Integration of Markets for Sovereign Bonds in the European Union

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Abstract
Financial integration is a complex process which has been taking part in the European Union for decades. In this paper, the attention is paid to the integration of markets for sovereign bonds in the European Union. The aim of the paper is to find out if markets for sovereign bonds are integrated in the European Union, if the financial crisis, sovereign debt crisis and the banking union announcement had the impact on the government bond market integration. The co-integration approach is used to assess the integration of sovereign bond markets in the European Union separately for the euro area member countries and other EU member countries. The results suggest that both crises had the significant impact on market integration process. The situation improved a bit after the banking union announcement in 2012, although the level of the integration did not reach pre-crises level.

Keywords: co-integration, European Union, financial integration, sovereign bond market
JEL codes: C23, C58, G01, G15

1. Introduction

Financial integration has been accompanying economic integration in the European Union (EU) for decades and its importance grows together with the increasing level of economic integration. It brings together both advantages and disadvantages. Since there is not a unified definition of financial integration, the European Central Bank (ECB) and many authors follow the definition by Baele et al. (2004), and same we do. They define financial integration in the following way: market for a given set of financial instruments and services is fully integrated if all potential market participants with the same relevant characteristics: a) face a single set of rules they decide to deal with those financial instruments or services, b) have equal access to the above-mentioned set of financial instruments and c) are treated equally when they are active in market. The law of one price is closely related to the previous definition. It claims that if two assets constitute perfect substitutes, they should beat the same price irrespective of the residency of the issuer (ECB, 2015).

The evaluation of integration is a complicated process since it covers all financial market sectors – money, bond, equity and banking markets – and the indicators of financial integration are not unified. However, the ECB regularly assesses a progress towards financial integration in the euro area. For the evaluation, the ECB uses the indicators suggested by Baele et al. (2002) and Adam et al. (2002). These indicators were adopted also by central banks or many authors for assessing the overall level of financial integration or the level of integration in induvial sectors of financial market, e. g. see Baltzer et al. (2008), Chaloupka (2012), Vodová (2012), Pungulescu (2013). Also one can find several number of studies using a cointegration approach for assessing the integration of selected market segments, e. g. see Centeno and Mello (1999), Guillaumin (2009), Mylonidis and Kollias (2010), Yu et al. (2010), Boubakri et al. (2012), Laopodis (2012), Szarowská (2013), Deev (2014), Koukouritakis et al. (2015) or studies employing factor model e. g. Christiansen (2014) or CAPM-based model, see Abad et al. (2010).

In this paper, the attention is paid to the integration of markets for sovereign bonds in the European Union. The aim of the paper is to find out if the integration was achieved in market for sovereign bonds and if the financial and sovereign debt crises had the impact on the government bond market integration; moreover, the impact of the banking union announcement is assessed as well. The

integration is assessed separately for the euro area (EA) member countries and other EU member countries German 10year government bonds spreads were chosen as a benchmark.

2. Model

We follow the authors who used co-integration approach. The long-run relationship is investigated between government bond spreads and benchmark which is represented by spreads of German sovereign bonds. The relationship between markets is examined both for the EA member countries and other EU member countries.

The long-run relationship between markets is observed with use of co-integration tests. The variables are co-integrated if they have a common stochastic trend, see Granger (1988) and Engle and Granger (1987). To check the stochastic non-stationarity of the data, the unit root is required. The Augment Dickey-Fuller (1981) unit root test (ADF) is therefore employed.

Consequently, a Johansen (1988) and Johansen and Juselius (1990) procedure is conducted for finding the common trend in the multivariate time series, which is based on the vector autoregressive (VAR) model:

$$y_t = A_1 y_{t-1} + \ldots + A_p y_{t-p} + Bx_t + \varepsilon_t \tag{1}$$

where y_t is a *k*-vector of non-stationary *I(1)* variables, x_t is a *d*-vector of deterministic variables, and ε_t is a vector of innovations.

The appropriate lag length for the co-integration test (order of VAR) is determined by Schwarz Bayesian criterion (BIC) and Hannan-Quinn criterion (HQC).

