“Empirical analysis of the links between sovereign bond markets and economic growth for European non-EMU countries”

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Empirical analysis of the links between sovereign bond markets and economic growth for European non-EMU countries

Abstract

The purpose of this paper is to empirically investigate the dynamic causal relationships between the government bond market and growth rates for 14 European non-EMU countries. Using a dynamic panel ECM model over the period of 2002-2012, the author finds that the slope of the yield curve is negatively related to the growth in real GDP, and to a lesser extent that growth rates negatively influence term spreads. The author's results are robust to various specifications and the use of different set of periods.

Keywords: bond markets, spread, panel Granger causality, European non-EMU countries.
JEL Classification: C23, F34, F36, G01.

Introduction

The relationship between economic growth and finance through the bond market's performance is a key issue for the economic development. From a theoretical perspective, the finance-growth relationship is controversial. Some authors consider finance a pivot element of growth because it channels savings to the most productive investments (Schumpeter, 1934; Goldsmith, 1969; McKinnon, 1973; Shaw, 1973; King and Levine, 1993; whilst for others it basically follows economic growth being endogenously determined by real economy needs (Robinson, 1952; Coase, 1956; Lucas, 1988). These opposite views, and possible interactions between them, have been formulated as the supply-leading, demand-following and interdependence hypothesis, no causal links or as a negative causality from finance to growth. These five hypotheses have been analyzed in a large number of empirical studies to assess the quantitative importance of the financial system for economic growth. The greater part of them focused their attention only on the stock market and financial intermediaries.

The bond issuance, the second resource of funding for growth behind financial intermediaries, which has been progressively increasing over time and, since the recent financial crisis at a relatively faster pace than before, was rather neglected. According to data provided by BIS (2012), the share of international bonds increased in 2012 compared to previous periods in developing countries (Latin America, Emerging Central and Eastern Europe, Asia and Pacific). At the end of 2012, international bonds have accounted for 9,4% of total bonds outstanding in developing countries while it has decreased slightly from 85,2% to 82,9% of total bonds outstanding in advanced economies. Overall, despite considerable growth, debt markets in developing economies remain small compared to those of industrialized countries.

Although bond markets are the second resource of financing for businesses, a large body of the empirical literature centers lesser on this important vector of external finance. Two strands of this literature studying the international bond markets can be distinguished. The first one focuses on the predictive links between the economic growth and bond markets (Estrella and Hardouvelis, 1991; Estrella and Mishkin, 1997; Davis and Fagan, 1997; Harvey, 1991; Sédillot, 1999; Kim and Rajapakse, 2001; Eichengreen and Leungnareumitchai, 2004, 2006). More precisely, this literature considers that the behavior of the yield curve changes across the business cycle. Recessions are characterized by upward sloping yield curves because premia on long-term bonds tend to be high and yields on short bonds tend to be low in these periods. Guided by this intuition, many of these papers highlight that when the slope or term spread increase, the GDP growth is expected to be larger in the future. The second strand investigates the determinants of government bond spreads essentially since the global financial crisis of 2008 with a particular focus on different econometric specifications. Studies like De Bondt (2002), Claes et al. (2002), Fink, Haiss and Hristoforova (2003), Burger and Warnock (2006) mostly look at time-series methods to investigate the links between finance and growth. Other studies wholly employ panel data models to assess the factors that influence bond markets such the evidence by Cordogno et al. (2003); Schuknecht, von Hagen and Wolswijk (2009, 2011); Manganelli and Wolswijk (2009); Oliveira et al. (2011); Matei and Cheptea (2012) and Poghosyan (2012) reveals. Although the empirical evidence existing in the literature suggests certain links between the real and financial sector, the estimated results are rather heterogeneous with respect to the panels, empirical methods and/or time periods explored.

The present paper contributes more to the first strand of this empirical literature by applying a modern panel approach to the issue of causal linkages between bond market (via a term spread) and economic growth in the case of 14 European non-EMU members.

Based on a recent time horizon 2002-2012, the paper uses panel-base ECM techniques which have two major advantages over the standard fixed effects estimators frequently used in panel data studies. First, the short-run coefficients vary across countries whilst the impact of the long-run factor remains the same. Second, the term spread can deviate from their long-run equilibrium level measuring the extent of this deviation in non-EMU's countries during three periods: the whole period, the pre-crisis period and the global financial crisis period. Furthermore, it permits to evaluate the speed of adjustment of the term spread with respect to the long-run equilibrium level. Therefore, the method employed in the current paper has the advantage to react to two drawbacks of the traditional dynamic panel-data literature: (1) the intercept and slopes parameters can differ across the economies (2) the non-stationarity issue tacked by the bias of the mean-group estimator (Pesaran and Smith, 1995). Furthermore, some empirical models that forecasts output growth based on the term spread provide evidence in favor of structural breaks in data (Stock and Watson, 2002; Estrella, Rodrigues and Schich, 2003). However, theory suggests (Estrella, 2005) that there is a persistent predictive link between the slope and future growth, although the precise parameters may change over time.

The author results suggest evidence in favor of a negative impact of the term spread on economic growth (and vice-versa) in the case of the European non-EMU countries. The author first finding supports the idea that the real economic activity is negatively influenced by the dynamics of the bond markets while the second finding explains *that growth rates negatively influence term spreads*.

The reminder of the paper is structured as follows. In the next section, the author presents our data and the econometric methodology. Section 2 reports the empirical results. Section 3 offers some concluding remarks.

