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Impact Of The Ban On Uncovered SCDS Trade On The Interdependencies Between The CDS Market And Other Sectors Of Financial Markets. The Case Of Safe And Developed Versus Risky And Developing European Markets

Abstract

The aim of the article is to verify the impact of the ban on uncovered sCDS trade in Europe on the interdependencies between the sCDS market and other sectors of financial markets. We analyse two European markets: the safe and developed Swedish market, and the risky and developing Hungarian one. The study covers the period from October 2008 to October 2013. We analyse changes in the interdependencies between the sCDS market and the bond market, as well as between the sCDS market and the stock exchange. We found out that in the case of the safe Swedish market, the strength of relationships of each sector of financial markets with the sCDS one was much weaker than in the case of Hungary, which may suggest that the Swedish market is less prone to crisis transmission arising from herd behaviour or speculative attacks. In the end we show that in the two economies, the influence of the sCDS market on the other sectors of financial market indeed diminished following introduction of the ban on uncovered sCDS trade.

Keywords: *sovereign CDS (sCDS), bonds, exchange rate, stock exchange, volatility, financial crisis.*

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1. Introduction

The aim of our study was to verify the impact of the change in the regulation of sCDS trade on the interdependences between various sectors of financial markets, taking into account two different markets: Sweden's and Hungary's. Sweden already experienced its "own" financial crisis in late '1980s and early '1990s. Some market analysts even compare it to the recent mortgage crisis in the USA and give Sweden as an example of a model recovery. The lessons learnt from that crisis and the banking reforms and other regulations implemented (see e.g.: Joung et al. 2009, Ergunor 2007, pp. 6–10) probably explain why Sweden (and other Nordic countries) did not suffer from the current financial instability.

On the other hand, Hungary is a small market in Central Europe. In the early 1990s Hungary had only started new reforms as it transitioned from the communist regime. Already at the beginning of the financial crisis the country experienced its first problems with its currency, due to speculative attacks on the forint at the end of 2008 and the beginning of 2009. Shortly after the outbreak of the Greek crisis it became apparent that Hungary could have experienced similar difficulties. The country had to implement new reforms, such as the reform connected with its financial system in November 2010.

One of the most common indicators of risk connected with a country's solvency is sovereign CDS spread. Owing to their construction, these contracts have gained a bad reputation during the current crisis. The buyer of the CDS protects himself against the insolvency of his debtor, entering the sCDS contract and paying the seller a pre-specified amount (spread or premium), expressed in basic points. The underlying instrument of sovereign CDS is the government bond. In particular, the buyer of the sCDS was not obliged to possess the bond and the instruments could have been used by hedge funds simply to express their opinion on the given country. During the Greek crisis such speculators were blamed for raising the cost of the issuers of government debts (including Greek debt itself). Therefore the legislators in the European Parliament and the Council issued a new Regulation in March 2012, which came into force on November, 1, 2012. According to this Regulation (EU No 236/2012) it is prohibited to enter into a short position in uncovered sovereign debt through a CDS contract in the European Union (ISDA 2014, p.1). This decision has been widely criticized by market analysts and investors. In ISDA research (ISDA 2014, pp. 5–6) it was shown that after the implementation of the new regulation the liquidity of the sCDS market declined drastically. The volume traded fell even by 50% in the case of Western Europe and 40% in the case of Central Europe, and market participants started to utilize another indices, e.g. iTraxx Europe Senior Financials.

The aim of our research was to verify whether, together with the implementation of the new regulations, any changes have appeared in the interrelationships between the sCDS market and other sectors of financial markets. In the literature the problem is usually discussed from the other angle – what impacts the CDS market. However, if the fear was that the role of sCDS was so high that a ban on speculation had to be imposed, we wished to verify whether this fear was justified, i.e. whether the changes in sCDS premiums could have influenced other sectors of financial markets, and if so, whether this impact diminished after the new regulation came into force.

The problem of the consequences of the ban on the bond market was analysed by (Capponi and Larsson 2014, pp. 481–508). The authors developed a partial equilibrium model and demonstrated that if the investors are risk averse and take relatively small positions compared to the amount of outstanding debt, the ban should have only a minor effect on the bond market.

The relationships between sCDS and the sovereign bonds market, regardless of the ban, has already been widely studied in the literature, which however has yielded no clear results about their lead-lag relationships or causality directions (see for instance: Fontana and Scheicher 2010, pp. 4–28, Coudert and Gex 2010, pp. 1–7, Kliber 2013, pp. 125–161 or Arce et al. 2011, pp. 124–145). The researchers showed that the lead-lag relationships between instruments are rather country-specific and can change during different crisis phases.

There are also articles analyzing the interrelationship between CDS and stock exchange markets (Coronado et al. 2012, Platev and Marinova 2013, pp. 2–15 or De Silva 2014). In most of cases the authors find that the stock market leads the sCDS one. The exceptions were Ireland and Southern Europe after 2010 (Coronado et al. 2012, pp. 32–63), as well as Finland and France (De Silva 2014, pp. 145–167). (Platev and Marinova 2013, p. 14) also documented causality from the sCDS market in the case of Hungary, Romania and Bulgaria.

In the end, this strand of literature is the least developed when it comes to the relationship between sCDS and foreign exchange markets. (Carr and Wu 2007, pp. 2392 – 2401) present an analysis of covariance between sovereign CDS and currency option implied volatility, as well as its slope in moneyness for Mexico and Brazil. (Della Corte et al. 2014, pp. 36–37) document a strong contemporaneous relationship between sovereign CDS spreads and exchange rates. The authors show that an increase in the sovereign risk of a country is associated with a depreciation of its currency and an increase in exchange rate volatility. They claim that this link is largely driven by global CDS shocks. (Breuer and Sauter 2012, pp. 1–18) analyse the effect of a credit event in the European market on the EUR/USD exchange rate.

This article contributes to the existing literature in several ways. First, we analyse the relationships between the pairs of markets prior to and after the introduction of the new regulations, which to our knowledge has not yet been done. We choose two totally different markets – a safe and immune one (Sweden), and a risky one prone to crisis contagion (Hungary). Both markets appear rather rarely in analyses concerning CDS markets. We verify whether the impact of sCDS on other sectors of financial markets was of the same magnitude and importance in both economies. This impact can also be attributed to the vulnerability of the country to crisis transmission or herd behaviour. Analysis of the results with regard to the type of the market can shed some light on the question whether the new regulation could be more in favour of some particular types of economies (e.g. the risky ones).

