Vulnerability of the Czech and Slovak Economies to the Transmission of Crises – the Case of the Hungarian and Greek Turmoil

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Abstract
The aim of this research is to verify vulnerability of the Czech and Slovak economies to transmission of financial crises based upon the behaviour of their sovereign bond spreads. The bond spreads are constructed through subtracting the yield of the least risky bond in the region (in our case: the German one) from the yield of sovereign bond of the same maturity. We investigate the impact of the Greek and Hungarian crises to the dynamics of the bond spreads of the countries. We analyse the period from January 2009 to the end of 2012. We construct four-dimensional copula-GARCH model. The dynamics of the crises are approximated through bond spreads of Greek and Hungarian bonds, approximately. We attribute the differences in the dynamics to differences in the economies, inter alia to the fact of retaining the own currency (the Czech Republic) or adopting euro (the Slovak Republic).

Keywords: bond spread, copula-GARCH, debt crisis
JEL codes: C32, C51, G01, G15

1. Introduction

The aim of our research was to verify vulnerability of the Czech and Slovak economies to the transmission of financial crises based upon the behaviour of their sovereign bond spreads. Up to 1993 both republics used to constitute one economy. Later, in 2009 Slovakia, already as an independent economy, adopted euro as its currency. At the same time, the financial crisis started spreading from the USA to Europe, as a result of which some of the member states of the Eurozone experienced severe economic and fiscal crises. Economic problems also appeared in Hungary which is an important country in the region of Central Europe. These crises influenced the way the investors rate risk in the remaining economies in Europe as a whole or in the sub-region.

Our goal is to verify the direction and strength of transmission of these two crises to the two above-mentioned economies. Slovakia, contrary to the Czech Republic, adopted euro as its currency, and thus become a member of the Eurozone. At the same time, Greece, another member of the Eurozone, experienced acute economic problems. Therefore, our first research question is: was the influence of Greek crisis more severe to Slovakia than to the Czech Republic? At the same time Hungary, one of the Central-European economies, but not a Eurozone member, also experienced its own crisis. Therefore, our second research question is: did the Hungarian crisis spread to the Czech Republic, while leaving Slovakia unaffected? Our reasoning is as follows: Slovakia, through adopting the new currency, could have become more immune to Central-European problems and thus may be associated by investors more with the Western Europe than with Central Europe.

In our study we concentrate on bond spreads. Spreads of the bonds to the yield of the safest economy in the region are treated as indicators of the country's risk relative to the safest country in the region. D'Agostino and Ehrmann (2014) showed that in the case of spread of any country relative to a "safe heaven" government bond (e.g. German), country's fundamentals constitute a considerably more influential determinant of spread dynamics than fundamentals of the benchmark economy. Researchers confirm that importance of fundamentals in bond spread pricing increased especially during the financial crisis (e.g. Bernoth and Erdogan, 2012 or Borgy et al., 2011). Moreover, many studies proved that bond yields are much less vulnerable to sunspots and volatility spillovers from abroad that any of the daily-priced instruments (see e.g. Kocsis, 2014[1]; Będowska-Sójka and Kliber, 2013).

We analysed the influence of the Greek and Hungarian crises on Czech and Slovak economies through studying common dynamics of their volatilities. To estimate the volatilities, we used the DCC-copula model. Such an approach also allowed us to obtain the dynamics of the rank correlation coefficient, the Kendall τ, as well as tail dependence coefficient (λ). The latter measure is especially important for our analysis. It provides us with information on the possibility of the transmission of extreme events from risky countries.

Contrary to our expectations, it appeared that Slovakia, despite having introduced euro, was more immune to the Greek crisis transmission than the Czech Republic. What is interesting, however, is that the two economies seemed to be similarly exposed to the Hungarian crisis. Key points in the Hungarian policy, resulting in the growth of the Hungarian spread, were reflected in the correlation and probability of extreme events transmission. Moreover, together with the evolution of the crisis, the interdependencies between the Czech Republic and Slovakia grew.

The structure of the article is as follows. First, we present the data used in the study i.e. bond spreads of the Czech Republic, Greece, Hungary and Slovakia over the period 2009-2012, together with descriptive statistics. Next, we present the model used in the study: the DCC-copula. Finally, we describe and interpret the results of our model.