In first difference error correction the model is specified as follows:

$$\Delta y_t = \Pi y_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta y_{t-p} + Bx_t + \varepsilon_t \text{, where: } \Pi = \sum_{i=1}^{p} A_i - I \text{ and } \Gamma_i = -\sum_{j=i+1}^{p} A_j \tag{2}$$

The null hypothesis of no co-integration is rejected, if the rank of the coefficient matrix is at least 1. Johansen and Juselius (1990) developed two test statistics to determine the number of co-integrating vectors (the rank of the matrix) namely the trace statistic and the maximum eigenvalue statistic, which are computed for the null hypothesis as:

$$LR_{tr}(r|k) = -T \sum_{i=r+1}^{k} \log(1-\lambda_i) \tag{3}$$

$$LR_{\max}(r|r+1) = -T \log(1-\lambda_i) = LR_{tr}(r|k) - LR_{tr}(r+1|k) \tag{4}$$

Trace statistic tests the null hypothesis of *r* co-integrating relations against the alternative of *n* co-integrating relations, where *n* is the number of variables in the system for *r =0,1,2…n-1*. The maximum eigenvalue statistics tests the null hypothesis of *r* co-integrating relations against the alternative of *r+1* co-integrating relations for *r =0,1,2…n-1*. In some cases trace and maximum eigenvalue statistics may yield different results.

3. Data

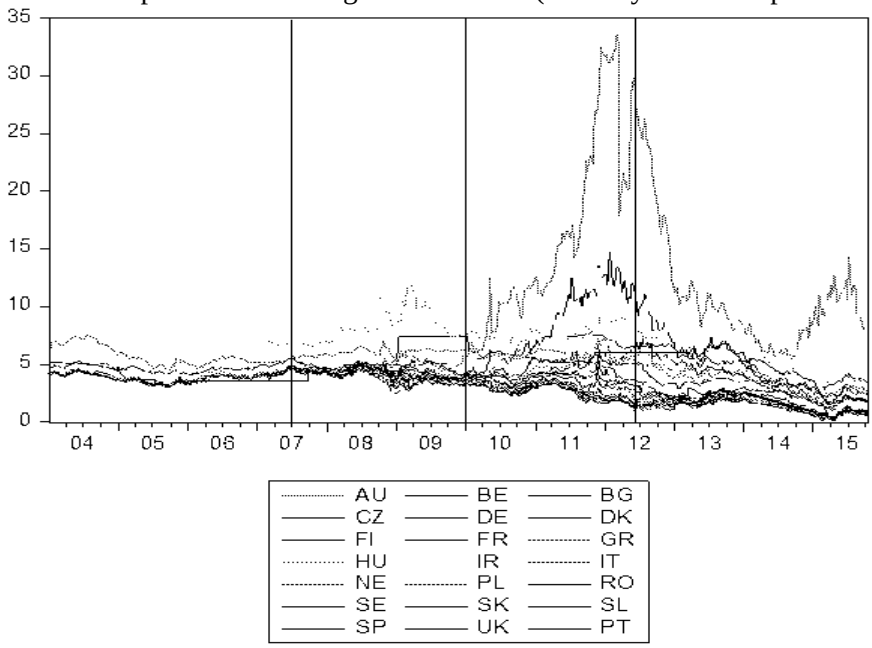
We obtained 10year government bond spreads from Bloomberg database on weekly basis. The spreads were obtained for all EU countries which issued bonds and time series were long sufficiently (Croatia, Cyprus, Luxembourg, Malta, Romania were not included in research). The total sample covers the period from January 2004 to September 2015 and is divided into four sub-periods:

a) pre-crisis period (January 2004 – May 2007),
b) financial crisis period (June 2007 – December 2009),

c) sovereign debt crisis period (January 2010 – June 2012),
d) period after the banking union announcement (July 2012 – September 2015).

The development of sovereign bond yields for all EU countries included in the research is shown in Figure 1 together with all sub-periods.