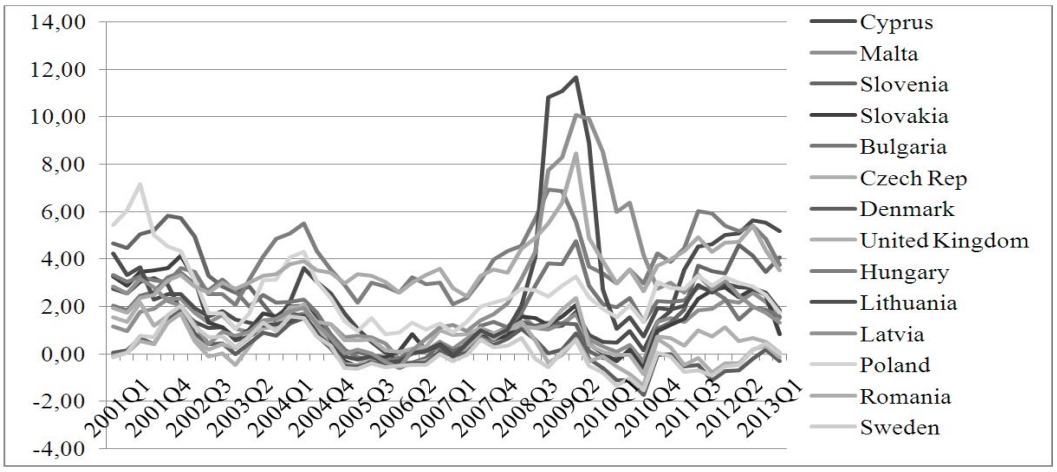
1. Data and econometric methodology

1.1. Data and variables. The data panel includes observations from 14 European non-EMU countries and covers the 2002-2012 period. We take into account all non-EMU countries for which the European Central Bank (ECB) publishes sovereign bond yields, i.e. all non-EMU members except Estonia. Our panel also includes real growth rates from Eurostat database and the euro area yield curve spot rate (one year maturity, accounting for all issuers whose rating is triple A) from Datastream database.

The recent empirical literature shows that variations in the slope of the term structure (commonly measured as the difference between the yield on a long-term treasury bond and a short-term bill rate) provide information about the future economic performance of the economy (e.g., Bernanke, 1990; Harvey, 1989, 1991). The slope of the yield curve is defined as the difference between the long-term yield on 10-year government bond issued by each country in the panel and the short-term yield of euro zone (one-year maturity, no default risk rate). The inclusion of the short-term yield of euro area aims also to capture that euro becomes the "natural anchor" for the European non-EMU countries (Kocenda, Maurel and Schnabl, 2013) after 1999. This choice allows for the comparability between estimated results, too.

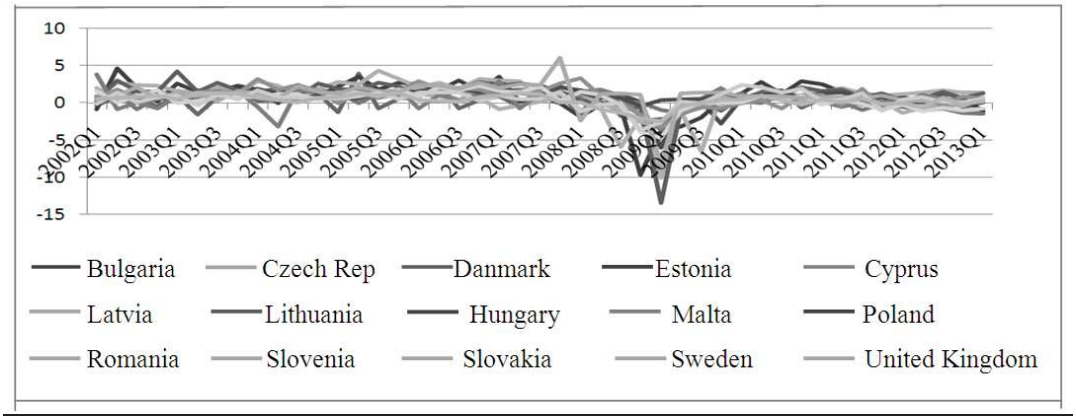
The author employs monthly data on yields provided by the ECB and take quarterly averages. For these countries, the author also employed quarterly data of the GDP growth from 2002 Q1 to 2012 Q4 period to capture the state of the economy. Our panel includes the following non-EMU countries: Bulgaria, Cyprus, Czech Republic, Denmark, Hungary, Lithuania, Latvia, Malta, Poland, Romania, Slovakia, Slovenia, Sweden and the United Kingdom. Some of these countries (Cyprus, Malta, Slovakia and Slovenia) became euro area members after 2008. Because they are not EMU's members on the whole considered period (particularly, during the pre-crisis period), the author included these countries in our sample. Furthermore, most part of these countries are developing countries (Emerging Europe) and only four states are advanced economies (Denmark, Malta, Sweden and the United Kingdom). Therefore, the panel includes countries with diverse stages of economic development and accordingly, with different structures of country's financial system.

Figure 1 displays the quarterly 10-year term spreads for each country in our sample for the whole period. The figures indicate the differences in the bonds behavior before and after the financial crisis of 2008. The imbalances between non-EMU members still persist especially during the recent crisis period reflecting investors' beliefs about market risks. Figure 2 plots the growth rates for non-EMU's members. The figure shows that all economies faced severe growth contractions in early 2009 and slower beginnings to recovery since 2010.



Note: Author's calculations.

Fig. 1. The evolution of the term spread: 2002Q1-2013Q1



Note: Author's calculations.

Fig. 2. The evolution of the growth rates: 2002Q1-2013Q1

1.2. Empirical model. The empirical analysis proposes to disentangle the long-term and the short-term effect of sovereign bond markets on growth (and vice-versa), which may, possibly, bring together two strands of the literature presented previously: the supply channel and respectively, the demand channel. The benchmark models can be written as follows:

$$spread_{it} = \beta_{0i} + \beta_{1t}\, growth_{it} + u_{it}, \quad (1)$$

$$growth_{it} = \beta_{0i} + \beta_{1t}\, spread_{it} + u_{it}, \quad (2)$$

where u_{it} is the error term, β_{0i} and β_{1t} are the constant and the slope coefficients while i and t are country and time period indices. The equations (1) and (2) capture changes in the slope of the term structure $spread_{it}$ (respectively, in growth rate) as a function of real growth, $growth_{it}$ (respectively, of the term spread) and represents benchmark specifications.