2. Literature Review

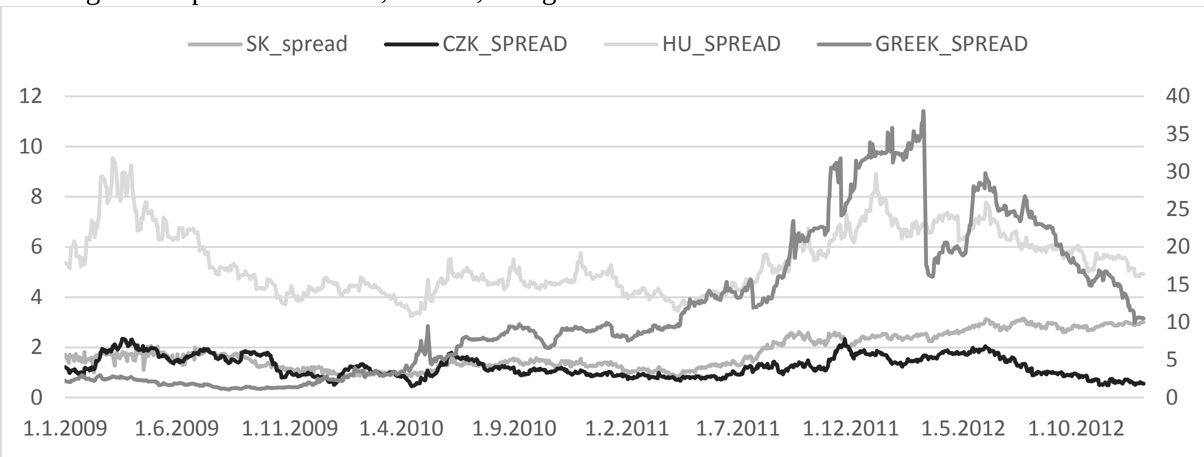
Bond spreads of European countries, including Central European economies, have been analysed for instance by Claeys and Vasicek (2014). The authors found that the CEE countries were linked by bilateral relationships (unlike the UK, Denmark and Sweden, which seemed to be quite isolated from other EU countries). They also confirmed that a downgrade of the neighbouring markets affects the economy more than their own downgrade. Nickel et al. (2009) investigated the CEE-countries together with Turkey in their study of the impact of expected fiscal deficit on bond spreads over the period 1997-2007. Dumicic and Ridzak (2010) analysed spreads of emerging European markets over the years 2000-2010 to find out that before the crisis spreads were determined mainly by market sentiment and macroeconomic fundamentals, while together with crisis outbreak external imbalances gained importance as well. Some CEE markets were included in the study of Balazs and Ivaschenko (2013), who also confirmed that in the periods of severe market stress (e.g. intensive phase of the Eurozone debt crisis) global factors tend to drive changes in spreads, and that the countries with stronger fundamentals are more immune to changes in global factors. The issue of reaction of the Central European economies to the Hungarian and Greek crises was already described by Kliber (2013). The author, however, concentrated on Poland, the Czech Republic and Hungary and investigated sCDS premiums, which are more vulnerable to international events and sunspots than bond yields. The authors proved, inter alia, that the co-movement between CEE sovereign markets increased as a result of the increase of market volatility in crisis period. The results confirm the finding presented in Komárková et al. (2013), obtained for the Czech Republic.

[1] According to this study, in the case of Hungary the idiosyncratic factor can explain up to 80% of the variance of bond yields, while in the case of sovereign CDS this figure is only 33%.

3. The Data

Our data consisted of four time series of spreads of Czech, Greek, Hungarian and Slovak bonds to the German ones; see Figure 1. Czech, Hungarian and Slovak spreads have been presented on left axis, while the Greek ones on the right axis. At first, we can observe that the values of Czech and Slovak spreads were small i.e . in the range of 0 to 4 points, while the Hungarian spread took up to 10 points in the moments of speculative attack on forint (2009) and in the moment of the Hungarian crisis in 2012. Greek spread values are much higher than by the Hungarian ones. In March 2012 we observe a sharp decrease in the spread; this was the moment of the restructuring of the Greek sovereign bonds.

Figure 1: Spreads of Czech, Slovak, Hungarian and Greek Bonds to German one: 2009-2012



Note: Czech, Slovak and Hungarian spreads: left axis, Greek spread: right axis.

Source: own calculations

In Table 1 we present the descriptive statistics of the changes of the spreads. We modelled the changes, since the levels of the spreads are non-stationary. We decided not to logarithm the data for the sake of interpretation. We observe that the most volatile (in terms of the standard deviation) was Greece. Hungarian spread was– unsurprisingly – less volatile than the Greek one – but more than the Czech and Slovak ones. The least volatile was the spread of the Czech bonds. In all the cases the ARCH effect was observed.