Figure 1: Development of Sovereign Bond Yields (Janurary 2004 – September 2015)



Source: Bloomberg

Table 1: Descriptive Statistics of Bond Yields

	Mean	Median	Max.	Min.	Std. Dev.	Skew.	Kurtosis	J.-B. Stat.
AU	3.0740	3.4150	4.8740	0.2030	1.1593	-0.7049	2.4203	52.7690
BE	3.3208	3.6745	5.8140	0.3690	1.1187	-0.9751	3.0281	87.1798
BG	4.7483	4.9370	7.4460	2.1180	1.4940	0.3380	2.1689	17.6456
CH	1.4253	1.1380	3.4180	-0.2930	0.9908	0.2954	1.9110	26.7974
CZ	3.1954	3.5620	5.3650	0.3400	1.4172	-0.4365	1.9442	31.8293
DE	2.7758	3.1660	4.6770	0.0770	1.2261	-0.4103	1.8965	43.8873
DK	2.9641	3.3735	4.9520	0.0990	1.3056	-0.3762	1.8600	43.0666
FI	2.9513	3.3380	4.8290	0.1420	1.1960	-0.5601	2.1462	46.2067
FR	3.1032	3.4075	4.8250	0.3680	1.0539	-0.7621	2.7012	55.8923
GR	10.6245	8.5835	33.7020	4.1610	7.0465	1.5395	4.7145	214.2387
HU	7.0144	7.1595	12.0530	2.7780	1.7163	-0.1776	3.4858	5.5822
IR	4.7886	4.1150	13.7440	0.6910	2.2956	0.8217	3.4176	66.6025
IT	4.1069	4.2470	7.2440	1.1470	0.9787	-0.6368	4.3741	80.8775
NE	2.9813	3.3480	4.8380	0.2240	1.1606	-0.5740	2.2236	45.0592
PL	5.1937	5.5095	7.5830	1.9720	1.2040	-0.7425	2.9747	51.1031
PT	5.2289	4.3490	14.6580	1.5460	2.5308	1.6185	4.9781	337.5759
RO	5.3833	5.3035	7.5960	2.6470	1.3838	-0.0309	1.8762	10.9781
SE	2.5460	2.5170	4.5780	0.2240	1.1233	0.0005	1.9647	18.5326
SK	3.5552	3.6085	5.2890	0.3780	1.1923	-0.7882	2.9861	58.6060
SL	4.6028	5.2320	6.8040	0.8020	1.7221	-0.6606	2.0106	25.8849
SP	4.0605	4.0960	7.2260	1.1450	1.0764	-0.3005	3.6793	18.6773
UK	3.5261	3.6400	5.5470	1.4630	1.1512	-0.1954	1.6775	43.7407

Source: author's calculations in Eviews

The descriptive statistics of bond yields is shown in Table 1. For the whole sample period, the highest yield was observed for Greek bond, followed by bonds of Portugal, Ireland and Hungary. Standard deviation values show that bonds with the highest yields are the most risky. Almost all yields are skewed left, and the kurtosis measures are positive. The probabilities of Jarque-Bera tests are equal to zero (not reported), hence the normality is rejected in all cases.

Since the studied variables should be integrated of order one *I(1),* we performed the ADF unit root tests to investigate the order of integration. The results of the ADF unit root tests are reported in Table 2. They indicate that data at levels are non-stationary series. However, the ADF tests performed at first differences suggest that data are stationary and therefore of order one *I(1)* except of time series for Portugal that will be excluded from the consequent research.