To examine the linkages between the term spreads and economic growth, the author first tests for the stationarity of the employed variables by several first – and second – generation panel unit root tests (Levin and Lin, 1993; Maddala and Wu, 1999; Im, Pesaran and Shin, 2003; and Pesaran, 2003). The author finds that the quarterly growth rates and term spreads are stationary only during the whole period and the pre-crisis period. While the considered panel contains combines stationary and non-stationary data, the author can apply a dynamic vector error correction model to our 14 European non-EMU countries to infer the Granger causal linkages between the term spreads $spread_{it}$ and economic growth $growth_{it}$.

The autoregressive distributive lag dynamic specification ARDL (1, 1) associated to the equation (1) can be expressed in the following form:

$$spread_{it} = \delta_{0i} + \delta_{1i}\, growth_{it} + \delta_{2i}\, growth_{i,t-1} + {}_{i,}\, spread_{i,t-1} + u_{it}. \quad (3)$$

By subtracting $spread_{i,t-1}$ from the equation (3), we obtain the relation (4) below:

$$spread_{it} - spread_{i,t-1} = \delta_{0i} + \delta_{1i}\, growth_{it} + \delta_{2i}\, growth_{i,t-1} + {}_{i,}\, spread_{i,t-1} + u_{it} - y_{i,t-1}. \quad (4)$$

Therefore, the error correction re-parameterization (4) takes the form:

$$\Delta\, spread_{it} = \varphi_i (spread_{i,t-1} - \theta_{0i} - \theta_{1i}\, growth_{it})\, \delta_{2i}\, growth_{i,t} + u_{it}, \quad (5)$$

where, $\varphi_i = -(1-i)$, $\theta_{0i} = \delta_{0i}/(1-i)$ and $\theta_{1i} = (\delta_{1i} + \delta_{2i})/(1-i)$. (6)

In the equation (5), the φ_i term is the error correction (speed of adjustment) parameter and term θ_{1i} is the long-run coefficient. The inclusion of the term θ_{0i} allows for a non zero mean of the cointegrating relationship. The author expects a negative sign for the term φ_i meaning that the variables exhibit a return to long-run equilibrium. The author notes that the PMG estimator imposes that long-run coefficients be constant for all countries, but it allows short run heterogeneity. Therefore, the error correction model will be tested can be expressed as:

$$\Delta\, spread_{it} = \varphi_i (spread_{i,t-1} - \theta_{0i} - \theta_{1i}\, growth_{it}) - \delta_{2i}\, growth_{i,t} + u_{it}. \quad (6)$$

Similarly, $\Delta\, growth_{i,t} = \varphi_i (growth_{i,t-1} - \theta_{0i} - \theta_1\, spread_{i\,it}) - \delta_{2i}\, spread_{i,t} + u_{it}$. (7)

The author tests for causality with lag length m (based on AIC information criterion) to examine the direction of causality between the considered variables in both short- and long-run horizon. With respect to the system (6) and (7), we can have the situations:

- unidirectional causality from GDP growth ($growth_{it}$) to the term spread ($spread_{it}$);
- unidirectional causality from the term spread ($spread_{it}$) to growth ($growth_{it}$);
- bi-directional causality between growth ($growth_{it}$) and the term spread ($spread_{it}$);
- no causality between GDP growth ($growth_{it}$) and the term spread ($spread_{it}$).

The long-run relationship between the independent and dependent variables imposes the following condition under the null hypothesis: H_0: $\varphi_i = 0$ for all i. This hypothesis means that there is no long-run stable relationship between independent and dependent variables in the model. The decision rule is that when the error correction term is negative and significant, the null hypothesis of no causality is rejected.

2. Results and discussion

2.1. Unit root test results. The results on the unit root tests for growth and term spreads are presented in Tables 1 and 2. The author observes that these variables appear stationary or nonstationary depending on the unit root tests used and/or the considered time period. This makes possible the estimation of the equations (1) and (2) using a dynamic error-correction model (ECM).

Table 1. Panel unit root results for growth rates

Tests	Period	Statistics	Model without trend	Model with trend	Lags
Panel A: Generation models					
Levin and Lin (1993)	Whole	t_ρ^*	-6.61723*** (0.000)	-5.96119*** (0.000)	1
	Ex-ante	t_ρ^*	-2.73193*** (0.003)	-1.83480*** (0.033)	1
	Ex-post	t_ρ^*	-	-	
Maddala and Wu (1999)	Whole	P_{MW}	94.2726*** (0.000)	79.0362*** (0.000)	1
	Ex-ante	P_{MW}	79.6607*** (0.000)	58.8512*** (0.0006)	1
	Ex-post	P_{MW}	67.8809*** (0.000)	51.7325*** (0.0041)	1
Im, Pesaran, Shin (2003)	Whole	$Z[t\_bar]$	-3.739*** (0.000)	3.982*** (0.000)	1
		$Wtbar$	-9.378*** (0.000)	8.338*** (0.000)	1
	Ex-ante	$Z[t\_bar]$	2.839*** (0.000)	-3.405 (0.000)	
		$Wtbar$	-5.418*** (0.000)	-5.380*** (0.000)	1
	Ex-post	$Z[t\_bar]$	-	-	-
Panel B: Generation models					
Pesaran (2003)	Whole	t_ρ^*	-3.637*** (0.000)	-3.794*** (0.000)	1
		$Z[t\_bar]$	-7.432*** (0.000)	-6.181*** (0.000)	1

Table 1 (cont.). Panel unit root results for growth rates

Tests	Period	Statistics	Model without trend	Model with trend	Lags
	Ex-ante	t_ρ^*	-2.860*** (0.000)	-2.168 (0.729)	1
		Z [*t_bar*]	-4.205*** (0.000)	-3.139*** (0.000)	1
	Ex-post	t_ρ^*	-	-	
		Z [*t_bar*]	-2.724*** (0.000)	-6.604*** (0.000)	1

Note: *p*-values are in parenthesis; ***, **, * mean significant at 1%, 5% and 10% levels; variables in levels "means that panel is unbalanced; only standarized Z [t_bar] statistic are calculated for Pesaran (2003).