Table 1: Descriptive Statistics of the Bond Spreads Changes

Variable	Obs. no	Mean	Std. Dev.	Minimum	Maximum	skewness	kurtosis
dSK	1042	0.001	0.093	-0.685	0.670	0.116	14.846
dCZ	1042	-0.001	0.065	-0.280	0.328	0.319	5.633
dGR	1042	0.008	0.837	-19.641	4.218	-13. 061	302.802
dHU	1042	0.000	0.165	-0.974	0.942	0.002	8.716

Note: dSK - changes of Slovak bonds spread, dCZ - changes of the Czech bonds spread, dGR - changes of the Greek bonds spread and dHU- changes of the Hungarian bonds spread.

Source: own calculations

The dynamics of the Greek and Hungarian spreads reflected domestic turbulences. Already in 2010 stability and credibility of Greece started being questioned. In April 2010, the Greek government requested for activation of the first EU/IMF bailout package, as a result of which rating of the Greek sovereign debt was lowered. The package has been activated in May and the Greek rating was subsequently lowered by international rating agencies. This event was reflected in the first spread peak (Figure 1). The domestic situation was getting worse and worse. Attempts to implement the budget cuts and austerity measures met with strikes and social disapproval. Again, in June 2011 the Greek sovereign bonds were downgraded to CCC. In June 2011, the European Financial Stability Facility was created to provide another aid package for Greece. In July 2011, the private investors and government institutions accepted a cut of the nominal value of Greek bonds. Subsequently, in February 2012 the second bailout package was finalized, and private investors had to accept the cut in the face value of Greek bonds of 53.3%. This restructuring eventually made ISDA trigger credit event with respect to the Greek sCDS (see also: Nelson et al., 2011; Traynor, 2011; Kliber, 2013; Kliber, 2014).

The Hungarian crisis was less severe. Although in June 2010 vice-chairman of the ruling Fidesz party warned that Hungary was close to follow the Greek scenario (after: FTMDaily[2]), the country managed to overcome the crisis. However, confidence in the market was so low, that this statement itself led to a sharp growth of the Hungarian sovereign CDS (see Kliber 2013). Consequently, rating agencies performed a series of downgrades of Hungarian sovereign bonds. By March 2009 forint depreciated by 26% against euro and by November 2011 by 56% against Swiss franc (see Valentinyi, 2012 and EEAG, 2012). As a consequence, the country faced a huge problem with foreign-currency loans. In September 2011 the government passed a legislation that unilaterally changed the terms and conditions of all foreign currency loans contracts, the cost of which had to be born entirely by banks. In mid-December 2011, the government and banks agreed to share costs of further arrangements. Following this decision, rating agencies lowered the ranking of Hungarian debt once again on November, 25th and December, 22nd. This situation has led to an increase in the Hungarian spread, as observed in Figure 1. However, the steepest increase was observed throughout the year 2012. The reason for this growth could be also connected with the fact that in January 2012 new Hungarian constitution came into force, the change of which had been criticised by the EU.

4. The Model

When time series distribution is not normal, using Pearson's correlation coefficient to identify the dependencies between random variables may lead to misleading conclusions (Lindskog, 2000). This is because Pearson's correlation coefficient is very sensitive to outliers. Zero correlation implies independence only if the variables are normally distributed. The heavier the tails, the larger the error of the estimator. Empirical distributions of the modelled data vary across samples. Empirical kurtosis of the Greek bond spread growth series is equal to 302.8, but the empirical kurtosis of the Czech bond spread only 5.6. Values of estimated degrees of freedom parameters in univariate GARCH allow us to suspect that conditional error distribution are also varied, while in M-GARCH models all univariate conditional error distributions has to be the same.

Therefore, in order to verify the strength of linkages among the analysed countries we used the DCC-copula model. In this model, there are no restrictions on marginal distributions and it allows for determining measures of dependences other than correlation coefficient. We present the dynamic estimation of the rank correlation coefficient, the Kendall τ, as well as tail dependence coefficient (λ). The latter measure is especially important for our analysis. It provides us with information on the possibility of the transmission of extreme events from the risk countries. Schmidt (2002) explained that asymptotic dependencies should not be identified with linear correlation coefficient. It is well known, that in some cases correlation between the considered series is strong, but there exists no dependence in tails. Note that bivariate normal distribution is asymptotically tail independent if its correlation coefficient ρ is less than 1.