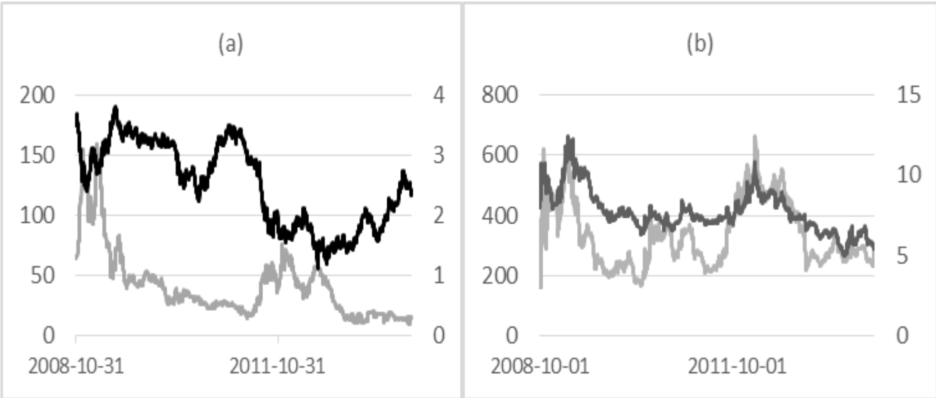
The remainder of the paper is structured as follows. First, we present the data and discuss its characteristics. Next we discuss the methodology used in the paper. Subsequently we present the analysis of conditional variance and correlation for four sectors of the financial market in each country. At the end we estimate a series of ARMA-GARCH-type models for bond yields, exchange rates and stock indices, with and without an explanatory variable (i.e. the change of sCDS spread). Based upon the log-likelihood ratio test, we test the hypothesis whether, in the period prior and after the new regulation, the full model is justified over the reduced one. We end the article with a discussion of the results.

2. The data

2.1. Bonds and CDS

In Chart 1(a) we present the dynamics of Swedish sCDS and government bonds. We can observe that the dynamics of the two series was of a rather different nature. In the first part of the crisis, when it was just transmitted to Europe, the sCDS drastically moved up, while the bond yield declined. The situation on the sCDS market stabilized shortly afterwards, and the sCDS premium dropped to a very low level. It remained at this low level until the summer of 2011, and in autumn 2012 it declined again. In the case of Swedish bonds, the situation was more dynamic. Following the decline in the yield, corresponding to the increase in sCDS, the yield stabilized at a level between 3 and 3.5%. Next, we observe a decline from April to December 2010. Starting from April 2011 the yield started to decline again. The minimum –1.1% – was obtained in June 2012, and since that time the yield has constantly increased.

Chart 1. Sovereign CDS and government bonds: Sweden (a) and Hungary (b)



Source: Reuters DataStream and stooq.pl.

The dependencies between the Hungarian sCDS and bonds are of a quite different nature (see Chart 1 b). First, the bonds and CDS do not seem to be a mirror reflection of each other, but rather follow the same patterns. Moreover, in the case of Hungary we can observe two episodes of the crisis, indicated by the growth of the spreads. The first peaks are observed at the beginning of the crisis, when it was transmitted to Europe. The second one appeared in 2011, together with the Greek and Hungarian internal problems.

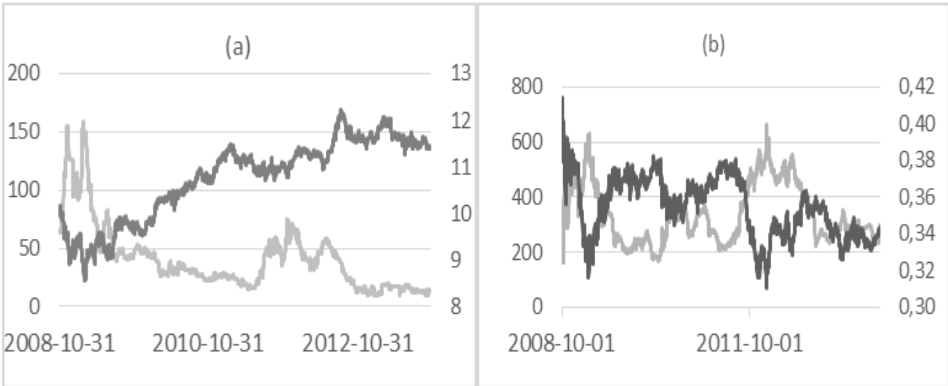
When we compare the analogous measures for Sweden in Hungary, we note that the sCDS spreads had two episodes of growth and the episodes overlap in the two countries. The first one was a consequence of the crisis transmission to Europe, while the second one should be attributed to the Greek problems (in Sweden) and to both the Greek and Hungarian problems (in Hungary). However, the values taken by the Swedish CDS were much lower than those of the Hungarian CDS. The maximum value obtained by the Swedish CDS was even lower than the minimum value obtained by the Hungarian one. This indicates how risky Hungary is in the opinion of the investors, as compared to Sweden.

2.2. Exchange rates

Both Sweden and Hungary have a floating rate regime; however in the case of Sweden this is a free float. In Chart 2 we present the evolution of the exchange rates of the Swedish crown (a) and the Hungarian forint (b), compared to the evolution of the respective sCDS spreads. We observe a gradual slight appreciation of the Swedish crown and a depreciation of the Hungarian forint.

In the case of the forint we even observe a slight reaction to the changes of sCDS spread, namely during episodes of sCDS increases (growth of the country's risk), the forint depreciated.

Chart 2. Swedish sCDS vs SEKEUR exchange rate (a) and Hungarian sCDS vs HUFEUR (b)



Source: Reuters DataStream and stooq.pl.

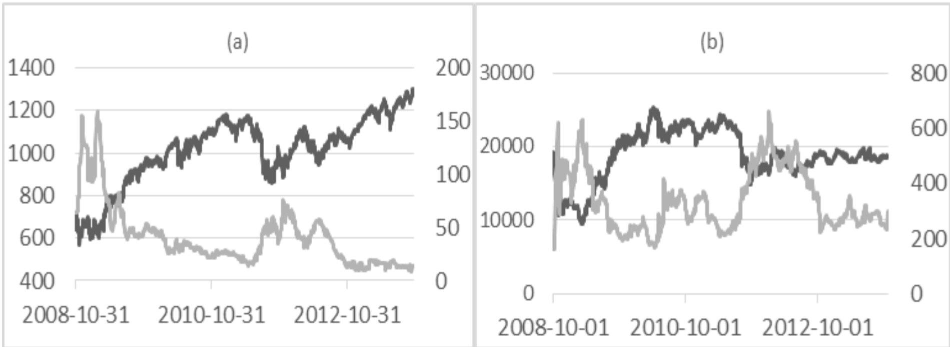
2.3. Stock indices

We selected the main indices of the Swedish and Hungarian stock exchanges to verify the relationships between them and the respective sCDS premia. In the case of Sweden we chose OMXS30 – the OMX Stockholm 30 Index. This is a price return index comprised of 30 shares which have the largest volume of trading. It is calculated in Swedish kronor (NASDAQ OMX 2014, p.4). In the case of Hungary, we analyse the BUX - the official index of blue-chip shares listed on the Budapest Stock Exchange. The index is a total return one, i.e. taking into account dividend payments. It consists of a varying number of shares, up to 25.