Table 2: Augment Dickey-Fuller Unit Root Test Statistics

Country	Level			First differences		
	t-Stat.	Critical value	Prob.	t-Stat.	Critical value	Prob.
AU	-2.1490	-3.4192	0.5165	-22.0644	-3.4204	0.0000
BE	-1.7739	-3.4189	0.7161	-23.8943	-3.4200	0.0000
BG	-2.3100	-3.4229	0.4269	-16.7095	-3.4239	0.0000
CH	-2.3367	-3.4214	0.4126	-19.5923	-3.4223	0.0000
CZ	-3.0579	-3.4221	0.1182	-16.0953	-3.4234	0.0000
DE	-2.0955	-3.4188	0.5466	-22.6029	-3.4197	0.0000
DK	-1.6061	-3.4188	0.7896	-20.9742	-3.4198	0.0000
FI	-2.4225	-3.4187	0.3673	-23.0803	-3.4197	0.0000
FR	-1.6813	-3.4188	0.7584	-21.9514	-3.4198	0.0000
GR	-1.4307	-3.4216	0.8507	-19.1667	-3.4227	0.0000
HU	-2.1828	-3.4290	0.4965	-19.3637	-3.4268	0.0000
IR	-0.5865	-3.4188	0.9790	-21.1298	-3.4196	0.0000
IT	-0.5390	-3.4198	0.9815	-22.2008	-3.4198	0.0000
NE	-1.8536	-3.4185	0.6770	-22.9556	-3.4193	0.0000
PL	-1.8326	-3.4188	0.6875	-19.9063	-3.1326	0.0000
PT	-3.1538	-3.4468	0.0988	-2.9170	-3.4468	0.1609
RO	-1.4821	-3.4334	0.8326	-12.8407	-3.4356	0.0000
SE	-1.8045	-3.4219	0.7009	-17.7156	-3.4231	0.0000
SK	-1.2180	-3.4185	0.9051	-23.0185	-3.4192	0.0000
SL	-1.2791	-3.4308	0.8902	-12.6330	-3.4320	0.0000
SP	-2.5647	-3.4205	0.2969	-25.4738	-3.4205	0.0000
UK	-2.3342	-3.4190	0.4141	-21.4746	-3.4199	0.0000

Source: author's calculations in Eviews

4. Results

The results of employed co-integration tests are provided separately for EA member countries and non-EA member countries.

4.1 Sovereign Bond Market Integration in Euro Area Member Countries

The following two tables bring the results of Johansen co-integration rank tests which were conducted to find if the long-run relationship existed between variables during the individual sub-periods. Table 3 includes values of trace statistics. If the value of trace statistics is higher than the critical value 15.4947, the null hypothesis of no co-integration can be rejected and therefore the co-integration exists between variables.

During the pre-crisis period, the co-integration was found between German government bond yields and Austrian, Belgian, French, Dutch and Spanish bond yields. We did not investigate the relationship between German and Greek and Slovak bond yields since Greece and Slovak Republic

did not issue bonds during this period. The similar results were obtained by Laopodis (2008), except of Belgium, the integration was found for same countries.

We found only one co-integrated relationship during the financial crisis period between German and Irish bond yields. This is in the line with a paper by Pungulescu (2013) who concluded that the financial crisis brought the diverging forces to the EU15 core.

We also did not evidenced any long-run relationship during the sovereign debt crisis period. We believe that it can be a consequence of that that market participants began to perceive a tangible credit risk for some euro area sovereigns as the ECB state in its annual report on financial integration (ECB, 2015). In the period after the banking union announcement, the co-integrated relationships were found between German and French, Greek and Spanish bond yields.

Table 3: Results of Johansen Cointegration Rank Tests (Trace Statistics) for Euro Area Member Countries

	Pre-crisis period	Financial crisis period	Sovereign debt crisis period	Banking union announcement
AU	104.3910*	3.1926	0.6392	14.4742
BE	30.0829*	7.3105	1.5775	8.6531
FI	13.2946	6.6228	5.5357	9.4811
FR	21.9248*	2.8192	7.5380	26.0074*
GR	-	12.0346	8.3729	23.1870*
IR	5.0923	33.5103*	1.6340	4.9485
IT	9.9211	2.0830	3.2450	3.0915
NE	17.8690*	4.8280	6.4429	12.1062
SK	4.0721	3.9059	6.6439	14.8243
SL	-	-	10.3398	6.2872
SP	52.0370*	7.9028	4.8186	31.3303*

Note: critical value is 15.4947

Source: author's calculations in Eviews

Table 4 provides values of max-eigen value statistics, the results confirm the results of trace statistics provided in the previous table. The null hypothesis of no co-integration can be rejected in case the value of max-eigen value statistics is higher than critical value 14.2646.