Our research is based on the DCC-copula model. Let us denote the multivariate time series by $x_t = x_{1,t},....,x_{d,t}$. The model was applied in two steps using maximum likelihood method. In the first step, we fit each univariate series $x_{i,t}$, and the $u_t = u_{1,t},....,u_{d,t}$ is the multivariate time series, with each $u_{i,t}$ having been determined as the value of cumulative distribution function for $\tilde{\varepsilon}_{i,t}$, to one of the univariate GARCH-type models with *t* Student or GED innovation distribution.

[2] FTMDaily (2010). *EU Urges Hungary to Slash Huge Budget Deficit* [online]. Available at: <https://ftmdaily.wordpress.com/2010/06/04/eu-urges-hungary-to-slash-huge-budget-deficit/>. [cit. 25.09.2015].

$$
\begin{aligned}
x_{i,t} &= \mu_{i,t} + y_{i,t} \\
y_{i,t} &= \sigma_{i,t}\varepsilon_{i,t}, \\
\varepsilon_{i,t} &\sim iid(0,1), \\
u_{i,t} &= F_i(\tilde{\varepsilon}_{i,t}),
\end{aligned} \tag{1}
$$

where $\tilde{\varepsilon}_{i,t}$ stands for standardized residual series and F_i is the cumulative distribution function of innovation distribution from the model fitted to $x_{i,t}$. Conditional mean $\mu_{i,t}$ was modelled as an ARMA-type model of the form:

$$
x_{i,t} = a_0 + \sum_{i=1}^{p} a_i x_{t-i} + \sum_{j=0}^{q} b_j y_{t-j.}
$$

We considered standard GARCH models (Bollerslev, 1986), GJR-GARCH (Glosten at al., 1994), EGARCH (Nelson, 1991), the Spline-GARCH (Engle and Rangel, 2008) and the IGARCH (Engle, Bollerslev, 1986) with *t* Student or GED innovation distribution with υ degrees of freedom. In specific models, the conditional variance equations have the following form:

- GARCH(*p*,*q*) – $\sigma_t^2 = \omega + \sum_{i=1}^{p} \alpha_i y_{t-i}^2 + \sum_{j=1}^{q} \beta_j \sigma_{t-j}^2$, where y_t is the residual series,
- GJR-GARCH(*p*,*q*) – $\sigma_t^2 = \omega + \sum_{i=1}^{p} \alpha_i y_{t-i}^2 + \gamma_i S_{t-i}^{-} y_{t-i}^2 + \sum_{j=1}^{q} \beta_j \sigma_{t-j}^2$, where S_t^{-} is a dummy variable that takes the value of 1 when γ_i is negative and 0 when it is positive,
- EGARCH(*p*,*q*) – $\log(\sigma_t^2) = \omega + \sum_{i=1}^{q} \alpha_i \left[\frac{y_{t-i}^2}{\sigma_{t-i}^2} - E\left(\frac{y_{t-i}^2}{\sigma_{t-i}^2} \right) \right] + \gamma \left(\frac{y_{t-1}^2}{\sigma_{t-1}^2} \right) + \sum_{j=1}^{q} \beta_j \log(\sigma_{t-j}^2),$
- Spline-GARCH(*p*,*q*) with *k* knots – $\sigma_t^2 = \tau_k \left(\omega + \sum_{i=1}^{p} \alpha_i y_{t-i}^2 + \sum_{j=1}^{q} \beta_j \sigma_{t-j}^2 \right),$

  where $\tau_k = \exp\left(\sum_{i=0}^{k-1} \delta_i (t - t_i)^2 \right)$ is the exponential of a quadratic Spline with *k* knots $t_0, ..., t_{k+1}$.
- IGARCH(1,1) – $\sigma_t^2 = \alpha y_{t-1}^2 + \beta \sigma_{t-1}^2$, where $\alpha + \beta = 1.$

In the second step, to u_t series we fit the conditional *t* copula, where the rank correlation matrix R_t is driven by the DCC model of Engle (2002).