In Chart 3 (a) we present the evolution of Swedish OMX30 compared to the evolution of the sCDS. Apart from the first period, when sCDS reached its peak, the data changed in opposite directions, as if one of the series was a mirror reflection of the other. Similar conclusions also apply to the interdependencies between BUX and the Hungarian sCDS premium (Chart 3 b). The episodes of increase in the stock exchange correspond to episodes of diminishing risk connected with Hungary (measured by sCDS spread).

In Table 1 we present descriptive statistics of all the data series that are used in the article. If we compare the statistics of CDS premia, we observe that the Hungarian instruments were indeed much more volatile than the Swedish ones. The same conclusion applies to the government bonds and stock indices. However, it seems that the exchange rate of the Swedish crown was more dynamic than that of the Hungarian forint.

Chart 3. Swedish sCDS vs OMX30 (a) and Hungarian sCDS vs BUX (b)



Source: Reuters DataStream and stooq.pl.

Table 1. Descriptive statistics of sCDS, exchange rate, stock exchange indices and bonds yields

Variable	obs. Number	transform.	min	Mean	max	std.dev
SWEDEN						
OMXS30	1279	log-difference	-6.9681	0.0555	9.8650	1.5283
SEKEUR	1279	difference	-0.2690	0.0010	0.2732	0.0595
SW_bond	1279	difference	-0.2470	-0.0009	0.3560	0.0497
SW_CDS	1279	difference	-27.0000	-0.0394	20.0000	2.6621
HUNGARY						
BUX	1203	log-difference	-12.6490	-0.0018	13.1770	2.0105
HUFEUR	1203	difference	-0.0224	-0.0001	0.0221	0.0030
HU_bond	1203	difference	-1.2800	-0.0021	1.2700	0.1693
HU_CDS	1203	difference	-145.000	0.1137	129.4500	14.7410

Source: own calculations in G@RCH package of OxMetrics7.

3. Methodology

In this article we utilize a class of GARCH-type models, the univariate and multivariate ones. Let us first present the univariate ARMA-GARCH model of Bollerslev (Bollerslev 1986, p.308–310).

3.1. Univariate GARCH models

Let us denote by y_t the value of the process at time *t*. The following model:

$$r_t = \sum_{i=1}^{m} a_i r_{t-i} + \sum_{j=1}^{n} b_j y_{t-j} + y_t + \sum_{k=1}^{s} c_k z_{k,t},$$
$$y_t = \sigma_t \epsilon_t, \tag{1}$$
$$\sigma_t^2 = \omega + \sum_{i=1}^{p} \alpha_i y_{t-i}^2 + \sum_{j=1}^{q} \beta_j \sigma_{t-j}^2 + \sum_{k=1}^{r} \gamma_k w_{k,t}$$

is called an ARMA-GARCH model with explanatory variables z_i and w_j. We assume that ε_t is an iid process of mean 0 and unit variance. Moreover, $\varpi_i > 0, \alpha_i \geq 0, \beta_i \geq 0$. In our research we estimated only the GARCH(1,1) models, and thus the conditional variance equation reduced to the following form:

$$\sigma_t^2 = \omega + \alpha y_{t-1}^2 + \beta \sigma_{t-1}^2 + \sum_{k=1}^{r} \gamma_k w_{k,t}. \tag{2}$$

If there were no explanatory variables in the volatility equation, the last part of the equation disappeared (i.e. $\gamma_k = 0$ for each k).

Another GARCH-type model used in the research was the integrated GARCH one – the so-called IGARCH model. It is estimated in the case when the data exhibit strong persistence and thus $\alpha + \beta \approx 1$, imposing the restriction that $\alpha + \beta$ is actually exactly equal to 1. Thus, the volatility equation in the case of IGARCH(1,1) model takes the following form:

$$\sigma_t^2 = (1-\beta) y_{t-i}^2 + \beta \sigma_{t-1}^2. \tag{3}$$

In our research we also estimated the simplest of the GARCH-type models – the RiskMetrics^{TM} one (J.P.Morgan 1996, pp. 77 – 100). The RiskMetrics^{TM} is an IGARCH(1,1) model where ARCH and GARCH coefficients are fixed:

$$\sigma_t^2 = (1-\lambda)\varepsilon_{t-1}^2 + \lambda \sigma_{t-1}^2, \tag{4}$$

where λ is by default set at 0.94.

3.2. The multivariate GARCH models

The extension of the univariante GARCH models are the multivariate ones, estimated for the set of variables. Such an approach allows for also modelling conditional correlations. We utilized two of them – the one with constant and dynamic conditional correlation: the CCC-MGARCH model of Bollerslev (Bollerslev 1990, pp. 499 – 502) and DCC model of Engle (Engle 2002, pp. 339–343).

Let us denote by y_t the value of the process at time t. Let us assume also that:

$$y_t | F_{t-1} \sim N(0, \mathbf{H}_t)$$

$$\mathbf{H}_t = \mathbf{D}_t \mathbf{R}_t \mathbf{D}_t \qquad (5)$$

In CCC model $\mathbf{D}_t = diag\left(\sqrt{h_{11},t} \ldots \sqrt{h_{NN,t}}\right)$, where h_{iit} can be defined as any univariate GARCH-type model and: $\mathbf{R} = (\rho_{ij})$ is a positive-defined symmetric constant correlation matrix (for all i: ρ_{ii}=1). In the case of DCC model of Engle: $\mathbf{D}_t = diag\left(\sqrt{h_{11},t} \ldots \sqrt{h_{NN,t}}\right)$,

$$h_{ii,t} = \omega + \sum_{i=1}^{p} \alpha_i y_{t-i}^2 + \sum_{j=1}^{q} \beta_j \sigma_{t-j}^2 + \sum_{k=1}^{r} \gamma_k w_{k,t} \qquad (6)$$

(or can be defined as any univariate GARCH-type model), while:

$$\mathbf{R}_t = \left(diag(\mathbf{Q}_t)^{-0.5} \mathbf{Q}_t diag(\mathbf{Q}_t)\right)^{-0.5},$$
$$\mathbf{Q}_t = \left(1 - \sum_{m=1}^{M} a_m - \sum_{n=1}^{N} b_n\right)\bar{\mathbf{Q}} + \sum_{m=1}^{M} \alpha_m \mathbf{u}_{t-m} \mathbf{u}'_{t-m} + \sum_{n=1}^{N} \beta_n \mathbf{Q}_{t-n} \qquad (7)$$

The vectors $\mathbf{u}_t$ are k-dimensional and $u_{i,t} = \frac{y_{i,t}}{\sqrt{h_{ii,t}}}$. The k-dimensional matrix $\bar{\mathbf{Q}}$ is the unconditional covariance matrix of $\mathbf{u}_t$. It is also assumed that the scalars a_m and b_n are non-negative and $\sum_{m=1}^{M} a_m + \sum_{n=1}^{N} b_n < 1$.

