. As the first estimation method we employ GARCH (1,1) model which is described in according Asteriou and Hall (2011) by equation (1) and (2):

$$Y_{it} = \alpha_i + \beta_i Y_{(t-1)} + \varepsilon_i \,, \tag{1}$$
$$h_{it} = \alpha_0 + \sum_{j=1}^{1} \lambda_i \, h_{(t-j)} + \sum_{n=1}^{1} \gamma_i \varepsilon_{(t-n)}^2 \,, \tag{2}$$

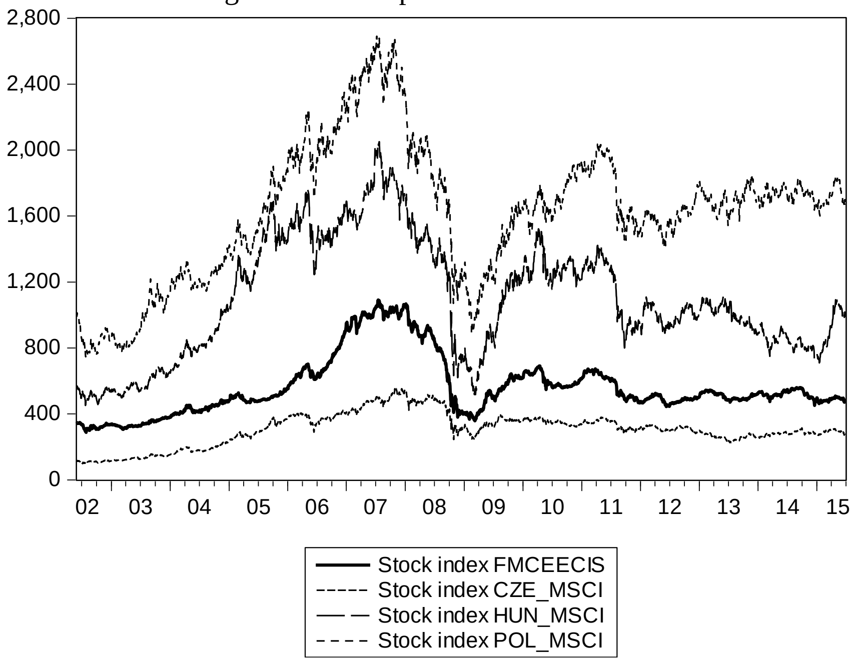
where Y_{it} means volatility of stock returns in time t. All selected stock markets are investigated separately to show differences between each country. Variable $Y_{(t-1)}$ is always volatility of the stock price in previous day. Symbols α_i and ε_i are constant and residuals of each equation. In variance equation h_{it} it is included α_0 as a constant, one lagged value of GARCH $h_{(t-1)}$, and $\varepsilon_{(t-n)}^2$ as one lagged value of squared residuals.

As the second estimation method we employ also TARCH (1,1) model which differs from GARCH (1,1) in variance equation (3):

$$\boldsymbol{h_{it} = \alpha_0 + \sum_{j=1}^{1} \lambda_i \, h_{(t-j)} + \sum_{n=1}^{1} \gamma_i \varepsilon_{(t-n)}^2 + \vartheta_i D_{i(t-1)} \varepsilon_{i(t-1)}^2} \,, \tag{3}$$

where $D_{i(t-1)}$ is dummy variable. Stavárek (2010) argue that the core of the TARCH term is the dummy variable that equals 1 in the case of a negative shock and zero otherwise. Thus, a positive value of the coefficient ϑ_i means that the positive innovations (increase of the yield or spread) tend to increase the subsequent volatility more than do the negative shocks (decrease of the yield or spread).

Figure 1: Development of Stock Prices



Source: authors' illustration

On the Figure 1 we see impacts of the global financial crisis in 2008/2009. Polish stock market prices are the highest, whereas those Czech prices are the lowest in comparison. We see that selected RFM CEE CIS index prices are bellow stock prices of the both, Poland and Hungary. If we take a look at Table 1 with descriptive stats of the stock indices' daily returns, we see the highest level of risk in Hungarian stock market with the highest standard deviation. On the other hand, it is obvious that Hungarian stock exchange is more active and liquid than the Czech stock exchange. Therefore it is a bit surprising that the Czech stock index has the deepest minimum and the second maximum of the change of price.