$$
C_{\upsilon,R_t}^{t}(u_1,...,u_d) = \int_{-\infty}^{t^{-1}(u_1)} \cdots \int_{-\infty}^{t^{-1}(u_d)} \frac{\Gamma\left(\frac{\upsilon+d}{2}\right)}{\Gamma\left(\frac{\upsilon}{2}\right)\sqrt{(\pi\upsilon)^d \, |R_t|}} \left(1 + \frac{\begin{pmatrix} x_1 \\ \vdots \\ x_d \end{pmatrix}^T R_t^{-1} \begin{pmatrix} x_1 \\ \vdots \\ x_d \end{pmatrix}}{\upsilon} \right)^{-\frac{\upsilon+d}{2}} dx_1 \cdots dx_d, \tag{2}
$$

where $\Gamma(x) = \int_0^\infty x^{t-1} e^{-x} dx$ is the gamma function, $R_t = diag(Q_t)^{-1/2} Q_t diag(Q_t)^{-1/2}$, where the positive-definite matrix Q_t is described by the following formula:

$$
Q_t = (1 - \sum_{m=1}^{M} \alpha_m - \sum_{n=1}^{N} \beta_n)\overline{Q} + \sum_{m=1}^{M} \alpha_m \tilde{u}_{t-m} \tilde{u}'_{t-m} + \sum_{n=1}^{N} \beta_n Q_{t-n}, \tag{3}
$$

where $\widetilde{u}_t = t_\upsilon^{-1}(u_t)$. The log-likelihood function is given by the following formula:

$$L_{St}(R_t,\upsilon,\theta,\widetilde{u}_t) = -T\ln\frac{\Gamma\left(\frac{d+\upsilon}{2}\right)}{\Gamma\left(\frac{\upsilon}{2}\right)} - pT\ln\frac{\Gamma\left(\frac{\upsilon+1}{2}\right)}{\Gamma\left(\frac{\upsilon}{2}\right)} - \frac{d+\upsilon}{2}\sum_{t=1}^{T}\ln\left(1+\frac{\widetilde{u}_t' R_t^{-1}(\theta)\widetilde{u}_t}{\upsilon}\right)$$
$$-\sum_{t=1}^{T}\ln|R_t(\theta)| + \frac{\upsilon+1}{2}\sum_{t=1}^{T}\sum_{i=1}^{p}\left(1+\frac{\widetilde{u}_{i,t}^2}{\upsilon}\right), \tag{4}$$

where θ is the DCC parameter vector. More details about conditional copulas can be found in Doman, Doman (2013), Patton (2002) and Patton (2006).

We use Kendall τ as a measure of dependence. This is a measure of the so called “concordance”. Let (x_1,y_1), (x_2,y_2), (x_n,y_n) be a set of observation pairs generated form random variables *X* and *Y*. Observation pairs (x_i,y_i) and (x_j,y_j) are concordant if their ranks are consistent (i.e. if $x_i > x_j$ and $y_i > y_j$ or $x_i < x_j$ and $y_i < y_j$). Similarly, observation pairs (x_i,y_i) and (x_j,y_j) are disconcordant if their ranges are not consistent (i.e. if $x_i < x_j$ and $y_i > y_j$ or $x_i > x_j$ and $y_i < y_j$). If $x_i = x_j$ or $y_i = y_j$, then observation pairs are neither concordant nor disconcordant. Kendall τ coefficient is the difference between the probability of concordance of observation pairs (x_i,y_i) and (x_j,y_j) and probability of their disconcordance. Thus

$$\tau(X,Y) = P\bullet[(x_i - x_j)(y_i - y_j) > 0] - P\bullet[(x_i - x_j)(y_i - y_j) < 0]. \tag{5}$$

For the sake of our research, it is very important to check how the occurrence of extreme values of one series influences the probability of occurrence of extreme values of the other series. The coefficients of tail dependence λ^L and λ^U provide asymptotic measures of the dependence in the left and right tail respectively. They are given by following formulas:

$$\lambda^L = \lim_{\alpha\to 0+} P(X_2 \le F_2^{-1}(\alpha) \mid X_1 \le F_1^{-1}(\alpha)), \tag{6}$$

$$\lambda^U = \lim_{\alpha\to 1-} P(X_2 > F_2^{-1}(\alpha) \mid X_1 > F_1^{-1}(\alpha)), \tag{7}$$

if the limits exist. For elliptical copulas $\lambda^U = \lambda^L$.

5. Results

In Table 2 we present the results of the estimation of univariate GARCH-type models. In the case of Slovakia and the Czech Republic we assumed that the distribution of errors follows Student distribution, while in the case of Hungary and Greece it the GED distribution. We chose the best models based on their abilities to explain all linear and non-linear dependencies in the data, stability of parameters and information criteria. Lack of linear dependencies in residuals and squared standardized residuals in all models was confirmed by Ljung-Box (1978) test. In the case of Slovakia, Spline-GARCH with three knot-points and deterministic trend proved to be the best model. In the case of the Czech Republic the best model was simple GARCH(1,1). In the case of Hungary it was again the GARCH(1,1) model that performed best, while in the case of Greece it was the IGARCH(1,1) with two explanatory variables in mean equation: dummies indicating jumps in the data. Based upon the results of the Ljung-

Box test, we claim that in each case all the linear and non-linear dependencies in the data have been explained (for the sake of consistency the results are not reported in the article, but are available upon request).