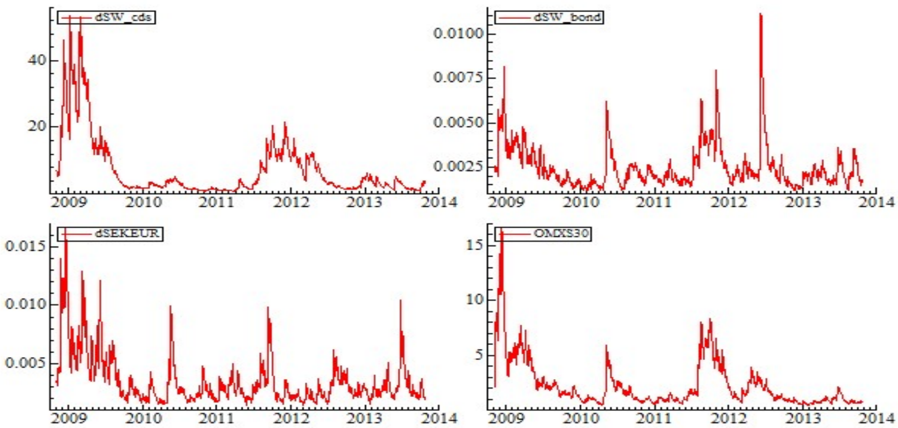
In our study we first estimated the MGARCH models with dynamic conditional correlation, to verify the strength of the relationships between sCDS market with other sectors of financial markets. When the correlation was time-varying, we studied its changes after the new regulation of sCDS trade came into force.

In the second part of the research we estimated the univariate GARCH models for bonds, exchange rates and stock indices with explanatory variables: changes of sCDS spreads. We estimated the models for the full sample and in subsamples: prior to and after the new regulations. Utilizing the log-likelihood ratio test we answered the questions whether the model with explanatory variables was better than the reduced one, and whether the results differ depending on the subsample and country.

4. Conditional correlation among the sectors of financial markets in Sweden and Hungary

As the opening step of our research we estimated the joint model for conditional variance with conditional correlation – either constant or dynamic, depending on the results of the test (Engle and Sheppard 2001, pp. 10–3). This initial step already allowed us to point out the first important difference between the Hungarian and Swedish stock markets. In the case of Sweden each sector of the financial market has its own dynamics (see Chart 4).

Chart 4. Volatility of Swedish sCDS, bonds, SEKEUR exchange rate and OMXS30 - the results of the DCC-MGARCH model. Note: starting from left-top corner, row-wise: sCDS, bonds, SEKEUR, OMX30



Source: own calculations in OxMetrics7.0.

In the case of sCDS we observe two volatility peaks: at the beginning of the crisis and during the period 2011-2012. The second peak can be attributed to the subsequent phase of the financial crisis and is not connected with a worsening situation of the country, nor with a change of its rating. The volatility of Swedish bonds is of very different nature (see Chart 4). First, the values taken by conditional variance are very small. Secondly, we observe four peaks: at the beginning of the crisis, in the middle of 2010, at the end of 2011, and in the middle of 2012. The dynamics of the bonds volatility resembles that of the SEKKEUR; however in the latter case we observe yet another peak in summer 2013. In the case of OMXS30, the volatility pattern is more similar to the one of sCDS, although we observe yet another peak in summer 2010.

In Chart 5 we present the conditional correlations obtained from the DCC-MGARCH model of Engle (Engle 2002, pp. 339–343). We must keep in mind that our aim is to assess the influence of the new regulation of sCDS trade on the common dynamics of sCDS and other sectors of financial markets. Thus, we should expect that after the new regulations had been imposed the correlation between the sCDS market and other markets should have diminished. In the case of sCDS and government bonds we indeed can observe a decline in correlation (in absolute values, since in general the correlation was negative) starting from the second half of 2012. Another change in correlation patterns was observed in 2010 and 2011 and could be an echo of the Greek crisis. The same conclusions apply to the correlation between sCDS and OMXS30. The correlation between sCDS and SEKEUR was insignificant, as well as between bonds and SEKEUR (see Table 2).

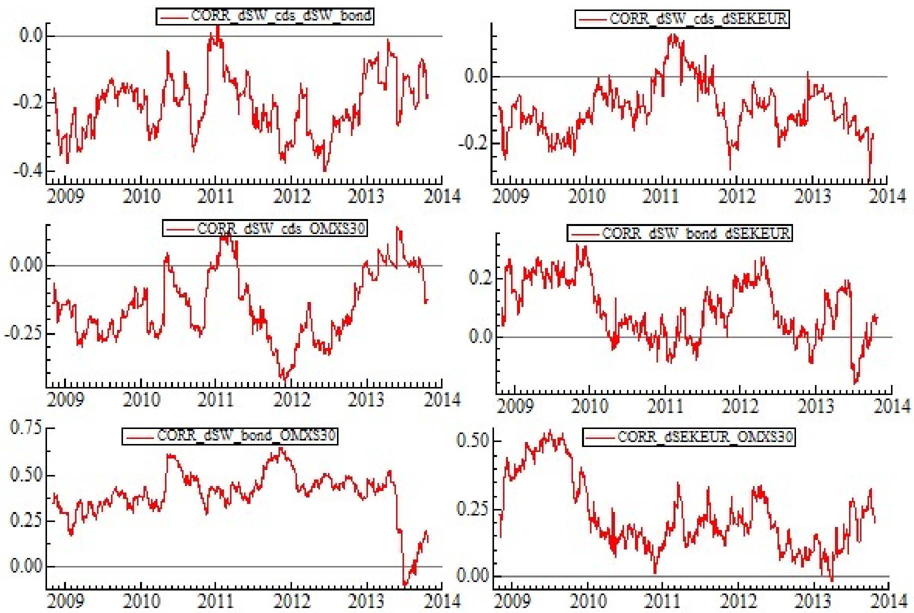
Table 2. Estimates of the conditional correlation parameters - Sweden

	Coefficient	std. Error	p-value
rho(CDS-bonds)	-0.18585	0.06199	0.0028
rho(CDS-SEKEUR)	*-0.08832*	*0.062905*	*0.1605*
rho(CDS-OMXS30)	-0.13907	0.070686	0.0494
rho(bonds-SEKEUR)	*0.100624*	*0.081129*	*0.2151*
rho(bonds-OMXS30)	0.346155	0.071138	0
rho(SEKEUR-OMXS30)	0.232159	0.071569	0.0012
Alpha	0.016918	0.00355	0
Beta	0.973354	0.006503	0

Note: in two cases the correlations were insignificant: CDS-SEKEUR and bonds-SEKEUR (put in italics).

Source: own calculations in G@RCH package of OxMetrics7.