Table 2. Panel unit root results for term spread

Tests	Period	Statistics	Model without trend	Model with trend	Lags
Panel A: Generation models					
Levin and Lin (1993)	Whole	t_ρ^*	-3.13011*** (0.0009)	-2.89657*** (0.0019)	1
	Ex-ante	t_ρ^*	-4.13024*** (0.000)	-2.39935*** (0.008)	1
	Ex-post	t_ρ^*	-	-	1
Maddala and Wu (1999)	Whole	P_{MW}	68.410*** (0.000)	48.091*** (0.0105)	1
	Ex-ante	P_{MW}	68.0521*** (0.000)	27.4589 (0.493)	1
	Ex-post	P_{MW}	33.0049 (0.2356)	20.1523 (0.8588)	1
Im, Pesaran and Shin (2003)	Whole	*Z* [*t_bar*]	-2.207*** (0.002)	-2.226 (0.409)	1
		Wtbar	-2.822*** (0.002)	-0.230 (0.409)	1
	Ex-ante	*Z* [*t_bar*]	-2.110*** (0.005)	-2.331*** (0.000)	
		Wtbar	-2.592*** (0.005)	-3.415*** (0.000)	1
	Ex-post	*Z* [*t_bar*]	-	-	-
		Wtbar	-	-	-
Panel B: Generation models					
Pesaran (2003)	Whole	t_ρ^*	-	-	1
		Z [*t_bar*]	-2.451*** (0.007)	-0.478 (0.316)	1
	Ex-ante	t_ρ^*	1.959 (0.233)	-1.753 (0.989)	1
		Z [*t_bar*]	-0.728 (0.233)	2.280 (0.989)	1
	Ex-post	t_ρ^*			
		Z [*t_bar*]	-0.094 (0.537)	-5.875*** (0.000)	1

Note: *p*-values are in parenthesis; ***, **, * represent significant at 1%, 5% and 10% levels; variables in levels "-"means that panel is unbalanced; only standarized Z [t_bar] statistic are calculated for Pesaran (2003) test etc.

2.2. The results on the dynamic specifications ARDL. The results on the dynamic specifications ARDL are given in the Tables 3-4. Three econometric estimation frameworks are generally chosen for the ECM for panel data: pooled mean group (PMG), mean group (MG), and dynamic fixed-effects (DF) estimators. The PMG estimator is an intermediate estimator between the MG and FE estimators allowing the intercept, short-run coefficients and error variances to be different across the groups but constraints the long-run coefficients to be equal across these groups (as the FE estimator). The most restrictive estimator is the DF estimator because it states that all parameters are constant across countries except for the intercept which varies across them. The MG estimator is more general in the sense that it assumes that all short-run and long-run coefficients are different across economies. The author is interested to detect short-run and long-run causal relationships between growth and term spreads among European non-EMU countries by implementing in the paper only the PMG and MG estimators.

Tables 4 and 5 report the results based on the PMG estimator with the long-and short-run parameterestimates for the whole period (column 2), the pre-crisis period (column 3) and the crisis period (column 4). Tables 6 and 7 present results obtained by applying the Mean Group Estimation (MGE – Error Correction Form) for the sample period and sub-sample periods. The author starts the presentation by showing the results in the following tables.

Table 4. PMG model: long-run and short-run estimates (dependent variable, the term spread)

	Whole period	Pre-crisis period	Crisis period
*SEC*_growth	-1.227*** (0.113)	0.120 (0.142)	-0.648*** (0.100)
Bulgaria			
*SEC*_growth	-0.125* (0.072)	-0.097* (0.056)	-0.520** (0.225)
Δ growth	0.056 (0.073)	0.409*** (0.160)	0.131 (0.103)
Constant	0.332 (0.226)	0.028 (0.100)	1.307** (0.569)
Cyprus			
*SEC*_growth	0.104 (0.079)	-0.215** (0.102)	0.017 (0.102)
Δ growth	0.006 (0.137)	-0.010 (0.145)	-0.108 (0.212)
Constant	0.277 (0.188)	0.135 (0.153)	0.228 (0.244)
Czech Rep.			
*SEC*_growth	-0.223*** (0.075)	-0.242** (0.116)	-0.617*** (0.172)
Δ growth	0.273*** (0.111)	0.158 (0.134)	0.318**(0.142)
Constant	0.291** (0.132)	0.033 (0.111)	0.406** (0.172)
Denmark			
*SEC*_growth	-0.102* (0.064)	-0.232** (0.112)	-0.502***(0.200)
Δ growth	0.104* (0.056)	0.020 (0.040)	0.173* (0.103)
constant	-0.010 (0.078)	0.033 (0.085)	-0.268* (0.155)
Hungary			
*SEC*_growth	-0.256*** (0.098)	-0.262* (0.139)	-0.607*** (0.195)
Δ growth	0.036 (0.147)	-0.082 (0.194)	0.138 (0.200)
Constant	1.141*** (0.432)	0.879 (0.458)	2.794*** (0.892)
Latvia			
*SEC*_growth	-0.278*** (0.041)	-0.150 (0.110)	-0.307***(0.089)
Δ growth	0.114** (0.047)	-0.028 (0.072)	0.039 (0.076)
Constant	1.030*** (0.172)	0.879* (0.458)	1.372 (0.462)
Lithuania			
*SEC*_growth	-0.402*** (0.070)	-0.156** (0.073)	-0.380*** (0.138)
Δ growth	0.109 (0.082)	0.024 (0.053)	-0.042 (0.129)
Constant	1.402*** (0.287)	0.037 (0.089)	1.588** (0.678)
Malta			
*SEC*_growth	-0.073 (0.057)	-0.206** (0.094)	-0.135 (0.146)
Δ growth	0.036 (0.048)	-0.008 (0.034)	-0.001 (0.098)
Constant	0.124 (0.115)	0.145 (0.111)	0.255 (0.234)
Poland			
*SEC*_growth	-0.270** (0.119)	-0.258*** (0.094)	-0.608*** (0.225)
Δ growth	-0.055 (0.171)	-0.422** (0.185)	0.304 (0.222)
Constant	0.911** (0.432)	0.434* (0.229)	1.853*** (0.689)
Romania			
*SEC*_growth	-0.274*** (0.107)	-0.589*** (0.174)	-0.601*** (0.210)
Δ growth	0.142 (0.118)	-0.073 (0.075)	0.202 (0.191)
Constant	1.375*** (0.522)	1.763*** (0.550)	2.745*** (0.949)
Slovenia			
*SEC*_growth	-0.118*** (0.045)	-0.151*** (0.039)	-0.033 (0.120)
Δ growth	-0.051 (0.082)	-0.172** (0.085)	-0.088 (0.128)
Constant	0.189 (0.125)	-0.001 (0.095)	0.207 (0.215)
Slovakia			
*SEC*_growth	-0.106** (0.055)	-0.220***(0.089)	-0.115 (0.124)
Δ growth	0.103** (0.049)	0.033 (0.054)	0.071 (0.062)
Constant	0.241 (0.166)	0.069 (0.145)	0.279 (0.238)