After estimating the univariate models, we collected standardized residuals, and fit to the $u_{i,t}$ series the *t* Student copula with conditional matrix explained by DCC(1,1) model. The estimation results are presented in the Table 3.

Table 2: Results of the Estimation of Univariate GARCH Models – Slovakia, the Czech Republic, Hungary and Greece.

SLOVAKIA: ARMA(1,1)-Spline-GARCH (*t* Student)				
	Estimate	Std.Error	t-value	p-value
υ	5.066	0.851	5.954	0.000
a_1	0.228	0.117	1.943	0.052
b_1	-0.435	0.101	-4.307	0.000
ω	0.052	0.032	---	---
δ_0	-13.282	3.802	-3.493	0.001
δ_1	16.915	5.115	3.307	0.001
δ_2	-27.124	8.296	-3.270	0.001
α_1	0.163	0.055	2.953	0.003
β_1	0.723	0.113	6.396	0.000
The CZECH REPUBLIC: GARCH(1,1) (*t* Student)				
	Estimate	Std.Error	t-value	p-value
υ	6.472	1.232	5.252	0.000
ω	1.285	0.737	---	---
α_1	0.074	0.027	2.766	0.006
β_1	0.895	0.039	23.070	0.000
HUNGARY: AR(1)-IGARCH(1,1) (GED)				
	Estimate	Std.Error	t-value	p-value
υ	0.981	0.0626	---	---
a_0	-0.00228	0.00114	-1.992	0.047
a_1	0.0611	0.000645	94.72	0.000
ω	0.000682	0.000452	---	---
α_1	0.162	0.069	2.317	0.021
β_1	0.838	---	---	---
GREECE: AR(1)-IGARCH(1,1) (GED)				
	Estimate	Std.Error	t-value	p-value
υ	0.807	0.0455		
a_0	-0.00158	0.000596	-2.647	0.008
gr1 (M)	-19.545	0.000653	2993	0.0000
gr2 (M)	-2.223	0.000444	-5006	0.0000
a_1	0.1055	0.00025	422.7	0.0000
ω	0.000649	0.000452	---	---
α_1	0.191	0.0637	3.004	0.003
β_1	0.809			

Source: authors´ calculations

Table 3: Estimation Results of 4-dimensional Copula with Conditional Matrix R_t Explained by DCC(1,1) Model – Slovakia, the Czech Republic, Hungary and Greece.

	Estimate	Std. Error	*t*-value	*p*-value
υ	16.183	3,385	---	---
α_1	0.0196	0.004	5.234	0,0000
β_1	0.975	0.005	203.224	0,0000

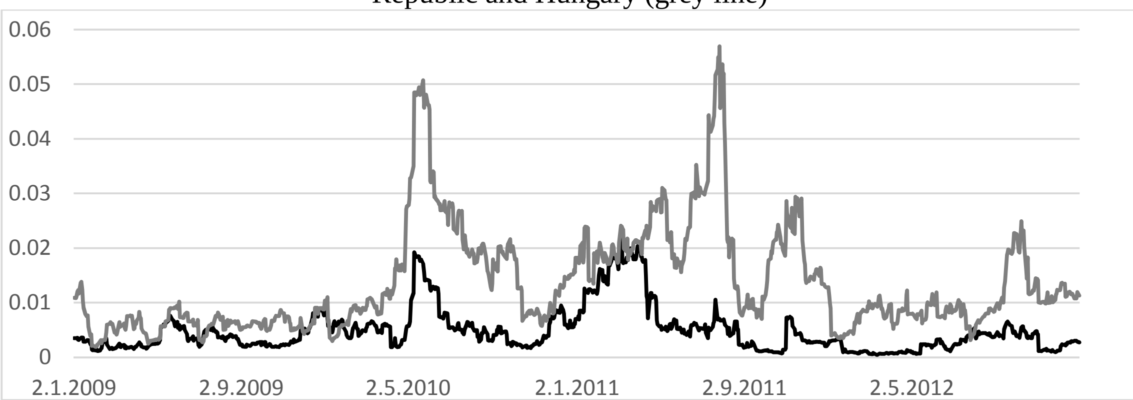
Source: authors´ calculations

Figure 2: Kendall's Tau: the Czech Republic and Greece (black line) vs the Czech Republic and Hungary (grey line)