Chart 5. Conditional correlations between various sectors of the Swedish financial market

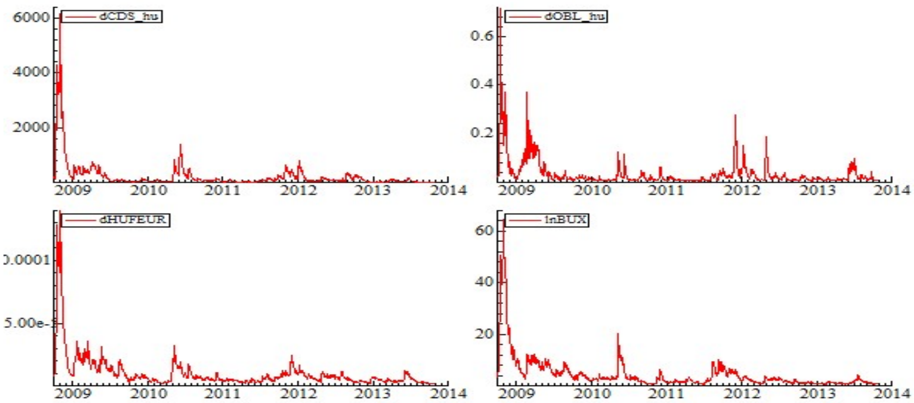


Note: starting from left-top corner, row-wise: sCDS and bonds, sCDS and SEKEUR, sCDS and OMX30, sCDS and SEKEUR, bonds and OMXS30, SEKEUR and OMXS30.

Source: own calculations in OxMetrics7.0.

In the case of Hungary the situation was different. First of all we could not reject the hypothesis that the correlation between the different sectors of the financial market in Hungary was constant over time. Next, the values taken by the correlation were much higher than in the case of analogous variables in Sweden, and their absolute value oscillated around 0.4 (such an observation is also valid for Poland, see e.g. Będowska-Sójka and Kliber 2013, p. 93). The only exception was the pair CDS-HUFEUR, where the correlation coefficient was very small (-0.06) but still significant – see Table 3. We also note that the correlation between bonds and HUFEUR was exceptionally high and amounted to almost 0.6. In the end, the conditional variances obtained from the CCC-MGARCH model showed many more similarities than the analogous variables from the Swedish market – see Chart 9. However, since the estimated model did not included time-varying correlation, we can conclude that in the case of Hungary the change in sCDS trade regulation was not of such importance so as to change the correlation patterns between the sectors of financial markets.

Chart 9. Volatility of Hungarian sCDS, bonds, HUFEUR exchange rate and BUX – the results of the DCC-MGARCH model



Note: starting from left-top corner, row-wise: sCDS, bonds, HUFEUR, BUX.

Source: own calculations in OxMetrics7.0.

Table 3. Estimates of the conditional correlation parameters - Hungary

	Coefficient	std. Error	p-value
rho(CDS-bonds)	0.4010	0.0275	0.0000
rho(CDS-HUFEUR)	-0.3873	0.0322	0.0000
rho(CDS-BUX)	-0.0633	0.0302	0.0364
rho(bonds-HUFEUR)	-0.5627	0.0235	0.0000
rho(bonds-BUX)	-0.0048	0.0334	0.8866
rho(HUFEUR-BUX)	0.0097	0.0339	0.7749

Source: own calculations in G@RCH package of OxMetrics7.

5. Influence of the sCDS market on other sectors of the financial market in Sweden and Hungary

In this section we continue our investigation on the impact of the sCDS market on the other sectors of the financial market in the two economies. First, for each data pair we computed a GARCH-type model with explanatory variables and without them. The selection criterion for the model was its ability to explain all linear and non-linear dependencies in the data. The dependent variables were: bonds, exchange rates and stock indices, while the explanatory ones were changes in the sCDS.

5.1. Bond market

In the case of Sweden the best performing model was the AR(1)-GARCH(1,1) with explanatory variable in mean. The sCDS change was included into the model with the same lag as the dependent variable. In the model estimated for the two longer periods the test preferred the full model, while in the case of the shortest sample – the reduced one. Thus, we can presume that after introducing the ban on uncovered sCDS trade the immediate interdependencies between the two markets became insignificant.

Table 4. Estimates of the full and reduced model for Swedish bonds

Full model			Reduced model			
Full sample						
	Coefficient	std. Error	p-value	Coefficient	std. Error	p-value
Constant in mean	-0.0003	0.0015	0.8655	0.0006	0.0017	0.7108
dCDS	-0.0050	0.0008	0.0000	---	---	---
AR(1)	0.0761	0.0371	0.0407	0.1048	0.0348	0.0027
ω x 10^4	1.4203	1.0878	0.1919	0.8750	0.4822	0.0698
ARCH(α)	0.0860	0.0475	0.0707	0.0693	0.0329	0.0352
GARCH(β)	0.8540	0.0843	0.0000	0.8959	0.0442	0.0000
Log likelihood	**2108.2880**	---	---	**2073.3550**	---	---
Up to November 2012						
Constant in mean	-0.0012	0.0018	0.5018	-0.0002	0.0021	0.9417
dCDS	-0.0054	0.0008	0.0000	---	---	---
AR(1)	0.0633	0.0400	0.1139	0.0972	0.0379	0.0104
ω x 10^4	0.2874	0.3346	0.3906	0.2588	0.2739	0.3449
ARCH(α)	0.0903	0.0547	0.0987	0.0818	0.0428	0.0564
GARCH(β)	0.9097	---	---	0.9182	---	---
Log likelihood	**1680.1750**	---	---	**1644.6610**	---	---
From November 2012						
Constant in mean	0.0036	0.0030	0.2284	0.0036	0.0030	0.2289
dCDS	-0.0013	0.0019	0.4868	---	---	---
AR(1)	0.0937	0.0773	0.2266	0.0969	0.0754	0.2000
ω x 10^4	17.5115	1.8359	0.0000	17.5565	1.8092	0.0000
Log likelihood	**426.4170**	---	---	**426.1060**	---	---

Note: In the shortest sample the ARCH effect was not found and thus we modelled only linear dependencies. In the first two cases - the full sample and the sample up to November 2012 - the obtained p-values for the log-likelihood ratio test amounted to <0.0001, while in the case of the shortest model, to 0.43.

Source: own calculations in G@RCH package of OxMetrics7.

In the case of Hungary the dependencies between the two markets were of a different nature. The explanatory variable was the change of CDS from the same period and a lagged one. Again, in the full period and in the period prior to the new regulation the full model was preferred, while in the shortest period – the reduced one.