Table 4 (cont.). PMG model: long-run and short-run estimates (dependent variable, the term spread)

	Whole period	Pre-crisis period	Crisis period
Sweeden			
*SEC*_growth	-0.073 (0.060)	-0.199** (0.099)	-0.283 (0.181)
Δ growth	0.073 (0.075)	0.096 (0.084)	0.066 (0.110)
Constant	0.019 (0.091)	0.014 (0.090)	-0.080 (0.145)
United Kingdom			
*SEC*_growth	-0.064 (0.067)	-0.316** (0.139)	-0.549** (0.241)
Δ growth	0.061 (0.143)	-0.233 (0.164)	0.246 (0.194)
Constant	0.032 (0.105)	0.219 (0.138)	-0.157 (0.153)
No. obs.	604	350	254
No. groups	14	14	14

Note: EC is the long-run coefficient, SEC is the speed of adjustment, Δ/SR are the short-run dynamics.

In the output, the estimated long-run growth elasticity is significantly negative (at 1% level) only for the whole period and the crisis samples. In the crisis period, the long-run coefficient of the GDP growth is negative and significant, suggesting that faster growing countries pay lower interest rates (there is a negative impact on the term spreads): 1 percentage point higher real GDP growth leads to 65 basis points average decrease in the term spread. Overall, the links between the term spread ($spread_{it}$) and growth ($growth_{it}$) has considerably weakened in non-euro area members in the crisis period.

The speeds of adjustment coefficients are negative and significant only across several countries of the panel in both sub-samples (non-significant in the crisis period for Cyprus, Malta, Slovenia, Slovakia and Sweeden). The existence of a long-run relationship between the term spread and growth rates reflects that the development of non-EMU's bond markets may be endogenously influenced by real economy needs (Coase, 1956). Furthermore, short-run coefficients are not statistically significant in the crisis period in all estimations (except for Denmark and Czech Republic) and differ across countries and periods.

The MG models estimated in Tables 6 and 7 are presented as a two equation model: the normalized cointegration vector and the short-run coefficients. In comparing the PMG and MG models, we note that the estimated long-run growth elasticity is statistically significant at 1% level for all three considered samples. Furthermore, the PMG estimate of the growth elasticity is larger in magnitude than the estimate from the MG model for the whole period (-1.22 for the PMG and -0.71 for the MG estimator). The situation is quite different during the crisis period when the impact is greater for the MG estimator.

The author also performs tests of difference in these models using the Hausman test. The Hausman test favors the PMG model against the MG model for all three considered periods (results upon request). One possible explanation is that although the MG is a consistent estimator, it is not good enough when either *N* or *T* is small (Pesaran and Smith, 1995).

Table 5. PMG model: long-run and short-run estimates (dependent variable, growth)

	Whole period	Pre-crisis period	Crisis period
*EC*_growth	-0.445*** (0.044)	-0.131*** (0.031)	-0.440*** (0.072)
Bulgaria			
*SEC*_growth	-0.827*** (0.150)	-0.922*** (0.189)	-1.176*** (0.236)
Δ growth	0.103 (0.302)	0.354*** (0.138)	0.257 (0.483)
Constant	1.364*** (0.318)	1.600*** (0.321)	1.119** (0.492)
Cyprus			
*SEC*_growth	-0.498*** (0.133)	-1.011*** (0.196)	-0.527*** (0.212)
Δ growth	0.025 (0.156)	0.184 (0.181)	0.257 (0.483)
Constant	0.543*** (0.183)	1.091***(0.234)	1.119** (0.491)
Czech Rep.			
*SEC*_growth	-0.342*** (0.129)	-0.906*** (0.197)	-0.517** (0.244)
Δ growth	0.202 (0.192)	0.145 (0.197)	0.121 (0.290)
Constant	0.310* (0.168)	1.216*** (0.276)	0.066 (0.213)
Denmark			
*SEC*_growth	-1.066*** (0.154)	-1.522*** (0.174)	-0.598*** (0.222)
Δ growth	0.481 (0.371)	0.290 (0.497)	0.501 (0.351)
Constant	0.204 (0.193)	0.762*** (0.222)	-0.168 (0.247)

Table 5 (cont.). PMG model: long-run and short-run estimates (dependent variable, growth)