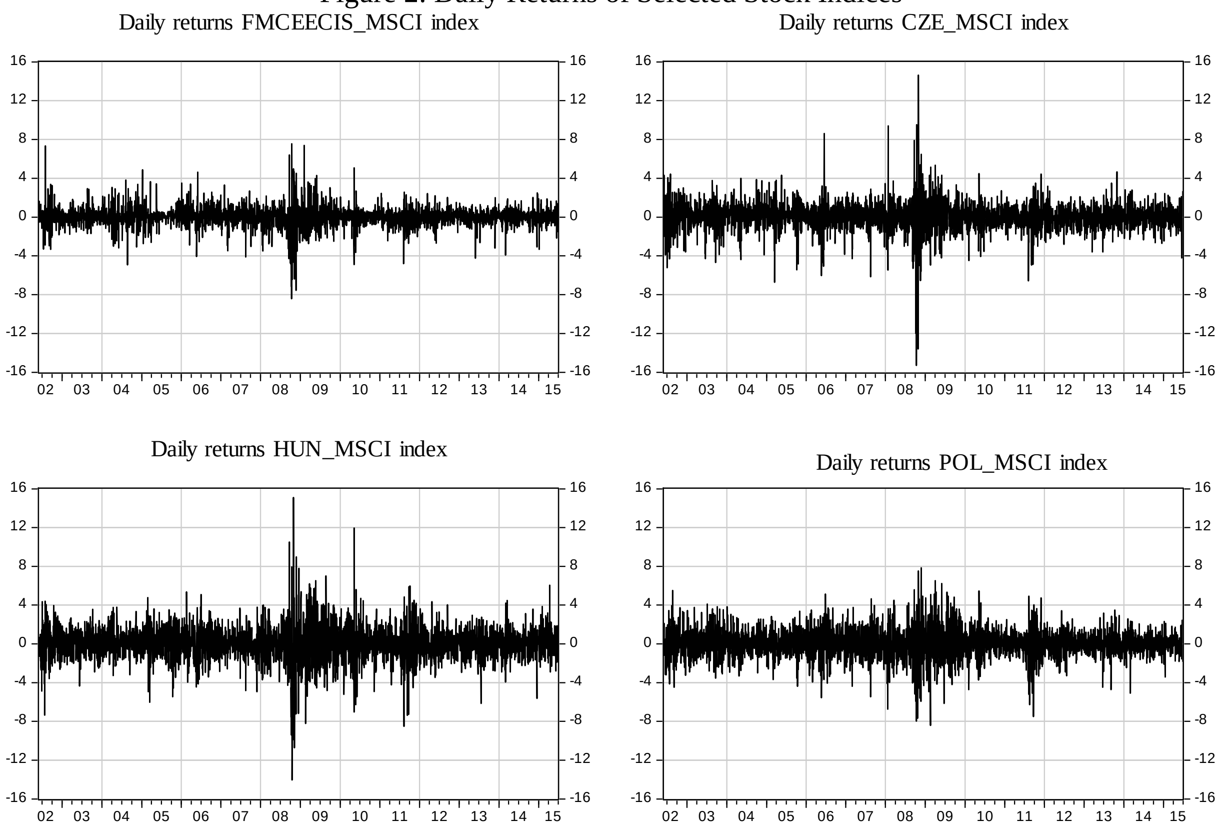
Table 1: Descriptive Statistics of the Stock Indices' Daily Returns

	RFMCEECIS	RCZE_MSCI	RHUN_MSCI	RPOL_MSCI
Mean	0.0099	0.0264	0.0170	0.0151
Median	0.0261	0.0249	0.0000	0.0000
Maximum	7.5669	14.6377	15.1117	7.8552
Minimum	-8.4068	-15.2974	-14.0444	-8.4233
Std. Dev.	1.0639	1.4601	1.7615	1.4680
Skewness	-0.2628	-0.5138	-0.0589	-0.1910
Kurtosis	11.8089	16.6730	9.9000	6.0514
Jarque-Bera	11071	26736	6772	1345
Probability	0.0000	0.0000	0.0000	0.0000
Sum	33.6965	89.9806	58.1697	51.5056
Sum Sq. Dev.	3861	7274	10587	7353
Observations	3412	3413	3413	3413

Source: authors' calculations

In Figure 2 we see daily returns of selected stock indices in the graph. The biggest volatility is obvious really in cases of Hungary and the Czech Republic, especially in times affected by the global financial crisis. On the other hand, the focus of the paper is to estimate differences in the sovereign debt crisis times in EMU. Whether the crisis change relations even among non-euro stock markets.

Figure 2: Daily Returns of Selected Stock Indices



Source: authors' illustrations

4. Empirical Results

On GARCH models' estimations in Table 2 we see that all variance equations are not statistically significant in the sovereign debt crisis period. Moreover, previous day volatility $Y_{(t-1)}$ is significant only in RFMCEECIS index. It is obvious that constant α_i is not significant in any case. It could be caused by Random walk theory of stock prices development. However, within TARCH estimations we see some weaknesses as insignificant variable γ_i among estimations for Visegrad countries or even negative sign of squared residuals in the case of Poland. Differences of RFMCEECIS index against the others can be caused by the fact that this index is formed by Russian stocks from more or less 60%. In all estimations is rejected the problem of heteroscedasticity through LM test. Darbin Watson stat indicates just a small value of autocorrelation among residuals and GED parameter is significant in all cases.