Table 5. Estimates of the full and reduced model for Hungarian bonds

	Full model			Reduced model		
Full sample						
	Coefficient	Std.Error	p-value	Coefficient	Std.Error	p-value
Constant in mean	-0.0043	0.0028	0.1327	-0.0091	0.0039	0.0201
dCDS	0.0018	0.0005	0.0005	---	---	---
dCDS(-1)	0.051	0.0007	0.0000	---	---	---
AR(1)	-0.0302	0.0390	0.4393	0.0817	0.0348	0.0190
ω	0.0008	0.0005	0.0921	0.0012	0.0007	0.0962
ARCH(α)	0.2401	0.0885	0.0068	0.2118	0.0716	0.0032
GARCH(β)	0.7599	---	---	0.7882	---	---
Log likelihood	813.823	---	---	666.283	---	---
Up to November 2012						
Constant in mean	-0.0036	0.0032	0.2569	-0.0081	0.0044	0.0631
dCDS	0.0056	0.0006	0.0000	---	---	---
dCDS(-1)	0.0017	0.0056	0.0012	---	---	---
AR(1)	-0.0339	0.0463	0.4366	0.0093	0.0042	0.0277
ω	0.0006	0.0003	0.0819	0.0014	0.0009	0.1081
ARCH(α)	0.2144	0.0990	0.0305	0.1546	0.0668	0.0209
GARCH(β)	0.7838	0.0836	0.0000	0.8034	0.0717	0.0
Log likelihood	648.647	---	---	495.007	---	---
From November 2012						
Constant in mean	-0.0103	0.0061	0.0962	-0.0101	0.0062	0.1041
dCDS	0.0012	0.0015	0.4123	---	---	---
ω	0.0013	0.0010	0.1714	0.0012	0.0008	0.1383
ARCH(α)	0.1604	0.0949	0.0923	0.1597	0.0865	0.0663
GARCH(β)	0.7497	0.1281	0.0000	0.7593	0.1095	0.0000
Log likelihood	182.071	---	---	181.13	---	---

Note: In the first two cases - the full sample and the sample up to November 2012 - the obtained p-values for the log-likelihood ratio test amounted to <0.0001, while in the case of the shortest model, to 0.17.

Source: own calculations in G@RCH package of OxMetrics7.

According to (Kocsis 2013, p.13), the domestic bond market is the one most isolated from external influences, compared to sCDS, the exchange rate or stock exchange markets. The dynamics of domestic bonds are determined to the greatest degree by internal, not external factors. Indeed in the case of Sweden the relationships between the markets were only immediate, which can be interpreted such that the markets are influenced by common factors (fundamentals and external ones), but follow opposite directions (the negative value of the coefficient). In the case of Hungary we also found lagged dependencies, which can suggest that the changes in the sCDS markets preceded the changes in the bond market (this result is also supported by Kliber 2013, p.159). Moreover, the changes of the two variables follow the same direction (positive value of the coefficient).

5.2. Exchange rates

In the case of the model for exchange rates the conclusions for both countries are analogous. With respect to the full sample and the sample for the period up to November 2012, the full model performed significantly better. The model including an explanatory variable was strongly preferred by the test. It is worth noting that only in the case of Sweden was it justified to also include the lagged value of sCDS change in the model, and thus we can talk about causality. Again, similarly to case of bonds, the changes in the exchange rate and CDS follow opposite directions. In the case of Hungary only the sCDS change from the same day was a significant explanatory variable, and thus we conclude that only instantaneous relationships between the two markets can be found. The relationships between the markets is negative. This negative relation is obvious – the growth in risk of a country is followed (or accompanied) by a depreciation in the exchange rate.

However, the situation changes when we analyse the shortest period. In the case of Sweden we modelled the exchange rate via a simple RiskMetrics model, while in the case of Hungary – a GARCH(1,1) one. In the case of both Hungary and Sweden, not only were the explanatory variables insignificant, but the test strongly rejected the hypothesis that the full model was better than the reduced one.

Table 6. Estimates of the full and reduced model for SEKEUR

	Full model			Reduced model		
Full sample						
	Coefficient	Std.Error	p-value	Coefficient	Std.Error	p-value
Constant in mean	0.0013	0.0011	0.2316	0.0016	0.0012	0.1833
d_CDS (M)	-0.0026	0.0007	0.0003	---	---	---
dCDS(-1) (M)	-0.0013	0.0007	0.0805	---	---	---
AR(1)	0.7844	0.0710	0.0000	0.8201	0.1174	0.0000
MA(1)	-0.8380	0.0594	0.0000	-0.8593	0.1002	0.0000
ω x 10^4	1.3700	0.6199	0.0273	1.3117	0.6179	0.0340
ARCH(α)	0.1042	0.0321	0.0012	0.0948	0.0286	0.0010
GARCH(β)	0.8564	0.0436	0.0000	0.8672	0.0411	0.0000
Log	1889.041	---	---	1878.93	---	---
Up to November 2012						
Constant in mean	0.0020	0.0013	0.1114	0.0023	0.0013	0.0870
d_CDS (M)	-0.0026	0.0007	0.0006	---	---	---
dCDS(-1) (M)	-0.0014	0.0008	0.0713	---	---	---
AR(1)	0.7763	0.0822	0.0000	0.8337	0.2188	0.0001
MA(1)	-0.8316	0.0691	0.0000	-0.8687	0.1905	0.0000
ω x 10^4	1.2546	0.6094	0.0398	1.1589	0.5768	0.0448
ARCH(α)	0.1138	0.0378	0.0027	0.0985	0.0312	0.0017
GARCH(β)	0.8525	0.0472	0.0000	0.8699	0.0413	0.0000
Log Likelihood:	1516.9480	---	---	1507.5920	---	---
From November 2012						
Constant in mean	-0.0016	0.0020	0.4246	-0.0017	0.0020	0.4186
dCDS(-5) (M)	0.0015	0.0022	0.4905	---	---	---
d-Arfima	-0.0815	0.0579	0.1605	-0.0816	0.0579	0.1602
AR(5)	-0.1477	0.0701	0.0362	-0.1520	0.0688	0.0281
ARCH(α)	0.0600	---	---	0.0600	---	---
GARCH(β)	0.9400	---	---	0.9400	---	---
Log	374.1700	---	---	373.9200	---	---

Note: In the shortest sample the best-performing model was a simple Risk-Metrics one. In the first two cases – the full sample and the sample up to November 2012 – the obtained p-values for the log-likelihood ratio test amounted to <0.0001, while in the case of the shortest model, to 0.1573.

Source: own calculations in G@RCH package of OxMetrics7.