Table 4: Results of Johansen Cointegration Rank Tests (Max-eigen Value Statistics) for Euro Area Member Countries

	Pre-crisis period	Financial crisis period	Sovereign debt crisis period	Banking union announcement
AU	97.7902*	2.7400	0.6149	11.7489
BE	28.0194*	6.9661	1.5205	6.5907
FI	10.5664	5.0171	4.4204	7.4523
FR	21.0690*	2.7800	5.2404	22.5678*
GR	-	11.6494	8.1321	23.0987*
IR	5.0037	28.1834*	1.3306	4.9290
IT	6.4914	1.9301	3.2433	3.0696
NE	16.1772*	3.1566	6.2277	9.1205
SK	4.0717	2.4865	6.0716	13.5870
SL	-	-	10.3085	6.2871
SP	47.2002*	4.9890	4.5169	29.4063*

Note: critical value is 14.2646

Source: author's calculations in Eviews

4.2 Sovereign Bond Market Integration in Non-Euro Area Member Countries

Since we would like to compare the situation within EA member countries and non-EA member countries, the co-integration test were employed for non-EA members subsequently. The results of Johansen co-integration rank tests – trace statistics – are presented in Table 5.

Data were not available for the majority of countries during the pre-crisis period because these countries did not issue bonds. Data only for three countries were available – for Denmark, Poland and the United Kingdom, however, the existence of co-integrated relationship between their and German bond yields was not confirmed. The value of trace statistics was lower than the critical value 15.4947.

Table 5: Results of Johansen Cointegration Rank Tests (Trace Statistics) for Non-Euro Area Member Countries

	Pre-crisis period	Financial crisis period	Sovereign debt crisis period	Banking union announcement
BG	-	12.9382	15.4080	23.1865*
CZ	-	19.3282*	7.6842	12.1317
DK	14.9651	21.8320*	5.8762	12.3335
HU	-	20.4187*	5.9724	4.4408
PL	10.0409	5.3602	10.4883	7.1681
RO	-	-	12.8458	4.7782
SE	-	15.8980*	13.6394	10.3058
UK	12.6495	21.1963*	8.6599	78.6276*

Note: critical value is 15.4947

Source: author's calculations in Eviews

Compared to the results of pre-crisis period, the number of co-integrated relationships increased during the financial crisis period. The null hypothesis of no co-integration was rejected for the long-run relationship between German government bond yields and yields of Czech, Danish, Hungarian, Sweden and the UK government bonds. Looking at the results for the EA member countries, it is surprising that co-integration between yields was found for the majority countries in the sample. We believe that one of the reasons can be that the financial crisis hit the EA member countries first, since they evinced the higher level of integration and interconnectedness of their markets.

During the sovereign debt crisis period, we did not evidence any co-integration between yields. After the banking union announcement, the co-integrated relationships were found between German and Bulgarian and the UK bond yields

The results of max-eigen value statistics provided in Table 6, bring the same results as the results based on trace test statistics.

Table 6: Results of Johansen Cointegration Rank Tests (Max-eigen Value Statistics) for Non-Euro Area Member Countries

	Pre-crisis period	Financial crisis period	Sovereign debt crisis period	Banking union announcement
BG	-	12.5128	13.8490	20.0754*
CZ	-	17.2931*	7.0010	10.9198
DK	9.9375	17.6513*	5.8696	8.0012
HU	-	19.4237*	4.8231	4.1782
PL	9.0327	5.3544	10.2989	5.0576
RO	-	-	12.8448	4.7293
SE	-	14.6273*	12.8450	7.6364
UK	11.4323	17.7795*	8.5586	67.0075*

Note: critical value is 14.2646

Source: author's calculations in Eviews

5. Conclusion

The aim of the paper was to find out if markets for sovereign bonds are integrated in the European Union, if the financial crisis, sovereign debt crisis and the banking union announcement had the impact on the government bond market integration. For assessing the integration between sovereign bond markets, the co-integration approach was used. The co-integration was found between German yields and the majority of EA member countries government bond yields during the pre-crisis period. However, our results suggest that both crises had the significant impact on market integration process within EA countries. The situation improved a bit after the banking union announcement in June 2012, although the integration did not reach the pre-crises level. When assessing the situation for non-EA countries, it was a bit different. During the pre-crisis period, the presence of co-integration was not proved, however it was found for the majority of countries in our sample during the financial crisis period. The results obtained during the sovereign debt crisis period and during period after the banking union announcement are similar to the results for EA countries. The paper provides a primary look at integration of market for sovereign bonds. However, future research should employ other methods for assessment the level of integration, since co-integration approach is only the one of many that can be used.

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