	Whole period	Pre-crisis period	Crisis period
Hungary			
*SEC*_growth	-0.477*** (0.127)	-0.616*** (0.173)	-0.699*** (0.239)
Δ growth	-0.041 (0.145)	-0.107 (0.164)	-0.150 (0.222)
Constant	0.948*** (0.299)	0.706*** (0.249)	1.250** (0.546)
Latvia			
*SEC*_growth	-1.019*** (0.131)	-0.592*** (0.200)	-1.163*** (0.149)
Δ growth	-1.422*** (0.267)	-0.339 (0.470)	-1.525*** (0.303)
Constant	2.117*** (0.397)	1.231*** (0.482)	2.142*** (0.635)
Lithuania			
*SEC*_growth	-1.097*** (0.130)	-1.064***(0.209)	-1.154*** (0.193)
Δ growth	-0.672*** (0.159)	-0.055 (0.498)	-0.664*** (0.223)
Constant	2.221***(0.383)	2.182*** (0.461)	2.002*** (0.726)
Malta			
*SEC*_growth	-1.016*** (0.138)	-1.215***(0.173)	-0.740*** (0.231)
Δ growth	0.183 (0.416)	0.258 (0.706)	-0.015 (0.523)
Constant	0.904*** (0.237)	1.470*** (0.380)	0.495 (0.349)
Poland			
*SEC*_growth	-0.648*** (0.134)	-0.963*** (0.235)	-0.609*** (0.215)
Δ growth	0.139 (0.123)	0.202 (0.180)	0.278 (0.181)
Constant	1.303*** (0.281)	1.470*** (0.380)	1.079*** (0.419)
Romania			
*SEC*_growth	-0.578*** (0.140)	-0.941***(0.194)	-0.880*** (0.262)
Δ growth	0.064 (0.740)	-0.397 (0.401)	0.278 (0.181)
Constant	1.482*** (0.406)	1.977*** (0.439)	1.079*** (0.419)
Slovenia			
*SEC*_growth	-0.378*** (0.108)	-1.200*** (0.190)	-0.461** (0.204)
Δ growth	-0.371 (0.235)	0.569 (0.240)	-0.042 (0.409)
Constant	0.344* (0.193)	1.608 (0.296)	0.023 (0.309)
Slovakia			
*SEC*_growth	-1.034*** (0.156)	-1.252***(0.191)	-1.102*** (0.241)
Δ growth	0.373 (0.427)	0.368 (0.412)	0.568 (0.777)
Constant	1.649*** (0.377)	2.272*** (0.423)	0.890 (0.588)
Sweeden			
*SEC*_growth	-0.572*** (0.137)	-1.127*** (0.194)	-0.542*** (0.214)
Δ growth	0.278 (0.294)	0.446*(0.277)	0.083 (0.496)
Constant	0.338** (0.173)	0.916*** (0.198)	0.058 (0.312)
United Kingdom			
*SEC*_growth	-0.234*** (0.092)	-0.337 (0.217)	-0.456*** (0.174)
Δ growth	0.117 (0.157)	-0.201 (0.208)	0.361* (0.218)
Constant	0.115 (0.102)	0.236 (0.210)	-0.026 (0.161)
No. obs.	604	350	254
No. groups	14	14	14

Note: EC is the long-run coefficient, SEC is the speed of adjustment, Δ/SR, are the short-run dynamics. The econometric estimation results in which the term spread is the independent variable are presented in Tables 5-7. The estimated long-run spread coefficient is negative and statistically significant (at 1% level) for all three considered samples.

The error correction coefficients (speeds of adjustment) are negative and statistically significant in all cases (except for the UK in the pre-crisis period). This is an important finding because it supports the existence of a long-run cointegrating relationship between growth and term spreads. The fact that bond market changes are found to influence real economic activity may favors the supply-leading view assuming that the creation of financial institutions, bond market developments and accumulation of financial assets may generate economic growth (e.g., Levine, 1997; Arestis and Demetriades, 1997). It also reflects that financial reforms may influence unfavorable economic growth. Furthermore, short-run coefficients are more or less significant and have different signs across countries and periods. Again, in this case the Hausman test favors PMG estimator against the MG estimator.

Table 6. Mean group estimation (MG): error correction form

	Whole period	Pre-crisis period	Crisis period
*EC*_spread	-0.381*** (0.049)	-0.176*** (0.596)	-0.584*** (0.118)
SR			
*SEC*_spread	-0.718*** (0.080)	-1.005 *** (0.075)	-0.803*** (0.073)
Δ spread	-0.048 (0.127)	0.167*** (0.055)	0.048 (0.152)
Constant	1.085*** (0.235)	1.336*** (0.171)	0.906*** (0.306)
No. obs.	604	350	254
No. groups	14	16	14

Note: EC is the long-run coefficient, SEC is the speed of adjustment, Δ/SR are the short-run dynamics; standard error is in parenthesis, * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 7. Mean group estimation (MG): error correction form

	Whole period	Pre-crisis period	Crisis period
*EC*_spread	-0.709*** (0.242)	-0.977*** (0.763)	-1.291*** (0.730)
SR			
*SEC*_spread	-0.267*** (0.027)	-0.244*** (0.033)	-0.482*** (0.077)
Δ spread	-0.042 (0.031)	-0.043*** (0.071)	0.143 (0.369)
Constant	0.587*** (0.166)	0.226*** (0.141)	0.868*** (0.294)
No. obs.	604	350	254
No. groups	14	16	14

Note: EC is the long-run coefficient, SEC is the speed of adjustment, Δ/SR are the short-run dynamics; standard error in parenthesis, * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