Table 2: GARCH and TARCH Models Output (the Sovereign Debt Crisis Period)

	RFMCEECIS		RCZE_MSCI		RHUN_MSCI		RPOL_MSCI	
	GARCH	*TARCH*	*GARCH*	*TARCH*	*GARCH*	*TARCH*	*GARCH*	*TARCH*
α_i	0.0194	0.0144	0.0029	-0.0003	-0.0087	-0.0242	0.0094	-0.0003
$Y_{(t-1)}$	0.0682 [b]	0.0688 [a]	0.0218	0.0252	0.0039	0.0106	-0.0141	-0.0129
Variance Equation								
α_0	0.0671 [a]	0.0604 [a]	0.0643 [a]	0.0722 [a]	0.0929 [a]	0.1022 [a]	0.0286 [b]	0.0309 [a]
γ_i	0.1726 [a]	0.0717 [b]	0.0661 [a]	0.0315	0.0842 [a]	0.0329	0.0573 [a]	-0.0068
λ_i	0.7238 [a]	0.7612 [a]	0.8798 [a]	0.8729 [a]	0.8741 [a]	0.8731 [a]	0.9171 [a]	0.9315 [a]
ϑ_i		0.1261 [a]		0.0647 [a]		0.0954 [a]		0.0908 [a]
GED	1.1719 [a]	1.1789 [a]	1.3140 [a]	1.3326 [a]	1.2999 [a]	1.3373 [a]	1.2975 [a]	1.3381 [a]
DW stat	1.9984	1.9959	1.9766	1.9832	2.0017	2.0149	1.9184	1.9209
ARCH	x	x	x	x	x	x	x	x

Note: Symbol [a], [b] and [c] means statistically significant coefficients at 1%, 5% and 10% level.
Source: authors' calculations

Table 3: GARCH and TARCH Models Output (Pre-Crises Period)

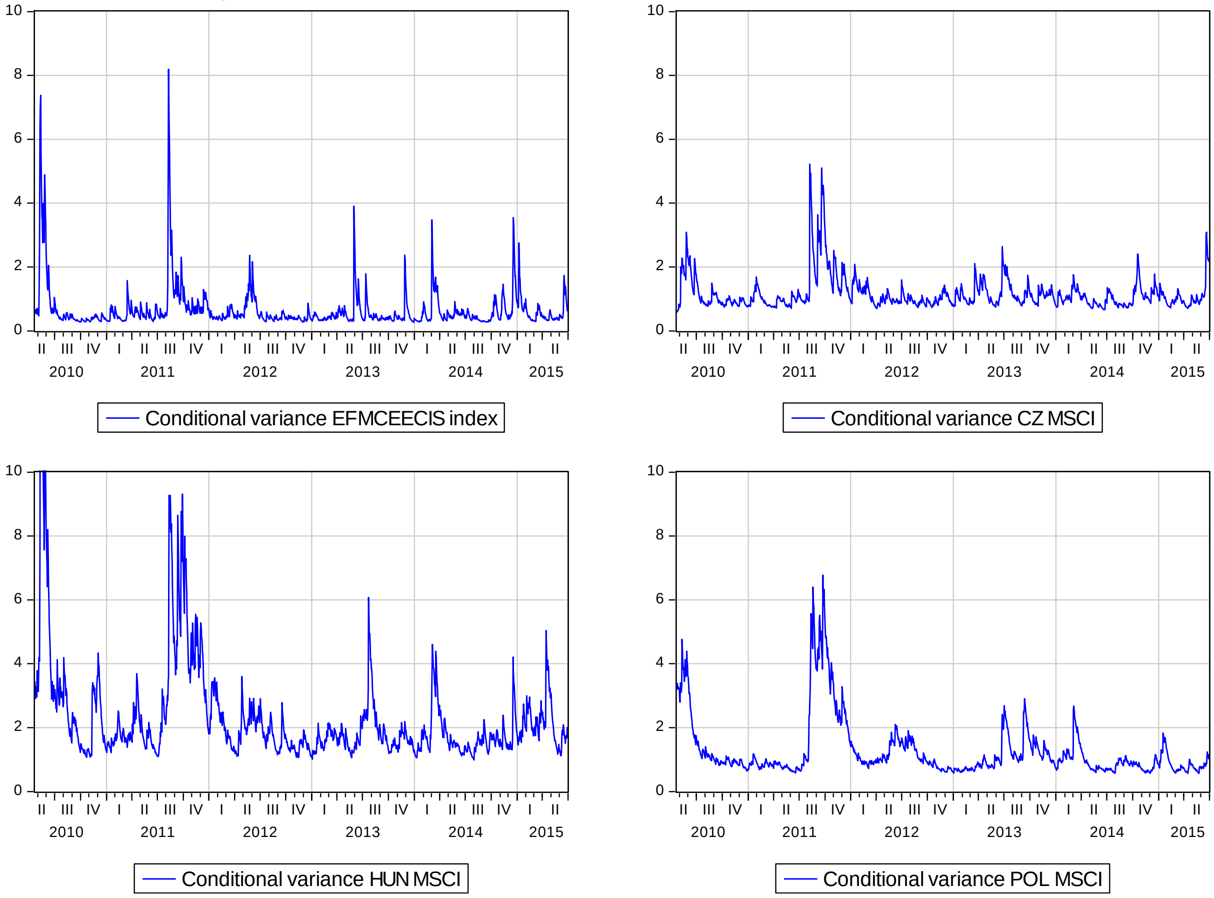
	RFMCEECIS		RCZE_MSCI		RHUN_MSCI		RPOL_MSCI	
	GARCH	*TARCH*	*GARCH*	*TARCH*	*GARCH*	*TARCH*	*GARCH*	*TARCH*
α_i	0.0500 [a]	0.0442 [a]	0.1352 [a]	0.1090 [a]	0.0478	0.0598 [c]	0.0423	0.0333
$Y_{(t-1)}$	0.0143	0.0170	0.0191	0.0351	0.0183	0.0074	-0.0211	-0.0198
Variance Equation								
α_0	0.0134 [b]	0.0208 [b]	0.1014 [a]	0.1679 [a]	2.1251	0.1289 [a]	0.0335 [c]	0.0482 [b]
γ_i	0.0671 [a]	0.0429 [a]	0.1220 [a]	0.0195	0.1500	0.0557 [a]	0.0460 [a]	0.0283 [c]
λ_i	0.9231 [a]	0.0550 [b]	0.8238 [a]	0.1803 [a]	0.6000	0.0710 [a]	0.9387 [a]	0.0361 [c]
ϑ_i		**0.9123 [a]**		0.7878 [a]		**0.8490 [a]**		**0.9312 [a]**
GED	0.9922 [a]	0.9964 [a]	1.2927 [a]	1.3286 [a]	2.0000 [a]	1.5699 [a]	1.3830 [a]	1.3873 [a]
DW stat	1.9528	1.9584	1.9447	1.9782	1.9979	1.9759	1.9504	1.9532
ARCH	x	x	x	x	x	x	x	x