Table 7. Estimates of the full and reduced model for HUFEUR

	Full model			Reduced model		
Full sample						
	Coefficient	Std.Error	p-value	Coefficient	Std.Error	p-value
Constant in mean	-2.45 x e-05	6.28E-07	0.6388	-1.5 x e-05	9.95E-07	0.824
d_CDS (M)	-0.0001	4.96E-06	0.0003	---	---	---
AR(1)	-0.1437	0.0384	0.0002	-0.0010	0.0326	0.9744
AR(2)	-0.0939	0.0336	0.0053	-0.0245	0.0299	0.4128
AR(3)	-0.0901	0.0383	0.0188	-0.0835	0.0317	0.0085
ω x10^6	0.1193	0.1059	0.2603	0.1971	0.1344	0.1426
ARCH(α)	0.0527	0.0279	0.0590	0.1099	0.0475	0.0210
GARCH(β)	0.9250	0.0438	0.0000	0.8672	0.0542	0.0000
Log Likelihood	5575.018	---	---	5452.116	---	---
Up to November 2012						
Constant in mean	-0.00002	3.52 x e-06	0.8	-1.4E-05	1.36E-06	0.8753
d_CDS (M)	-0.0001	5.58 x e-06	0.0001	---	---	---
AR(1)	-0.16056	0.0426	0.0002	0.0017	0.0357	0.9621
AR(2)	-0.0790	0.0364	0.03	-0.0130	0.0338	0.7003
ω x 10^6	0.0833	0.0668	0.2125	0.3000	0.1956	0.1255
ARCH(α)	0.0405	0.0189	0.0327	0.1125	0.0503	0.0256
GARCH(β)	0.9441	0.0276	0	0.8558	0.0601	0
Log Likelihood	4462.473	---	---	4340.71	---	---
From November 2012						
Constant in mean	-0.00002	0.0001	0.8145	-2.4E-05	0.000113	0.8331
d_CDS (M)	-0.00006	8.0 x e-06	0.1413	---	---	---
AR(1)	0.5039	0.2632	0.0569	-0.77307	0.1389	0
MA(1)	-0.5659	0.2365	0.0175	0.7740	0.1396	0
ω x 10^6	0.4331	0.3686	0.2412	0.2253	0.1956	0.2505
ARCH(α)	0.0863	0.0642	0.1808	0.0817	0.0434	0.0612
GARCH(β)	0.7846	0.1434	0.0000	0.8546	0.0711	0
Log Likelihood	1109.14	---	---	1109.139	---	---

Note: In the first two cases - the full sample and the sample up to November 2012 - the obtained p-values for the log-likelihood ratio test amounted to <0.0001, while in the case of the shortest model, to 0.9643.

Source: own calculations in G@RCH package of OxMetrics7.

5.3. Stock indices

In the case of stock indices, we again found immediate relationships between the Swedish OMXS30 and sCDS changes, which disappeared after the new regulation was implemented. In the case of the full sample, as well as the sample up to November 2012, we fit the AR(2)-IGARCH model with the explanatory variable in mean, while in the case of the short ending sample, the best model was the simple RiskMetrics. Our findings confirm those found in literature and the results from the analysis of dynamic correlation – the relationships between the stock index returns and the sCDS premium changes is negative – a growth of risk of a country is accompanied by declines on its stock exchange.

Table 8. Estimates of the full and reduced model for OMXS30

	Full model			Reduced model		
Full sample						
Constant in mean	0.0583	0.0329	0.0765	0.0659	0.033599	0.0502
dCDS (M)	-0.1139	0.0248	0.0000			
AR(1)	-0.0761	0.0331	0.0219	-0.0408	0.032414	0.2084
AR(2)	-0.0672	0.0366	0.0665	-0.0684	0.035437	0.0538
ARCH(α)	0.0617	0.0130	0.0000	0.0616	0.012385	0
GARCH(β)	0.9383	---	---	0.9384	---	---
Log likelihood	-1812.56	---	---	-1842.32	---	---
Up to November 2012						
Constant in mean	0.0405	0.0413	0.3265	0.0497	0.0422	0.2383
dCDS (M)	-0.1528	0.0279	0.0000	---	---	---
AR(1)	-0.0766	0.0351	0.0292	-0.0332	0.0345	0.3369
AR(2)	-0.0735	0.0414	0.0757	-0.0719	0.0396	0.0694
ARCH(α)	0.0636	0.0147	0.0000	0.0664	0.0150	0.0000
GARCH(β)	0.9364	---	---	0.9336	---	---
Log likelihood	-1812.56	---	---	-1842.32	---	---
From November 2012						
Constant in mean	0.0954	0.0633	0.1331	0.0950	0.0634	0.1353
dCDS (M)	0.0067	0.0396	0.8651	---	---	---
ARCH(α)	0.0600	---	---	0.0600	---	---
GARCH(β)	0.9400	---	---	0.9400	---	---
Log likelihood	-302.335	---	---	-302.335	---	---

Note: In all the cases the best performing model for volatility was an IGARCH(1,1). In the first two cases – the full sample and the sample up to November 2012 – the obtained p-values for the log-likelihood ratio test amounted to <0.0001, while in the case of the shortest model, to 0.882.

Source: own calculations in G@RCH package of OxMetrics7.

Quite interesting results were obtained for the Hungarian BUX. The explanatory variable – the lagged value of sCDS change - appeared to be significant in the volatility equation. Thus the relationships between the two markets were of a non-linear nature. Moreover, since the lagged value of the CDS was significant in the variance equation, we can talk about the preceding role of CDS with respect to the volatility of BUX. Growth of the country's risk (measured by the CDS premium) causes growth of volatility in the Hungarian stock exchange on the following day. Again, in the case of the short sample after the new regulation was imposed, the relationship became insignificant.

Table 9. Estimates of the full and reduced model for BUX

	Full model			Reduced model		
	Coefficient	Std.Error	t-prob	Coefficient	Std.Error	t-prob
Constant in mean	0.0219	0.0406	0.5897	0.034	0.040	0.3935
Ω	0.0622	0.027	0.0223	0.054	0.027	0.0437
dCDS(-1) (V)	0.007	0.003	0.0073	---	---	---
ARCH(α)	0.095	0.024	0.0001	0.102479	0.026	0.0001
GARCH(β)	0.885	0.0261	0	0.881477	0.028	0
Log likelihood	-2298.39	---	---	-2302.37	---	---
Up to November 2012						
Constant in mean	0.019734	0.050375	0.6953	0.041119	0.049294	0.4044
Ω	0.110216	0.047307	0.02	0.09402	0.04676	0.0446
dCDS(-1) (V)	0.009947	0.003336	0.0029	---	---	---
ARCH(α)	0.100526	0.027868	0.0003	0.111592	0.030054	0.0002
GARCH(β)	0.869606	0.031765	0	0.865048	0.032795	0
Log likelihood	-1967.96	---	---	-1973.27	---	---
From November 2012						
Constant in mean	0.014759	0.072454	0.8388	0.014529	0.071404	0.8389
dCDS(-1) (V)	0.000111	0.004582	0.9807	---	---	---
ARCH(α)	0.06	---	---	0.06	---	---
GARCH(β)	0.94	---	---	0.94	---	---
Log likelihood	-324.828	---	---	-324.828	---	---

Note: In the shortest sample the best performing model for volatility was RISKMETRICS. In the first two cases - the full sample and the sample up to November 2012 - the obtained p-values for the log-likelihood ratio test amounted to <0.0001, while in the case of the shortest model, to >0.999.

Source: own calculations in G@RCH package of OxMetrics7.

6. Conclusions

The aim of our study was to verify the impact of the change in the regulation on sCDS trade on the interdependences between the various sectors of financial markets, taking into account two different markets, i.e. those of Sweden and Hungary. To achieve our goal we first estimated the MGARCH models with conditional correlation to verify the strength of the relationships between each pair of financial markets - CDS-bonds, CDS-stock exchange, and CDS-exchange rate - in Hungary and Sweden separately. The results of the research show that Hungary is much more prone to crisis transmission through herd behaviour and speculation than Sweden – the conditional correlation coefficients obtained for the Hungarian markets using the CCC-MGARCH model estimation were much stronger than the analogous values obtained for Sweden. Moreover, the relationships by market were stable in the case of Hungary, while in the case of Sweden they were time varying.