3. Robustness checks

Empirical literature pointed out the linear/nonlinear nature of the finance-growth relationship. Most part of the studies like King and Levine (1993a, 1993b), Levine, Loayza and Beck (2000), Loayza and Ranciere (2006) demonstrate the existence of a linear and strong positive link between financial development and economic growth and also that financial development is a good predictor of future economic growth. The linearity assumption is abandoned by other recent studies (as Rioja and Valev, 2004; Deidda and Fattouh, 2002), which suggest that this relationship is nonlinear by imposing an exogenous/endogenous threshold. For example, when pooling countries together in cross-sections, Rioja and Valev(2004) show that the link between finance and growth depends on the stage of economic development: highly and low developed countries are characterized by a weak link, while for developing economies, finance exerts a stronger influence on growth. Their result is nuanced by Kettenni et al. (2007) who demonstrate, by using parametric and non-parametric methods, that the finance-growth relationship is linear when the nonlinearity between initial per capita income, human capital and economic growth is taken into account. One of the advantages of the dynamic panel co-integration framework employed in our study is that it takes into account the controversial issue of country-specific effects (via short-run coefficients) and enables to disentangle the long-term and short-term effects of term spread on growth (and vice-versa). As robustness checks, the author has estimated different panel dynamic specifications by including in the sample only developing economies (Emerging Europe) to ensure the results are not affected by different sample coverage. By doing so, Luliana proposes to test the non-linearity assumption pointed out by Rioja and Valev (2004) which argue that the link between finance and growth depends on the stage of the economic development.

The results of these specifications are presented in Tables 8 to 11. Tables 8 and 10 show results based on the PMG estimator while Tables 10 and 11 report results obtained by applying the MG estimator for all three considered periods. As in the previous section, the tests of difference in these models, the Hausman test, favor the PMG models. Estimation results reported in these tables suggest that the main conclusions remain qualitatively unchanged when the advanced countries are dropped from the sample. One possible explanation behind this result is that the finance-growth relationship seems to be linear. In the previous output, the estimated long-run growth elasticity is significantly negative (at 1% level) only for the whole period and the crisis period (Table 8). Overall, the links between the term spread ($spread_{it}$) and growth ($growth_{it}$) are qualitatively similar with those found in the previous section (Table 4). But, they differ from a quantitative point of view because the impact of growth on the slope of the term structure is more important during the crisis period.

Table 8. PMG model: long-run and short-run estimates (dependent variable, the term spread)

	Whole period	Pre-crisis period	Crisis period
*EC*_growth	-1.320*** (0.120)	0.238 (0.171)	-1.130*** (0.143)
Bulgaria			
*SEC*_growth	-0.113* (0.069)	-0.097* (0.056)	-0.197** (0.173)
Δ growth	0.054 (0.074)	0.404*** (0.160)	0.070 (0.124)
Constant	0.306 (0.223)	0.010 (0.095)	1.514 (0.450)
Cyprus			
*SEC*_growth	-0.109 (0.078)	-0.214** (0.100)	0.001 (0.111)
Δ growth	0.014 (0.138)	-0.022 (0.146)	-0.104 (0.218)
Constant	0.292 (0.190)	0.111 (0.146)	0.259 (0.250)
Czech Rep.			
*SEC*_growth	-0.202*** (0.071)	-0.227** (0.114)	-0.386*** (0.139)
Δ growth	0.269** (0.112)	0.146 (0.136)	0.319** (0.159)
Constant	0.275** (0.132)	-0.005 (0.109)	0.229 (0.163)
Hungary			
*SEC*_growth	-0.242*** (0.095)	-0.277** (0.140)	-0.665*** (0.178)
Δ growth	0.037 (0.147)	-0.100 (0.195)	0.331 (0.206)
Constant	1.091*** (0.424)	0.899** (0.447)	2.931*** (0.791)
Latvia			
*SEC*_growth	-0.269*** (0.039)	-0.112 (0.102)	-0.306*** (0.061)
Δ growth	0.120*** (0.046)	-0.034 (0.073)	0.113* (0.065)
Constant	1.024*** (0.167)	0.045 (0.109)	1.291*** (0.325)
Lithuania			
*SEC*_growth	-0.400*** (0.067)	-0.150** (0.072)	-0.452*** (0.112)
Δ growth	0.126 (0.081)	0.015 (0.054)	0.110 (0.125)
Constant	1.433*** (0.281)	-0.001 (0.086)	1.819** (0.553)
Poland			
*SEC*_growth	-0.254** (0.119)	-0.254*** (0.091)	-0.450** (0.212)
Δ growth	-0.052 (0.174)	-0.436** (0.185)	0.390 (0.248)
Constant	0.876** (0.444)	0.390* (0.216)	1.518** (0.716)
Romania			
*SEC*_growth	-0.241** (0.101)	-0.593*** (0.169)	-0.536*** (0.202)
Δ growth	0.132 (0.118)	-0.108 (0.078)	0.302 (0.218)
Constant	1.232** (0.502)	1.654*** (0.541)	2.395*** (0.895)
Slovenia			
*SEC*_growth	-0.112*** (0.044)	-0.148*** (0.039)	-0.015 (0.100)
Δ growth	-0.049 (0.082)	-0.180** (0.085)	-0.090 (0.134)
Constant	0.183 (0.125)	-0.026 (0.093)	0.185 (0.191)
Slovakia			
*SEC*_growth	-0.096* (0.053)	-0.208** (0.087)	-0.058 (0.089)
Δ growth	0.102** (0.050)	0.022 (0.055)	0.068 (0.068)
Constant	0.228 (0.165)	0.018 (0.140)	0.206 (0.213)
No. obs.	432	250	182
No. groups	10	10	10

Note: EC is the long-run coefficient, SEC is the speed of adjustment, Δ/SR are the short-run dynamics.

The speeds of adjustment coefficients are negative and significant only across several countries of the panel in both sub-samples (non-significant in the pre-crisis period for Cyprus, Slovenia and Slovakia). Short-run coefficients are not statistically significant in the crisis period in all estimations (except for Czech Republic and Latvia) and differ across countries and periods. The MG models (Table 9) show that long-run growth elasticity is statistically significant at 1% level for all three periods. Speed of adjustment coefficients and short-run coefficients appear significant in all three models (except short-run coefficients in the crisis period). In comparing the PMG and MG models, the estimated long-run growth elasticity is significant and larger in magnitude than the estimates of the PMG models.