Source: author´s calculations

In Figures 2 and 3 we plot the estimated Kendall's tau (Figure 2) and tail dependence coefficients (Figure 3) describing the interrelationships between the Czech Republic and Hungary as well as between the Czech Republic and Greece. First of all, we observe that both correlation as well as probability of tail dependencies are higher in the case of the Czech-Hungary pair. We observe an interesting pattern as the highest peaks are dated: May 2010, July 2011 and the remaining lower two are from November 2011 and October 2012. It is hard not to notice that the first peak corresponds to activation of the first aid package for Greece, while the second to the moment of cutting nominal value of Greek bonds. The third jump can be associated with the implementation of new regulations in Hungary, concerning foreign-currency debt, as well as with the fifth austerity package implementation in Greece. The fourth jump can be again attributed to the worsening situation in Greece during the negotiations of the seventh austerity package that has been eventually implemented in November 2012. This confirms the results obtained by Kliber (2014) that the Greek crisis contributed to the growth of the strength of relationships between the Czech Republic and Hungary.

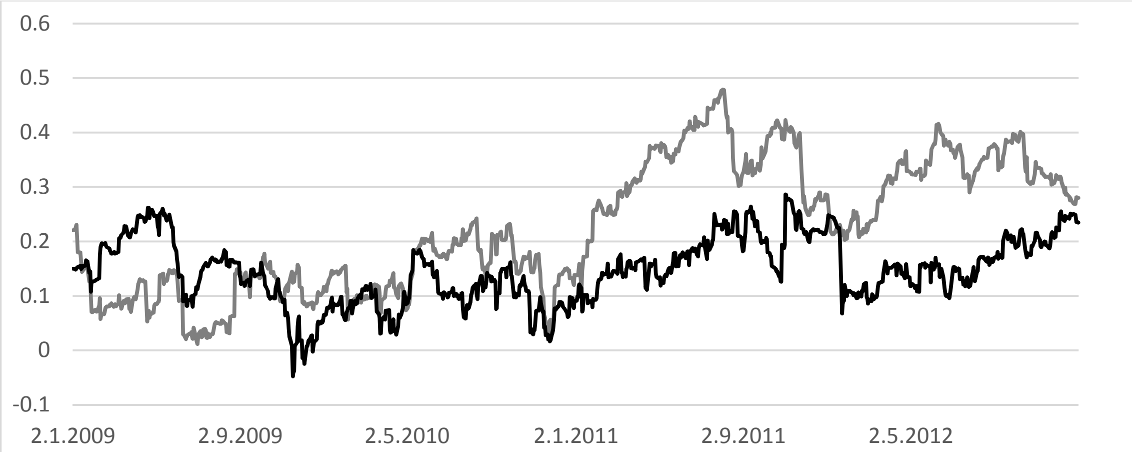
Figure 3: Tail Dependence Coefficient: the Czech Republic and Greece (black line) vs the Czech Republic and Hungary (grey line)



Source: authors´ calculations

In the case of Slovakia, the situation is different (see Figure 4 and 5). In the first phase of the crisis Slovakia seemed to be quite immune to spillovers and crisis transmission. Even in May 2010 we did not observe any growth in interrelationships between Slovakia and Greece (nor between Slovakia and Hungary). However, starting from November 2010 (when Hungary implemented unpopular pension policy[3]), the interrelations between Hungary and Slovakia started to grow. Kendall's tau reached its maximum in August 2011 (0.47). The peak in August, 2011, should not be, however, attributed to either Greek or Hungarian problems but to the downgrade of the American credit rating from AAA to AA+ by S&P. As a consequence, the global markets experienced sharp falls of stocks. The interrelations remained high until the end of the studied period.