In the next step we modelled bonds, exchange rates (SEKEUR and HUFEUR) and stock indices (OMXS30, BUX) via the ARMA-GARCH type models with explanatory variables – changes of sovereign CDS premia. We estimated the models for the whole period, and then for the two sub-periods: before and after implementation of the new regulation. Using the log-likelihood ratio test we verified the hypotheses whether the full model outperforms the reduced one for each sub-period. In the case of the period before November 2012 the full model outperformed the reduced one. We found however significant differences between the two countries. In the case of the Hungarian bond market changes in the CDS led to changes of bonds' yield, and the two series followed the same directions, while the Swedish bonds and Swedish CDS reacted to the same group of factors (the relationships were only of an immediate nature), but they changed in opposite directions. In the case of exchange rates the situation was opposite – the changes on the sCDS market led to changes of SEKEUR, while the relation between HUFEUR and the Hungarian CDS was only immediate. In both cases the growth of the CDS premium was accompanied by a depreciation of the currency. Finally, in the case of stock exchange the relationships between OMXS30 and CDS were immediate, while the changes of Hungarian CDS led to changes in volatility of the BUX.

In all the cases and in each country in the period following the introduction of the new policy the reduced model outperformed the full one. However, in our analysis we assumed *a priori* that the break-point in the model should be November 2012. Indeed in the models estimated for the sub-samples starting at the beginning of November 2012 the explanatory variables were insignificant. However, the breakpoint of the model could have been any other date before November 2012. To verify this, we recursively estimated the models, moving the breakpoint date upwards. It appeared that the breakpoints in the models should be localized in the period between the announcement of the new legislation and the moment of its entry into force. This finding strongly supports the thesis that the importance of the sCDS market began to gradually diminish following the announcement of the new legislation.

References

Arce O., Mayordomo S., Peña J. I. (2011), *Credit-risk valuation in the sovereign CDS and bonds markets: Evidence from the euro area crisis*, 'Journal of International Money and Finance', 35.

Będowska-Sójka B., Kliber A. (2013), *Economic Situation of the Country or Risk in the World Financial Market? The Dynamics of Polish Sovereign Credit Default Swap Spreads*, 'Dynamic Econometric Models', 13.

Bollerslev, T. (1986), *Generalized Autoregressive Conditional Heteroskedasticity*, 'Journal of Econometrics', 31.

Bollerslev T.(1990), *Modeling the Coherence in Short-run Nominal Exchange Rates: A Multivariate Generalized ARCH model*, 'Review of Economics and Statistics', 72.

Breuer A., Sauter O. (2012), *The impact of a sovereign default within the Euro-zone on the exchange rate,* 'Applied Economics Quarterly', 58.

Capponi A., Larsson M (2014), *Will Banning Naked CDS Impact Bond Prices?*, 'Annals of Finance', 10 (3).

Carr P, Wu L (2007), *Theory and evidence on the dynamic interactions between sovereign credit default swaps and currency options*, 'Journal of Banking and Finance', 31.

Coronado M. Corzo T.M. Lazcano L. (2012), *A Case for Europe: The Relationship between Sovereign CDS and Stock Indexes,* 'Frontiers in Finance and Economics', 9 (2).

Coudert V., Gex M., (2010), *Credit Default Swap and Bond Markets: Which Leads the Other?,* 'Financial Stability Review', Banque de France, 14/2010.

Della Corte P., Sarno L., Schmeling M., Wagner C, (2014), *Sovereign Risk and Currency returns*, Working Paper.

Engle R. (2002), *Dynamic Conditional Correlation – a Simple Class of Multivariate GARCH Models*, 'Journal of Business and Economic Statistics', 20.

Engle R. F., Sheppard K. (2001), *Theoretical and Empirical properties of Dynamic Conditional Correlation Multivariate GARCH,* 'NBR Working Paper', 8554.

Ergunor E.O. (2007), *On the Resolution of Financial Crises: The Swedish Experience*, 'Policy Discussion Papers,' 21.

Fontana A., Scheicher M. (2010), *An Analysis of Euro-Area Sovereign CDS and their Relation with Government Bonds*, 'European Central Bank Working Paper' no 1271.

ISDA (2014), *Adverse Liquidity Effects on the EU Uncovered Sovereign CDS Ban*, ISDA Research Note.

Jonung L., Kiander J., Varttia P. (eds.) (2009), *The Great Financial Crisis in Sweden and Finland: The Nordic Experience of Financial Liberalization*, Edward Elgar Publishing Ltd.

J.P.Morgan (1996), *Riskmetrics Technical Document*, 4th ed. J.P.Morgan, New York.

Kliber A. (2013), *Influence of the Greek Crisis on the Risk Perception of European Economies*, 'Central European Journal of Economic Modelling and Econometrics' 5 (2).

Kocsis Z. (2013), *Global, Regional and Country-Specific Components of Financial Market Indicators: an Extraction Method and Applications*, Central Bank of Hungary Working Paper no. 3.

NASDAQ OMX (2014), Rules for the Construction and Maintenance of the OMX STOCKHOLM 30 INDEX, Version 1.4., https://indexes.nasdaqomx.com/docs/Methodology_OMXS30.pdf

Platev P., Marinova E. (2013), *The Link Between Credit Default Swaps and Stock Markets in Central and Eastern Europe,* 'Dialogue', 4.

De Silva P. P. (2014), *Sovereign Credit Risk and Stock Markets–Does the Markets' Dependency Increase with Financial Distress?* 'International Journal of Financial Studies', 2.

Streszczenie

WPŁYW ZAKAZU HANDLU "NAGIMI" KONTRAKTAMI CDS NA RYNKU EUROPEJSKIM NA SIŁĘ POWIĄZAŃ MIĘDZY RYNKIEM CDS A INNYMI SEKTORAMI RYNKU FINANSOWEGO

Celem artykułu było zbadanie wpływu zakazu handlu „nagimi" kontraktami CDS na rynku europejskim na zmianę powiązań między rynkiem tych kontraktów a innymi segmentami rynku finansowego. W artykule wzięliśmy pod uwagę dwie gospodarki europejskie: bezpieczną i rozwiniętą (Szwecja) oraz ryzykowną i rozwijającą się (Węgry). Badanie dotyczyło okresu 2008-2013 oraz rynków: giełdowego, obligacji i kursowego. W przypadku Szwecji zależności okazały się mniej silne niż w przypadku Węgier, co sugeruje, że Węgry są bardziej podatne na przenoszenie się kryzysów na skutek zachowań stadnych, czy ataków spekulacyjnych. W przypadku obu krajów siła powiązań między rynkami znacznie osłabła od momentu wprowadzania nowych regulacji.

Słowa kluczowe*: sovereign CDS, obligacje, kursy walutowe, indeksy giełdowe, zmienność, kryzys finansowy.*