Table 9. Mean group estimation (MG): error correction form

	Whole period	Pre-crisis period	Crisis period
EC_spread	-3.444 *** (1.245)	-6.615 *** (1.922)	-2.355 *** (0.418)
SR			
*SEC*_spread	-0.304 *** (0.077)	-0.098 (0.096)	-0.509 *** (0.100)
Δ spread	-0.246 ** (0.117)	0.020 *** (0.116)	0.368 (0.131)
Constant	-1.261 *** (0.293)	-1.224 *** (0.271)	-1.316 *** (0.379)
No. obs.	452	250	254
No. groups	10	10	10

Note: EC is the long-run coefficient, SEC is the speed of adjustment, Δ\SR are the short-run dynamics.

The results in which the term spread is the independent variable, are presented in Tables 10 and 11. The estimated long-run spread coefficient is negative and statistically significant (at 1% level) for all three considered samples. Results are consistent with those obtained for all non-EMU countries regarding the qualitatively responses of the long-run coefficients, the error-correction coefficients and the short-run coefficients. The author finds that long-run coefficients of the term spread are negatively related to the growth in real GDP.

Table 10. PMG model: long-run and short-run estimates (dependent variable, growth)

	Whole period	Pre-crisis period	Crisis period
EC_growth	-0.462*** (0.046)	-0.130*** (0.032)	-0.387*** (0.071)
Bulgaria			
*SEC*_growth	-0.830*** (0.150)	-0.922*** (0.189)	-1.145*** (0.232)
Δ growth	0.110 (0.303)	0.353*** (0.138)	0.263 (0.472)
Constant	1.394*** (0.322)	1.603*** (0.321)	0.985** (0.465)
Cyprus			
*SEC*_growth	-0.488*** (0.132)	-1.012*** (0.196)	-0.619*** (0.213)
Δ growth	0.031 (0.157)	0.184 (0.181)	0.092 (0.228)
Constant	0.544*** (0.185)	1.090*** (0.234)	0.330 (0.210)
Czech Rep.			
*SEC*_growth	-0.343*** (0.129)	-0.906***(0.197)	-0.540*** (0.216)
Δ growth	0.205 (0.192)	0.145 (0.197)	0.099 (0.282)
Constant	0.313* (0.169)	1.215*** (0.276)	0.034 (0.204)
Hungary			
*SEC*_growth	-0.478*** (0.127)	-0.617*** (0.173)	-0.664*** (0.231)
Δ growth	-0.036 (0.146)	-0.107 (0.164)	-0.182 (0.221)
Constant	0.982*** (0.308)	0.705*** (0.249)	0.984** (0.479)
Latvia			
*SEC*_growth	-1.029*** (0.131)	-0.592*** (0.200)	-1.145*** (0.171)
Δ growth	-1.418*** (0.267)	-0.339 (0.470)	-1.695*** (0.346)
Constant	2.183*** (0.403)	1.230*** (0.483)	1.558** (0.653)
Lithuania			
*SEC*_growth	-1.103*** (0.131)	-1.064*** (0.209)	-1.129*** (0.187)
Δ growth	-0.661*** (0.160)	-0.055 (0.498)	-0.707*** (0.217)
Constant	2.276*** (0.389)	2.182*** (0.461)	1.651*** (0.673)
Poland			
*SEC*_growth	-0.642*** (0.133)	-0.962*** (0.235)	-0.607*** (0.210)
Δ growth	0.140 (0.123)	0.201 (0.180)	0.260 (0.173)
Constant	1.315*** (0.284)	1.465*** (0.380)	0.992*** (0.384)
Romania			
*SEC*_growth	-0.585*** (0.140)	-0.941*** (0.194)	-0.882*** (0.246)
Δ growth	0.071 (0.192)	-0.397 (0.401)	0.105 (0.220)
Constant	1.538*** (0.417)	1.974*** (0.439)	1.356*** (0.549)
Slovenia			
*SEC*_growth	-0.375*** (0.108)	-1.199*** (0.191)	-0.490*** (0.196)
Δ growth	-0.370 (0.235)	0.058 (0.240)	-0.066 (0.396)
Constant	0.350* (0.194)	1.607 (0.296)	-0.042 (0.296)

Table 10 (cont.). PMG model: long-run and short-run estimates (dependent variable, growth)

	Whole period	Pre-crisis period	Crisis period
Slovakia			
*SEC*_growth	-1.033*** (0.156)	-1.252*** (0.191)	-1.097*** (0.233)
Δ growth	0.381 (0.427)	0.368 (0.412)	0.601 (0.731)
Constant	1.667*** (0.380)	2.270*** (0.423)	0.850 (0.561)
No. obs.	432	250	182
No. groups	10	10	10

Note: EC is the long-run coefficient, SEC is the speed of adjustment, Δ\SR are the short-run dynamics.

Table 11. Mean group estimation (MG): error correction form

	Whole period	Pre-crisis period	Crisis period
*EC*_spread	-6.798** (3.318)	-0.888*** (0.454)	-2.893*** (0.932)
SR			
*SEC*_spread	0.050*** (0.075)	0.224** (0.095)	0.123 (0.084)
Δ spread	-0.024 (0.051)	0.125*** (0.060)	0.020 (0.069)
Constant	-0.388* (0.226)	-0.636*** (0.190)	-0.705** (0.312)
No. obs.	432	250	182
No. groups	10	10	10

Note: EC is the long-run term, SEC is the speed of adjustment, * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Conclusions

This paper examines the dynamic causal linkages between government bond markets and economic growth for 14 European non-EMU countries using recent econometric methods: a dynamic panel ECM model which accounts for heterogeneous country effect. The author estimates the models with quarterly data over the 2002-2012 period. The author provides evidence that (1) the slope of the yield curve is negatively related to the growth in real GDP and (2) the economic growth negatively influence the term spread. In terms of policy implications, this result suggests that financial reforms may have favorable impact on economic growth. As concerns the short-run effects of term spreads on growth or of growth rates on spreads, effects are unclear (positive or negative) and not statistically significant for all non-EMU members.

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