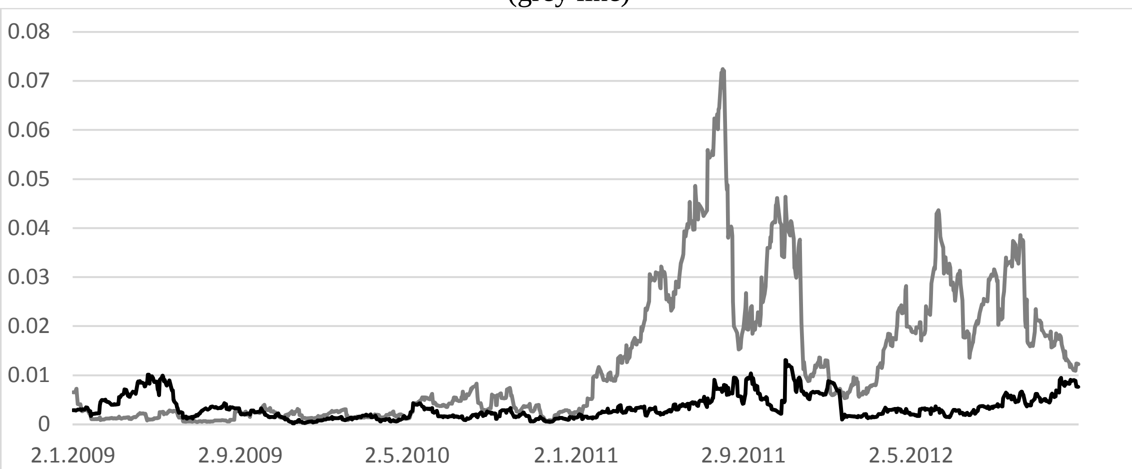
Figure 4: Kendall's Tau: Slovakia and Greece (black line) vs Slovakia and Hungary (grey line)



Source: authors´ calculations

The same conclusions can be derived from the plot of tail dependence coefficients. The probability of the transmission of extreme events was low in the whole period, but we observe that in the case of Hungary it grew fast in the half part of 2011. The four peaks observed are dated August 2011, November 2011, June 2012 and October 2012).

Figure 5: Tail Dependence Coefficient: Slovakia and Greece (black line) vs Slovakia and Hungary (grey line)



Source: authors´ calculations

[3] Until 2010 the mandatory pension system in Hungary was a two-pillar one: the first was the social security pillar, while the second – obligatory private one. Since November 2010 the system has become "nationalized" – the entrance to the private system is not mandatory and most of the savings were removed from the private pillar to the state one. The legislation, however, imposed firm penalties upon those Hungarians who did not transfer their pension assets back into the state system – see e.g. Maśniak and Lados (2014).

If we compare the situation of the Czech Republic and Slovakia, we observe that in the first crisis period both republics were immune to the crisis transmission both from Hungary and from Greece. However, already in March the probabilities of the transmission of the crises grew for Czech Republic. If we analyse peaks of “Hungarian” tail dependence coefficient i.e. the probabilities of the extreme events transmission, we observe that they do not always overlap. The common peaks are: October/November 2011 and October 2012. In the case of the Czech Republic we observe the first peak in May 2010, while in the case of the Slovakia it was in August 2011. The first can be attributed to the Greek problems, while the second one to the downgrade of USA.

Figure 6: Kendall’s Tau: Slovakia and the Czech Republic

Source: authors´ calculations

In Figure 6 we present estimates of the Kendall’s tau for the relationships between Slovakia and the Czech Republic. The picture confirms our previous expectations as the relationships between the two countries grew. The moment of change was 2011.

Conclusions

In the article we present an analysis of the changes of interdependencies between the two Central-European economies: the Czech and Slovak Republics with two European economies especially hit by the debt crisis: Greece and Hungary. Since Slovakia adopted euro in 2009, we suspected that the Greek crisis could have had more influence on Slovakia, while the Hungarian crisis was expected to have more influence on the Czech Republic. In order to check this hypotheses we estimated the multivariate copula-GARCH models for the bond spreads of the four economies. The reference spread was the German one. The results falsified our hypotheses.

First of all, Slovakia seemed to be more immune to crisis transmission throughout the first phase of the crisis. The bond spreads reacted spectacularly neither to the Greek nor to Hungarian problems. However, the situation changed in 2011 when we observe a growth of dependence between the Slovak and Hungarian spreads, while the probability of the extreme events transmission from Hungary started to grow but rather as a response to the Greek problems.

In the case of the Czech Republic, until 2010 the dependence between Czech and Greek spreads seemed to be similar to the dependence between Czech and Hungarian spreads and oscillated around 0.2. Starting from 2010, the dependence with Hungary grew.

The results obtained in our research confirm the phenomenon described in Kliber (2014): CEE countries are more linked as a group, and the linkages became even stronger as a reaction to the Greek events. In other words, reaction of the countries to the pan-European problems was the same, which was reflected in the growth of linkages between them. Slovakia did not seem to be more prone to the pan-European problems, despite having adopted euro. Eventually, the linkages between Slovakia and the Czech Republic grew in consequence of the crisis.

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