Note: Symbol [a], [b] and [c] means statistically significant coefficients at 1%, 5% and 10% level.
Source: authors' calculations

In Table 3 we see differences against to the pre-crises period. We see that before the both, the sovereign debt crisis in EMU as well as the global financial crisis, there were statistically significant constants α_i, except the case in Poland. However, there were not significant coefficients of previous day volatility $Y_{(t-1)}$, even in the case of RFMCEECIS index. The biggest difference is an argument that is obvious from TARCH output. We argue that mainly positive changes affected stock prices' volatility before the crises. The outputs for variance equation are very similar in general, except the case of Hungary.

The Figure 3 shows us that even in times affected by the sovereign debt crisis in EMU, there has been higher level of prices' volatility, especially in half of 2011. The lowest level of the volatility is obvious in RFMCEECIS index, the highest in Hungary. But from our pre-crisis and the crisis models' results we can conclude that those selected stock markets works efficiently after the global financial crisis. Before the crises there were even significant constants among volatility models. We argue, the nature of the volatility patterns in the case of Visegrad countries is close to Random walk theory after the global financial crisis. Finally,

Figure 3: Conditional Variance from the Crisis Period GARCH Models



Source: authors' illustrations

5. Concluding remarks

We have found different relations within price volatility of selected stock index and stock indices from three Visegrad countries (CZ, HUN, POL) in period affected by the sovereign debt crisis. Due to Sharma and Vipul (2015), volatility forecasting of financial assets has important implications for option pricing, portfolio selection, risk management and volatility trading strategies. Nevertheless, if there are some differences among GARCH and TARCH models for selected Visegrad markets included into one representative stock index, how such analyses could be usable for those stakeholders group concerned? From our results it is obvious that after the global financial crises there have changed relations within the volatilities of those markets. Therefore it may be changed the formation of some representative indices, as well. Without that it cannot be forecasted anything in technically point of view.

However, more than 60% of selected MSCI FEM CEE CIS index is formed from stocks of Russian companies. In future research we will pay our attention to Russian stock market therefore. Whether we find those relations within volatility among Russian market, which do not exist among our estimated CEE markets, it could be a good signal to change the portfolio of this index. Therefore we would like to investigate the Russian stock market with the same estimation method.

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